ANNUAL REPORT 2019

भाकृअनुप
ICAR

भा.कृ.अनु.प.-केन्द्रीय बकरी अनुसंधान संस्थान
मखदूम, फरह-281 122, मथुरा (उ.प्र.)

ICAR - CENTRAL INSTITUTE FOR RESEARCH ON GOATS

(AN ISO 9001:2008 CERTIFIED ORGANIZATION)
MAKHDOOM, P.O. FARAH - 281122, MATHURA (U.P.) INDIA

CIRG
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FOREWORD

Annual Report 2019 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 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 directed to newer approaches and accepted methodologies on genetic improvement of goat breeds, reproductive management, reproductive efficiency enhancement, economic feed formulation , farmer centric low cost technologies , climate change studies , effective healthcare and herbal drug /formulation for organic goat farming , suitable to different agro climatic zone of the county, with better economic return to rural and commercial goat farmers of the country.

Institute is committed to bring efficiency in our research environment to develop pro-farmer technology as well as popularizing the goat farming through viable enterprise to improve the goat keeper's income and their nutritional security. Our major focus have been on planned selective breeding to improve the body weight, milk yield in Barbari, Jamunapari and Jakhrana goats. Besides, basic research also carried out on identification of new bio peptide in milk having human health benefit in different goat breed reared in different agro-climatic conditions. Beside, three other important native goat breed as Beetal, Sirohi and Bundelkhandi reared as demonstration unit to show production potential to visiting farmers.

AICRP on goat improvement is coordinated by this Institute has 20 units at different locations across the states with the objective to improve the performance of goats in their natural habitat involving local farmers. Different units under the project have validated traditional and management technologies which have increased their income. This project has given emphasis to the biological attributes of indigenous breeds and need to exploit them for local advantage and future global application.

AI technology is being used as tool for conservation and improvement of breed performance at the farmer's flock and continuously conducting innovative research and intervention to improve deep frozen technology for better conception. Institute is inviting the professional for special skill development and training on Artificial insemination in goats. Institute has conducted the research on stem cell by using spermatogonial cell to new dimension in solving problem of infertility in male.

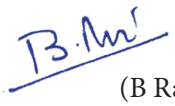
CIRG has worked towards better control of diseases in farmer's fock and thereby increasing farmer's income. Research was being carried on adaptability of goat, effect of climate on production of goat and mitigation approaches for rearing with accepted animal welfare. Health technologies and diagnostics are being developed regularly for the benefit of goat as well as goat keepers. Herbal formulations are being developed for immunomodulation for reducing stress to optimise the physiology and production. Research on feed formulation, agroforestry development, feed storage and complete feed formulation has been successfully tested for growth and milk yield.

The Institute has standardised retort processed technology for preserving meat products without refrigeration and also carrying out research towards nutritional benefits and safety standard of goat meat and milk products. The referral laboratory has awarded NABL accreditation.

Skill development and capacity building of goat farmers is priority programme for all class of stakeholders , considering the high demand among rural youth and progressive farmers. 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. 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. B.N. Tripathy, 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. Ashok Kumar , ADG (Animal Health), Dr. V.K. Saxena ADG (AG & B) ICAR and all other SMD staff, Chairman and members of 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. Ashok Kumar, Dr Ravindra Kumar, Dr. A.K. Dixit, Dr. V. Rajkumar , Dr S P Singh and Dr.Nitika sharma 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



(B Rai)

Director

CONTENTS

2 EXECUTIVE SUMMARY

2.1 GOAT BREED IMPROVEMENT:

Nucleus flock of Barbari goats is maintained under semi-intensive feeding system . The 243 kids were born out of 158 does. Flock growth was 140% and kidding rate was 1.54%. 138 goats (83 male and 55 female) were provided to farmers and other stake holders. Overall mortality of the flock was 2.49%. Averages Age at first service (AFS), weight at first kidding (WFK), age at first kidding (AFK), first kidding interval (FKI) and gestation period (GP) were 406.77±11.2 days, 24.06±0.65 kg, 551±11 days, 298.01±7.15 days and 144.5±0.87 days, respectively. The least squares means of body weight of kids at birth, 3, 6, 9, and 12 month of ages for kids born in year 2019 were 1.80±0.02, 9.05±0.10, 14.02±0.23, 18.86±0.34, 22.69±0.23 kg, respectively. The h^2 estimated of growth traits by animal model was moderate. Least square mean for 90 days milk yield, 140 days milk yield, total lactation yield and lactation length in 2019 were 82.46±1.13, 113.61±2.13, 111.93±2.56 and 146.21±3.24, respectively. There was a significant and consistent improvement in lactation traits from 2015 onwards whereas net improvement in 90D-MY, 140 day-MY, TMY and lactation length over previous year was 32.5, 31.2, 40.2 and 11.4% respectively. The Total milk produced from April 2019 to December 2019 was 11214.4 litres which was ever highest in given period of time. Live weight, dressing % and carcass weight of Barbari male kids under stall feeding at 10 months of age with green fodder were 28.44 kg, 13.18 kg and 49.13. Corresponding values without green fodder were 28.50, 12.91 and 48.88% and difference was non-significant. The population growth of the flocks was 77.93% during the period. The nucleus flock is maintaining 294 breedable does. During the reported period, 141 kids were born from 96 does. Multiple born kids were 62.41%. The kidding rate was 1.47. The overall flock mortality during April 2019 to December 2019 was 5.69% and annual culling rate was 2.25%. Least square means for age at first service, age at first kidding, weight of dam at first kidding and kidding interval were 651.36±13.76 days, 979±28 day's, 36.99±0.98 kg and 225.37±43 days, respectively in 2019. The mean body weights of kids at birth, 3, 6, 9 and 12 months of age were 4.17kg, 10.74kg, 15.51kg, 21.95kg and 25.947kg, respectively. Year, season of birth, type of birth sex and parity of dam had significant affected ($P<0.01$) kid's body weight at different ages. Males had higher body weight than females at all the ages. There was fluctuating growth trend observed over the year with consistent improvement from 2018 onwards. Least squares means of lactation milk yield in 90, 140 days and total milk yield were 84.52±2.08, 117.68±4.16 and 82.35±4.56 liters, respectively. These traits also indicated a consistent improvement in lactation performance traits over the year since 2017 except total lactation yield. The 90day and 140 days milk yield was 9.54 % and 6.93 % higher over the last year (2018) kidding. Year and season of kidding had highly significant ($P<0.01$) effect with high magnitude in all lactation traits. Goats kidding in spring season has more milk yield than those doe's which kidded in autumn season. Parity do has significant effect on milk yield over the years indicating that Ist kidders have significantly lesser milk yield than their counterparts doe's. The effect of type of birth was non-significant on lactation traits. During the year, 82 superior goats were supplied to goat developmental agencies and farmers. During the period 7405.0 litre milk from unit was supplied to GPT.

In Jakhrana Goat , Average milk production in 2019-20 for 30 days (59.67±1.55 liter), 60 days (107.44±2.54 liter), 90 days (147.72±3.66 liter), and 120 days (192.40±5.58 liter) were recorded . Females are selected on the basis of 90 days milk production for selective

breeding. In Muzzafarnagari sheep, The overall means of body weights of lambs at birth, 3, 6, 9 and 12 month age were 3.48±0.02, 15.99±0.14, 24.89±0.21, 30.40±0.24 and 36.60±0.27 kg, respectively during the year 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 141.53±2.54, 87.89±2.95 and 66.70±1.93g under semi-intensive feeding management. The overall average monthly body weights of adult males and females were respectively 54.5 and 43.1 kg.

2.2 GOAT HEALTH MANAGEMENT:

Division of Animal Health caters to the disease diagnostic services besides the round-the-year therapeutic and control measures for the CIRG livestock units. During the reporting period, sero-surveillance studies were carried out in 1060 bio-samples and the major causes of disease outbreak were PPR, Brucellosis, pneumonia, posterior paralysis, malnutrition and weakness based on laboratory tests. For the diagnosis of brucellosis a total of 145 sera samples were subjected to SAT, of which 12.41% were positive for brucellosis, and 85 sera were subjected to iELISA which showed a positivity of 15.29%. Genital swabs were screened for shedding of *Brucella* using OMP31 TaqMan® probe qRT PCR and of the 32 samples tested, 9.38% were positive for *Brucella*. For the screening of *Mycobacterium Avium* Subspecies *Paratuberculosis* (MAP), a total of 294 fecal samples, 39 milk samples and 108 sera samples were screened for MAP from Johne's disease suspected animals across three states viz., Uttar Pradesh, Odisha and Madhya Pradesh using fecal microscopy, fecal IS900 TaqMan® probe real time PCR, milk smear microscopy, milk IS900 TaqMan® probe real time PCR, milk Indirect ELISA, serum iELISA. Indirect detection tests like iELISA revealed more occurrence of MAP in serum (59.26%) followed by milk (53.84%), followed by microscopy (fecal - 30.95%; milk - 10.29%) and PCR (fecal-0.35%; milk-0%). From 16 bio samples, collected from 16 animals (12 goats, 4 sheep), (including blood, semen, liver, lung, kidney tissues, mastitis milk etc.) subjected to microbiological isolation studies, organisms such as *Corynebacterium ovis* (from milk) *Staphylococci* spp. From lung and liver tissues (2), *Streptococci* spp. from lung tissue (1) was isolated. Of 393 faecal samples subjected for parasitological examination, 87.27% were positive for coccidia, 16.79% for strongyles, and 4.32% for Moniezia species.

Quick and early detection of coenurosis was done using serological based diagnostics TM16p-iELISA, which was developed using a 16 amino acid peptide from oncosphere antigen of Taenia multiceps at Animal Health Division. TM16p-iELISA has been standardized and validated with 100 per cent sensitivity and specificity based on ROC analysis. The advantage of this serological technique is excellent specificity cum early detection of coenurosis due to the use of Oncosphere based peptide antigen unique to Taenia multicepsA total of 341 sera samples were subjected to TM16p-iELISA, of which 6.16% were positive for Coenurosis.

Under the study on Enterotoxaemia in goats, novel isolates which are unique with mutations at the ETX gene were identified based on Molecular characterization and phylogenetic analysis. iELISA was developed under this project for detection of protective antibody titer in goats post ET-vaccination. Similarly, Sandwich ELISA (toxin trap ELISA) developed for direct detection of ET from affected animals fecal/ intestinal contents was standardized. Both these ELISA diagnostic tools were validated on-site at CADRAD, ICAR-IVRI, Izatnagar and will be subsequently commercialized.

In another study on zoonotic diseases, the risk factors and human-animal interface were studied for MAP infection in animal herds especially in lactating animals. The incidence rate of MAP was higher by iELISA with sera and milk, but lesser by microscopy (milk, fecal) and by IS900 TaqMan® probe real time PCR, showing the risk factor where immuno compromised individuals exposed to MAP infection could lead to development of Crohn's disease.

IL18 was identified as biomarker for MAP vaccinated animals, while IL1 and IFNγ for chronic MAP infected animals based on the GO-KEGG analysis and WGCNA.

The up-regulation of Calcium signaling (CS) pathway during the early stage of MAP infection, suggests cell invasion and persistence. On-site Validation of DIVA-ELISA kit developed for differentiating infected and vaccinated Johne's disease in domestic animals was conducted at CADRAD, ICAR-IVRI, Izatnagar, Bareilly, which has a specificity value of 100 % and sensitivity of 93.33%.

In the study on antimicrobial resistance INFAAR, ICAR-CIRG centre at the Division of Animal Health has processed 159 bio samples from milk, fecal, nasal origin from all the specified domestic species as per the SOPs for the reporting period. *Staphyloccus aureus and Escherichia coli* has been isolated following the SOPs from the collected bio samples. In the reporting period, 90 samples were collected from Mathura district and 69 samples from Etawah district. In the Quarter-2 (Apr-Jun, 2019), 87 isolates were obtained with 50 confirmed E.coli isolates and 37 S. aureus isolates, and in Quarter-2 (Jul-Sep, 2019), 1 isolate of E.coli and 4 isolates of S. aureus were used for AMR studies, and in the Quarter-3 (Oct-Dec, 2019), 11 isolates with 01 E.coli isolate and 10 S. aureus were obtained and processed further. World antibiotic awareness week celebrated at ICAR-CIRG attended by 22 veterinarians from 9 states under the theme 'Antimicrobial resistance – One Health Perspective' for the benefit of society.

With the aim to select herbal prototype for Kid diarrhoea, diarrheic fecal samples collected from nearby villages and from CIRG farms from goat kids (0-3months). *E. coli* isolates were tested for their pathotypes and antibiotic sensitivity test. 14 plants selected for screening against the multi-drug resistant *E. coli* pathotypes and their Methanolic extracts were used for further clinical trials.

Overall incidence of Cryptosporidium in neonates of different farms at ICAR-CIRG by screening with microscopic methods was 50.0% (76/152). However, a total of 67.1% faecal samples of neonates were found positive when screened with PCR method. Out of 19 dams (of oocyst shedding kids) 17 (89.47 %) were found positive for Cryptosporidium oocysts in faecal smears . Breed-wise observations on prevalenc of Cryptosporidium oocysts revealed that Barbari had higer prevalence than Jamunapari and it was also high as seen in field outbreak. PCR method of screening was found to be more efficient in diagnosis/detection.

Research work on alternative drug development and therapeutics is also being carried out in the division and an oral poly-herbal formulation was successfully developed and field tested against sub-clinical mastitis.

Three technologies-Parachek (A standardized Targeted selected therapy chart), Sanjeevani (polyherbal formulation for the amelioration of weaning stress) and Easy kidder (herbal formulation for the amelioration of weaning stress) were standardized.

2.3: NUTRITION MANAGEMENT:

Economical pellet feed using unconventional protein such cotton seed cake was evaluated in goats.There was an increasing trend in the fat % of milk by replacement of linseed cake with cotton seed cake. Reducing trend in short chain fatty acids and increasing trend of mono unsaturated fatty acids was reported in milk in pellet feeding. Preparation of potato silage was standardized. At laboratory scale silage of potato (*Solanum tuberosum*) and paddy straw (*Oryza sativa*) was prepared in airtight plastic Jar. On the basis of the quality of the prepared silage in the plastic jar, bulk quantity of silage I (Potato (*Solanum tuberosum*) +Paddy (*Oryza sativa*) straw+ DCP) was prepared in the plastic silage bags. This silage was anaerobically fermented for 60 days .

A power operated weeder was designed and developed for weeding in moringa and other similar fodder crops. Average weeding efficiency achieved was 71% with left out weeds within the crop row which is out of the reach of the machine. Field performance testing of power weeder has shown proper cutting of weeds and soil turning without any damage to crop if the crop is sown with uniform row spacing.

Moringa was sown in the area of 15 acres at Ag. Farm section of CIRG . Moringa dry biomass based complete feed was prepared using the mixture of 70% moringa biomass and 30% concentrate (Ground barley 97%, Min. Mix ,2.0% and salt,1.0%) sprinkled with water (5%). The

pellets of 8-10 mm were prepared and stored for feeding of experimental goats. In moringa pellet fed goats , body wt gain was observed higher (16.98kg) than the control (12.44 kg). The growth rate (g/d) was also found higher (125.81) in moringa pellet fed goats than control (92.15). In another trial , performance of poor growing female goats under moringa feeding for 150 days indicated average wt. gain of 7.04 kg and growth rate of 47g/d which seems to be satisfactory and improved . Over the entire period animal are healthy and looking shiny and active.

2.4. THERMAL STRESS AND MITIGATION:

Effect of feeding of *Moringa oleifera* on humid stress in goats was evaluated for a period 153 days on growing female goats of Barbari breed. Animals under moringa fed group were given pellets containing Moringa biomass,87%,Min.mix.2%,Salt1% and Barley grain,10%, which compared with control animals fed on Straw (gram/arhar) adlib + 300g concentrate per animal/ day. Result indicated the moringa feeding has effect on reducing the humid stress in goats as evidenced by no significant change in the values of body weight, blood & biochemical parameters and concentration of HSP 70 between treatment and control group.

2.5 GOAT REPRODUCTION AND ARTIFICIAL INSEMINATION

The effect of addition of different concentrations of catalase in semen diluent on post-thaw quality and conception rate through frozen semen AI technique was studied. The data revealed that the post thaw motility, live sperm count, acrosomal integrity and HOS positive spermatozoa were significantly ($P < 0.05$) higher at 800 U/mL of catalase. A total 10 goats were chosen for frozen semen AI technique and 4 goats (40%) were pregnant by this technique using frozen semen straw with 800 U/mL catalase. The conception rate in control group was 35%. During the period under report, a total of 3616 semen doses of different goat breeds (Jamunapari, Barbari and Jakhrana) were cryopreserved. In two major breeding seasons 64 goats of different breeds (Barbari, Jamunapari, Jakhrana and Bundelkhandi) were inseminated with frozen semen. A total 23 goat conceived by frozen semen AI and 35 kids (19 females and 16 male) were born. The kidding per cent was 35.94%. Besides this, the effects of different concentrations of misoprostol and pyridoxine on sperm functional parameters during cryopreservation of buck semen were studied. The results suggest that addition of 15 µM/ml misoprostol or 4 mM/ml pyridoxine reduced the detrimental effects of cooling on plasma membrane and acrosome integrity during cryopreservation.

In another project, the effects of bone marrow derived mesenchymal stem cells (BMMSCs) transplantation into ovary were studied. The results indicated that the intra-ovarian transplantation of MSCs significantly increases the number follicles and expression of fertility related genes in ovary compared to ovary of the control animals. The expression of pluripotent marker genes on spermatogonial stem cells (SSCs) was studied. The qPCR analysis showed that cultured pSSCs expressed OCT4, NANOG, SOX2 and ID4, but not c-Kit and PPARγ. The conditions for isolation, enrichment and in vitro culture of germ cells were standardized. After enzymatic digestion, the germ cells were enriched by differential plating and percoll density gradient centrifugation methods. The germ cells were then subjected to ALP stating and IHC analysis. Enriched germ cells were found to be positive for ALP stating. The results of IF analyses demonstrated presence of OCT4 and PGP 9.5 markers on germ cells.

During the period under report, the animal trials was conducted in 4 different types of fabricated portable plastic enclosures [PPE-1, PPE-2, PPE-3 and (PPE-4)]. The fabricated PPEs yielded 5.0, 4.9 and 3.4°C higher mean minimum temperature inside the enclosures as against only 1.6°C higher mean minimum temperature inside the kidding shed during extreme winter night hours.

2.6. VALUE ADDED MILK AND MEAT PRODUCTS

In CIRG Barbari goat morning milk proline, leucine and serine were significantly higher while glutamic acid was lower than the evening milk. In the Jakhrana

morning milk alanine, glycine, valine and methionine were significantly lower while tyrosine was significantly higher with respect to the evening milk. Methionine, threonine, lysine and histidine were significantly higher in Barbari milk whereas glutamic acid, valine and tyrosine were higher in the Jakhrana milk samples. Barbari and jakhrana goat milk sample do not have antimicrobial activity against E. coli, S. aureus, S. typhi and L. monocytogenes.

Shelf life study of Goat meat Sausage, Goat meat Kebab, Goat meat LSO+GF+SO (Linseed Oil + Goat Fat + Soybean Oil) Nuggets and Goat meat mini Patties was carried out in retort processing , where these products maintains the nutritive value.

2.7. TECHNOLOGY TRANSFER AT FARMERS DOOR STEP

Three farmers scientists interactions, three health camps, one demonstration on goat milk paneer, three Swachchh Bharat Mission Programmes, three mineral mixture distribution program were conducted and provided advisory services to 32 farmers in the adopted villages. A program on Parthenium awareness week was also conducted in the adopted village. Leaflets on scientific goat farming were distributed among the farmers of adopted village. The schedule for impact assessment was prepared and tested. Under the project, Technological and Livelihood Improvement of Goat Farmers in Uttarakhand, base line survey conducted on 114 goat rearing households (hhs) in Dehradun and Pauri Gharwal districts of Uttarakhand and suggested different intervention to improve the production and health through training programme, clinical camps and awareness programme. Under model goat village, farmers were trained in modern goat practices , financially supported for goat house, provided protection to goat by vaccination and preventive anthelmintic dosing. It's a unique structure for goats in the model village and centre of attraction for many goat keepers in the same as well as nearby villages, who visits the model goat house often and gets motivation to construct similar type of model house for goats.

3 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
- 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 fibre production and value addition of goat products.
- To provide referral and consultancy services on goat production and product technologies.

4 CIRG: AN INTRODUCTION

The Indian Council of Agricultural Research established as 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 at equidistance from two famous places – Mathura (25 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 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 fulfill the mandate 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 0565-2970999. 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 packages of practices technologies; and commercially viable technologies for goat improvement in the country. 20 patents have been filed; thirteen technologies have been commercialized for larger production. Other important technologies such as Value added goat meat and milk products, diagnostics for brucellosis and JD, herbal formulation, intravaginal 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.
- Established germ-plasm resource improvement and conservation centers (multiplier flocks) of Barbari goat breed in fields.
- Analyzed milk composition traits such as protein, fat and SNF in different breeds and association of protein percentage with different allelic combinations.
- Positive genetic improvement trend in body weight at birth, at 3, 6, 9, and 12 month of age in Jamunapari and Barbari goats.
- Significant improvement in milk yield in Jamunapari, Barbari and Jakhrana goats compared to their base population performance.
- Refined semen freezing protocol involving 7.5% (v/v) egg yolk and glycerol 5.4% (v/v) with 100 million sperms/dose of 0.25 ml French mini straw resulted in overall post thaw motility of 50.55%, irrespective of four breeds viz. Jamunapari, Barbari, Jakhrana and Sirohi goats.
- Artificial Insemination (A.I.) with Frozen Semen in 149 goats of different breeds resulted in successful conception in 52 goats with a success rate of 35.32% on actual kidding basis.
- Developed a new method for isolation of mesenchymal stem cell (MSCs) from goat bone marrow.
- 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.
- Enriched goat meat nuggets and goat meat sausages with omega 3 fatty acids.
- Standardized retort processing of goat meat curry and goat milk paneer curry which has non refrigerated shelf life at room temperature.
- 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 highly sensitive indigenous molecular diagnostic tests for Brucellolsis and Johne's disease in goats.
- Developed database repertoire for *Clostridium perfringens* strains prevalent in causing Enterotoxaemia in goats.
- Developed sensitive and specific diagnostic assay (purified toxin based iELISA and peptide based iELISA) for detection of anti-epsilon antibodies in order to assess protective antibody titer against enterotoxaemia post-vaccination.
- Developed Johne's disease vaccine using native strain of JD organism.
- Developed phage-based therapeutic agent against neonatal colibacillosis in goat-kids, three phages viz. *E. coli* Phage/CIRG/11, *E. coli* Phage/CIRG/3 and *E. coli* Phage/CIRG/12 showed highly encouraging lytic activity against pathogenic *E. coli* isolates.
- Developed herbal medicine formulations for diarrhoea, septic wound, acaricide, anthelminitic and stress management.
- Developed prebiotic (Mannan oligosaccharide) and herbal based formulation (IMU-4 bolus) for enhancement of immunity in goat kids.
- Created baseline data on commercial goat farming.
- Developed base-line data from farmers of selected districts of Bihar and Uttar Pradesh for goat meat/ milk value chain analysis in order to improve socio-economic condition of goat rearers, traders, butchers and other stakeholders under ICAR-ILRI collaboration programme.

Following technologies have been commercialized and under commercialization:

Commercialized Technologies :

Alquit® - An eco-parasiticidal product for the control of ecto-parasites *viz* Ticks and Lice in animals has been commercialized to M/S Natural Remedies Private Limited, Bengaluru (Karnataka)

GMIN®- an area specific mineral mixture for Uttar Pradesh commercialized to M/S Girraj Industries, Sirsaganj, U. P.

HEALEX-FR®- An ointment/gel for external injuries, and wounds for animals, commercialized to M/S Girraj Industries, Sirsaganj, U.P.

Diarrionex-HS®- This is an extract base herbal anti-bacterial anti-diarrhoeal powder for management of diarrhea in animals 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.).

Johne's disease Vaccine (Bio JD gel®**)** : This Killed vaccine is developed by using native strain of Mycobacterium avium subspecies paratuberculosis for animals transfer to M/s Biovet, Bangaluru for vaccine production.

IMU-4® Herbal immunomodulatory bolus: This herbal formulation is developed to improve the immunity in animals. This bolus reduces the pregnancy stress and

improves the immunoglobulins in pregnant dam and colostrum quality to protection for neonatal infection. This product was developed under ICAR-AINP on 'neonatal mortality in farm animals' project. This product is commercialized and available in Indian market by Brands Name of "IMU-4" Bolus by M/S Girraj Industries, Sirsaganj, U. P.

Wormolex® bolus and liquid (Herbal anthelmintic bolus) : Herbal dewormer in bolus and liquid form , commercialized by M/S Girraj Industries, Sirsaganj, U. P.

Meggatex® Herbal acaricidal liquid : This formulation effectively eliminates 90-100% ticks/lice in naturally infected animals in single topical application. This drug is commercialized by M/S Girraj Industries, Sirsaganj, U. P.

Semen freezing technology and Artificial insemination in goats: Goat Semen Diluent Composition (TCFEYG) and Cryopreservation Protocol technology transferred to M/S Aegipan Animal Biocare Pvt. Ltd. Hooghly, West Bengal India

Under Commercialization

BRUCHEK: A Dot-ELISA Kit for detaction of brucellosis in goats and Sheep

Diagnosis of para tuberculosis ELISA KIT (Serum and Milk)

Stressol-G: An Herbal Antistress Formulation

Helmokil: Herbal anthelminitic bolus

IMU-4 : Herbal immunomodulatory bolus

Ectofree : Herbal Acaricidal liquid / Sprey

Intra vaginal pessaries for oestrus synchronization in goats.

Goat meat Pickle

Goat meat Nuggets

Herbal Goat meat Nuggets

Goat meat Sausage

Goat meat Patties

Meat Shami Kebab

Meat Murukku

Meat Nimkee

Meat/Milk Biscuits

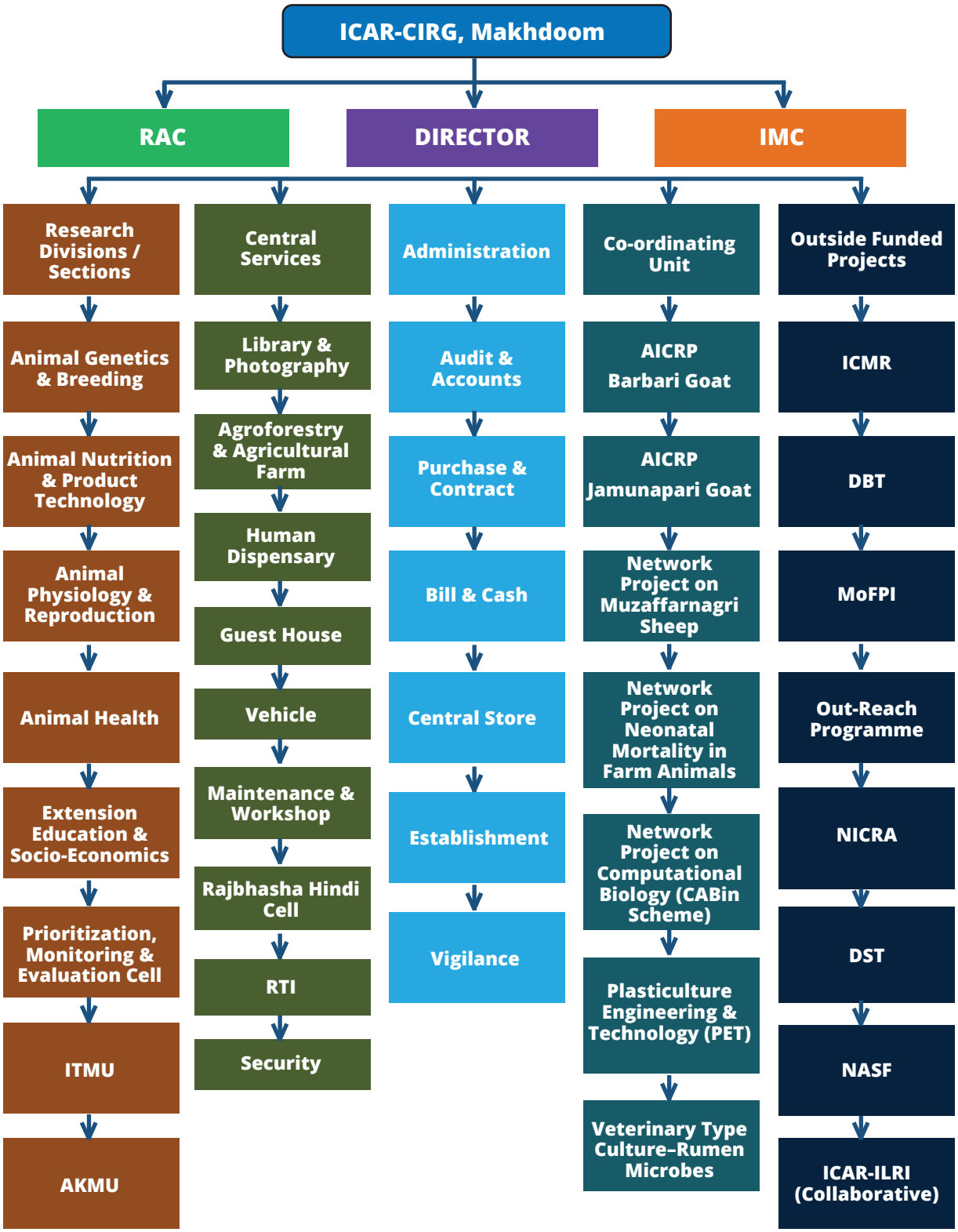
Goat Feeders for Better Feed Utilization

Pelleted Complete Feed Technologies for Sustainable Goat Production under intensive feeding system

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).
- NRDC National Societal Innovation Award, 2014 and 2018
- ICAR–Rafi Ahmad Kidwai Award- 2016.
- VASVIK Industrial Award 2019 by IARI, New Delhi.
- Rajbhasha Gaurav Award (2015) to Dr. D K Sharma to his book Bakri-Bhed Rog: Chikitsa Avam Prabandhan.by Rajbhasha Vibhag Govt of India (Bestow by President of India) on 14 sept 2016
- International Endeavour award-2018 by Government of Australia.

5 ORGANIZATIONAL SETUP



6 GENETIC IMPROVEMENT IN GOAT AND SHEEP

6.1 GENETIC IMPROVEMENT IN JAMUNAPARI GOAT

Fig1. Jamunapari Goat Flock

Jamunapari goat is one of the largest goat breeds of India, and is known for milk production in the subcontinent. These goats are also known as "Pari" in its home tract due to its majestic appearance. The natural habitat of this breed is ravine locked Chakarnagar block of Etawah district in Uttar Pradesh. These goats are more adapted to vegetation shrubs and trees and perform well under similar semi-arid agro-climate conditions.

6.1.1 Flock statistics

The opening balance of the nucleus flock was 614 and closing balance was 603. During the period 141 kids were born, in which 77 were males and 64 were females. The goats sold and disposed off were 82 and 73 (Table 1). The population growth in the flocks was 77.93% during the year (Table 2).

Fig2. Jamunapari Goat Male

6.1.2 Breeding and Reproductive performance

The breeding efficiency and kidding efficiency on the basis of doe tupped were 92 and 133% respectively. The litter size was 1.45 (Table 3). The least squares means for age at first service, age at first kidding, weight of dam at first kidding and kidding interval were 651.36±13.76, 979± 28 days, 36.99±0.98 and 225.37±43, respectively, showing slightly improvement over the years (Table 4 and 5). The year, season of birth had significant effect (P<0.05) on age at first kidding. The overall least squares mean of 1st, 2nd and 3rd kidding interval were 365.039, 361.723 and 342.567, respectively (Table 4 and 5). Year, season and type of birth had significantly affected age at first kidding. Female born in season-I (spring) had low age at first as multiples also have higher age at first kidding. Female born as multiples also have higher age at first kidding. During this year, a total of 96 does kidded 141 kids, out of which single, twin and triplet born kids were 53, 41 and 02 respectively..

6.1.3 Growth performance of kids under semi-intensive management system

The least squares means of body weights of kids at birth, 3, 6, 9 and 12 months of age during the year were 4.17kg, 10.74kg, 15.51kg, 21.95kg and 25.95kg, respectively (table.6). Year, season of birth, type of birth sex and Parity of dam had significant effect (P<0.01) on kid's body weight, 3 month, 9 month and 12 month of age. However, season of birth and parity of dam had no significant effect on 6 month body weight. Males had higher body weight than females at all the ages. Kids born in spring season had significantly higher birth weight. However, kids born in autumn season attained significantly higher 9 and 12-month body weight as compared to those which born in spring season. Kids born as multiple had significantly lower weight as compare to those which born as multiple however, weight gain was higher in multiple born kids as compared to single born kids.

6.1.4 Growth performance of male under intensive management system

The 66 Jamunapari male kids at 3 months of age were put under intensive feeding management under which they were provided adlib concentrate feed, green fodder and fry fodder. The least squares mean of these male kids at 3, 6, 9 and 12 month 14.23± 0.27, 20.09 ± 0.40, 29.52± 0.59 and 36.34 ± 0.70 kg respectively (table 7).

Selection differential

The selection differential for 9 months body weight was 13.92 kg and dam milk yield at 90 was 8.59 litre (table 8).

6.1.5 Lactation performance of Jamunapari goats

The overall Least squares means of part lactation milk yield in 90 days, 140 days and total milk yield were 84.52±2.08, 117.69±4.16 and 82.35±4.56 liters, respectively during reported period (table 9). Year of kidding had significant (P<0.01) influence on all the lactation traits. The 90day and 140days milk yield was 9.54% and 6.93 % higher over the previous year performance (2018). Parity had significant effect on milk yield over the years and no consistent trend observed over lactation order however maximum lactation yield was obtained from 2nd to 5th parity. The season of kidding had highly significant (P<0.01) effect on all lactation traits. Goat kidded in spring season yielded higher milk yield than those which kidded in autumn season (table 9). Lactation performance show fluctuating trend over the year might be attributed to use of different set of sires and environmental factors. The effect of type of birth was non-significant on lactation traits.

6.1.6 Mortality status in flock:

The overall mortality of the flock during the period was 5.69% and annual culling rate was 2.25 % (table 10). The incidence of mortality was 3.41, 2.63, 2.17 and 1.15% in 0-3, 3-6, 6-9 and 9-12-month age groups respectively (Table 10). By and large slightly declining trend in mortality rate was observed over the years from 2015-16 (table 11).

6.1.7 Superior goats supplied and revenue generation

During the reported period 34 bucks and 48 does were provided for breed improvement to farmers and various livestock developmental agencies for genetic improvement in the field conditions (table 12). During the reported period 7405.0 litre milk from unit was supplied to GPT for sale and processing. The revenue generated for the flock during reported period was Rs. 7,50,081 through sale of milk, sale of goats, culling of animals etc. (table-13).

Table 1: Flock Statistics of Jamunapari Unit

Age group	Opening balance	Addition			Reduction							Closing balance
		Birth	Draft	Total	Died	Sale	Culling	Transfer	Slaughter	Draft	total	
Male												
0-1 M	68	77	-	145	2	-		-	-	141	143	02
1-3 M	05	-	141	146	3	-		-	-	130	133	13
3-6 M	68	-	130	198	5	1		-	-	147	153	45
6-12 M	01	-	281	282	5	7	1	-	-	195	208	74
Adult	39	-	61	100	5	26	2	-	2	-	35	65
Total	181	77	613	871	20	34	3	0	2	613	672	199
Female												
0-1 M	58	64	-	122	02	-	-	-	-	117	119	03
1-3 M	01	-	117	118	02	-	-	-	-	108	110	08
3-6 M	74	-	108	182	05	-	-	06	-	135	140	42
6-12 M	06	-	255	261	04	02	-	02	-	190	202	59
Adult	294	-	70	364	10	46	14	-	-	-	72	292
Total	433	64	550	1047	23	48	14	08	-	550	643	404
Grand total	**614**	**141**	**1163**	**1918**	**46**	**82**	**17**	**08**	**2**	**1163**	**1315**	**603**

Table -2: Population Growth (%) of Jamunapari Flock

Year	Initial Adult Doe (A)	No of Kids born (B)	Total (A+B)=C	No of Kids died (D)	Population Growth (%) (B-D/AX100)
2015 – 2016	294	294	588	32	89.11
2016 – 2017	282	264	546	26	84.39
2017-2018	261	262	523	44	83.52
2018-2019	284	284	568	26	90.84
2019	294 (145)	141	286	28	77.93

Table 3: Breeding Performance in Barbari Goats over the year

S.N.	Particulars	2015-16	2016-17	2017-18	2018-19	2019-20
`1	No. of available does for breeding(X)	294	282	261	284	294
2	No. of does bred (Y)	276	274	240	248	258
3	Tupping % (Yx100)/X)	93.88	97.16	91.95	87.3	87.5
4	Does Died /sold/ culled between breeding and kidding	31	27	44	08	41
5.	No. of does available during kidding of those available for breeding (A)	245	262	217	232	253
6	Tupped does available at kidding (B)	230	247	192	209	204
7	Does kidded	213	196	191	209	97
	Single (C)	133	130	123	135	53
	Twin (D)	79	64	65	73	41
	Triplet (E)	01	02	03	01	02
8	No. of abortion (G)	04	15	-	-	
9	No. of still birth (H)	02	01	01	-	
10	Actual live birth (I)	294	264	262	284	141
11	Breeding efficiency on does available (%)	89.39	83.92	88.01	73.59	97/177=55
	Breeding efficiency on does tupped (%)	95.22	86.63	99.47	84.27	97/106=92

S.N.	Particulars	2015-16	2016-17	2017-18	2018-19	2019-20
12	Kidding (%) on does available	120	103.53	120.73	100.00	79.7
	Kidding (%) does tupped	127.83	106.88	136.45	122.4	133
13	Kidding rate (litter size)	1.38	1.35	1.36	1.36	1.45

Table 4: Least squares means of age at first kidding (kg) in jamunapari goats

Factor	Reproductive Traits		
	Age at first service	Age at first kidding	Weight of dam at kidding
Year	**	**	**
2014	724.49±18.51^{a} (66)	1045.11± 27.97^{a} (65)	34.65±0.63^{a} (59)
2015	653.92±18.51^{b} (37)	1047.31 ± 37.43^{a} (35)	31.91±0.95^{a}(97)
2016	643.00±13.70^{b} (76)	894.21 ± 27.10^{b} (76)	34.10±0.62^{a} (38)
2017	669.75±13.95^{b}(68)	974.64 ± 28.24^{b} (64)	36.87±0.56^{b} (85)
2018	674.13±14.78^{b} (58)	991.26 ± 29.57^{b} (56)	36.99±0.98^{b} (108)
2019	651.36±13.76^{b} (68)	979.47 ± 28.83^{b} (61)	36.73±0.75^{cb} (35)
Season of birth	**		
1st	669.04±7.39^{a} (264)	917.36± 14.93^{a} (254)	34.66±0.39^{a} (275)
2nd	669.85±11.26^{a} (109)	1059.36±22.79^{b}(103)	35.75±0.49^{a} (147)
Type of birth	*	**	
Single	670.34±7.63^{a} (255)	963.42± 15.53^{a} (242)	34.16±0.40^{a} (230)
Twins	668.55±10.59^{a} (118)	1013.92±21.10^{a}(115)	36.25±0.44^{b} (192)

**P<0.01, *P<0.05

Table 5: Least squares means of kidding interval in jamunapari goats

Factor	KIDDING INTERVAL		
Year	**Kidding interval-I**	**Kidding interval-II**	**Kidding interval-III**
Overall	365.04±12.00(203)	361.70±13.70(113)	342.57±19.92(66)
	**	**	**
2014	355.62±18.12^{a}(53)	404.50±33.32^{a}(17)	-
2015	471.83±23.22^{b}(22)	405.07±25.60^{a}(21)	363.13±38.65^{a}(9)
2016	352.95±19.27^{c}(49)	381.63±25.81^{a}(24)	415.31±23.30^{a}(22)
2017	398.83±19.46^{c}(44)	409.20±24.01^{a}(26)	380.81±25.01^{a}(21)
2018	385.63±23.90^{c}(27)	352.05±28.04^{a}(20)	345.47±31.58^{a}(12)
2019	225.37±43.64^{d}(8)	217.90±55.92^{a}(5)	208.13±77.77^{b}(2)
Season of birth			
Season I	384.70±12.57(144)	372.47±19.12(49)	368.26±26.54(23)
Season II	345.38±18.51(59)	350.98±18.97(64)	316.88±24.26(43)
Type of birth			
Single	370.55±12.70(141)	358.47±16.23(69)	354.25±20.39(44)
Twins	359.53±17.47(62)	364.98±20.07(44)	330.88±27.81(22)

**P<0.01, P<0.05

Table 6: Least squares means of body weight (kg) in Jamunapari goats at different ages

Factor	Body weight at different ages				
Overall Mean	**Birth**	**3M**	**6M**	**9M**	**12M**
	3.38±0.04(1582)	**11.02±0.14(1433)**	**15.03 ±0.24(1255)**	**20.38±0.33(1176)**	**25.27±0.44(959)**
Year of birth	**	**	**	**	**
2014	3.28±0.05^{a}(337)	11.72±0.17^{a} (297)	15.73 ±0.25^{a}(285)	20.07±0.40^{a}(282)	25.37±0.50^{a}(274)

Factor	Body weight at different ages				
2015	3.24±0.05^{a}(294)	12.59±0.18^{b}(265)	17.31 ±0.26^{b}(245)	22.19±0.41^{b}(245)	27.49±0.52^{b}(225)
2016	3.18±0.05^{a}(264)	11.00±0.17^{c}(255)	15.12 ±0.25^{ca}(250)	19.61±0.39^{ca}(240)	23.84±0.49^{c}(222)
2017	2.93±0.05^{b}(262)	10.03±0.18^{d}(227)	13.48 ±0.27^{d}(187)	17.93±0.45^{d}(150)	22.89±0.61^{dc}(106)
2018	3.49±0.05^{c}(284)	11.03±0.18^{e}(281)	15.60 ± 0.26^{ea}(275)	22.11±0.41^{eb}(259)	**26.80±0.60^{e}(132)**
2019	**4.17±0.06^{d}(141)**	**10.77±0.23^{e} (108)**	**12.95±0.76^{f} (13)**		
Season of birth	**	**	*		
1	3.45±0.04(663)	11.20±0.16(613)	14.89 ±0.25(590)	19.93±0.36(550)	24.92±0.49(401)
2	3.31±0.04(919)	10.84±0.14(820)	15.18 ±0.25(665)	20.83±0.35(626)	25.61±0.46(558)
Sex of kid	**	**	**	**	**
Male	3.544±0.04(774)	11.35±0.15(666)	15.79±0.25(567)	21.912±0.35(532)	27.19±0.48(401)
Female	3.220±0.04(808)	10.70±0.15(767)	14.27±0.25(688)	18.849±0.34(644)	23.34±0.45(558)
Type of birth	**	**	**		
1	3.89±0.03(690)	11.96±0.09(627)	15.72±0.17(563)	20.742±0.21(523)	25.38±0.26(420)
2	3.34±0.03(862)	10.67±0.08(782)	14.50±0.16(672)	19.443±0.18(634)	23.94±0.23(526)
3	2.92±0.10(30)	10.44±0.39(24)	14.87±0.60(20)	20.957±0.93(19)	26.48±0.26(13)
Parity	**	**	* *	*	
1	3.17±0.04(422)	10.65±0.16(378)	14.67±0.27(335)	19.25±0.38(310)	23.69±0.52(218)
2	3.34±0.04(355)	11.08±0.16(327)	15.08±0.27(282)	20.08±0.40(262)	24.88±0.52(211)
3	3.31±0.05(271)	11.06±0.17(234)	15.19±0.28(205)	20.63±0.41(199)	25.24±0.51(177)
4	3.33±0.05(208)	11.07±0.19(185)	15.13±0.31(157)	20.40±0.46(149)	24.93±0.58(137)
5	3.48±0.06(158)	11.32±0.21(152)	15.15±0.32(140)	20.45±0.48(128)	25.20±0.62(109)
6	3.55±0.06(100)	11.08±0.25(91)	14.91±0.37(79)	20.15±0.55(75)	25.40±0.70(64)
Parity ≥7	3.44±0.10(45)	10.91±0.27(66)	15.10±0.41(57)	21.71±0.62(53)	27.51±0.78(43)
P<0.01, *P<0.05					

Table 7: Least squares means at different ages in feedlot (Intensive Feeding)

	3 Month	6 Month	9 Month	12 Month
Mean weight	14.23± 0.27	20.09 ± 0.40	29.52± 0.59	36.34 ± 0.70
Range	(9.7 – 16.0)	(13.2 – 23.0)	(23.2 – 39.5)	(30.6 - 45.5)

Table 8: Selection differential of Selected buck

Traits	Population mean	Selected Sire Mean	Selection differential
9 M bodyweight	21.95 kg (259)	34.68 (28)	12.73 Kg
90 d-Dam's Milk Yield	77.15 lit (128)	84.60 (28)	7.45 Litre

Table 9: Lactation Performance of Jamunapari Goats

Factor	90d milk yield (L)	140dmilk yield (L)	Total milk yield (L)	Lactation length (d)
Overall Mean	76.02±0.97(1060)	108.35±1.53(850)	94.68 ±1.79(1211)	143.25±1.94(1211)
Year	**	**	**	*
2014	78.62±1.53^{a}(255)	111.68±2.13^{a}(226)	107.14±3.15^{a}(270)	156.26±3.42^{a}(270)
2015	71.25±1.87^{b}(161)	100.39±2.53^{b}(151)	98.39±3.67^{ba}(189)	164.61±3.97^{a}(189)
2016	70.81±1.65^{cb}(212)	103.70±2.30^{b}(189)	99.28±3.22^{ba}(250)	157.35±3.49^{a}(250)
2017	73.74±1.93^{cb}(163)	106.63±2.79^{b}(131)	90.26±3.54^{cb}(213)	138.63±3.84^{b}(213)
2018	77.16±2.18^{cb}(128)	110.05±3.31^{b}(95)	91.69±4.21^{cb}(158)	130.93±4.56^{c}(158)
2019	84.52±2.08^{da}(141)	117.69±4.16^{cb}(58)	81.35±4.56^{db}(131)	111.73±4.94^{d}(131)

Factor	90d milk yield (L)	140dmilk yield (L)	Total milk yield (L)	Lactation length (d)
Season of Birth	*			
Season-1	80.87±1.28^{a}(555)	113.30±1.91^{a}(466)	102.69±2.49^{a}(622)	150.02±2.69^{a}(622)
Season- 2	71.17±1.17^{b}(505)	103.41±1.86^{b}(384)	86.68±2.25^{b}(589)	136.49±2.44^{b}(589)
Type of birth				
Single	76.90±1.19(622)	109.63±1.79(505)	94.56±2.23(721)	142.50±2.41(721)
Twin	75.13±1.23(438)	107.08±1.90(345)	94.81±2.40(490)	144.01±2.59(490)
Parity	*	*	*	
Parity-1	70.10±1.34^{a}(323)	99.82±1.92^{a}(266)	98.75±2.77^{a}(356)	159.55±3.00^{a}(356)
Parity 2	78.09±1.41^{b}(264)	108.40±2.06^{b}(214)	107.83±3.00^{ba}(274)	161.39±3.25^{ba}(274)
Parity 3	80.47±1.73^{b}(176)	113.09±2.51^{cb}(142)	108.76±3.59^{ba}(191)	157.01±3.89^{ba}(191)
Parity 4	80.78±2.05^{cb}(126)	117.25±3.01^{cb}(101)	101.48±4.00^{ba}(155)	148.21±4.33^{ba}(155)
Parity 5	75.82±2.40^{c}(93)	112.56±3.61^{cb}(69)	94.11±4.69^{ba}(113)	141.07±5.08^{ca}(113)
Parity 6	81.69±3.41^{cb}(45)	112.07±4.89^{cb}(36)	85.99±6.11^{c}(66)	128.02±6.61^{d}(66)
Parity ≥7	65.17±3.98^{da}(33)	95.29±6.27^{dc}(22)	65.88±6.59^{dc}(56)	107.52±7.14^{ed}(56)

Table 10: Age-wise mortality during April to December 2019

Particulars	0-3 M	3-6 M	6-9 M	6-12 M	Adult	Overall
Animals available	264	380	283	260	464	755
Animals died	09	10	06	03	15	43
Mortality (%)	3.41	2.63	2.12	1.15	3.23	5.69

Table 11: Age-wise mortality during different years

Particulars	2015-16	2016-17	2017-18	2018-19	2019
Flock Strength	1041	983	960	860	755
Goats Died	63	56	82	53	43
Mortality (%)	6.05	5.69	8.54	6.16	5.69

Table 12: Goats supplied for breed improvement

Year	Males	Females	Total
2015-16	123	82	205
2016-17	111	43	154
2017-18	90	79`	169
2018-19	38	15	53
2019 (April-December)	34	48	82

Table 13: Total Milk Production over the year

Year	Total Milk Production (Litre)
2015-16	9771.9
2016-17	13079.0
2017-18	10500.0
2018-19	9426.2
2019 (April-December)	**7405.0**

Table 14: Details of receipt for 2019 (April-December)

Receipt	Income Rupees
Improved animal	Rs. 526550
Milk Production /sale	Rs. 148100
Culled animals	Rs. 59431
Slaughter	Rs. 16000
Total	**Rs. 750081**

(AICRP (G): Improvement and sire evaluation of Jamunapari goats for milk production
(Dr. M S Dige ,M K Singh , P K Rout, Gopal Dass, R Pourouchottamane, V Kumar)

6.2 GENETIC IMPROVEMENT OF BARBARI GOAT

Barbari breed of goat has attained special significance among progressive goat farmers due to higher weight gain, prolificacy, reproductive efficiency, sufficient milk to nourish their kids and most importantly suitability under stall feeding/intensive feeding and semi-intensive feeding. Nucleus flock of these goats is maintained under semi-intensive feeding system from 1983 as Institute flock and from 1993 under AICRP on Goat Improvement (fig.3&4). The opening and closing balance of flock was 638 and 644 on Ist April 2019 and 31st December 2019. The 243 kids were born out of 158 does. Flock growth was 140% and kidding rate was 1.54%. 138 goats (83 male and 55 female) were provided to farmers and other stake holders.

Fig 3 : Barbari Male and Female

6.2.2 Reproductive performance:

Least squares means for age at first service, first kidding, weight at first kidding, gestation period and first kidding interval for 2019 were 406.77±11.23 days, 551.27±11.22 days, 24.06±0.65 kg, 144.50±0.87days and144.50±0.87days, respectively (table-15&16). Females born in spring season and as single have significantly less age at first kidding and kidding interval than their counterparts. There have been gradual increase in weight at first kidding and decrease in kidding interval indicating significant improvement in these traits. Tupping percentage of goats was 71.8%, whereas 52.5% goats deliver multiple births and kids born as multiples were 69%. Breeding and kidding efficiency on the basis of tupped were 76.33 and 117.4%, respectively and kidding % on the basis of does available and doe's tupped were 95.15 and 115.5% respectively. The kidding rate was 1.54.

Fig 4 : Flock of Barbari goat

6.2.3 Growth performance (body weights)

The data on body weight at birth, 3, 6, 9, and 12 month of ages recorded from 2015 to 2019 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 born during 2019 at birth, 3, 6, 9, and 12 month of ages for the kids were 1.80±0.02, 9.05±0.10, 14.02±0.22 and 18.86±0.34 kg, respectively (Table-17). Single born kids were significantly heavier than those born as multiple and maintained superiority for body weight 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. The body weight of Barbari kids is showing improvement over the years however magnitude of difference was quite low. The estimates of heritability (h^2) for body weight of kids at different ages were moderate in this flock.

6.2.4 Milk yield performance:

The data on lactation performance of does kidded during 2015 to 2019 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 and lactation length were 60.75±0.85, 82.55±1.29, 77.32±1.45 litre and 134.87 ± 1.82 days, respectively. Corresponding values of goats kidding in 2019 were 82.46±1.13, 113.61±2.13, 111.93±2.58 and 146.21±3.24 days, respectively (Table-18). There was a significant and consistent improvement in lactation traits from 2015 onwards whereas net improvement in 90D-MY, 140 day-MY, TMY and lactation length over previous year (2018) was 32.5, 31.2, 40.2 and 11.4% respectively. Goats kidded in spring produced significantly higher milk yield than those which kidded in autumn season. Goats in their Ist parity produced low milk yield than 2nd parity onwards might be due to lesser developed mammary system. The selection differential for 9 months body weight was 6.73 kg and dam's 90 days milk yield was 8.83 liters (Table-19). The total milk production during 2019 of unit was 11214.4 from 158 kidding's.

Mortality rate

The overall mortality and culling was 2.49 and 3.86% (Table-20). The major causes of death were diseases of Gastro-Intestinal System (Enteritis, diarrhoea, acidosis), Respiratory System (Pneumonia), Systemic Disorder like Septicaemia, Toxaemia Peritonitis and parasitic diseases.

6.2.5 Germ-plasm supplied and revenue generated

During the year 138 superior goats (83 male and 55 female) were supplied for breed improvement and conservation of Barbari goats and popularization of commercial and livelihood goat models among farmers. (Table-21). A sum of Rupees 2322898 was generated through sale of milk and animals of Barbari goat breed.

6.2.6 Technology/management practices development:

10 male were divided in two groups with 05 males in each group at 4 months of age to evaluate growth performance exclusively on dry fodder and concentrate mixture i.e. without green fodder in one group and with green fodder, dry fodder and concentrate in another group to study growth performance with the objective to develop feeding package for rain-fed regions and broiler goat production. Live weight, dressing % and carcass weight of Barbari male kids under stall feeding at 10 months of age with green fodder were 28.44 kg, 13.18 kg and 49.13. Corresponding values without green fodder were 28.50, 12.91 and 48.88% and difference was non-significant. Results indicated that performance of kids maintained without green fodder were significantly not different than those which offered green fodder (Table-22). Thus Barbari goats could be reared for commercial meat production on stall feeding in rain-fed regions of India and also suitable for broiler production.

6.2.7 Multiplier flock establishment :

Multiplier Flock Establishment for genetic improvement, conservation promoting scientific goat farming, Multi-location testing of Barbari breed across states and popularization of livelihood and business models (fig.6). There were 42 multiplier flocks of Barbari goats were established through providing pure-bred Barbari goat unit with 12-16 animals besides technical support from time to time. These flocks were established in UP, Haryana, Uttarakhand. Multiplier flocks have been playing important role in the development business model, livelihood models, conservation model and dissemination scientific goat farming practices, innovative management and Rajasthan, Bihar, marketing of goat, backward and forward linkage besides conservation of Barbari breed (fig.5). Mr. Radhey Shyam one of multiplier flock owner based at Karnal received prestigious **breed conservation award** by ICAR-NBAGR, Karnal in 2019. The kidding rate at such farms varied from 1.3 to 1.7 and

Fig : Multiplier Flock at Farah Mathura

Fig 5 : Multiplier Flock at Patna Bihar

mortality rate from 0.0% (Vrindavan & Raibareily) to 08% (Makhdoom). The adult goats were sold @ Rs 7000 to 26000/goat. The net profit per goat was ranged from Rs 4700 to 10200/year with an average of Rs. 5625.

There are sustainable and positive trends in performance (milk production, growth, reproduction and survival) traits over the years.

1. Barbari Breed has been conserved and no more endangered with more than 5000 females and 200 male populations available with multiplier flocks.
2. Multi-location testing of Barbari breed in semi-arid regions/states of India has proved it's adaptability and productivity attributes.
3. The established multiplier flocks acting as on-farm demonstration units for nearby keepers thus help in technology dissemination about scientific goat farming.
4. Developed and disseminated packages of management practices among goat farmers.
5. Pedigreed and high potential bucks of Barbari breed were provided to goat keeper's and goat development agencies to improve genetic potential and breed purity of goats available with rural household. These superior bucks have enhanced genetic potential of farmer's goat. Each buck used to cover on an average

Fig 6 : Trainee visit to Barbari goat unit

100 females in both breeding season/ year. Kids born from this supplied buck/ram were delivered higher kid's growth rate (body weight) by 15-20 % and also fetches higher price (20-25%) for breed purity. Breeding intervention (serving from superior sire) has resulted in additional economic gain of Rs 2359/ adult goat/year.

6. During last 5 year 484 Barbari were provided to farmers to create breeders stock at their own farm. It has resulted in formation of nucleus breeding farm and in situ-conservation of goat breeds Male and female produced from such nucleus unit fetched higher price i.e. RS 350kg live body weight. Gross incomes from such pure-bred and high potential females were Rs. 10380 (Net profit Rs. 5400) whereas, gross income from non-descript/low potential goats was Rs. 6350 (Net profit Rs. 3600).

Table 15: Reproductive performance in Barbari goats (2015-2019)

Factor	Reproductive Performance			
Overall Mean	Gestation Period	Age at first Service	Age at kidding	Wt. at kidding
	145.14±0.26(384)	**404.96±3.39(384)**	**550.09±3.39(384)**	**23.11±0.20(384)**
Year of kidding	*	*	*	
2015	145.01±0.49(83)	383.15±6.32^{a}(83)	528.16±6.32^{a}(83)	21.72±0.37^{a}(83)
2016	146.02±0.48(83)	410.14±6.22^{b}(83)	556.16±6.23^{b}(83)	22.29±0.36^{ab}(83)
2017	144.59±0.46(102)	406.74±5.93^{ab}(102)	551.32±5.93^{b}(102)	22.87±0.35^{b}(102)
2018	145.57±0.47(89)	417.98±6.12^{b}(89)	563.55±6.12^{b}(89)	24.60±0.36^{c}(89)
2019	144.50±0.87(27)	406.77±11.23^{ab}(27)	551.27±11.22^{b}(27)	24.06±0.65^{c}(27)
Season of kidding	*	*		
1	145.39±0.35(222)	384.18 ±4.61(222)	529.56±4.60(222)	23.10±0.27(222)
2	144.89±0.36(162)	425.73±4.68(162)	570.62±4.68(162)	23.12±0.27(162)
Type of birth	*			
1	145.39±0.29(261)	390.20±3.77(261)	535.58±3.77(261)	23.00±0.22(261)

Factor	Reproductive Performance			
2	144.89±0.41(123)	419.71±5.29(123)	564.60±5.29(123)	23.21±0.31(123)

Table 16: Kidding Interval over parity during 2015-2019 in Barbari goats:

Factor	Kidding Interval			
Overall Mean	KDI-I	KDI-II	KDI-III	KDI-IV
	340.02±5.40(220)	**319.31±6.26(100)**	**334±5.18(29)**	**318±4.75(10)**
Year of kidding *				
2015	391.65±13.22^{a}(28)	332.43±14.00(16)	349.32±12.13(07)	328.34±13.26(04)
2016	348.42±9.17^{b}(58)	327.34±09.31(32)	323.35±08.20(14)	308.40±09.30(06)
2017	322.03±11.31^{abc}(38)	304.85±11.80(19)	330.23±11.50(08)	-
2018	298.01±7.15^{c}(96)	312.62±09.11(33)	-	-
Type of birth		*	*	
Single	341.42±6.15(142)	315.58±5.96(75)	336.38^{a}±4.80(23)	324.52^{a}±08.62(09)
Twin	338.63±8.25(78)	323.05±10.75(25)	313.50^{b}±09.50(06)	240.10^{b}±10.02(01)

Table 17: Least squares means of body weight (kg) in Barbari goats at different ages

Factor	Body weight at different ages				
Overall Mean	Birth	3M	6M	9M	12M
	1.88±0.012(1852)	**8.50±0.06(1756)**	**12.63±0.10(1396)**	**17.15±0.15(128)**	**21.45±0.15(1065)**
Year of birth	**	**	**	**	**
2015	1.88±0.016^{a}(360)	8.42±0.08^{a} (359)	11.99±0.14^{a} (305)	15.89±0.18^{a}(293)	20.12±0.19^{a}(280)
2016	1.87±0.015^{a} (422)	7.81±0.08^{b} (408)	12.44±0.13^{ab}(368)	16.82±0.18^{b}(356)	21.36±0.18^{b}(334)
2017	1.98±0.018^{b}(343)	8.93±0.09^{c} (334)	12.86±0.15^{b}(307)	17.32±0.21^{b}(301)	22.52±0.23^{c}(235)
2018	1.86±0.017^{a}(386)	8.27±0.09^{a}(375)	11.82±0.15^{a}(308)	16.85±0.21^{b}(256)	22.65±0.23^{c}(216)
2019	1.80±0.018^{c}(341)	9.05±0.10^{d}(280)	14.02±0.23^{c}(108)	18.86±0.34^{c}(76)	-
Season of birth	**	**	*		
1	1.89±0.014^{a}(730)	8.59±0.07^{a}(714)	12.47±0.12(637)	16.34±0.17^{a}(547)	21.37±0.18(422)
2	1.87±0.012^{b}(1122)	8.40±0.07^{b}(1042)	12.79±0.12(759)	17.96±0.17^{b}(735)	21.52±0.16(643)
Sex of kid	**	**	**	**	**
Male	1.96±0.013^{a}(956)	8.85±0.07^{a}(904)	13.40±0.12a(715)	18.39±0.16^{a}(669)	23.31±0.17^{a}(518)
Female	1.80±0.013^{b}(896)	8.14±0.07^{b}(852)	11.86±0.12^{b}(681)	15.91±0.17^{b}(613)	19.59±0.17^{b}(547)
Type of birth	**	**	**		
1	2.01±0.013^{a}(665)	9.21±0.07^{a}(638)	13.55±0.12^{a}(519)	17.92±0.16^{a}(485)	22.14±0.17a(396)
2	1.85±0.01^{b}(1095)	8.10±0.05^{b}(1031)	12.35±0.09^{b}(793)	16.89±0.13^{b}(721)	21.22±0.13^{b}(603)
3	1.76±0.027^{c}(92)	8.18±0.14^{b}(87)	11.98±0.23^{b}(84)	16.63±0.32^{b}(76)	20.98±0.33^{b}(66)
***P<0.01, *P<0.05*					

Table 18: Lactation Performance of Barbari Goats during 2015-2019

Factor	90d milk yield (L)	140dmilk yield (L)	Total milk yield (L)	Lactation length (d)
Overall Mean	***60.75*±0.85(1103)**	***82.55*±1.29(782)**	***77.32±1.45(1031)***	***134.87 ± 1.82(1031)***
Year	**	**	**	*
Year 2015	48.13±1.06^{a}(204)	63.88±1.71^{a}(106)	57.57±1.79^{a}(204)	131.38±2.24^{a}(204)
Year 2016	53.76±1.01^{b}(244)	67.35±1.45^{a}(197)	65.47±1.70^{b}(244)	135.91±2.14^{a}(244)
Year 2017	59.52±1.10^{c}(196)	81.26±1.61^{b} (173)	71.86±1.76^{b}(228)	129.61±2.20^{a}(228)
Year 2018	62.22± 1.10^{c}(256)	86.66±1.57^{b}(230)	79.76±1.83^{c} (273)	131.25±2.30^{a}(273)
Year 2019	82.46± 1.13^{d}(203)	113.61±2.13^{c}(76)	111.93±2.58^{d} (83)	146.21±3.24^{b}(82)

Factor	90d milk yield (L)	140dmilk yield (L)	Total milk yield (L)	Lactation length (d)
Season of Birth				*
Season-1	63.00±0.96[a](438)	84.57±1.41 (343)	80.34±1.61(446)	137.75±2.02(446)
Season- 2	58.50±0.88[b](665)	80.53±1.41 (439)	74.30±1.58(585)	131.99±1.97(585)
Type of birth				
Single	60.82±1.00(608)	82.92±1.20 (437)	77.11±1.30(570)	133.69±1.63(570)
Twin	58.22±0.68(466)	80.45±1.09 (323)	73.52±1.18(432)	132.95±1.48(432)
Triplet	63.20±2.10(29)	84.28±3.08 (22)	81.32±3.55(29)	137.98±4.45(29)
Parity		*	*	
Parity-1	54.93±0.88[a](453)	74.19 ±1.33[a] (345)	72.77±1.54[a](434)	140.74±1.93(434)
Parity 2	60.91±0.91[b](307)	83.33±1.34[b] (232)	82.35±1.59[b](285)	142.98±1.99(285)
Parity 3	61.07±1.06[b](166)	81.72±1.73[b] (99)	76.63±1.93[b](140)	135.64±2.41(140)
Parity 4	61.57±1.28[b](89)	82.18±2.07[b] (52)	75.41±2.24[b](84)	130.59±2.80(84)
Parity 5	62.21±1.75[b](44)	84.98±2.93[b] (25)	78.53±3.09[b](41)	132.81±3.87(41)
Parity 6	63.05±2.25[b](25)	86.16±3.66[b] (15)	79.53±3.84[b](25)	131.09±4.81(25)
Parity ≥7	61.50±2.64[b](19)	85.30±3.95[b](14)	76.00±4.20[b](22)	130.24±5.26(22)

Table 19: Selection differential (9 months body weight and 90 days milk yield)

Traits	2016-17		2017-18		2018-19	
	9-Mwt	90d-my	9-Mwt	90-dMY	9-Mwt	90-dMY
Selected males (Mean)	22.4 (22)	70 (22)	24.2 (6)	71.2 (6)	24.67 (6)	71.42 (6)
Population (Mean)	16.5	54	17.47	62.37	18.86	62.22
Selection differential	**5.9**	**16**	**6.73**	**8.83**	**5.81**	**9.20**

Table 20: Mortality & Culling during 2013-2019

Year	2013- 14	2014-15	2015-16	2016-17	2017-18	2018-19	2019
Flock Strength	1017	977	1090	1204	1154	1001	881
Goats Died	37	38	33	35	36	32	22
Mortality (%)	**3.5**	**3.8**	**3.0**	**2.9**	**3.10**	**3.20**	**2.49**
Culling	73	56	50	82	61	91	34
Culling (%)	**7.2**	**5.7**	**4.6**	**6.8**	**5.2**	**9.09**	**3.86**

Table 21: Goats Supplied for breed improvement during 2014-2019

Sr. No.	Year	Male	Female	Total
1	2014 – 15	162	046	208
2	2015 – 16	85	67	152
3	2016 – 17	193	115	308
4	2017-18	141	161	302
5	**2018-19**	**173**	**86**	**259**
6	**2019**	**83**	**55**	**138**

Table 22: Carcass characteristics of Barbari Male kids under stall feeding:

Parameter	Barbari kids with green fodder	Barbari kids without green fodder
Live weight (Kg)	28.44 (5)	28.50(5)
Slaughter Weight (Kg)	26.80(5)	26.40(5)

Parameter	Barbari kids with green fodder	Barbari kids without green fodder
Slaughter Age	10 Month	10 Month
Empty body Weight (Kg)	22.09(5)	21.91(5)
Carcass weight (kg)	13.18(5)	12.91(5)
Dressing percent (%)	49.13(5)	48.88(5)
Hind quarter weight (kg)	5.60 (5)	5.47(5)
Four quarter weight (kg)	7.58(5)	7.44(5)

AICRP (G) : Genetic Improvement of Barbari Goats for Meat and Milk Production
(Dr(s) M K Singh , M S Dige, A. K. Dixit, S Paul, Ravindra Kumar, S P Singh, N Ramachandran, V Rajkumar, R Pourouchottamane)

6.3 GENETIC IMPROVEMENT OF JAKHRANA

Jakhrana is a valuable milch breed and also used for meat due to its compact and large size body. It is a hardy breed and can be reared in poor resources. 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. The breeding tract of Jakhrana breed is found in the Village – Jakhrana , Tahseel – Bahrod in Alwar district of Rajasthan. Small population of the breed and its grades are also reported in Narnaul, Gurgaon, Bhiwani and Rohtak districts of Haryana and adjoining areas of U.P. Many flock of Jakhrana like animals can be seen easily in the interior areas of Bundelkhand region of the U. P. and M. P. up to Gwalior district but they are known as Bundelkhandi goats or Deshi goats. Since it is a highly valuable breed of India and has very less number of animals in pure form however there is a need to evaluate, conserve, multiply and improve the breed genetically..

6.3.1 Field Experiment:

Ten goat framers were found in the Jakhrana village those have flock strength (FS) of above 25 goats. Details of the registered farmers in field (Table 23), summary status of 11 goat farmers of Jakhrana village (Table-24), body measurements of Jakhrana kids (cm) (Table 25), and body weight of Jakhrana kids in field (kg) at different age (±15 d (Table 26) has been observed. As per farmers report 20-30 liter milk production per goat was increased in total milk production of goats in the field after applying technical program of project.

Table 23: Details of the registered farmers in field

S. No.	Name of farmer	Caste of farmer	Education	Flock strength
1.	Sri Basti Ram s/o Jagdish	SC	UE	28
2.	Sri Ramkishan s/o Deendayal	SC	UE	27
3.	Sri Daya Ram s/o Jagdish	SC	UE	27
4.	Sri Dharni, s/o Umrav	SC	UE	26
5.	Sri Sube Singh s/o Dariyab	OBC	5th class	32
6.	Sri Hoshiyar Singh s/o Sri Foolchand	OBC	UE	33
7.	Sri Sube Singh s/o Onkar	OBC	UE	23
8.	Sri Lala Ram s/o Sri Ramnaresh	OBC	10th pass	36
9.	Sri Lilaram s/o Mannu	OBC	UE	32
10.	Sri Dinesh s/o sri Hari Narayan	OBC	8th pass	37

Table 24: Summary Status of Registered Goat Farmers in field

1.	SC farmers	4
2.	OBC framers	6
3.	Educated farmers	3
4.	Uneducated farmers	7
5.	Flock strength >30	6

6.	Flock strength <30	4
7.	Shed	kachcha/ local material
8.	Agriculture land <2 Bigha	5
9.	Agriculture land>2 Bigha	1
10.	Agriculture land (Nil)	4
11.	Buck per flock	1-2
12.	Doe No./ per flock	15-20
13.	Kid per flock	8-15

Flock strength of two flocks in Jakhrana village were measured: Two flocks were randomly chosen from Jakhrana village to measure flock strength as per 0-3, 3-6, 6-9, 9-12 months of age and adult goats (Table-24).

Table 25: Body measurements of Jakhrana kids (cm)

Traits	At Birth	3Month	6Month	9Month	12Month
Body length	30.92±0.30 (35)	50.59±0.23 (53)	56.35±0.41 (47)	65.68±0.42 (45)	68.08±0.55 (40)
Body height	35.54±0.19 (35)	53.86±0.25 (53)	60.36±0.56 (47)	70.02±0.44 (45)	74.26±0.60 (40)
Body girth	35.12±0.30 (35)	54.24±0.25 (53)	60.95±0.53 (47)	70.35±0.42 (45)	74.39±0.54 (40)

Table 26: Body weight of Jakhrana kids in field (kg) at different age (±15 d)

Traits	Birth Wt.	3M Wt.	6M Wt.	9M Wt.	12M Wt.
Overall mean	3.02 ±0.06 (35)	14.6 7±0.29 (53)	22.54 ±0.31 (47)	25.43 ±0.26 (45)	27.25 ±0.47 (40)
Sex	**	**	**	**	**
Male	3.19 ±0.09 (14)	15.66 ±0.44 (23)	23.99 ±0.45 (22)	27.76 ±0.39 (15)	29.24 ±0.80 (11)
Female	2.85± 0.07(21)	13.69 ±0.39 (30)	21.10 ±0.42 (25)	23.09 ±0.34 (30)	25.27 ±0.49 (29)

6.3.2. Work in the nucleus flock:

Population Dynamics of nucleus flock: Population strength of males and females of Jakhrana goats in nucleus flock under 0-1, 1-3, 3-6 and 6-12 months age kids and Jakhrana adults on dated 1st April, 2019 and 1st January, 2020 were recorded and presented in Table 27. In opening balance there were total 79 kids, 50 adult females and 25 adult males hence, there were total 154 animals in the farm on 01.04.19. In closing balance there were total 60 kids, 74 adult females and 19 adult males hence, there were total 156 animals in the farm on 01.01.20.

Evaluation of kidding, type of births and reproductive performance: Total 50 kids were born from 31 kidding in the year 2019-20. Out of 50 kids, 19 kids (38.00 %) were male and 31 kids (62.00 %) were female. Out of 31 kidding, 13 does (41.94 %) gave single birth, 18 does (58.06%) produced multiple births. The kidding rate of Jakhrana goats in 2019-20 was 1.60 (Table 28).

Production and supply of breeding bucks and does 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 mothers. Does were selected on the basis of 90 days milk yield as per parity. **37** breeding buck and 04 breeding does were supplied to the farmers, government and non-government agencies (Table 29).

Evaluation and improvement of body weight of Jakhrana kids: Data were collected from 269 kids born January, 19 to January, 20 to cover both kidding season. Up to 3 months body weight of each kids were measured fortnightly after 3 months body weight of each kids were taken monthly. Least square means for birth weight (2.53±0.08 kg), 3 month weight (9.85±0.28 kg), 6 month weight (15.27±0.49 kg), 9 month weight (21.84±0.75 kg) and 12 month weight (28.76±0.87 kg) were calculated for 2019-20 and these were compared with the body weights of kids of and 2017-18 and 2018-19. Data were collected in kg and detail comparison presented in the Table 30.

Evaluation and improvement of milk production of Jakhrana goats: Data were collected from 168 does. Average milk production in 2019-20 for 30 days (59.67±1.55 liter), 60 days (107.44±2.54 liter), 90 days (147.72±3.66 liter), and 120 days (192.40±5.58 liter) milk production of Jakhrana does for the year 2019-20

were recorded and average milk production of 2019-20 were compared with 2017-18 and 2018-19, which is presented in Table 31. Females are selected on the basis of 90 days milk production for selective breeding. Milk yield 2019-20 for 30, 60, 90 and 120 are increased than does kidded in 2017-18, 2018-19. Year was significant for all milk traits.

Mortality in Jakhrana flock: Data were collected from 204 animals. Mortality of Jakhrana goats reduced remarkably. Out of 204 animals, there were 04 (1.96 %) mortality cases in the Jakhrana flock in this year. Age wise and sex wise detail mortality is given in Table 32.

Table 27: Opening and Closing Balance of Jakhrana Goats in nucleus flock:

Age group	Opening Balance		Closing Balance	
	On 01.04.19 M	On 01.04.19 F	On 01.01.20 M	On 01.01.20 F
0-1 Month	07	08	01	01
1-3 Month	03	01	12	21
3-6 Month	16	21	02	04
6-12 Month	13	10	10	12
Adult	25	50	19	74
Total	64	90	44	112
GT	154		156	

Table 28: Kidding and Reproduction Traits of Jakhrana Goats.

S. No.	Traits	2019-20
1	No of kidding	31
2	Total kids produced	50
3	Male kids	19 (38%)
4	Female kids	31 (62%)
5	Single Birth	13 (41.94%)
6	Twins Birth	18 (58.06%)
9	Kidding Rate	1.61

Table 29: Production and supply of breeding bucks and does to the farmers for breed improvement.

Breeding Animals	Available	Supplied	Retained at farm for experiment
Breeding Buck	54	37	17
Breeding Does	78	04	74
Total	132	41	91

Table 30: Least Square Means of Body Weight of Jakhrana Kids.

Particulars	Birth Wt.	3M Wt.	6M Wt.	9M Wt.	12M Wt.
Overal1 mean	2.53±0.08 (269)	9.85±0.28 (146)	15.27±0.49 (183)	21.84±0.75 (169)	28.76±0.87 (156)
Sex	**	**	**	**	**
Male	2.65±0.08 (137)	10.16±0.30 (119)	16.67±0.56 (76)	23.92±0.32 (75)	32.29±0.95 (74)
Female	2.40±0.07 (132)	9.52±0.30 (127)	13.86±0.52 (107)	19.77±0.80 (94)	25.22±0.94 (82)
Year	**	**	**	**	**
2017	2.31±0.08 (127)	8.08±0.29 (106)	13.01±0.59 (47)	17.21±0.86 (43)	25.23±1.01 (39)
2018	2.60±0.09 (72)	10.90±0.32 (71)	17.05±0.53 (69)	24.75±0.83 (60)	34.20±1.00 (53)
2019	2.68±0.08 (70)	10.56±0.37 (69)	15.73±0.64 (67)	23.55±0.94 (66)	26.84±1.11 (64)
Season	**	**NS**	**	**	**NS**

Particulars	Birth Wt.	3M Wt.	6M Wt.	9M Wt.	12M Wt.
First	2.63±0.10 (189)	9.81±0.29 (175)	14.32±0.49 (134)	20.79±0.77 (120)	28.64±0.90 (108)
Second	2.43±0.08 (80)	9.88±0.33 (71)	16.21±0.59 (49)	22.89±0.86 (49)	28.87±1.00 (48)
Parity	**	NS	NS	NS	**NS**
I	2.40±0.09 (105)	9.55±0.32 (95)	14.94±0.57 (77)	21.57±0.83 (73)	28.80±0.98 (66)
II	2.50±0.10 (57)	9.98±0.37 (52)	15.18±0.67 (33)	22.23±0.98 (30)	28.91±1.15 (28)
III	2.44±0.11 (36)	9.62±0.41 (35)	15.19±0.78 (21)	21.75±1.17 (16)	28.58±1.38 (15)
IV	2.56±0.12 (19)	10.03±0.47 (16)	15.50±0.80 (13)	21.65±1.21 (11)	28.57±1.45 (10)
≥V	2.75±0.09 (52)	10.04±0.34 (48)	15.52±0.58 (39)	22.01±0.84 (39)	28.91±0.98 (37)
Type of Birth	**	**	**NS**	**NS**	**NS**
Single	2.91±0.05 (109)	10.46±0.39 (97)	15.76±0.39 (68)	22.19±0.55 (61)	28.93±0.67 (52)
Multiple	2.63±0.04 (160)	9.30±0.45 (149)	15.81±0.31 (115)	21.93±0.43 (108)	28.17±0.52 (104)

(*Significant at 5% level, **Significant at 1% level)

Table 31: Means of Milk Production (liter) of Jakhrana goats

Factor	30d milk yield (L)	60d milk yield (L)	90d milk yield (L)	120d milk yield (L)	TMY	LL
Overall Mean	59.67±**1.55 (168)**	107.44±**2.54 (161)**	147.72±**3.66 (130)**	192.40±**5.58 (74)**	177.12±**6.32 (148)**	126.97±**5.77**
	**	**	**	**	**	*
Year 2017	48.32±**1.94 (83)**	85.48±**3.23 (78)**	118.15±**4.88 (60)**	152.41±**6.90 (39)**	137.66±**8.01 (70)**	110.30±**7.89**
Year 2018	58.19±**2.66 (43)**	105.84±**4.38 (42)**	148.28±**6.49 (35)**	199.45±**10.02 (19)**	186.33±**10.66 (36)**	130.64±**9.16**
Year 2019	72.50±**3.13** (42)	131.01±**5.12** (41)	176.74±**7.44** (35)	225.34±**11.49** (16)	207.37±**12.03** (42)	139.98±**8.64**
	NS	*	*	NS	**	**
Season-1	61.73±**2.24 (87)**	113.20±**3.68 (82)**	155.77±**5.47 (66)**	198.03±**7.97 (43)**	192.88±**9.10 (73)**	139.93±**7.43**
Season- 2	57.61±**2.05 (81)**	101.69±**3.37 (79)**	139.68±**5.00 (64)**	186.77±**7.72 (31)**	161.37±**8.22 (75)**	114.02±**7.69**
TOB	**	*	**	*	NS	NS
Single	56.98±**2.14 (90)**	104.65±**3.54 (86)**	145.61±**5.23 (65)**	189.38±**7.70 (40)**	172.13±**8.96 (77)**	128.29±**7.48**
Twin	62.36±**1.97 (78)**	110.23±**3.24 (75)**	149.83±**4.69 (65)**	195.43±**7.39 (34)**	182.12±**7.67 (71)**	125.66±**6.82**
Parity 1	55.05±**2.08 (65)**	101.76±**3.46 (62)**	142.07±**5.44 (46)**	175.56±**8.49 (27)**	159.18±**7.94 (62)**	115.68±**5.54**
2	56.82±**2.83 (36)**	102.96±**4.81 (33)**	146.33±**7.21 (26)**	2204.94±**11.11 (14)**	162.53±**10.77 (34)**	114.64±**8.30**
3	55.15±**3.32 (26)**	101.40±**5.40 (26)**	131.26±**7.66 (24)**	170.75±**11.5 1 (14)**	177.34±**16.02 (15)**	127.57±**16.66**
4	61.43±**4.67 (13)**	108.03±**7.60 (13)**	147.02±**10.67 (12)**	192.94±**14.11 (9)**	190.14±**18.78 (11)**	161.42±**19.72**
5	69.90±**3.25 (28)**	123.05±**5.35 (27)**	171.92±**8.07 (22)**	217.82±**13.63 (10)**	196.42±**12.51 (26)**	115.57±**9.02**
	*	NS	NS	NS	NS	NS

(*Significant at 5% level, **Significant at 1% level)

Table 32: Mortality in Jakhrana Flock (01.04.19 to 31.12.19)

Age group	M	F	Total
0-3	01	01	02
3-6	0	0	0
6-12	0	0	0
Adult	0	2	02
Total	01	03	04
Out of 217 animals, total mortality in Jakhrana unit was 9 (4.14%)			

Fig 7 : Jakhrana flock in grazing area of Jakhrana Village

(Institute Project: Genetic improvement of Jakhrana goats for milk production in field conditions PI:(Saket Bhusan, Co-PI: Gopal Dass, B. Rai and V.K. Chaturvedi)

6.4. GENETIC IMPROVEMENT IN MUZAFFARNAGARI SHEEP

Muzaffarnagari, the heaviest mutton breed among all 43 sheep breeds of India, is mainly distributed in Muzaffarnagar and its adjoining districts of Western Uttar Pradesh viz. Meerut, Bulandshahar, Saharanpur and Bijnor. Now, the animals of this breed are also found in and around Mathura and Agra districts of Uttar Pradesh and 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.

Fig 8 : Muzaffarnagari Breeding Rams

6.4.1 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 516 which comprised of 143 males and 373 females and closing balance of 573 sheep had a stock of 157 males and 416 females. During this year a total of 266 lambs born and overall mortality was recorded 3.84%.

6.4.2 Production performance:

The overall least-squares means of body weights of lambs at birth, 3, 6, 9 and 12 month age were 3.48±0.02, 15.99±0.14, 24.89±0.21, 30.40±0.24 and 36.60±0.27 kg, respectively during the year under report (Table 33). The effect of sex, year of lambing and type of birth was highly significant (P<0.01) on all body weights except non-significant effect of year of lambing on birth and 6 month body weight whereas parity had highly significant influence on birth weights of lambs. 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 141.53±2.54, 87.89±2.95 and 66.70±1.93g under semi-intensive feeding management. The overall average monthly body weights of adult males and females were respectively 54.5 and 43.1 kg.

The overall least squares means for lambs 1st and 2nd six monthly and adult annual clips were calculated to be 511.51±5.75, 554.35±6.79 and 1237.21±20.31g, respectively. Sex and year of lambing had significant influence on all the lambs. 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.

Table 33: Growth performance of Muzaffarnagari lambs (kg).

Particulars	Birth Wt.	3M Wt.	6M Wt.	9M Wt.	12M Wt.
Overall mean	3.48±0.02 (772)	15.99±0.14 (677)	24.89±0.21 (572)	30.40±0.24 (511)	36.60±0.27 (410)
Sex	**	**	**	**	**
Male	3.58±0.03 (397)	16.68±0.18 (352)	26.26±0.27 (290)	33.06±0.32 (242)	39.74±0.36 (189)
Female	3.37±0.03 (375)	15.31±0.19 (325)	23.52±0.27 (282)	27.74±0.30 (269)	33.46±0.34 (221)
Year	**NS**	**	**NS**	**	**
2017	3.39±0.04(281)	15.56±0.22 (244)	24.28±0.30 (227)	28.09±0.35 (199)	35.87±0.42 (129)
2018	3.53±0.04 (241)	16.27±0.23 (211)	25.37±0.34 (178)	32.24±0.39 (157)	36.68±0.40 (151)
2019	3.52±0.04 (250)	16.55±0.22 (222)	25.02±0.33 (167)	30.88±0.38 (154)	37.27±0.41 (130)
Parity	**	NS	NS	NS	**NS**
I	3.39±0.04 (225)	15.74±0.25 (197)	24.65±0.35 (169)	29.76±0.40 (154)	35.76±0.45 (120)
II	3.54±0.04 (194)	16.04±0.25 (177)	24.77±0.35 (157)	30.37±0.40 (138)	36.45±0.44 (115)
III	3.55±0.05 (133)	16.53±0.29 (119)	25.41±0.42 (101)	30.91±0.49 (88)	36.76±0.52 (76)
IV	3.41±0.06 (93)	15.97±0.36 (78)	25.33±0.52 (63)	30.85±0.57 (58)	36.78±0.65 (48)
≥V	3.49±0.05 (127)	15.69±0.30 (106)	24.29±0.46 (82)	30.11±0.53 (73)	37.26±0.63 (51)
Type of Birth	**	**	**	**	**
Single	3.80±0.03 (550)	17.10±0.15 (495)	25.82±0.22 (429)	31.27±0.25 (388)	37.25±0.27 (313)

6.4.3 Reproduction performance:

Being large sized breed, the twinning rate in Muzaffarnagari sheep is comparatively low. But the intensive use of breeding rams having capabilities for producing twins and triplets, the twinning rate improved significantly. The annual tupping and lambing

on available basis were 95.0 and 80.0%. During this year, the annual twinning rate recorded to be 15.7%. The twinning rate remained between 15.0-20.0% during last three years. The overall replacement rate was calculated as 24.2%**.** The averages for weight at first service, age at first service, age at first lambing, ewes' weight at lambing and inter lambing period were 36.0kg, 420 days, 572 days, 38.4kg and 304 days, respectively.

Per Ewe Productivity was calculated as Ewe Productive Efficiency (EPE) at birth, weaning and six month age. It was estimated as sum of total lambs weight harvested at birth, weaning and six months of age per number of ewes lambed. The EPE at birth, weaning and six month were 4.25, 21.10 and 27.80 kg., respectively for the ewes lambed during year 2019. These parameters for year 2017 and 2018 were respectively and 4.18, 18.17 and 28.72kg, and 4.33, 21.23 and 27.02kg., respectively.

Fig 9 : Muzaffarnagari ewe with triplets

6.4.4 Growth performance in field:

During year 2019, 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 provided health care for routine illness. The overall mean of weight at birth, 3, 6 and 12 month age were 3.0, 13.6, 20.0 and 26.0 kg., respectively. The body weights recorded from farmers flocks were significantly lower than recorded in Muzaffarnagari Sheep Project, CIRG, Makhdoom. The main reason of lower body weights of farmers flocks is low genetic worth of animals, poor health care and availability of poor feed & fodder to the animals.

6.4.5 Selection of breeding rams:

Male lambs born in year 2016-17 were ranked on the basis of their 6 month body weight and out of total, top 10 were selected for breeding purpose. The selection differential for the trait under selection was 9.1 kg (2018-19). The population mean and the average of sire selected was 25.2 & 34.3 kg, respectively. The selection differential for 6 month body weight was 9.1 kg.

Breeding rams (10) were selected based on their 6 month body weight and then evaluated for various semen characteristics before using in breeding programme. Rams showing better libido and semen qualities in terms of volume, sperm concentration, mass motility etc. were finally selected and used as breeding rams in the flocks.

6.4.6. Distribution of elite germplasm and revenue generation:

A total of 84 elite animals (61 males and 23 females) were supplied to various developmental agencies, Research organizations, Non-Government organizations and progressive farmers for genetic improvement of their flocks under field conditions. During year 2019, a revenue of Rs. 7,99,944/- was generated which comprised of Rs. 4,92,400/- from sale of breeding animals, Rs. 1,53,844/- from sale of culled animals and Rs. 1,53,700 from internally transferred animals.

(Project : Genetic evaluation and improvement of Muzaffarnagari sheep for body weight. (Dr(s) Gopal Dass, Nitika Sharma, Vinay Chaturvedi, S.D. Kharche, Saket Bhusan)

6.5. GENETIC VARIABILITY OF MILK PROTEIN AND ITS CHARACTERIZATION BY PROTEOMIC APPROACH IN INDIAN GOATS

Goat is a precious genetic resource for future agricultural productivity and climate change. Goats are adapted efficiently in different agro-climatic conditions. Goat meat and milk is used for family nutrition in disadvantage places and plays a pivotal role in fulfilling the nutritional requirement of older people, pregnant women and children. India is the highest producer of goat milk in the world and produces over 5 million metric tons. Goat milk has several unexplored health-promoting and therapeutic properties that need to be investigated and promoted commercially. Furthermore, goat milk is being used for treatment of allergies and heat stress condition. There has been considerable interest in goat milk protein due to availability of various bioactive peptides. Therefore, the milk proteome analysis is required for future industrial application with respect to human health and nutrition. Considering the research gap in this context, this project started with a hypothesis "Casein haplotypes in association with protein content of milk in different breeds/geographical region. Identification of specific milk protein variants for application to human health and nutrition

6.5.1. Protein identification in 15 goat breeds/ genotypes has been carried out by 2DE and LCMS/MS.

Milk protein polymorphism was studied by 14% SDS PAGE for 15 Indian goat breeds/genotypes from different agro-climatic zones. Protein variants identified by SDS-PAGE were analyzed by 2DE followed by nLC-MS/MS. nLC-MS/MS analysis was performed using EASY-nLC 1000 system (Thermo Fisher Scientific) coupled to Thermo Fisher-OrbitrapQ- *Exactive* mass spectrometer equipped with nano-electrospray ion source. The .raw files generated were analyzed using Proteome Discoverer (v2.2) against the in-house Uniprot *Capra hircus* reference proteome database. For Sequest search, the precursor and fragment mass tolerances were set at 10 ppm and 0.5 Da, respectively. The protease used to generate peptides, *i.e.* enzyme specificity was set for trypsin and protein false discovery rate were set to 0.01 FDR. The mass spectrometry proteomics data have been deposited to the ProteomeXchange Consortium via the PRIDE partner repository with the dataset identifier PXD0135**. A total of **1307** proteins comprising casein and other low abundance proteins such as lactoferrin, albumin, lactotransferrin were identified and breed specific protein and peptide distribution was observed. The number of proteins identified in goat breeds varied from 171 in Gaddi to 667 in Surti. (Table 34).

6.5.2 GO annotation and KEGG pathway enrichment analysis :

GO analysis of annotated genes using DAVID Bioinformatics Resources 6.8. GO annotations for Biological Process were mainly metabolic process (18%), regulation of biological process (18.9%), defense response (8%), transport (10.7%), response to stimulus (16%) and cell organization and biogenesis (14.7%) (Figure 10(A)). Furthermore, few proteins were associated with process like cell division, cell growth, development, cell proliferation and cell communication. GO annotations for Cellular Component included terms such as nucleus (18.1%), extracellular space (17.2%) cytoplasm (14.3%), chromosome (7.4%), cytoskeleton (7.5%), membrane (13.4%) and also ribosome, spliceosome complex, proteasome, mitochondria, endosome, golgi, vacuole, organelle lumen (Figure 10B). Molecular functions associated were protein binding (25.9%), catabolic activity (15.9%), structural molecule (14.9%), metal ion binding (8.3%) and DNA binding (9.3%) (Figure 10C). Antioxidant activity, signal transducer, receptor, motor activity and nucleotide activity were also observed in considerable proteins of goat milk.

KEGG pathway analaysis was performed at kegg.jp. The proteins are found functional in **144** KEGG pathways (Figure 11). These included 27 signaling pathways in immune system, endocrine system, nervous system and signal transduction. The major signaling pathways were estrogen, NOD, AMPK, PPAR, HIF-1, adipocytokine, adrenergic signaling in cardiomyocytes and calcium signaling pathway. KEGG pathway analysis associated these proteins with various pathways in carbohydrate, lipid, nucleotide, amino acid metabolism, genetic information processing, environmental information processing, cellular processes, organismal systems and human diseases. The proteins are functional in immune system, circulatory system, signal transduction, cellular growth, cancer, metabolism as well as disease pathways such as tuberculosis, malaria, and measles. The diagram of tuberculosis pathway and PPAR signaling pathway are shown in Figure 12a, 12b with the identified proteins/ gene names. The interaction of major identified proteins was analysed by **STRING** and presented in Figure 13. We found CSN2 interacts with CSN1S1, CSN1S2, CSN3, LALBA, PAEP and BTN1A1.

6.5.3. Analysis of bioactive peptides:

The PTM analysis revealed the phosphosites of bioactive peptides for further study of functional mechanism (Table 35). Biologically and physiologically active peptides are produced from milk proteins during digestion in the gut. Peptide functions were determined for 1051 peptides by milk bioactive peptide database, 16 peptides had

known bioactive functions. The peptides were analysed for 100% alignment in the database with functions such as ACE-inhibitory, antimicrobial, proliferating, immunomodulatory and antioxidant. The peptides were small (<=7 amino acid) and medium (>7 and <25 amino acid) in length.

6.5.4.Haplotype analysis, heterozygosity and F-statistics analysis

The heterozygosity analysis was carried out to establish geographical relationship based on milk protein polymorphism. Allelic frequency at different loci, average number of alleles, observed and expected heterozygosity, percentage of polymorphic loci for each breed were estimated by POPGENE version 1.32. F-statistics and gene flow for all loci and measures of genetic identity and genetic distance between breeds was calculated. Percentage of polymorphic loci and observed number of alleles for all the breeds are presented in Table 36 and the genetic distance depicted in Figure 14 showing two clusters.

6.5.5. Association of genetic variants with milk composition and quality traits and differential gene expression between contrasting phenotypes.

The effect of genotype/haplotype on milk composition traits such as fat%, protein%, SNF% and lactose % was determined. Net energy of each sample was calculated and association with genotype was established. Protein% was significantly higher (P<0.05) in Himalayan local goat (4.31%), Ganjam (4.01%) and Gaddi (3.91%) as compared to other breeds. Similarly, fat% was also higher in Himalayan local (6.01%), Ganjam (7.13%), and Jakhrana (6.6%). The SNF content of milk was also higher in Himalayan local (9.61%) and Gaddi (9.53%) as compared to other breeds. The goats with *CSN1S1*^{AB} genotype had highest protein content (3.56%) followed by *CSN1S1*^{AA} (3.50%), *CSN1S1*^{BB} (3.26%), *CSN1S1*^{BF} (3.03%) and *CSN1S1*^{AF} (2.99%) genotypes. Parity and season of birth had significant effect (P<0.05) on SNF and lactose content. However, milk yield at 90 days was significantly affected by season of birth (P<0.01) and birth type (P<0.05).

Exon skipping in *CSN1S2* gene

Variations were observed in *CSN1S2* in exon 16 and seven novel alleles are identified by PCR-SSCP. Exon skipping was also observed in which exon 6 seems to be skipped most. *CSN1S2* D allele is associated with deletion of 106 nucleotides (last 11 nucleotides from exon 11 and 95 nucleotides from next intron). The variation at exon (5-7) was studied by PCR-RFLP (Figure 15) by MseI (Tru1I) enzyme. Marwari goats of Rajasthan are found to be monomorphic with AA genotypes only whereas, Jakhrana showed both A and B variants.

TABLES

Table 34: Number of proteins (gene names) identified in different breeds

S. No.	Breed	Total identified	Uniquely identified
1	Ganjam	416	29
2	Jakhrana	288	11
3	Barbari	278	17
4	Black Bengal	343	23
5	Sirohi	337	30
6	Jamunapari	351	55
7	Gaddi	171	3
8	Attapady	330	15
9	Himalayan Local	312	1
10	Malabari	389	11
11	Marwari	474	16
12	Osmanabadi	539	44
13	Pantja	516	24
14	Sangamneri	392	13
15	Surti	667	246

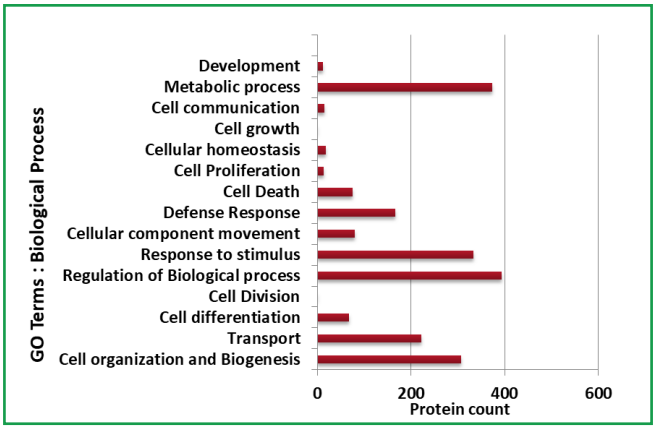
Table 35: Summary of Phosphosites identified in major casein and whey proteins

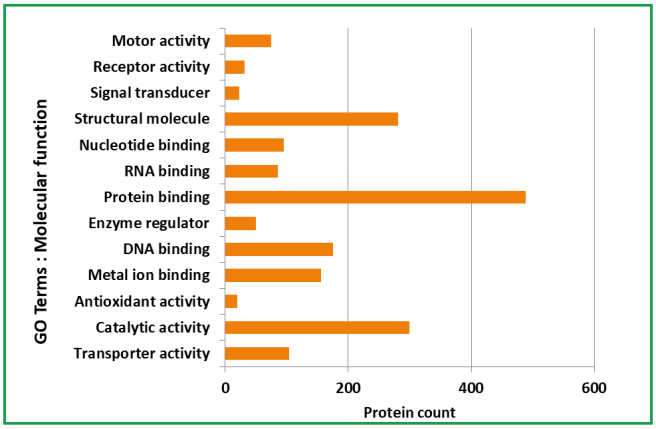
Protein Name	Uniprot Accessions	No of phospho attached
Alpha s1 casein	Q8MIH4	11
Alpha-lactalbumin	P00712	4
Alpha-S2-casein	P33049	13
Beta-casein	Q95L76	13
Beta-lactoglobulin	P02756	19
Kappa-casein	Q7YRX4	5

Table 36: The observed numbers of alleles and percentage of polymorphic loci for each breed based on polymorphism in caprine casein loci.

Breed	Observed No of Alleles	Percentage of Polymorphic Loci
Barbari	2.67±1.21	100
Jamunapari	2.33±0.82	100
Sirohi Vallabhnagar	2.00±1.55	50
Sirohi Avikanagar	2.17±1.47	66.67
Attapady	2.17±0.04	100
Malabari	2.17±1.21	100
Sangamneri	2.33±1.03	83.33
Osmanabadi	1.83±0.41	83.33
Pantja	2.33±1.37	83.33
Marwari	1.83±0.75	66.67
Himalayan Local	2.00±1.09	66.67
Surti	1.83±1.17	50
Black Bengal Kolkata	2.33±1.37	83.33
Black Bengal Patna	2.17±0.98	83.33
Gaddi	2.17±0.98	83.33
Ganjam	1.83±1.17	50
Jakhrana	1.83±1.17	50

FIGURES





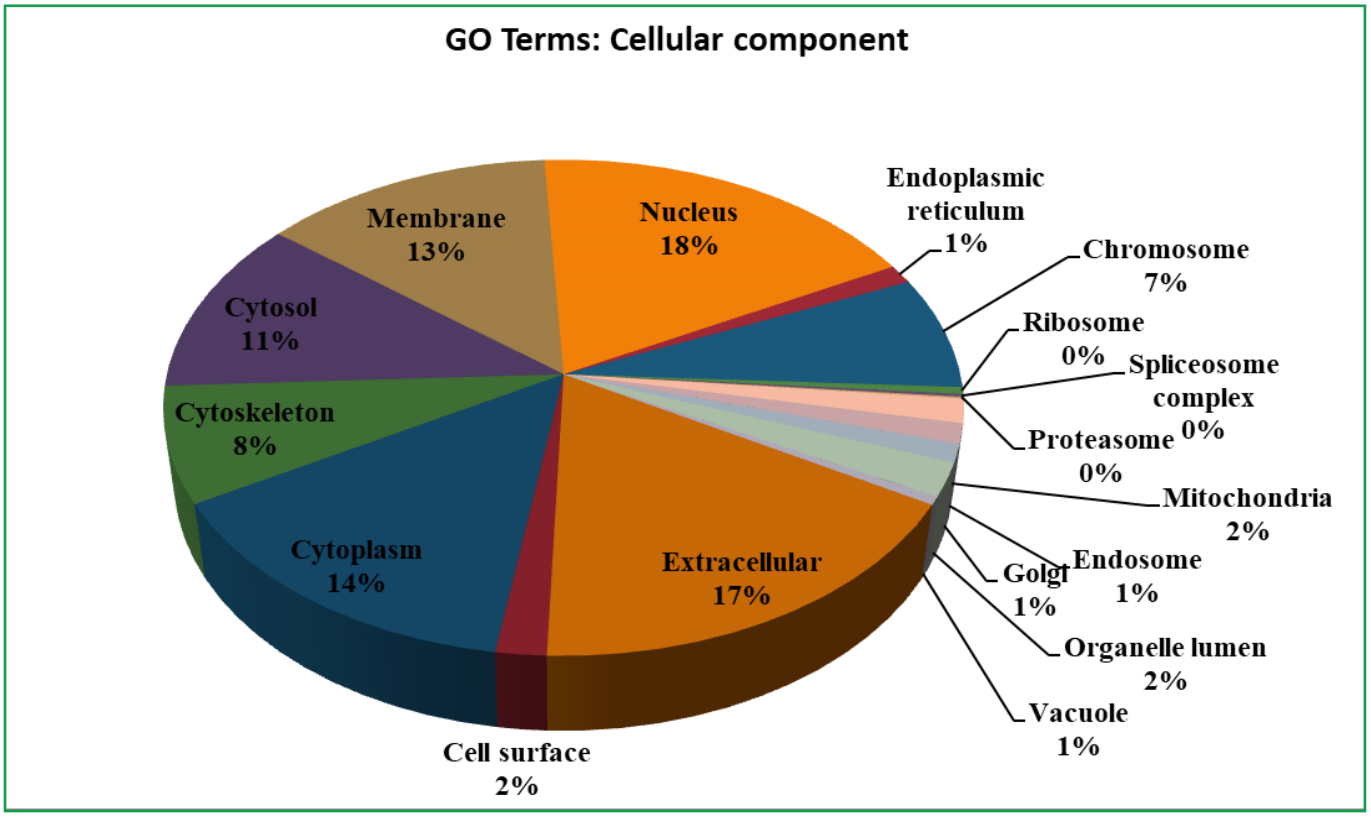


Figure 10: GO classification of identified proteins based on biological processes (a), cellular components (b) and molecular function (c).

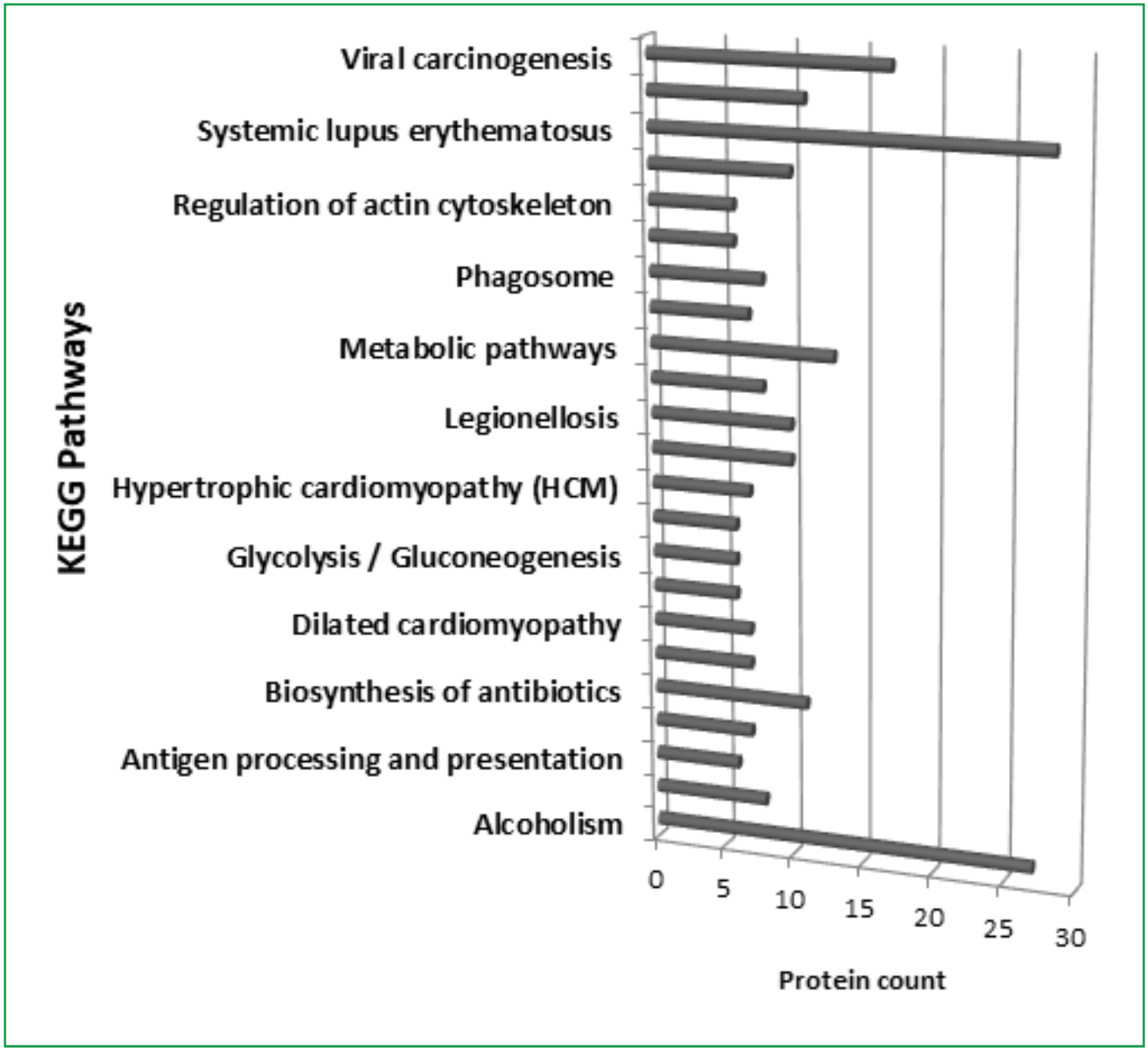


Figure 11: Analysis of identified goat milk proteins based on KEGG pathways

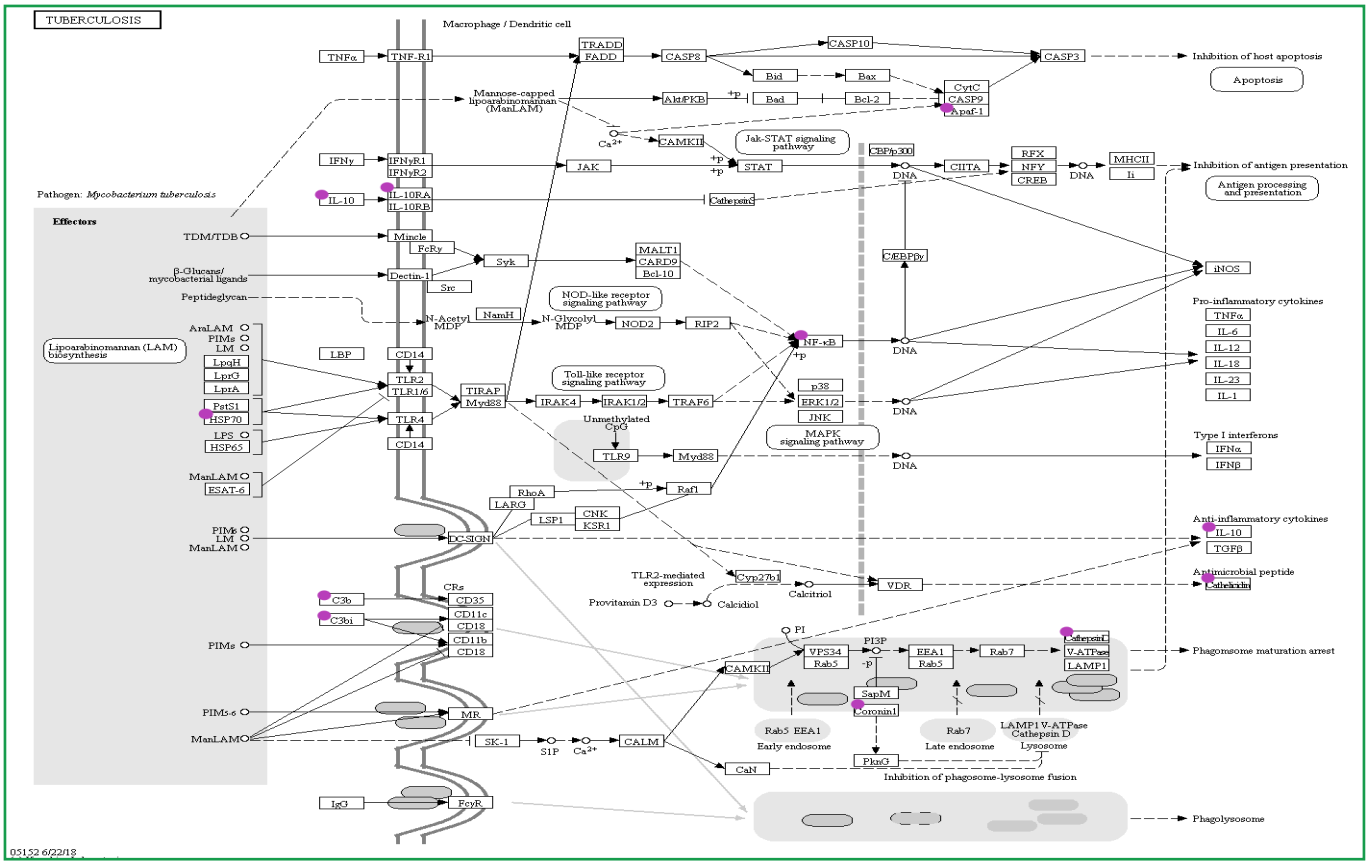


Figure 12a: KEGG analysis of identified proteins in Tuberculosis pathway. The identified proteins are highlighted by a coloured dot in the pathway diagram. Identified gene names included: NF-κβ, Cathepsin D, Corosin-1, Cathelicidin, IL-10, Apaf-1, C3b, HSP70.

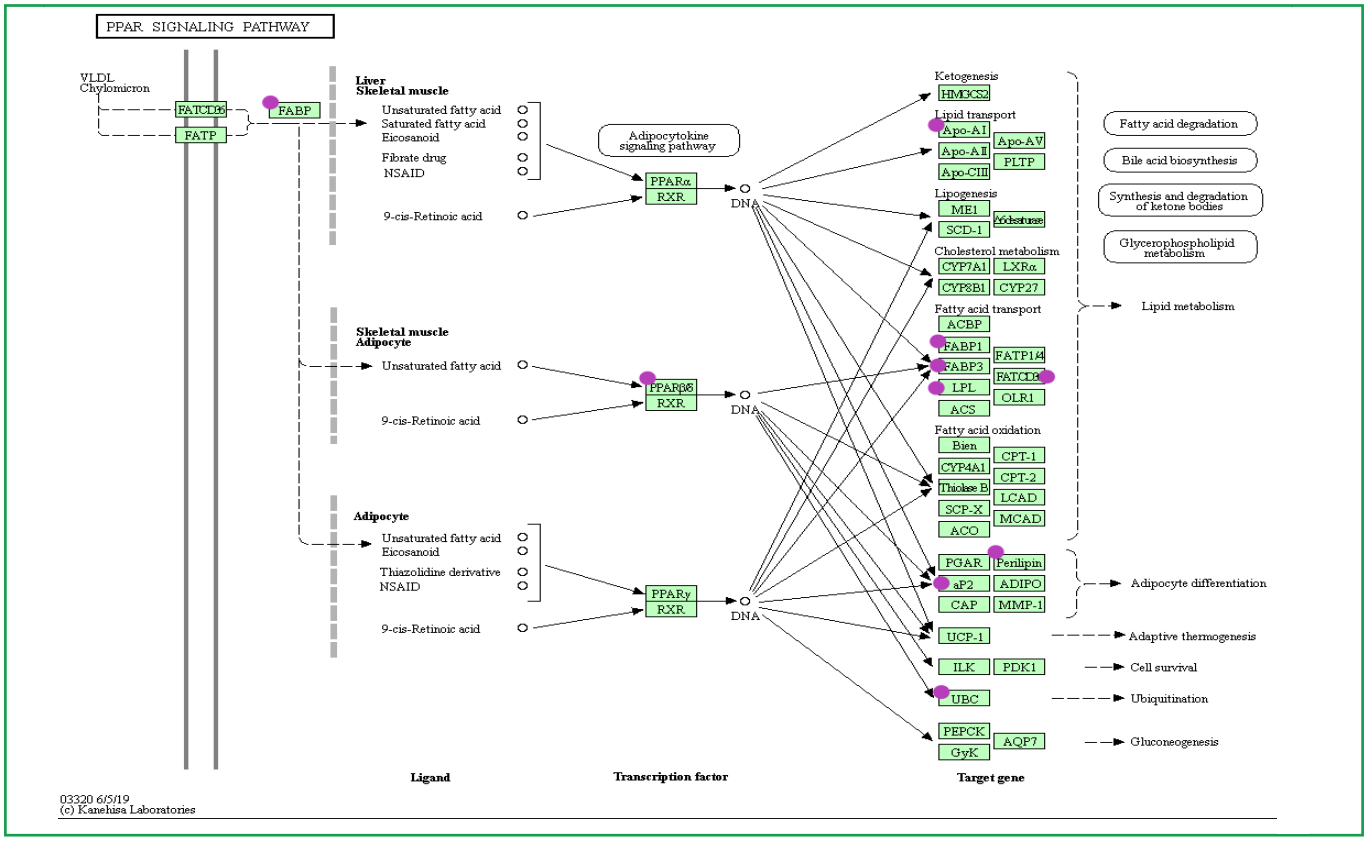


Figure 12b: KEGG analysis of identified proteins in PPAR signaling pathway. The identified proteins are highlighted by a coloured dot in the pathway diagram. Identified gene names included: FABP, FABP1, FABP3, FATCD3, LPL, PPARβ6, Apo-A1, ENO, aP2, Perilipin, TF, UBC.

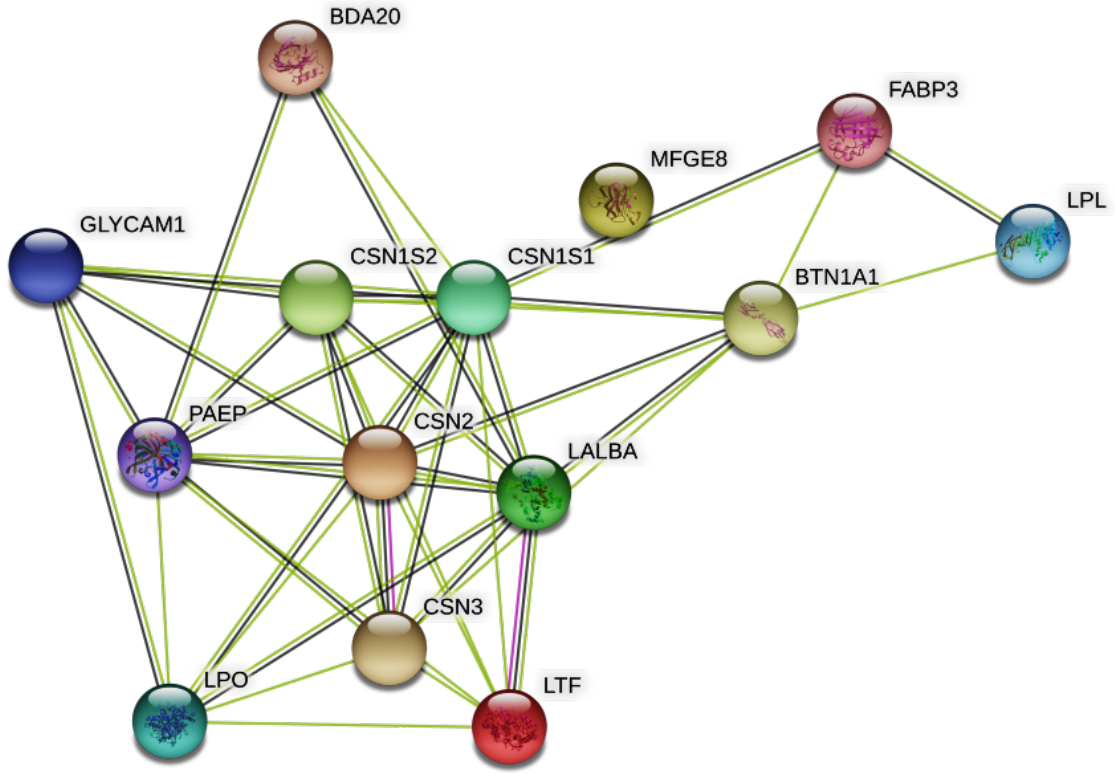


Figure 13: STRING analysis of major milk proteins based on homology from Bovine database. Each node represents a protein and different line colours represent types of evidence for association; pink lines from experimental study, blue lines from curated database, yellow lines from textmining.

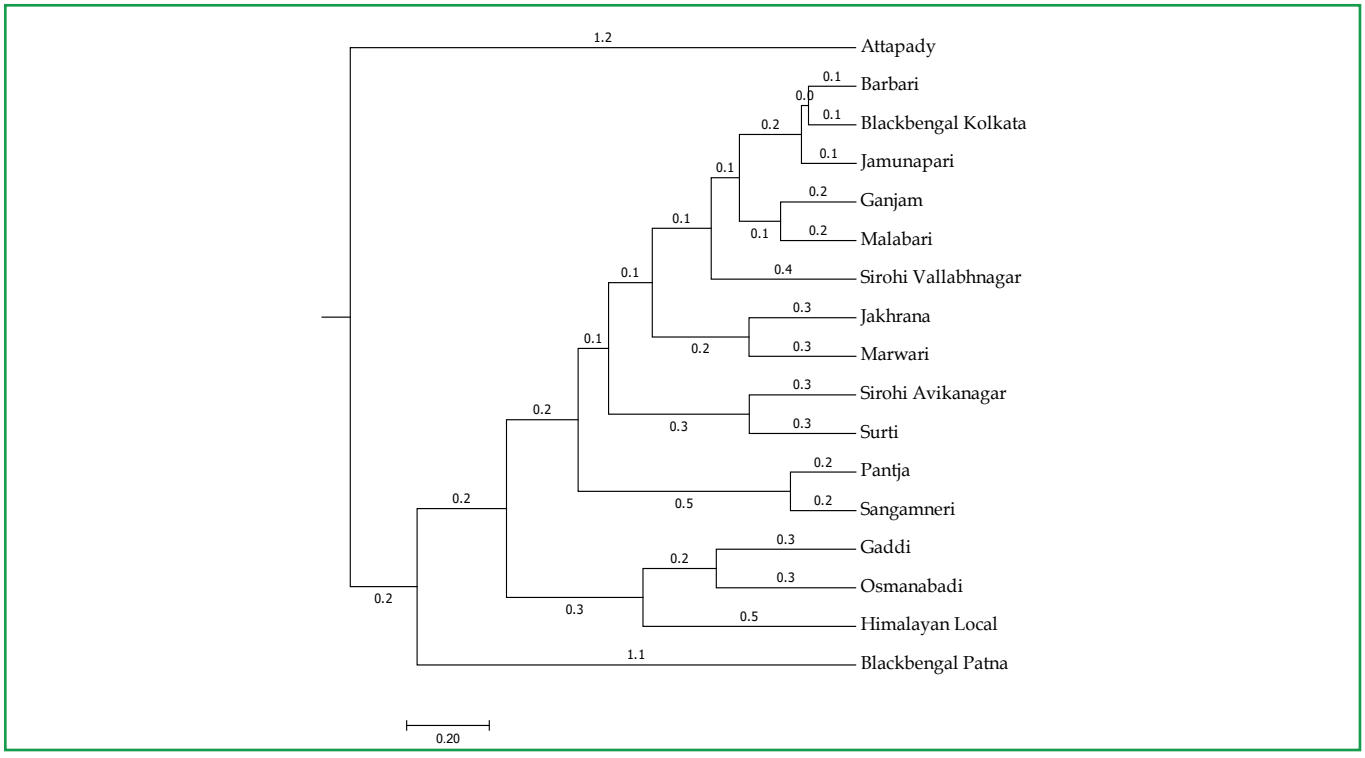


Figure 14: Phylogenetic tree based on milk protein variants showing the relationship among Indian goat breeds.

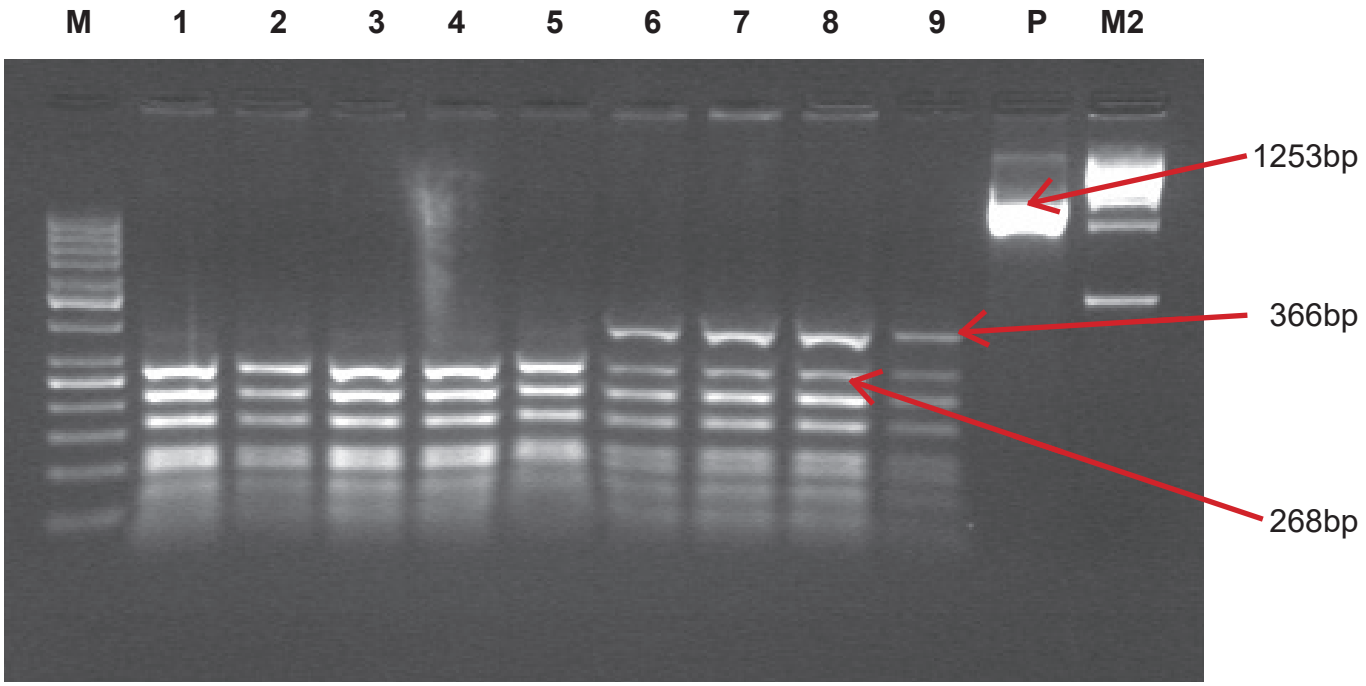


Figure 15: PCR-RFLP profile of *CSN1S2* gene (exon 5-7) region digested by MseI (Tru1I) enzyme products run on 3% agarose gel, Lane 1-5 represents AA of Sirohi goat, Lane 6-9 represent AB of Sirohi (6-7) and Jakhrana goat (8-9) and, Lane P is undigested PCR product. M and M2 are 50bp and 500bp DNA ladder.

(Genetic variability of milk protein and its characterization by proteomic approach in Indian goats, PI- Dr. P.K Rout)

6.2 AICRP ON GOAT IMPROVEMENT

All India Coordinated Research Project on Goat Improvement

The All India Coordinated Research Project (AICRP) on Goat Improvement is a major long-term programme focused to bring upon genetic improvement under prevailing ecosystems, to conserve goat genetic resources in their area of evolution and adaptation. The project explores genetic variations in local breeds through structured and systematic pedigree and performance recording of goats in the farmers flock. Presently, fifteen breeds and three local genotypes are covered through twenty one centres across the country, which are coordinated through a Coordinating Unit. The Project Coordinating (PC) Unit of the ICAR-AICRP on Goat Improvement is located at CIRG, Makhdoom, Farah, Mathura. Three breeds i.e. Barbari, Jamunapari and Sirohi are maintained under semi-intensive farming system with optimum feeding to explore genetic potential of the breed in given environment. Then other breeds viz. Assam Hill goat at Guwahati, Andman goat at Port Blair, Black Bengal at Kolkata and Ranchi, Gaddi at Palampur (HP), Marwari at Bikaner, Himalayan goat at Mukteshwar, Osmanabadi at Phaltan (Satara district of Maharashtra), Sangamneri at Rahuri, Sirohi at Vallabhnagar (Udaipur), Ganjam at Bhubaneswar, Surti at Navsari, Malabari at Thrissur, Uttarakhand goat at Pantnagar, Beetal goat at Ludhiana, Changthagi at Leh, J&K and Bundelkhandi at Jhansi are being improved under farmer's flock in their respective home tracts. Nine units are working as partially TSP unit under Tribal sub plan fund of the project. Assam hill goat unit is also operational in NEH region. AICRP is operational at Leh-Ladakh region of Jammu & Kashmir for conducting research on goats producing Pashmina in cold-dry climate; similarly, we are also working in Andaman & Nicobar Island. The major thrust of the project is to build up long-term capacity of goat keepers through technology demonstration, capacity building, application of health management practices and introduction of genetically superior breeder goats for enhancing their production and reproduction potential on sustainable basis.

Goat production is facing diverse challenges in different agro climatic condition and it is necessary to carry out research and development activity to increase farmer's income for better livelihood. 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 stakeholders.

Coordinating Centers of AICRP on Goat Improvement

S.N.	Centre	Location	TSP/NEH	Purpose
A)	*Field Units*			
	Andaman Goat Field Unit	ICAR- CIARI, Port Blair, A & N Island	***Island Region***	Meat
	Assam Hill Goat Field Unit	AAU, Khanpara, Guwahati, Assam	***NEH***	Meat
	Bengal Goat Field Unit	BAU, Kanke, Ranchi, Jharkhand	***Partially TSP***	Meat
	Black Bengal Goat Field Unit	WBUV and FS, Kolkata, West Bengal	***Partially TSP***	Meat
	Changthangi Goat Field Unit	SKUAST, Kashmir, Leh-Ladakh, J&K	***Partially TSP***	Fibre & Meat
	Gaddi Goat Field Unit	HPKVV, Palampur, Himachal Pradesh	***Partially TSP***	Meat & Fibre
	Ganjam Goat Field Unit	OUAT, Bhubaneswar, Odisha	***Partially TSP***	Meat
	Himalayan Local Goat Field Unit	ICAR-IVRI Campus, Mukteshwar, Uttarakhand		Meat
	Malabari Goat Field Unit	KV&ASU Mannuthy, Thrissur, Kerala	***Partially TSP***	Meat & Milk
	Marwari Goat Field Unit	RAJUVAS, Bikaner, Rajasthan		Meat
	Osmanabadi Goat Field Unit	NARI, Phaltan, Maharashtra,		Meat & Milk
	Sangamneri Goat Field Unit	MPKV, Rahuri , Maharashtra		Meat & Milk
	Sirohi Goat Field Unit	RAJUVAS, College of veterinary sciences & AH Vallabhnagar , Rajasthan	***Partially TSP***	Meat & Milk
	Surti Goat Field Unit	N.A.U., Navsari, Gujarat	***Partially TSP***	Milk & Meat
	Uttrakhand Local Goat Field Unit	GBPUA&T, Pantnagar, Uttarakhand		Meat
	Bengal Goat field Unit	ICAR-RCER, Patna (New Centre)	***Partially TSP***	Meat
	Bundelkhandi Goat Field Unit	IGFRI, Jhansi (New Centre)		Meat
	Beetal Goat Field Unit	GADVASU, Ludhiana, Punjab (New Centre)		Milk & Meat

S.N.	Centre	Location	TSP/NEH	Purpose
B)	*Farm Units*			
	Barbari Goat Farm Unit	ICAR-CIRG, Makhdoom, Uttar Pradesh		Milk & Meat
	Jamunapari Goat Farm Unit	ICAR-CIRG, Makhdoom, Uttar Pradesh		Milk & Meat
	Sirohi Goat Farm Unit	ICAR-CSWRI, Avikanagar, Rajasthan		Milk & Meat
C)	*Project Coordinating Unit*			
	Project Coordinator Unit	ICAR-CIRG, Makhdoom, Uttar Pradesh		

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

Andaman goat field unit is operational at ICAR-CIARI, Port Blair, A & N Islands and working to improve production performance of goat in Island region. Three clusters were established at South Andaman and Middle and North Andaman districts. The unit is operational in 3 clusters viz. Port Blair, Baratang and Nimbudera. The base line information on production and reproduction traits, managemental practices, disease pattern and socioeconomic status of goat keepers were recorded. Identification of animals was carried out in the adopted villages. The closing balance of the registered flock was 4414 goats in the entire three clusters of which 2805 were female and 1609 were male goats. During the period 633 kids were born with the population growth of 47.30%. The overall least squares mean of body weights at birth, 3, 6, 9 and 12 months of age were 1.46±0.02 kg, 5.80±0.08 kg, 9.83±0.14 kg, 13.63±0.25 kg and 16.40±1.09 kg, respectively. The kidding rate was 1.47 during the period. The percentage of singles, twins, triplets were 51.5, 43.1 and 8.0, respectively. A total of 6 improved breeding bucks of Andaman local goats were distributed to different villages of South Andaman clusters for genetic up-gradation of the Andaman local goats in the field. The overall mortality during the period was 3.83 %, however the highest mortality was observed in kids. The morality was mainly due to the diarrhea, weakness, bloat and grass poisoning. A total of 7 training/ awareness programmes/field day were conducted during the period, of which 165 farmers (86 males and 79 females) were benefitted. Under TSP (STC) capacity building programme on goat farming was conducted at Little Andaman. Within a span of last four years, the project has created a significant impact in terms of response and registration of farmers with the projects. Unit has contributed significantly towards the livelihood security through the technological intervention viz. increase in body weight at 12 month (5.49%), reduction in mortality (from 10.06 to 4.74%), increase in kidding rate (7.59%), increase in preventive health coverage (167.39%), increase in knowledge of scientific breeding, management and health practices.

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

The unit is operational at AAU, Khanpara & unit has 5 cluster such as Batabari, District Darrang, Tetelia Gandhinagar, District Kamrup (Metro), Nahira, District Kamrup (Rural), Tepesia, District Kamrup (Metro) and Digholbori, District Morigaon with population of 2695 goats. The population growth was 97.59% in the adopted villages. Eleven selected bucks of superior quality, were distributed to the farmers and 7 existing bucks were exchanged. The overall least squares means of body weights at 3, 6, 9 and 12 months were 5.16±0.05 kg, 7.86±0.08 kg, 10.49±0.09 kg and 13.26±0.13 kg, respectively. The least square means of milk yield in 30, 60 and 90 days were 4.01±0.23, 7.56±0.41 and 13.55±5.92 liter, respectively. The kidding rate was 1.66 and the average mortality was 5.96 % during the period. Twelve awareness cum training programmes were conducted under the project for augmenting and disseminating the knowledge on goat rearing. Thirty one vaccination camps and 37 treatment camps were organised during the period for adopted as well as non-adopted animals.

6.2.3. Black Bengal Goat Field Unit, BAU, Kanke, Ranchi, Jharkhand

The unit is operational at BAU, Kanke, Ranchi and Jharkhand. Four centers of AICRP have been established in different zones of Jharkhand having 9754 goat in which 3252 were males and 6502 were females. Data on growth and reproduction parameters have been recorded and analyzed. A total of 40 breeding bucks were distributed among the farmers at four centers and also exchanged. The overall least squares mean of body weight at birth, 3, 6, 9 and 12 month of age were found to be 1.34±0.13 kg, 5.93±0.11 kg, 8.64±0.20 kg, 11.39±0.20 kg, and 13.50±0.41 kg, respectively. Kidding rate (litter size) was estimated as 1.41 with 170% kidding. All the goats covered in the areas were provided with vaccination, dipping and deworming. Due to timely intervention mortality has come down to 1.68%. A total of 38 breeding bucks were distributed to 10 farmers at each center. Training on 'Scientific Goat Rearing' was organized for 100 tribal farmers in four Batches at Tribal Villages under TSP programme. One exposure visit of

tribal goat farmers and two exposure visits of 50 farmers from different centers were also organized. 39 farmers from different centers visited Kisan Mela AGROTEC 2019 and 48 farmers attended ten days training on Goat Farming.

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

The Black Bengal unit is operational at West Bengal Veterinary University, Kolkata. In 2018-19 with the addition of a new cluster at Tarai Zone (Purba Mallick Para village) under Dhupguri Block of Jalpaiguri District, the project is now operational at five clusters covering 10 village centres. During 2019, 1447 does were registered. A total of 1305 kids were born from 715 kidding during 1st April 2019 to 31st December 2019. The closing flock strength was 3644. The population growth rate of Black Bengal was 103.64%. The average flock size of Black Bengal goat in adopted area was 5.78. The average body weight at birth, 3 months, 6 months, 9 months and 12 months were 1.287±0.003 kg, 5.378±0.007 kg, 7.713±0.009 kg, 10.611±0.011 kg and 13.333±0.016 kg, respectively. The milk yield during first 15 days, 30 days, 45 days, and 60 days of lactation was 3.573±0.036 kg, 6.993±0.061 kg, 9.526±0.082 kg and 10.785±0.094 kg, respectively. The average lactation period was 60.59±0.27 days. The average kidding rate (litter size) was 1.83. Twin born kidding is maximum (54.69%) followed by singlet kidding (31.89%), triplet kidding (12.21%), quadruplet kidding (0.70%) and quintuplet kidding (0.42%). Total 42 bucks were selected from villages based on their 6 months body weight and prolificacy of their dams and 10 bucks have been purchased and distributed in the adopted villages. During 2019, 5 does were also distributed to tribal farmers for selective breeding. 12 mass deworming camps, 14 vaccination camps have been organized in adopted villages. Apart from this mineral mixture to all registered goats and concentrated feed to the pregnant does were provided. With the intervention of health care and prevention the overall mortality in the flock has been reduced to 3.91 %. During the year 7 training programme (355 farmers attended-duration 2 day), 17 gosthi meeting (559 farmers attended), and 17 seasonal advisory (471 farmers attended) were organized in adopted villages.

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

The unit is operational at HAMARI, SKUAST, Kashmir, Leh-Ladakh, with the main objective of breed improvement for pashmina fibre and meat production. Keeping in view the vast hostile terrain of Changthang region (the habitat of Changthangi Goat) and extensive system of rearing whole Ladakh area was divided into four major zones having 3-4 clusters/ villages in each zone. This year, addition of newborn male kids (615) and female kids (668) and by age group resulted in a total addition of 1708 by birth/age totaling to 3262 goats. The closing balance as on 31.12.2019 was 13564. The overall population growth for this year was 50.94%. The average body weight at birth, 3 months, 6 months, 9 months and 12 months were 2.52±0.45 kg, 6.65±0.15 kg, 9.81±0.12 kg, 13.15±0.10 kg and 16.82±0.21 kg respectively. The average pashmina production of all the three clusters for the year was recorded as 272±11.15g. This year 8 improved breeding bucks were distributed to the farmers. The number of does available for breeding purpose for the year 2019 was 3744 out of which 3262 does kidded. There was 3251 single born and 911 twining. The overall kidding percentage was 87.12% with litter size of 1.0121. During the year, the mortality rate was 4.31%. Most of the mortality attributed this year was the intense cold and heavy snowfall in Changthangi area which resulted in covering of pasture with a layer of snow and thus resulted in acute fodder shortage and mortality most in young stock and old animals. The health management including general treatment, vaccination, dosing and dipping, was done for all the goats of the 4 clusters (approximately 13,114 goats). The compost making from goat manure has been done successfully at farm for the last four years.

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

The unit is operational at college of veterinary science, HPKVV, Palampur, Himachal Pradesh. The closing balance for year 2019 was 1580. The least squares means during the year for body weights at birth, 3 months, 6 months, 9 months and 12 months of age were 3.09±0.02 kg, 15.40±0.07 kg, 19.85±0.07 kg, 24.75±0.07 kg and 27.75±0.08 kg, respectively. A total of 30 males were finally distributed to 30 different farmers as a breeding input. The overall population growth was observed to be 106.82 %. The overall mortality incidence was found to be 6.77%. The incidence of twin birth recorded was 20.26 %. The overall abortion incidence in the flocks was observed to be 5.49 %. The kidding percent of the flocks were observed to be 75.77. All selected animals were provided health coverage under migratory field conditions *viz.* vaccination against PPR, de-worming against endo-parasites after fecal sample analysis, periodic health check-ups etc. Strategic supplementary feeding was also provided in the form of mineral mixture and concentrate feed. Collaboration with state Animal Husbandry Department was ensured while providing health coverage and other related activities.

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

The unit is operational at IVRI, Campus, Muketeswar, Uttarakhand. The unit is operational at Lamkot, Khola Gandhak, and Jur cluster. These goats are mainly reared by landless, small and marginal farmers of Kumaon region of Uttrakhand for meat purpose. During the period 160 farmers have been registered and 484 goats were added in four clusters. The mean body weight of male at birth, 3, 6, 9 and 12 months were 11.95 ± 0.051 kg, 8.182 ±0.195 kg, 11.55 ±0.2 kg, 14.55 ±0.32 kg and 20.70 ± 0.34 kg, respectively. The mean milk yield of the lactating doe and lactation length were 31.79 ± 0.90 L/ lactation and 73.93 ± 1.46 days, respectively. A total of 914 faecal samples were collected during different seasons and screened for parasitic infections from goats of all the clusters. The representative samples were subjected for larval culture and found *Haemonchus contortus* (throughout year) and *Teladorsagia circumcincta* (winter) are predominant nematodes infecting goats of these clusters. Other important parasites are affecting goats in the clusters include *Trichostrongylus axei* (mainly October to mid-December), *Oesophagostomum columbianum* and *Bunostomum trigonocephalum,* coccidia, *Moniezia* spp and ticks. Method demonstrations were organized on strategic deworming, dipping and other health management. Faecal egg count reduction test and allele specific PCR were used for monitoring of anthelmintic resistance and the results showed that the resistant level was negligible (0.013%). Nutrition management using extra 6% crude protein (18 vs 24%) was found suitable against haemonchosis and also economically affordable. Regional health calendar was prepared and the preventive/prophylactic measures are being carried out. Seven superior bucks were selected on the basis of growth performance and distributed to two clusters. The twinning percentage has increased from 8.66% to 17.67% and triplet percentage was 2.6%. Six training programme on different aspects of goat production at hilly area were organized at Lamkot, Kanara and Jur Kafun villages with 219 participants. One workshop on "Goat farming for livelihood security of farmers of Uttarakhand under changing climatic scenario" was organized with 155 participants. Six animal health camps and two exposure visits of farmers to institute farm were conducted.

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

The unit is operational at KV&ASU Mannuthy, Thrissur, Kerala. The unit is operational at following clusters such Thalassery, Thaliparamba, Badagara, Perambra, Thavanur and Tanur located in Kannur, Kozhikode and Malappuram districts in northern and central parts of Kerala. Baseline information on production and reproduction traits, management practices and production trend were recorded and analyzed. Total of 273 farmers have been registered under the project and provided with breeding inputs, feed, feed supplements and health coverage. The closing balance was 3226. About 1094 adult females have been brought under insurance coverage. A total of 10 bucks of Malabari breed were selected and distributed to farmers. During the period, 988 kids were born from 577 kiddings, of which 536 were females. Overall population growth was 92.70%. The mean body weight recorded at birth, 3, 6, 9 and 12 months of age were 2.40±0.01 kg, 8.63±0.03 kg, 15.42±0.04 kg, 21.60±0.07 kg and 23.50±0.04 kg, respectively. The average daily milk yield recorded was 0.89±0.06 litres. The kidding rate was 1.63. Percentage of singles, twins and triplets were 38.65, 51.47 and 9.88, respectively. The mortality rate was 2.24% in the coverage area. As capacity building, 5 on-farm hands on training (2 days duration) were organized and 101 farmers participated. Besides, 22 on-farm / field classes of 2 hour duration was imparted to 778 farmers from through different agencies like Animal Husbandry Department, Agricultural Technology Management Agency, Kerala State milk Marketing Federations and NABARD. Three trainings for one day duration were offered to vocational students. Technologies for FAMACHA eye colour chart, Probiotic goat milk ice cream, treatment for orf were standardized. A goat shed was designed to accommodate 20 goats for high rain fall area. Published one book on goat rearing in local language with ISBN: 978-81937921-1-7, nine technical papers were presented in the International/National conference/seminars.

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

The unit is operational NARI, Phaltan. NARI is the only non-government organization running a field unit in AICRP. Osmanabadi field unit is operational in different clusters such as Ahmednagar, Beed, Pune and Satara districts. This year one new cluster was adopted - Malshiras taluka in Solapur district. The production performance of goats in farmers' flocks was assessed in the low rainfall, drought-prone, dry, Deccan plateau regions of five districts in Maharashtra state viz. Ahmednagar, Beed, Pune, Satara and Solapur districts. Five hundred fifty eight adult does belonging to 158 goat keepers are being recorded. 864 kids were born in 524 kidding of 470 does during April to December 2019, making the average litter size 1.65. The closing balance was 909 goats. The overall mortality was 1.8%. Four Osmanabadi bucks were purchased during the period, with 6 months weights of 16 kg. to 27 kg and dam's milk

yield 1 to 1.8 litres per day. During April to December 2019, total 2,500 Osmanabadi buck straws were supplied to A.I. technicians, farmers and entrepreneurs for breeding Osmanabadi goats. Conception rates of 50 to 55% have been reported by field technicians. The average 3, 6, 9 and 12-months weights of Osmanabadi kids under the Field Unit were 12.12 kg, 17.01 kg, 19.70 kg and 23.0 kg respectively. The least squares mean 90-day milk yield of Osmanabadi does to be 102.4 kg with 1574 records. This establishes the Osmanabadi breed to be among the top five dairy goat breeds in India. The least squares mean 90-day milk yields of does having singles, twins and triplets were 68.1, 103.4 and 135.8 Kg respectively, indicating that milk yield increases with the number of kids. We have published 14 information booklets/ leaflets in Marathi language to give information to goat keepers on better goat management practices. Regular preventive health care of goats was carried out in all villages including vaccinations, deworming and spraying against ecto-parasites.

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

The unit is operational at college of veterinary science, Vallabhnagar. The unit has following clusters such as Devgarh, Karget, Bojunda Farm. As per technical programme 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 five clusters. The closing balance of the registered flock was 2620 animals including 1611 adult females. During report period, 1069 kids were born out of which 517 were males and during report period population growth was 80.95%. The least squares means for body weight at birth, 3, 6, 9 and 12 months of ages were 2.35±0.03 kg, 12.01±0.30 kg, 15.95±0.41 kg, 19.57±0.49 kg and 23.99±0.45 kg, respectively. Year, season, sex of kid and type of birth had significant effect on the body weights. The overall least square means for milk yield over 30 days, 60 days, 90 days, 150 days, lactation yield and lactation length were 20.95±1.32 lit, 44.68±2.52 lit, 64.60±3.51 lit, 96.65±4.29 lit, 99.77±4.27 lit. and 152.82±1.34 days, respectively. The kidding rate (litter size) was 1.11 and the overall mortality was 4.53%. Animals were vaccinated, dewormed and provided with preventive measures.

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

The unit is operational at N.A.U., Navsari, and Gujarat. The unit has following clusters such as Bharuch, Karjan, Jambusar, Navsari, Bilimora and Vapi. The closing balance of the farm flock was 209 animals including 152 females. During the year, 34 new white coloured goats had kidded for the first time. During current year, 87 kids were born out of which 36 were males. There is no appreciable trait or physical character in this breed that can be counted as defect, but negative selection pressure is operating on this breed at high intensity due to higher demand of white bucks during Id-ul-Fitar festival. Farmers raise white Surti type buck for sacrificial purpose on Id-ul-Fitar festival. A total of 9 males were sold after 12 months age for breeding purpose. Overall population growth of 119.67% was recorded with the addition of 87 kids (50 singlet, 17 doublet and 1 triplet). The least square means for body weight at birth, 3, 6, 9 and 12 months of ages were 2.20 ± 0.23 kg, 7.855 ± 0.101 kg, 12.552 ± 0.181 kg, 17.840 ± 0.212 kg, and 21.856±0.270 kg, respectively. The least square mean weight of single born kids was found to be higher than the twins and triplet kids at all the age groups. The overall least square means for milk yield over 90 days, 140 days, lactation yield and lactation length was 91.45 ± 3.55 (372), 146.28 ± 4.90 (278), 154.42 ± 8.39(382) liters and 180.70 ± 6.67(382) days, respectively. Surti goats with higher litter size were found to be better milk producer compared to their counter parts. The kidding rate (litter size) was 1.28 justifying higher prolificacy in Surti Goats. Total 9 breeding bucks along with 27 breedable females were provided to goat farmers of adopted villages. Overall mortality in Surti flocks was 7.25%. Sensitization about benefits of AICRP on Goat scheme was made through various training programs. A training of one day entitled "Profitable Surti goat farming" was organized by Surti farm unit in which 72 female tribal farmers had participated. With continuous bilateral efforts from farmers and Surti field unit, around some village level goat cooperatives had been started in these villages. Additionally, twenty one (21) one day on campus trainings benefiting 587 farmers in collaboration with ATMA project were conducted.

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

The unit is operational at GBPUA&T, Pantnagar. The unit is operational at five clusters such as Bara, Tilpuri, Bhimtal, Kunda and Majhera. A total of 1562 kids were born during the period. The average body weights at birth, 3, 6, 9 and 12 months of age were recorded as 0.09±0.02 kg, 10.20±0.05 kg, 14.64±0.06 kg, 18.61±0.07 kg and 22.61±0.09 kg, respectively. Kid mortality between 0-3 months was 8.27% and overall mortality was 6.07%. The kidding rate has been recorded as 1.62 with remarkably higher number of twining and triplet kidding as 53.22%

and 3.64% respectively. A nucleus flock of Pantja goats has been established at Pantnagar, wherein 50 females and 16 males are maintained. Various inputs like compounded goat feed, mineral mixture, medicines, vaccines, lime and feeding bowls were distributed in the project area. Pantja bucklings were castrated at an early age for delicious meat of wethers. Goat keepers maintained their flocks within shed (58.33%) with *kaccha* floor (66.67%) and temporary roof (61.11%) during night and allowed grazing from morning to evening (61.12%) on community land. They did not provide manger (66.67%) but provided concentrate (41.67%) from ingredients available at their households.

6.2.13. Black Bengal Goat Field Unit, ICAR-RCER, Patna, Bihar

The unit is operational at ICAR-RCER, Patna. All India Coordinated Research Project on Goat Improvement started in ICAR-RCER during the year 2018 with five clusters in different districts of Bihar. The centre, being at initial years, attention was paid on strengthening the five clusters initially established, building rapport with the goat farmers and consolidation of activities. The closing balance was 3205. Number of goats registered under the project increased from 1243 to 2372 with an increase of 90.82%. A total of 18 bucks were selected, purchased and distributed among 5 clusters under field conditions. The population growth in the selected villages expanded to the tune 157.84% with the addition of breedable does and new births. The average body weight increased from 3.53±0.15 kg to 4.11±0.25 kg at 3 months of age and 5.56±0.34 kg to 6.15±0.26 kg at 6 months of age with the gain of 10.61 %. Mortality rate was recorded at 5.94 % for the year 2019. The mortality percentage was controlled within 6% due to comprehensive efforts of vaccination, deworming and timely therapeutic interventions. With respect to reproduction parameters, no significant gain was observed in spite of marginal increase in the parameters under evaluation. A positive trend with respect to socio-economic parameters of farmers registered under the project in the implementation area was observed.

6.2.14. Bundelkhandi Goat Field Unit, IGFRI, Jhansi, Uttar Pradesh

The unit became operational from May, 2018 at ICAR-Indian Grassland and Fodder Research Institute, Jhansi and it was initiated in 3 villages, Bajni and Parasari of Datia district (MP) and Palinda of Jhansi district (UP) with a total of 58 households/farmers. During the year 2019-20 one more village, Sersa was adopted under Datia cluster with 11 households and 313 numbers of goats. The goats under field conditions are mostly kept on extensive system of management with almost zero input except family labourers. A total of 9 breeding bucks were distributed to goat rearing farmers in adopted villages of Bajni and Parasari. Average body weights at birth, 3 months, 6 months, 9 months and 12 months were 2.41 kg, 10.18 kg, 13.75 kg, 17.35 kg and 20.45 kg, respectively. Average daily milk yield was 0.546 kg., while average milk yield at 90 days was 43.63 litres with lactation length of 104.1 days. Average kidding rate was also found as 1.13. The singlet and twining percentage was recorded as 83% and 17%, respectively. The selected animals of adopted villages were provided with health coverage under field conditions, namely vaccination, deworming, besides periodic treatment (508 cases) of animals suffering from different diseases/ sickness. Under field conditions the mortality of goats was less than 9%.

Groundnut (*Arachis hypogaea*) haulms, which were introduced as a strategic supplementary feed during winter season in Parasari village was extended to goat famers of Bajni and Sersa villages to reduce suffering from cold stress. One awareness-cum-interactive meeting/programme was organized where farmers were informed about importance of conserving local black Bundelkhandi goats and scientific goat rearing and health management practices.

6.2.15. Beetal Field Unit, Guru Angad Dev Veterinary & Animal Sciences University, Ludhiana, Punjab

Beetal Field unit is operational at GADVASU, Ludhiana, Punjab since Oct., 2018. Project team participated in Sensitization meeting of AICRP on Goat Improvement at Central Institute for Research on Goats (CIRG), Makhdoom, Mathura on December 11-12, 2018. One village (Bhundri) was adopted to execute Beetal goat development activities. Goat farmers are being provided various technical inputs under the project. One training programme on scientific goat farming at Bhundri village was organized and farmers were supplied with inputs i.e. mineral mixture, by-pass fat, dewormers, scientific literature (book and magazine) etc.

6.3 TECHNIQUES FOR AUGMENTATION OF FERTILITY IN GOATS

6.3.1 Semen cryopreservation and Artificial Insemination

Effect of catalase in semen diluent on the conception rate in goats using frozen semen Artificial Insemination

Artificial Insemination (AI) in goats is less developed compared to large animals due to lack of suitable protocol of goat semen freezing and AI. AI play a pivotal role for the long-term ex-situ *in vitro* conservation of threatened breeds, increased productivity and performance of large number of non-descript and low potential goats. The objective of the present study was to enhance the post thaw quality of buck semen by adding Catalase as an antioxidant in semen diluent and consequently conception rate through frozen semen AI technique. A total of thirty ejaculates collected from adult bucks maintained at this Institute. The samples were extended with Tris- Citric acid- Fructose diluent having 10% (v/v) egg yolk as a extracellular and 6% (v/v) glycerol as an intracellular cryo protecting agent. Catalases in different concentration were added in diluent (0 U/mL, 200 U/mL, 400 U/mL, 600 U/mL, 800 U/mL and 1000 U/mL). Sperm concentrations were adjusted to 1×10^{8} ml^{-1} and diluted semen was equilibrated at 5°C for 4 h before being frozen. Analysis of data revealed that motility, live sperm count, acrosomal integrity and hypo osmotic swelling positive spermatozoa were counted differed significantly ($P<0.05$) at different concentration of Catalase.. The post thaw motility, live sperm count, acrosomal integrity and hypo osmotic swelling positive spermatozoa were significantly ($P<0.05$) highest in 800 U/mL of Catalase used in the present study. Preliminary study suggested that addition of Catalase reduced the detrimental effects of freezing on motility, viability, plasma membrane and acrosome integrity and can be used for AI. A total 10 goats were chosen for frozen semen AI technique and 4 goats (40%) were pregnant by this technique using frozen semen straw of 800 U/mL catalase as an antioxidant. The conception rate in control group was 35%.

Table 1: Effect of catalase in semen diluent on post thaw quality

Concentration (Catalase U/ml)	Post Thaw Motility %	Live %	HOST %	Acrosome %
+ve Control	80.94±1.04	83.24±1.03	80.73±1.11	81.92±1.10
-ve Control	36.25±2.05^{b}	39.95±2.30^{b}	36.53±1.64^{b}	34.69±0.59^{b}
200	35.63±1.76^{b}	39.93±1.93^{b}	37.35±2.24^{b}	38.88±2.07^{b}
400	34.28±1.30^{b}	38.19±1.64^{b}	37.04±1.39^{b}	37.42±1.94^{b}
600	34.28±1.30^{b}	36.75±1.38^{b}	38.59±2.04^{ab}	39.87±1.38^{b}
800	42.86±2.86^{a}	47.81±2.29^{a}	44.73±3.48^{a}	46.81±2.50^{a}
1000	32.86±1.01^{b}	39.11±0.71^{b}	37.61±1.50^{b}	40.28±1.83^{b}

means with different superscript differ significantly within a column($p<0.05$)

Semen collection and cryopreservation

During the period under report, a total of 3616 semen doses of different breeds of goat (Jamunapari, Barbari and Jakhrana) were prepared and cryopreserved. Out of the total 3616 doses of frozen semen straws, 1008 straws were used under different experiments, Artificial Insemination under the project and demonstration to different types of visitors, trainee. 2040 frozen semen straw were sale to different farmer and rupees 51,000.00 revenue generated.

Table 2. Semen cryopreservation and post thaw quality of frozen semen

Breeds	Frozen straws
Jamunapari	1152
Barbari	1321
Jakhrana	585
Sirohi	558
Overall	**3616**

Table 3. Post thaw quality of frozen semen

Breeds	Progressive motility %	Live %	Acrosome intact sperm %	HOST %
Jamunapari	55.74^{a}±2.84	65.35^{a} ±2.94	72.51^{a} ± 3.24	68.72^{a} ± 2.81
Barbari	55.26^{a}±3.54	61.21^{b}±3.26	68.45^{b} ± 2.46	65.65^{b} ± 2.56
Jakhrana	50.16^{b}±3.12	54.39^{c}±3.12	64.31^{c} ± 2.54	61.23^{c} ± 3.12
Sirohi	50.62b±2.32	58.28^{bc} ±2.86	65.42^{c}± 2.86	63.22^{bc} ± 2.38

means with different superscript differ significantly ($p<0.05$) within a column

Artificial Insemination with Frozen Semen

In two major breeding seasons 57 goats of different breeds (Barbari, Jamunapari and Jakhrana and Bundelkhandi) were inseminated with frozen semen. A total 20 goats conceived by using frozen semen AI technology and total 28 kids (15 females and 13 male) were born through this technology. The kidding per cent was 35.09%.

Table 4: Kidding percent through AI (April-May, 2019)

Breeds	Does Inseminated	Does Pregnant	Conception rate %
Jamunapari	10	3	30.00
Barbari	14	5	35.71
Jakhrana	6	2	33.34
Overall	**30**	**10**	**33.01**

Table 5: Kidding percent through AI (September-October, 2019)

Breeds	Does Inseminated	Does Pregnant	Conception rate %
Jamunapari	3	1	33.33
Barbari	10	4	40.00
Jakhrana	14	5	35.71
Overall	**27**	**10**	**37.03**

Table 6: Overall kidding percent through AI

Breeds	Does Inseminated	Does Pregnant	Conception rate %
Jamunapari	13	4	30.77
Barbari	24	9	37.50
Jakhrana	20	7	35.00
Overall	**57**	**20**	**35.09**

(**Project:** Optimization of Semen Freezing Protocol and Artificial Insemination in Goats. PI- Dr. Ravi Ranjan; CO-PIs - Drs. A. K. Goel, S. D. Kharche, N. Ramachandran, Saket Bhushan, M. K. Singh, M. S. Dige, Chetna Gangwar)

6.3.2 Transcriptome profiling of spermatozoa for the development of biomarker for the selection of fertile bucks

RNA isolation was done from semen samples collected from Good and poor Fertility bucks (n=6), of Jamunapri and Barabri breeds by modified TRIZOL protocol. RNA quality was measured on the basis of Biophotometer, quantifications of the total RNA, yielded 1.60 to 1.79 µg/ml; Nanodrop concentration lies between 293-714 ng µl & Qubit concentration lies between 34-73 ng/µl. The libraries of four samples were sequenced on Illumina Hiseq 2500 to obtain 2x100bp PE reads. The total number of reads of each assembled mRNA obtained were Q>30 per sample. The MDS plot showed the level of similarity of individuals in a datasheet. The dendrogram plot represented the hierarchical tree. The Box plot showed the similar distribution pattern. Density plot showed the distribution of FPKM values of the samples on the x-axis and y-axis. Correlation scatter plot showed positive

correlation, a total of 3550 genes pass the filtering of q-value. We concluded about the RNA presence in the sperm of normal fertile bucks, mRNAs function for regulatory interactions, important transcripts and pathways.

(Project-1 DST WOS-A scheme): Transcriptome profiling of spermatozoa for the development of biomarker for the selection of fertile bucks (Investigators: PI: Dr.Sonia Saraswat; Mentor: Dr. S. D. Kharche)

6.3.3 Effect of Catalase on sperm functional parameters during liquid storage of buck semen

A total of 10 bucks (Barbari) were selected based on sexual behaviour (libido, reaction time) and seminal parameters (mass activity, volume, colour, consistency and sperm concentration). Semen samples (30) were collected by Artificial Vagina (AV), immediately after collection the volume, colour, consistency and Mass activity of collected samples was evaluated under 40X magnification in microscope without coverslip. After evaluation the samples were diluted with Tris-Egg Yolk-Glycerol-Citrate buffer and their progressive motility was examined under 400X magnification with coverslip. Collected samples having volume (0.5 ml), colour (creamy), consistency (Medium) and Mass activity (≥4) and motility >70% were cryopreserved. Trial has been conducted to evaluate the potential benefit of Catalase on sperm functional parameters (motility, viability, membrane integrity and acrosomal integrity) during liquid storage of buck spermatozoa at 24h, 48h, 72h and 96h. Semen samples from five bucks were pooled and diluted with tris-egg yolk-fructose extender with (200U/ml, 400U/ml, 600U/ml and 800U/ml Catalase) and without Catalase (Control) supplementation at a final concentration of 3-5 billion sperm/ml. Motility, viability, plasma membrane and acrosome integrity were observed highest for C600 in comparison to other concentrations (control, C200, C400, C600 and C800) at 48, 72 and 96 h incubation time. Preliminary study suggests that addition of CAT (600U/ml) reduced the detrimental effects of cooling on motility, viability, plasma membrane and acrosome integrity maintained at 5°C.

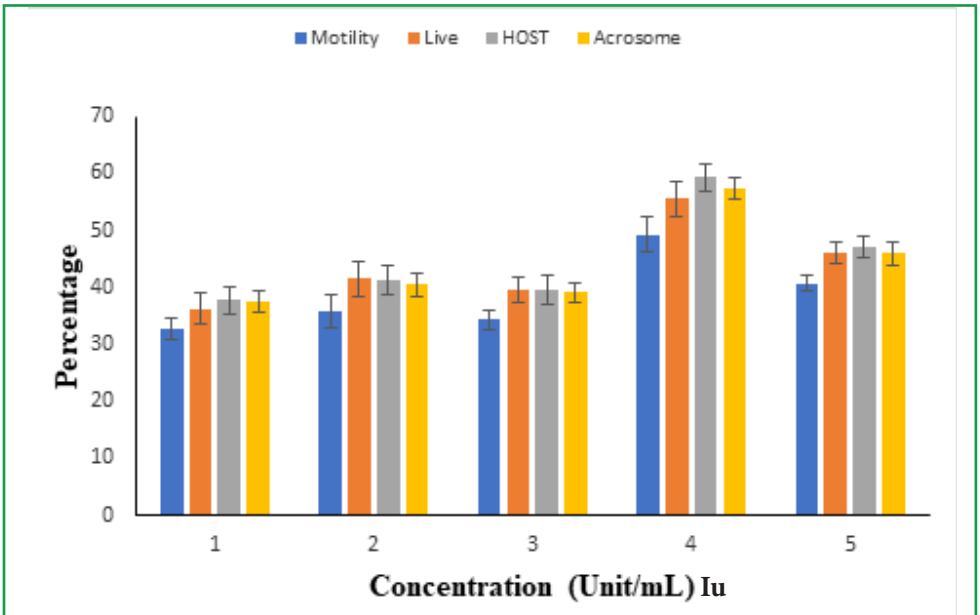


Figure 1. Effect of Catalase on seminal parameters at 96 hours of refrigeration temperature

Effect of Misoprostol on sperm functional parameters during cryopreservation of buck semen

A total of 10 bucks (Barbari) were selected based on sexual behaviour (libido, reaction time) and seminal parameters (Mass activity, volume, colour, consistency and sperm concentration). Semen samples (30) were collected by Artificial Vagina (AV), immediately after collection the volume, colour, consistency and Mass activity of collected samples was evaluated under 40X magnification in microscope without coverslip. After evaluation the samples were diluted with Tris-Egg Yolk-Glycerol-Citrate buffer and their progressive motility was examined under 400X magnification with coverslip. Collected samples having volume (0.5 ml), colour (creamy), consistency (Medium) and Mass activity (≥4) and motility >70% were cryopreserved. Trials

have been conducted to evaluate the potential benefit of Misoprostol on sperm functional parameters (motility, viability, membrane integrity and acrosomal integrity) during cryopreservation of buck spermatozoa. Semen samples from five bucks were pooled and diluted with tris-egg yolk-fructose extender with (5 µM/ml, 10 µM/ml, 15 µM/ml and 20 µM/ml Misoprostol) and without Misoprostol (Control) supplementation at a final concentration of 3-5 billion sperm/ml. Misoprostol is a Prostaglandin E_1 (PGE1) analogue that induces cervical ripening. In previous studies researchers injected Misoprostol before AI and observed its direct correlation with the rate of resulted pregnancy. In this study we used Misoprostol as an additive in semen extender as it causes natural relaxation of cervix and also prevents premature capacitation of spermatozoa, thereby increases their life span. No significant difference was observed in post thaw motility and viability between control and 15 µM/ml concentration. However, membrane integrity and acrosome intactness were observed to be highest in case of 15 µM/ml concentration. Preliminary study suggests that addition of Misoprostol (15 µM/ml) reduced the detrimental effects of cooling on plasma membrane and acrosome integrity during cryopreservation. Further, Malondialdehyde (MDA) and Mitochondrial Membrane Potential (MMP) will also be performed to know its any antioxidant property and inhibitor of premature capacitation.

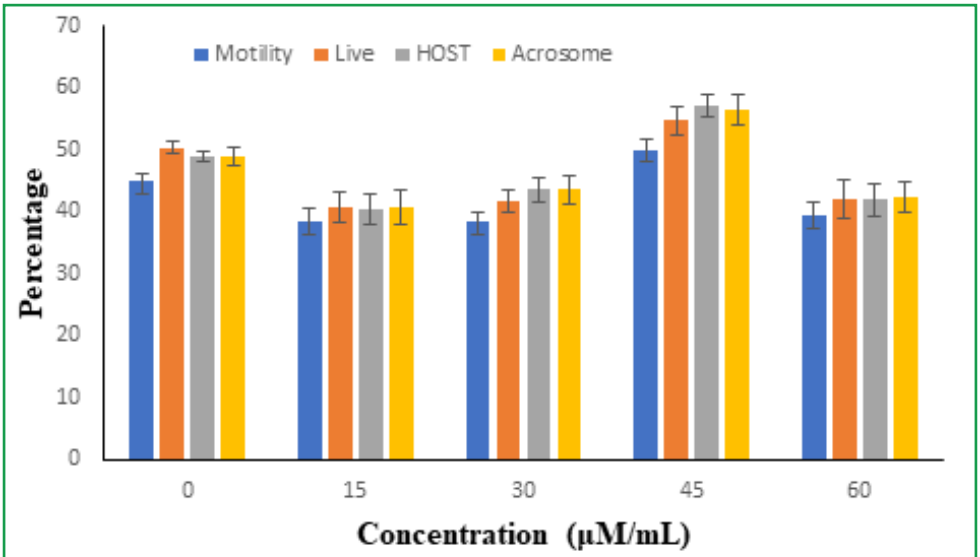


Figure 2. Effect of Misoprostol on post thaw sperm functional parameters at different concentrations.

Effect of Pyridoxine on sperm functional parameters during Cryopreservation of buck semen

A total of 10 bucks (Barbari) were selected based on sexual behaviour (libido, reaction time) and seminal parameters (mass activity, volume, colour, consistency and sperm concentration). Semen samples (30) were collected by Artificial Vagina (AV), immediately after collection the volume, colour, consistency and Mass activity of collected samples was evaluated under 40X magnification in microscope without coverslip. After evaluation the samples were diluted with Tris-Egg Yolk-Glycerol-Citrate buffer and their progressive motility was examined under 400X magnification with coverslip. Collected samples having volume (0.5 ml), colour (creamy), consistency (Medium) and Mass activity (≥4) and motility >70% were cryopreserved. Pyridoxine has effective antioxidant properties. It is involved in stress tolerance especially in alleviating oxidative stress. In eukaryotes, stress resistance has been implied to involve pyridoxine-dependent singlet oxygen quenching, whereby the pyridoxine itself would act as antioxidant. Trials have been conducted to evaluate the potential benefit of Pyridoxine on sperm functional parameters (motility, viability, membrane integrity and acrosomal integrity) during cryopreservation of buck spermatozoa. Semen samples from five bucks were pooled and diluted with tris-egg yolk-fructose extender with (2 mM/ml, 4 mM/ml, 6 mM/ml and 8 mM/ml Pyridoxine) and without Pyridoxine (Control) supplementation at a final concentration of 3-5 billion sperm/ml. Post thaw motility, viability, plasma membrane and acrosome integrity were observed highest for 4 mM/ml in comparison to other concentrations (control, C2, C6 and C8). Preliminary study suggests that addition of Pyridoxine (4 mM/ml) reduced the detrimental effects of cooling on motility, viability, plasma membrane and acrosome integrity during cryopreservation.

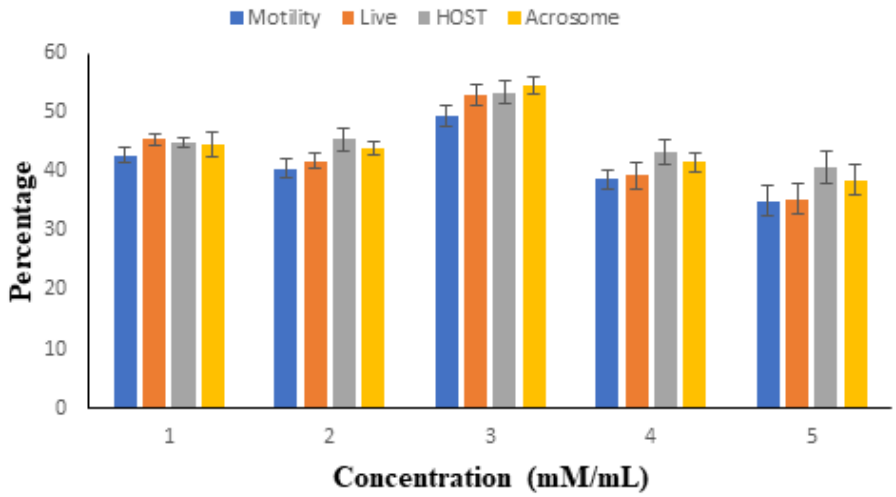


Figure 3. Effect of Pyridoxine on post thaw sperm functional parameters at different concentrations.

(DST WOS-A scheme): Minimizing mitochondrial and DNA cryodamages of goat sperm by modified dilutor (Investigators: PI: Dr Pallavi Singh; Mentor: Dr Ravi Ranjan)

6.3.4 Stem cell technology for fertility improvement in goats

Effect of different cryoprotectants/freezing media on preservation of BMMSCs

The BMMSCs were treated and cryopreserved in seven different types of freshly prepared cryoprotectant media. The following cryoprotectant media were prepared by the combination of dimethyl sulfoxide (DMSO) 10 %, sucrose 0.2 M, ethylene glycol (EG) 10% and FBS 10% (Table 7).

Table 7: Composition of different cryoprotectant media

Media Component	A	B	C	D	E	F	G
DMEM (%)	80	80	80	80	80	80	80
FBS (%)	10	10	10	10	10	10	10
DMSO (%)	10	x	x	10	10	x	10
EG (%)	x	10	x	10	x	10	10
Sucrose (mg)	x	x	342.3	x	342.3	342.3	342.3

Prior to cryopreservation, the confluent cells were treated with 0.25% trypsin-EDTA followed by determination of viable/total cell ratio by the trypan blue dye exclusion assay using an automated cell counter device (Countess L^{TM}, Thermo Fisher Scientific). Total of 1×10^6 viable cells were resuspended in 1 ml of every cryopreservation media. Then the cells were loaded in 0.25 ml of mini straws and kept for 2 h at -15°C followed by plunging in to liquid N_2 (-196°C) where the straws were kept for minimum six months.

On completion of six months, the straws were thawed (15 sec in air and 30 sec in 37°C warm water) and washed with washing media through centrifugation at 7000 rpm for 10 minutes. The cell pellets obtained after centrifugation were subjected to cell counting for live/dead by trypan blue exclusion assay through automated cell counter device (Countess L^{TM}, Thermo Fisher Scientific).

After determination of cell numbers, the cells were seeded in in 12 well culture plates for growth curve analysis and PDT determination as follows: the cells were seeded at a seeding density of 2×10^4 cells/well in a 12 well plate for growth curve analysis and population doubling time was calculated from the growth curve by using formula as described earlier. The growth curve analysis and Population doubling time was undertaken for single passage with duplicates to assess the proliferation capacity of the cells after cryopreservation in different media.

Effect of different culture media on growth and proliferation of BMMSCs

After the cell pellet was harvested they were suspended in four different media i.e. MesenPRO (ThermoFisher Scientific), Mesencult (STEMCELL Technologies), StemPro (Gibco) and complete DMEM/F12 (Gibco) media and incubated at 37°C in humidified atmosphere with 5% CO_2. Spent media was changed on every 48 h in order to get rid of non- adherent cells and to propagate the plastic adherent MSCs. After the cells attained 70-80% confluency they were passaged with 0.25% Trypsin-EDTA followed by re-suspension in different media as mentioned earlier.

The cells were seeded at a seeding density of 2×10^4 cells/well in a 12 well plate for growth curve analysis and as far as population doubling time was concerned, it derived by using log formula from the growth curve as mentioned in below section. The growth curve analysis and Population doubling time was undertaken from passage 0 (P0) to passage 3 (P3) in different media

Table 8: The population doubling time (PDT) derived from of different media against different passages (P)

Media	PDT (h) P0	PDT (h) P1	PDT (h) P2	PDT (h) P3
DMEM	88.81	42.03	45.74	46.79
MESENCULT	77.09*	44.09	49.64	54.87
MESENPRO	85.97	39.45	41.01	44.71
STEMPRO	84.94	43.20	46.59	48.49

* $p<0.05$

Effect of mesenchymal stem cell transplantation into the ovary.

Total thirty female goats and twelve female kids were selected for this study. The descriptions for each group of animals are be written as follows:

- **Group 1(n=6)**: This group of animals comprised of adult anestrus animals and were administered normal saline into ovaries, was termed as control group. They were used for comparative study against anestrus treatment group.
- **Group 2 (n=6)**: Anestrus treatment group, this group had anestrus adult does with more than 5 years of age and they were administered 1×10^6 cells/ovary third passaged BMMSCs into ovary.
- **Group 3 (n=6)**: Pre-pubertal control group, this group had pre-pubertal female kids aged between 5-6 months. They were administered normal saline into ovaries and treated as control.
- **Group 4 (n=6)**: Pre-pubertal treatment group; goats aged between 5-6 months and they received 1×10^6 cells/ovary BMMSCs (3^{rd} passaged) into ovarian cortex.
- **Group 5 (n=6)**: Cyclophosphamide control group, this group was consisted of healthy does without cyclophosphamide injection and compared with intravenous cyclophosphamide injected group (group 6 and group 7).
- **Group 6 (n=6)**: This group of animals received cyclophosphamide @ 30 mg/kg b.wt. intravenously and the effect of cyclophosphamide on ovarian activity was compared with that of Group 5.
- **Group 7 (n=6):** Cyclophosphamide and BMMSCs group: this group of animals were injected cyclophosphamide @ 30 mg/kg bwt intravenously. After a period of 15 days they were injected 1×10^6 cells/ovary BMMSCs in to the ovarian cortex to assess the BMMSCs therapeutic function to restore the ovarian functions.

Delivery of BMMSCs into ovarian cortex

Caprine bone marrow derived mesenchymal stem cells were transplanted into various treatment groups (Group 2, Group 4 and Group 7) to interpret their effect on ovarian responses. In that context, 1×10^6 cells/ovary passage 3 BMMSCs were transplanted into the ovarian cortex through laparoscopy/laparotomy. The operative procedure of laparoscopy and laparotomy was conducted.

Intraovarian injection of MSCs

Prior to operation, whole of flank and abdominal area was thoroughly clipped, surgically scrubbed, disinfected with 70 % alcohol and draped thoroughly. The animals were anaesthetized with Xylazine 0.02 mg/kg and Ketamine 20mg/ kg intramuscularly. Once anaesthesia was achieved, the does were placed in dorsal recumbency. After the animal was secured properly, a midline incision was given and uterus was gently surfaced after incising different layers i.e. fascia, muscle layer and peritoneum to visualize the ovary. Once ovary was secured properly,

1×10^6 BMMSCs in PBS were injected into ovarian cortex very carefully to avoid damage to the ovarian tissue. Once the cells were transferred, the different layers were sutured properly; the muscle layer was sutured with catgut with simple continuous suture followed by suture of peritoneal layer. Finally, the skin was sutured with silk by simple interrupted sutures. The animals were given a dose of antibiotic, anti-inflammatory and anti-histaminic as part of preventive and prophylactic measure. The ovariectomy was accomplished after 10 days of MSC injection.

Histological analysis

To assess the therapeutic effect of BMMSCs transplantation, the histological sections were examined for possible increase in follicle numbers. As per the findings, there was significant number of increase in follicle numbers in treatment groups than the respective control groups. The histological sections, both H & E and IHC are given in Figure (control) and Figure (MSC treated).

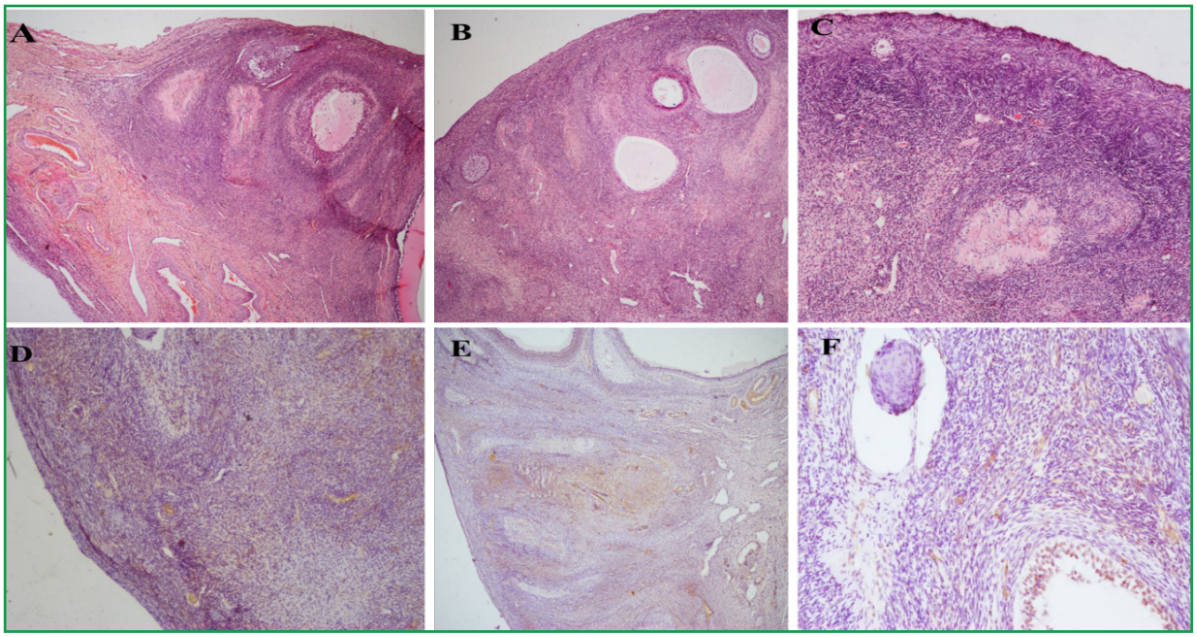


Figure 4: Ovaries of infertile goat model showing degenerated follicles (A, B, C, H&E staining) and absence of FSH receptor (D, E, F, immunocytochemistry)

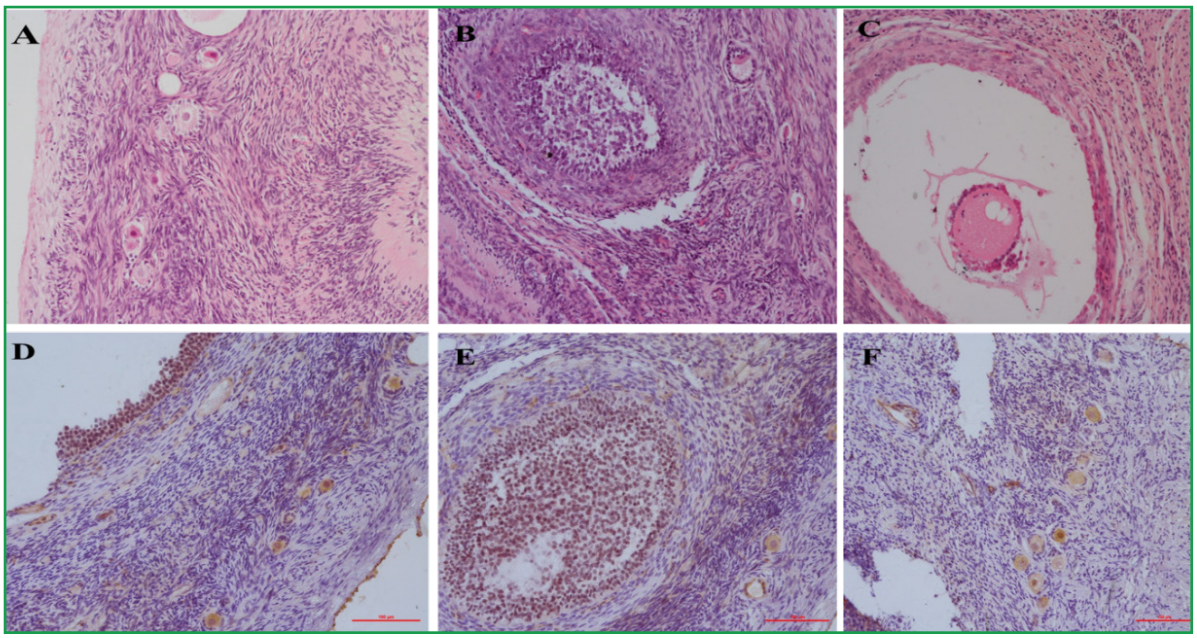


Figure 5: Ovaries of infertile goat model treated with MSCs, showing follicles (A, B, C, H&E staining) and presence of FSH receptor (D, E, F, immunocytochemistry)

Determination of follicle numbers in different group of animals

The number of follicles as determined by the histological sections. The number of primordial follicles in group 2 (adult treatment group) was significantly lower ($p<0.01$) as compared to group 2 (adult control group) albeit it had higher number of primary follicles when compared with the control group which was a case of significant difference ($p<0.001$). As far as secondary follicle count was concerned, there was non- significant higher number of follicles in group 1 when compared with group 2 and tertiary follicles were at nadir in both group 1 and 2. The result showed that, upon BMMSCs transplantation there was a decrease in primary follicle and secondary follicle count though the incidence of increased primary follicle was encountered.

The statistical analysis of follicle numbers from prepubertal groups revealed that, there was significantly higher ($p<0.05$) number of primordial follicle in group 4 when compared to group 3 (control group). Similarly, there was significant rise in secondary follicles ($p<0.01$) and tertiary follicles (non-significant). However, the number of primary follicles were in lesser numbers in group 4 when compared with group 3 which resulted to be significant ($p<0.001$). The follicular count in prepubertal groups revealed a stark difference in a fashion they counted in adult groups.

The number of different category of follicles of cyclophosphamide groups (group 5, group 6 and group 7) are presented in table 3 and fig 2. The mean primordial follicle number was significantly lowered ($p<0.001$) both in group 6 and group 7. However, the primordial follicles in group 7 had significantly ($p<0.01$) in higher numbers as compared to group 6 signifying the fact that BMMSCs transplantation had improved the condition ovarian cortex after cyclophosphamide injection. Similar trend was observed in all categories of follicles. Apropos of primary and secondary follicles were concerned; they followed the same fashion akin to primordial follicles. The primary follicles in group 6 were significantly reduced ($p<0.05$) compared to group 5 owing to cyclophosphamide injection. However, their numbers were significantly higher ($p<0.01$) in group 7 when compared to group 6 although it was significantly lower ($p<0.05$) as compared to group 5. The number of secondary follicles were significantly higher both in group 5 ($p<0.05$) and group 7 ($p<0.001$) when compared to group 6.

Table 9: Follicle count of different group of animals as expressed in mean ± SEM

Types of Follicles Group	Primordial follicle	Primary follicle	Secondary follicle	Tertiary follicle
Group 1	60.00±7.13	2.67±0.49	1.50±0.22	0.0±0.0
Group 2	21.50±1.54**	31.50±3.51***	0.83±0.30	0.0±0.0
Group 3	93.83±6.40	73.67±2.90	0.00±0.00	0.0±0.0
Group 4	113.00±4.34*	22.00±3.94***	2.83±0.40**	0.67±0.33

* $p<0.05$; ** $p<0.01$; *** $p<0.001$

Expressional analysis of fertility markers in ovarian tissues of different group of animals

As mentioned earlier expressional analysis of three fertility markers i.e. AMH, GJA5 and β defensin 1 were studied in this experiment between different treatment groups taking into consideration of their respective control groups. The groups sowed almost similar pattern of expression for all three fertility markers and discussed as below.

Anti-mullerian hormone (AMH)

The amplification curves and melt peaks of GAPDH and AMH is given in fig 40 (A and D) and 40 (B and E) respectively. The expression of AMH was significantly ($p<0.05$) up-regulated both in adult as well as pre-pubertal groups when compared with the cyclophosphamide group of animals. The fold change for adult as well as pre-pubertal was 0.37 times higher than the control groups. The AMH expression was down-regulated in both the cyclophosphamide groups (Table 5).

Gap Junction A, protein 5 (GJA5)

The amplification curves and melt peaks of GJA5 is given in fig 40 (B and E). The fold change expression of Gap Junction A, protein 5 (GJA5) in different treatment groups calibrated against control. As per the data, there was a significant up-regulation ($p<0.001$) of GJA5 expression in pre-pubertal animals when compared to cyclophosphamide groups. The adult group did not show significant difference in the fold change to the GJA5 gene compared with pre-pubertal and cyclophosphamide

groups (Table 6). Moreover, the down-regulation in group 6 and 7 varied significantly ($p<0.05$).

β defensin 1

As far as the expression level of β defensin 1 was concerned, the pre-pubertal group shared significant up-regulation when compared with cyclophosphamide groups. However, the adult group of animals shared non-significant up-regulation of the β defensin with both pre-pubertal as well as cyclophosphamide groups with a fold change of 22.50. and between the cyclophosphamide groups, the fold change was non-significantly down-regulated. Fold change expression of Gap Junction A, protein 5 (GJA5) in different treatment groups calibrated against control (Table 11).

Table 10: Fold change expression of Anti-mullerian hormone (AMH) in different treatment groups of animals calibrated against control.

Experimental Group	Fold change	Change in expression
Group 2	0.37[a]	Up-regulated
Group 4	0.37[a]	Up-regulated
Group 6	5.56[b]	Down-regulated
Group 7	1.65[ab]	Down-regulated

Table 11: Fold change expression of Gap Junction A, protein 5 (GJA5) in different treatment groups of animals calibrated against control.

Experimental Group	Fold change	Change in expression
Group 2	12.36[abc]	Up-regulated
Group 4	0.37[a]	Up-regulated
Group 6	13.04[b]	Down-regulated
Group 7	9.51[c]	Down-regulated

Table 12: Fold change expression of β Defensin in different treatment groups of animals calibrated against control.

Experimental Group	Fold change	Change in expression
Group 2	22.50[ab]	Up-regulated
Group 4	0.10[a]	Up-regulated
Group 6	12.90[b]	Down-regulated
Group 7	6.10[b]	Down-regulated

(**NASF Project:** Study the effect of mesenchymal stem cell transplantation on ovarian function and fecundity in goats. **Investigators**: PI: S D Kharche; COPI: Drs M. S. Dige, Ravi Ranjan and M. S. Chauhan, S. P. Singh and A. K. Goel)

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

Quantitative Real time expression of SSC specific pluripotent marker genes

RNA isolation and cDNA amplification

Spermatogonial stem cell colonies of bucks were detached from the culture plate by trypsinization to obtain a single cell suspension. Total RNA was then isolated using the *Trizol* method. The concentration and purity of RNA were determined spectrophotometrically. Approximately 2 µl of RNA sample was used for reverse transcription in a final volume of 20 µl according to the manufacturer's protocol (High capacity cDNA RT synthesis kit, Invitrogen, USA; 4368814).

SYBR Green based Real-Time PCR for quantification

Expression of different markers such as SSC specific marker *(PGP9.5),* SSC Pluripotent marker *(OCT4)* markers specific for SSC undifferentiated type A

spermatogonia (*UCHL1, BCL6B, ID4, THY1);* and SSC differentiation marker *(BMP4)* were analyzed in the present study. Quantitative real time PCR was performed on RT-PCR (Applied Biosystems QuantStudio® 5 Real-Time PCR) in a 20 µl reaction volume containing 10 µl SYBR Green Master Mix, 1 µL of each primer @ 10 Picomole concentration and 2 µl cDNA. The thermal cycling conditions consisted of initial denaturisation at 50°C for 2 min and 95°C for 10 minutes, followed by 40 cycles of 15 sec at 95°C, 1 min at the appropriate annealing temperature and 30 sec at 72°C and melting curve. All primers pairs used were confirmed for their PCR efficiency and specific products were checked by melt curve analysis. Primer sequences used for the genes are shown in the Table 1. GAPDH and β-Actin Tubulin were used as housekeeping gene. A non-template control (NTC) was also taken for each gene with every batch of run. All qPCR reactions were performed in duplicates.

The relative quantification of target genes expression was calculated using ΔCt. The threshold cycle (Ct) values were based on duplicate measurements. The data analysis was carried out by StepOne® software v 2.2.2.

Table 13: Primers sequences used for qPCR analysis of specific genes

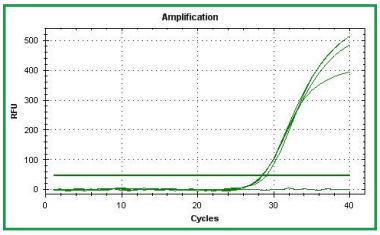
S. No.	Gene	Primer Sequence (5' to 3')	Annealing temp (°C)	Product length (bp)	Accession no.
1.	PGP 9.5	F: TTCTCTGGGTTGTGTTCGTTTC R: TCAGCACTTTGTTCAGCATCTC	60	120	NM_001046172.2
2.	UCHL1	F: GATAAGCACTTACCCTCAACC R:GCCTTAACTTACAGACACAAACC	58	165	XM_005681551.1
3.	ID4	F: TGTCACTGAGTTTCATGTCTG R: AGAAAGTGTTCATTGCCAAGAG	56	102	XR_139666.2
4.	THY1	F: TGCTAACAGTCTTACAGGTG R: GGCTGAACTCATACTGAATGG	57	131	BC104530.1
5.	PLZF	F: ATACCGAGAGCAACAGTTCC R: ATGAGGCTTTCTTTCCTTCC	58	169	NM_001037476.1
6.	BCL6B	F: GCCACCACCTTTAATTTCTCAC R: GAAATCAGGCTTCCAGTCTC	58	162	XM_005693476.1
7.	GAPDH	F: TCAAGAAGGTGGTGAAGCAG R: CCCAGCATCGAAGGTAGAAG	56	157	GU324291.1
8.	β-Actin	F: TGCCCTGAGGCTCTCTTCCA R: TGCGGATGTCGACGTCACA	60	180	

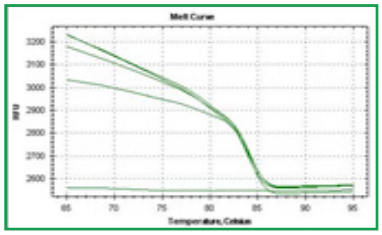
Results

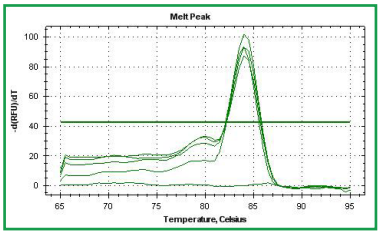
SYBR Green based Real-Time PCR for quantification

The qPCR results represent that the cultured putative SSCs showed the amplification of different markers such as SSC specific marker *(PGP9.5)*, SSC Pluripotent marker *(OCT4)*, markers specific for SSC undifferentiated type A spermatogonia (*UCHL1, BCL6B, ID4, THY1)* and SSC differentiation marker *(BMP4)*. Their expressions were studied by comparing their expression levels relative to the house keeping genes.

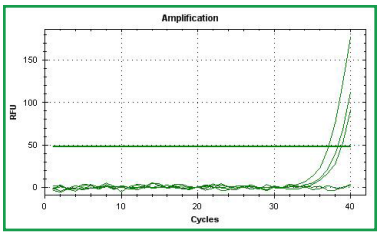
UCHL1

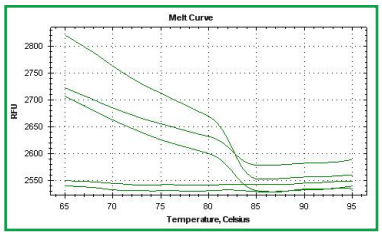


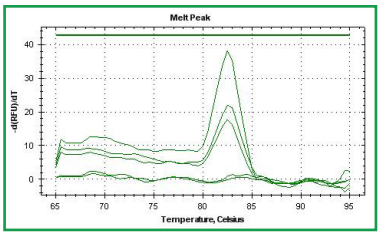




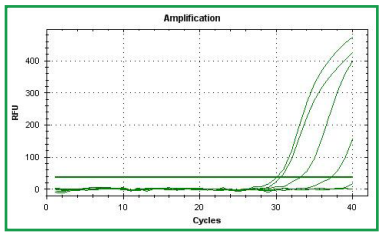
BCL6B

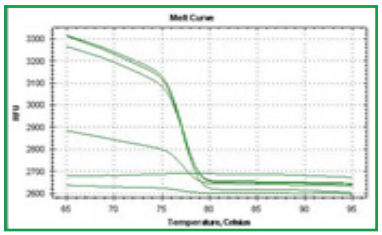


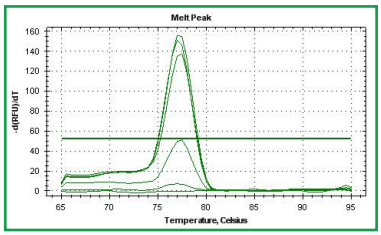




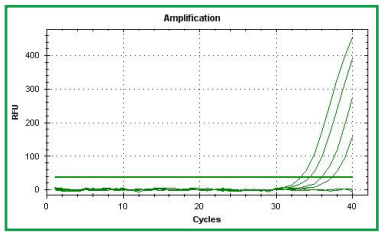
ID4

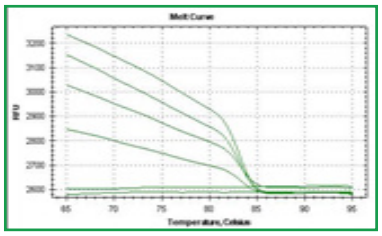


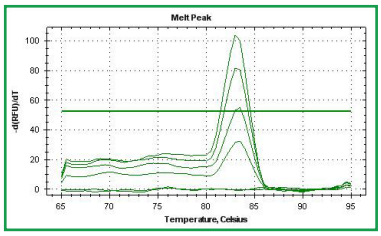




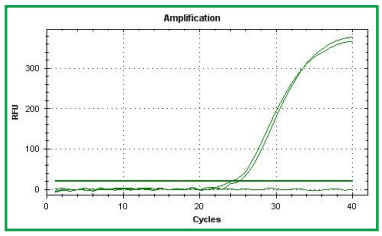
THY1

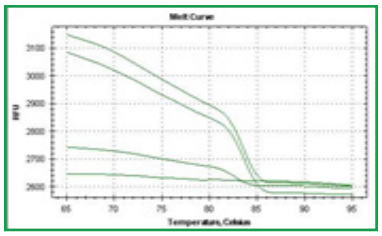


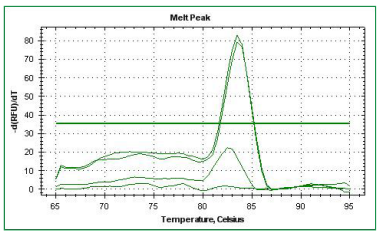




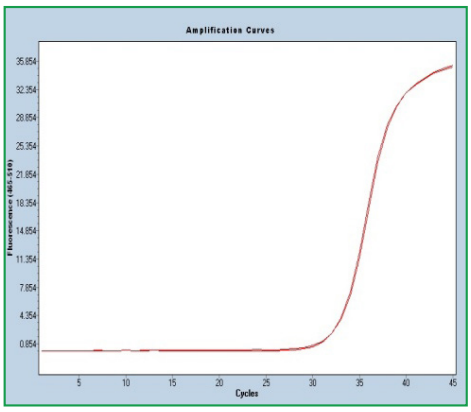
GAPDH

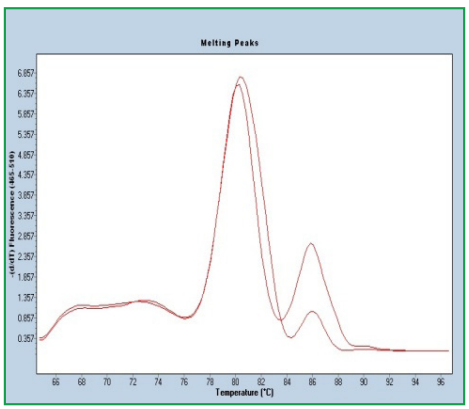




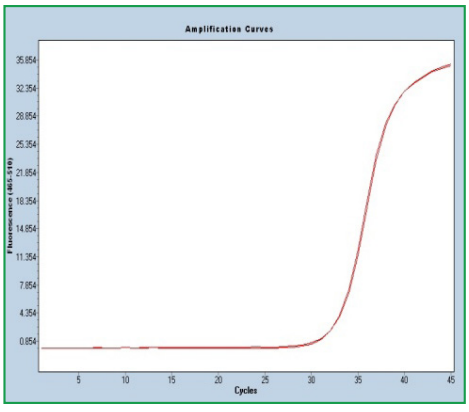


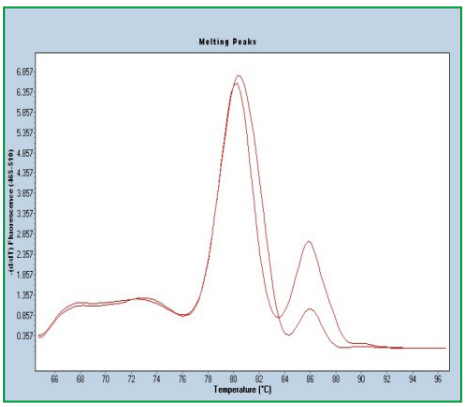
PGP9.5



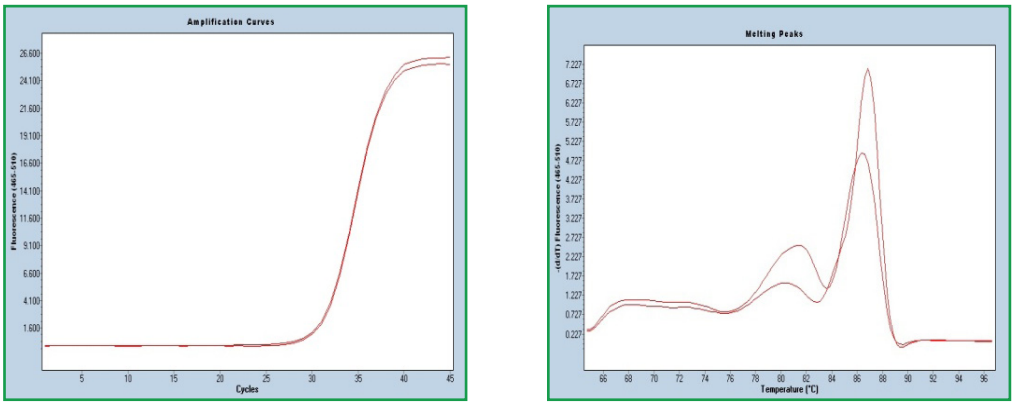


OCT4





BMP4



β-Actin

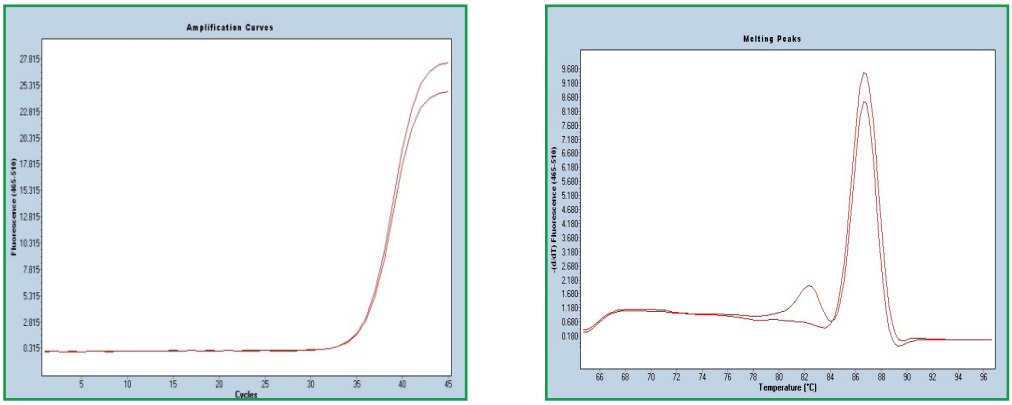


Figure 6: RT-PCR analysis (amplification and melting curves) of goat putative spermatogonial stem cell for the expression of markers of spermatogonial stem cell (PGP9.5), pluripotency (OCT4), undifferentiated type A spermatogonia (UCHL1, BCL6B, ID4, THY1) and SSC differentiation (BMP4). GAPDH and β-Actin were used as housekeeping genes.

After the standardization of protocol for isolation of spermatogonial stem cells; their enrichment by different techniques such as differential plating, percoll density centrifugation and magnetic assisted cell sorting and characterization of SSC by ALP and IFC staining; the quantitative characterization of SSC by isolation of mRNA and preparation of cDNA and study of its expression; cryopreservation of spermatogonial stem cells were standardized.

Isolation, enrichment and characterization of Spermatogonial Stem Cell like cells from Doom Pig

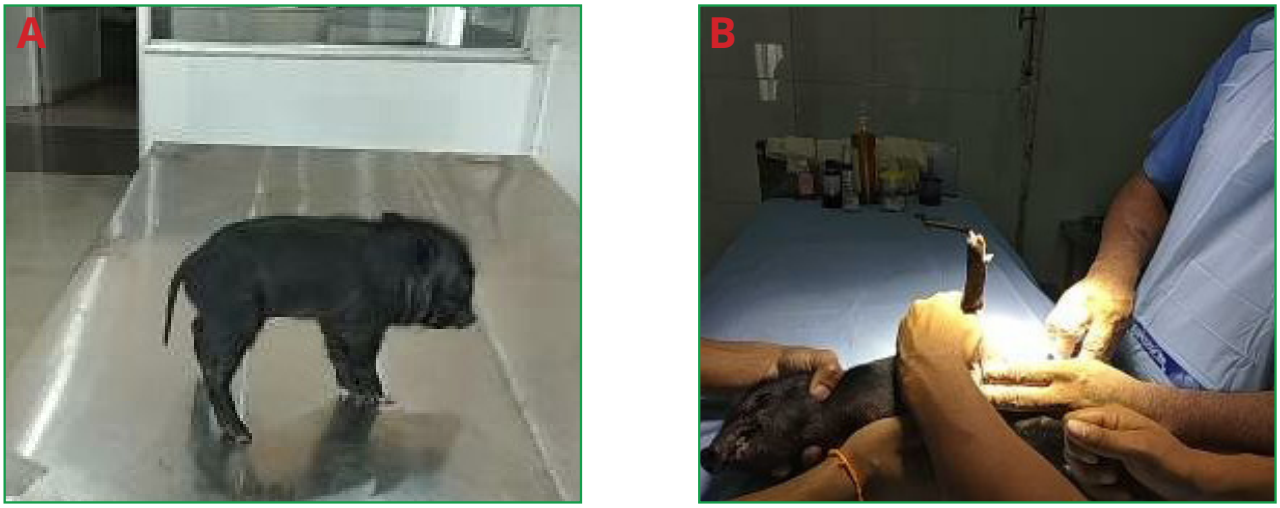


Figure 7: (A) 7 days old Doom Piglet; (B) Castration of 7 days old Doom Piglet for Testes Collection

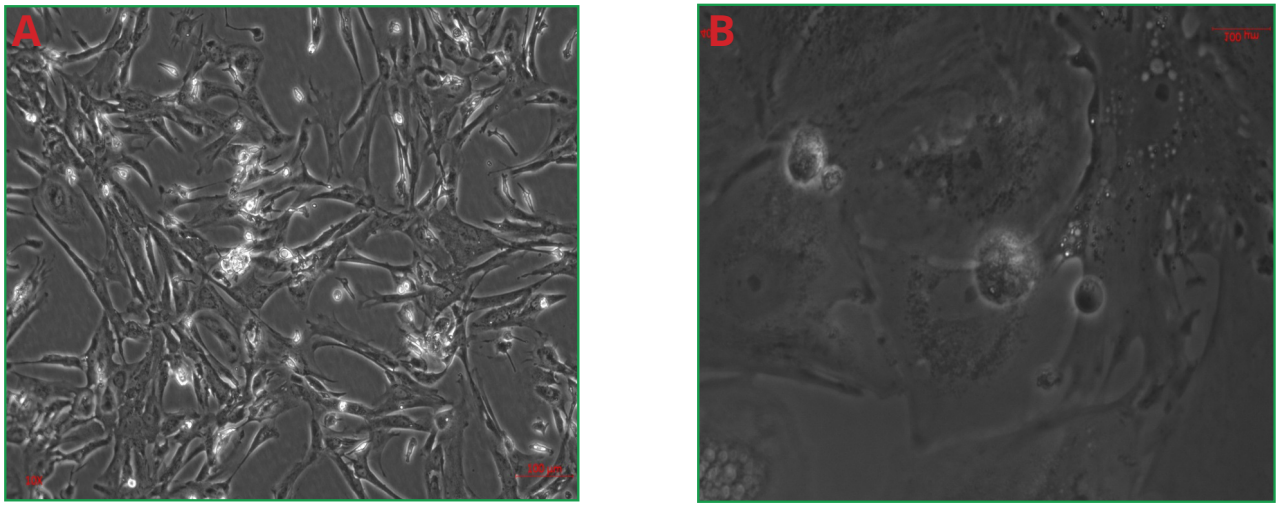


Figure 8: (A) Doom Pig feeder layer (100X magnification); (B) Doom piglet SSC colonies after 18 days of incubation (400 X magnification)

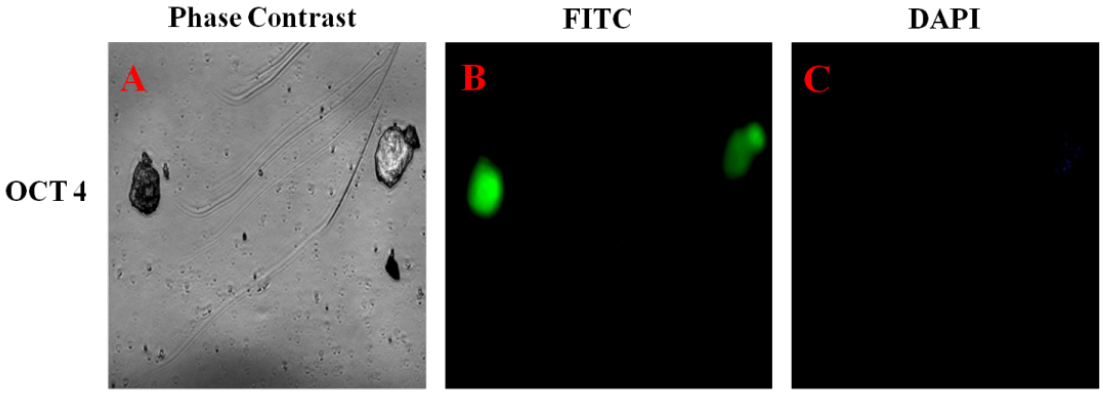


Figure 9: Immunofluorescent analysis of pluripotent marker OCT 4 (A-C), (200X magnification) in putative Doom Piglet SSC colonies. Phase Contrast Image (column A) FITC labeled image (column B), DAPI nuclear stained image (column C).

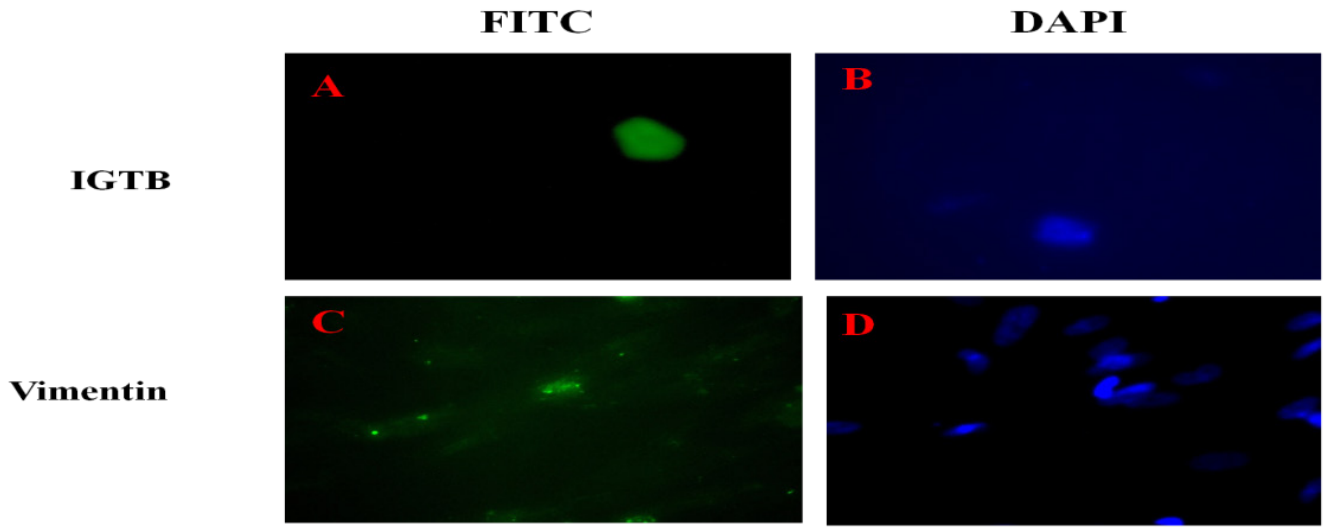


Figure 10: Immunofluorescent analysis of pluripotent and Sertoli cell marker IGTB (A-B), Vimentin AB (C-D) (200X magnification) in putative Doom Piglet SSC colonies. FITC labeled image (column A), DAPI nuclear stained image (column B).

Expression of gene specific markers

For this study, the cDNA (standardized at 70µg/ml concentration) of spermatogonial colonies of Doom pig and the aliquots of number of primers (10 pmole concentration) were transported from the AAU Khanapara laboratory to the CIRG laboratory for the quantitative characterization by using SYBR Green based Real-Time PCR. Also, the expression of SSC specific pluripotent marker gene *viz.*, *ID4 (from CIRG)* was analyzed in the present study (Table 14).

Table 14: Primers sequences used for qPCR analysis of specific genes

S. No.	Gene	Primer Sequence (5' to 3')	Annealing temp (°C)	Product length (bp)
1.	OCT 4	F: CGGAAGAGAAAGCGGACAAG R: CGATGTGGCTGATCTGCTG	58-59	103
2.	NANOG	F: CAGCCCTGATTCTTCCACAA R: CTGCCTCTGAAATCTGTCGT	58	160
3.	SOX2	F: TGGTCTGTCTTTCATGGTGTCT R: GTGGGAGGTTAAACCATGGGA	59	126
4.	GAPDH	F: AAGGCCATCACCATCTTCCA R: TCACGCCCATCACAAACATG	59	193
5.	BAX	F: AGCGCATTGGAGATGAACTG R: AAGTAGAAAAGCGCGACCAC	58	157
6.	Ckit	F: CTTTGGACGGCTTGCTAACG R: AAATCCACCGTGGGTATGGG	59	145
7.	PPARγ	F: TACCAAAGTGCCATCAAA R: TGGAGTGGAAATGCTGGA	56	111
8.	ID4	F: TGTCACTGAGTTTCATGTCTG R: AGAAAGTGTTCATTGCCAAGAG	56	102

Results

The expression of different SSC specific pluripotent marker genes *viz.*, *OCT4, NANOG, SOX2*, marker for undifferentiated type A spermatogonia i.e. ID4, apoptosis marker gene i.e. *BAX*, and markers of differentiating spermatogonia i.e. *c-Kit* and *PPARγ* was studied by observing their amplification cycle. The qPCR analysis showed that cultured pSSCs expressed *OCT4, NANOG*, *SOX2* and *ID4*, but not *c-Kit* and *PPARγ*, which are markers of differentiating spermatogonia. Also, the expression level of *BAX* marker gene was found to be low as comparison to expression of SSC specific

pluripotent marker genes, indicating the presence of undifferentiating PSSC cells.

(Project (DBT): Isolation, characterization and development of a culture method for long term preservation of spermatogonial stem cells from Doom pig

(**Investigators:** PI: Dr. M. S. Chauhan, CO-PI: Dr. (s) S. D. Kharche, S. P. Singh)

6.3.6 Establishment of efficient culture and transplantation system for male goat germ-cells

Standardization of *in vitro* culture conditions for germ cells:

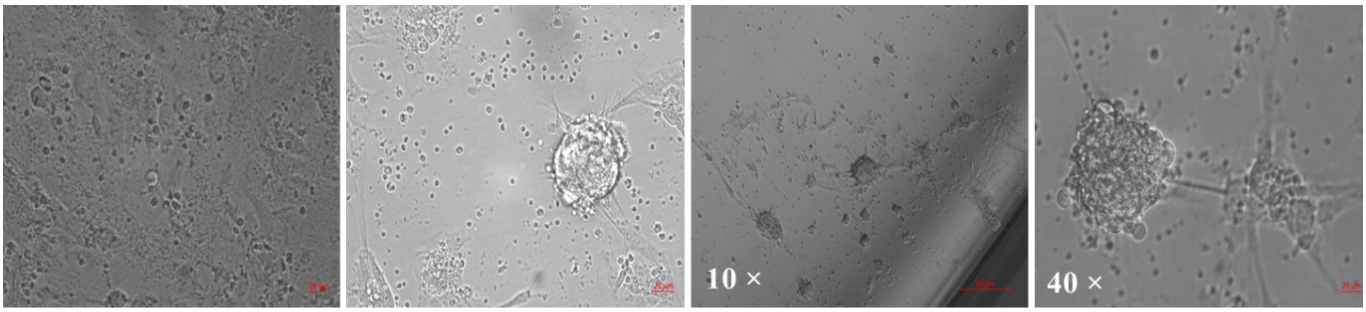
Standardization of conditions for isolation, enrichment and *in vitro* culture of germ cells was done. For this, pre pubertal testes were collected from 5-6 months old kids and two - step enzymatic digestion was used to isolate putative germ. After enzymatic digestion, the germ cells were subsequently enriched by differential plating (on sertoli cell monolayer) and percoll density gradient centrifugation methods. Sertoli cell feeder layer was developed and used for subsequent culturing of the germ cells. The identification of germ cells was initially done by their morphological assessment. The germ cells were then subjected to alkaline phosphatase stating and immunocytochemistry analysis. Enriched germ cells were found to be positive for alkaline phosphatase stating. The results of immunofluorescence analyses demonstrated that the germ cells were positive for OCT4 and PGP 9.5. It was observed that the colonies could be maintained with undifferentiated morphology for more than two months. Work on comparative expression of pluripotency and other related genes of germ cells in different culture system are going on.

A trial was conducted to evaluate the effect of different culture media on growth and development of male goat germ-cells. For this, three different types of culture media i.e. Dulbecco's modified Eagle's medium (DMEM), Minimum Essential Medium – alfa (MEM - α) and Mesen-pro, supplemented with L-glutamine, Non-Essential Amino Acids and antibiotic antimycotic solution were used. Different types of colonies were characterized morphologically, and by alkaline phosphatase and immunofluorescence (PGP 9.5 and OCT 4) staining. Numbers of single, paired, cluster and rosette colonies were calculated in four replicates on 4^{th}, 7^{th}, 9^{th} and 12^{th} day of culture, respectively. The size of colonies was also measured at different days of culture. The number of all type of colonies i.e. single, paired, cluster and rosette were higher in DMEM media compared with MEM α and Mesen-pro media. The results suggest suitability of DMEM media for culture of male goat germ-cell, among the three media tested. Further studies will be conducted to evaluate effect of different extracellular matrices on growth and development of male goat germ-cells using DMEM media.

Table 15: Effect of different culture media on number of goat germ cell colonie

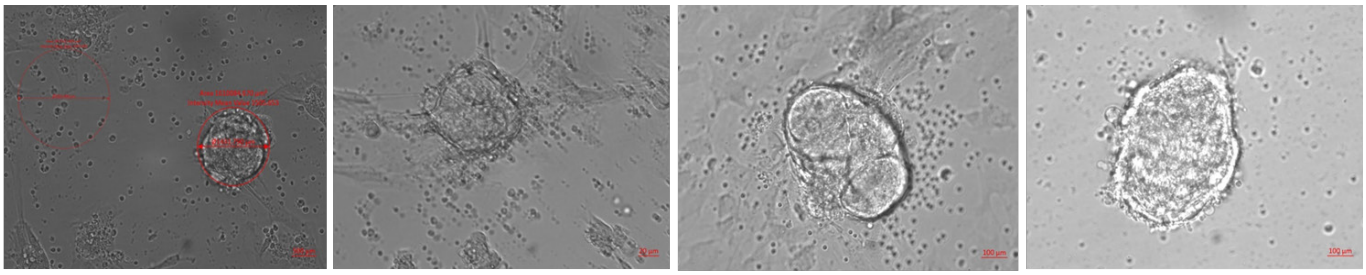
Type of media	Type of colony and day of culture			
	Single (d 4)	Paired (d 7)	Cluster (d 9)	Rosette (d 12)
DMEM	26.75 ± 2.14^{a}	17.50 ±1.44^{a}	9.25 ± 1.11^{a}	3.25 ± 0.75^{a}
MEM α	18.50± 1.32^{b}	15.00± 1.47^{b}	8.00 ± 0.71^{a}	3.00 ± 0.41^{a}
Mesen-Pro	14.25 ± 0.85^{c}	9.50 ± 1.04^{c}	4.50 ± 0.65^{b}	2.00 ± 0.41^{b}

(a)_



Single and pair colonies | Cluster colony | Cluster colonies with inter-cellular connections

(b)



Measurement of size of cluster colony | Cluster colony | Transition of cluster colony into rosette colony | Rosette colony

Figure 11: Morphological characterization of goat germ cells

Project (DBT funded): Establishment of efficient culture and transplantation system for male goat germ-cells (Investigators: PI: Dr. S. P. Singh; CO-PI: Dr. (s) S. D. Kharche, Ravi Ranjan, M. K. Singh, M. S. Chauhan)

6.3.7 Development and Evaluation of portable plastic enclosure for improved kid/lamb rearing

During the period under report, the animal trials in already fabricated portable plastic enclosures (PPE-1, PPE-2, PPE-3) and weather data in newly fabricated portable plastic enclosure (PPE-4) in comparison to conventional protection measures in kidding shed were recorded. The already fabricated PPEs yielded 5.0, 4.9 and 3.4°C higher mean minimum temperature inside the enclosures as against only 1.6°C higher mean minimum temperature inside the kidding shed during extreme winter night hours.

The details of PPE-4 are given as below. The Muzaffarnagari sheep wool available with our Institute is sandwiched between FRP sheets and panels were prepared and fixed to have a small enclosure in open sky in shed. The minimum temperatures inside portable plastic enclosures viz., PPE-1: Kidding cages covered with black Polythene inside kidding shed, PPE-2: Kidding cages covered with black Polythene inside kidding shed with ventilation, PPE-3:Double layered Black Polythene pen with ventilation outside kidding shed, PPE-4: Double layered FRP sheets sandwiched with sheep wool and PPE-5: Conventional winter protection in kidding shed, were recorded during December to February months revealed that portable plastic enclosures had higher minimum temperature as compared to open conditions.

Table 16: Minimum temperture (Tmin; °C) inside different portable plastic enclosures.

Plastic enclosures	PPE-1	PPE-2	PPE-3	PPE-4	PPE-5	Weather station
T min Mean	11.67	11.15	8.30	10.01	9.12	6.50
T min Difference	5.17	4.65	1.80	3.51	2.62	
Comparison of minimum temperatures inside PPE's when the days with minimum temperature is less than 5°C						
T min Mean	9.87	9.37	5.85	8.23	6.61	3.35
T min Difference	6.52	6.02	2.50	4.88	3.26	

6.3.8 Development of Conceptual Design for Plastic Based Two-tier Housing Model for Goats.

The goat rearing is being practiced traditionally since decades by our ancestors for livelihood and nutritional security. The goats are mainly reared by marginal and landless farmer's and labourers who are socio-economically weak and resource poor. The goats are species of choice among livestock for such socio-economically disadvantaged rural farmers. Due to these constraints, the average flock size of rural goat keepers is normally ranging between 2 to 10 with very less scope for horizontal expansion and increasing the number for goats. At this juncture, the possible technological intervention could be vertical expansion of available space i.e. two tier housing model so that people are able to increase the number of goats reared in more scientific

way for doubling their income through goat rearing.

Therefore, a conceptual design for two tier housing model was developed considering the requirements of rural goat keepers having generally 8-10 numbers of goats for their livelihood security. The floor dimensions were decided based on space requirement for 10 goats along with followers. As per design it is proposed to rear adult goats (weight ranging from 20-40 kg) in the ground floor and new born (weight ranging from 3-5 kg) and growing kids can be reared at the first floor of the structure. New born and growing kids can easily come down to their mother for suckling. The average height of first floor is kept 1625 mm, which is in such a way that caretaker can easily go inside and carry out farm operations. The first floor is made of perforated plastic slatted blocks interlocked together and finally fixed to the angle iron frame for rigidity. Supporting pillars can be made out of combination of reinforced plastic pipes and iron bars. Manure can fall down through the perforations to the plastic tray fixed just below the slatted floor. A gradient of 1:40 is given to the plastic tray towards back for easy and automatic shift of manure outside the structure. The size of ventilation and doors will be as per standard. The roof can also be made of FRP sheets for light weight and long lasting.

The practical utility of the conceptual design is that it will be helpful to develop two tier goat houses in rural areas for livelihood purposes having space constraints. Further, this model will open door for taking up goat based agri-business model by rearing goats in stall feeding system along with other enterprises with minimum space requirement. The concept of developed model can also open door to develop large two tier shelters for commercial goat farming as well as to develop integrated farming systems with other components.

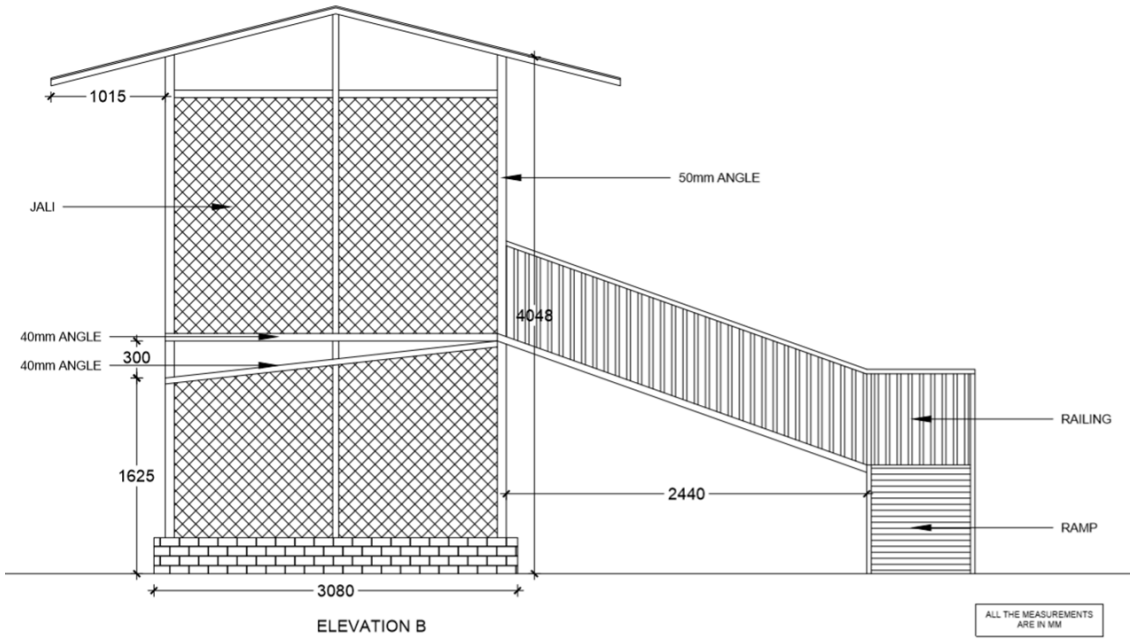


Figure 12: Elevation of conceptual two tier goat housing model

(Project: AICRP on Pet Project (PI- Dr. N. Ramachandran; CO-PIs - Drs. Ravi Ranjan, S. P. Singh, Arvind Kumar, B. Rai)

6.4 NUTRITION AND FEED FORMULATION FOR ECONOMIC GOAT PRODUCTION

6.4.1 Development of economical pellet feed using unconventional protein source for goats

Lactation cum feeding trial was conducted on eighteen female Barbari goats (Age approx. 3-5 years and mean body weight 36.35 ±1.33 Kg) for sixty days and effect on milk production, milk constituents, somatic cell count, nutrient intake and digestibility was studied. Animals were divided into three groups (Gr I, Gr II and Gr III) of six each as per completely randomized design. Three different type of concentrate pellet was formulated. Type I pellet was control, containing linseed cake as protein source while in type II and type III 50 and 100% of linseed cake was replaced with CSC, economical cake with good bypass protein respectively. All these pellets were made iso nitrogenous. Animals of Gr I was fed with type I concentrate pellet while Gr II and Gr III was fed with type II and type III pellet respectively. Fortnightly body weight changes were recorded and no significant difference was found. Milk production (kg/ day) was recorded at 30 and 60 days of experimental feeding for two consecutive days. The milk production and milk composition at 30 and 60 days of experimental feeding is presented in table 1.

Table 1: Milk production and milk composition in different group of lactating does

	Gr I	Gr II	Gr III
30 days of collection			
Milk production (Kg/day)	540.66±22.43	551.66±66.05	532.83±55.71
pH	6.82±0.02	6.91±0.03	6.89±0.04
Total solids (%)	13.79±0.6	12.89±0.21	13.56±0.54
Fat (%)	5.05±0.51	5.12±0.69	5.25±0.17
SNF (%)	8.72± 0.65	8.92 ±0.58	9.01± 0.26
Protein (%)	3.16±0.07	2.73±0.11	3.02±0.11
Ash (%)	0.81±0.01	0.81±0.01	0.82±0.02
60 days of collection			
Milk production (Kg/day)	561.50±38.00	545.00±51.14	525.80±50.32
pH	6.91±0.00	6.96±0.04	6.93±0.03
Total solids (%)	14.77±0.32	14.85±0.39	14.05±0.29
Fat (%)	4.90±0.51	5.31±0.51	5.20±0.27
SNF (%)	9.87 ±0.6	9.55 ±0.21	8.85 ±0.54
Protein (%)	3.10±0.14	2.95±0.13	3.08±0.16
Ash (%)	0.65±0.05	0.64±0.03	0.66±0.04

There was no significant difference in the milk production and milk constituents of different group of does. Total milk production (Kg/ day) and total solids (%), protein (%) and Ash (%) was statistically similar in all three groups of lactating goats. However there was an increasing trend in the fat % of milk by replacement of linseed cake with cotton seed cake. Milk fatty acid profile was studied. Reducing trend in short chain fatty acids and increasing trend of mono unsaturated fatty acids was reported in milk from treatment group of goats (fig 1).

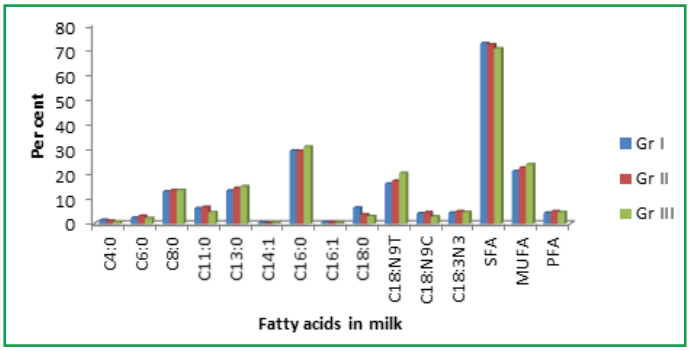


Fig 1: Milk fatty acid profile in different group of lactating does

Amino acid profiles of milk from different group of does were studied. Both essential and non-essential amino acids estimated in the milk sample were statistically similar in all three groups of does (Fig 2). However one essential amino acid lysine (%) was 12.63 in Gr I, 11.9 in Gr II and 10.14 in Gr III showing a decreasing trend with incorporation of cotton seed cake in place of linseed cake in the ration of goats.

Somatic cells are indicators of both resistance and susceptibility of animals to mastitis and can be used to monitor the level or occurrence of subclinical mastitis in herds or individual animal. SCC is a useful predictor of intra mammary infection (IMI), and therefore, an important component of milk in assessment of aspects of quality, hygiene and mastitis control. Somatic cell count (X 10^5/ml) was statistically (P>0.05) similar in all three group of does being 2.76 in Gr I, 3.35 in Gr II and 2.88 in Gr III. This show that incorporation of cotton seed cake in the diet of goats did not affect the chance of mammary infection.

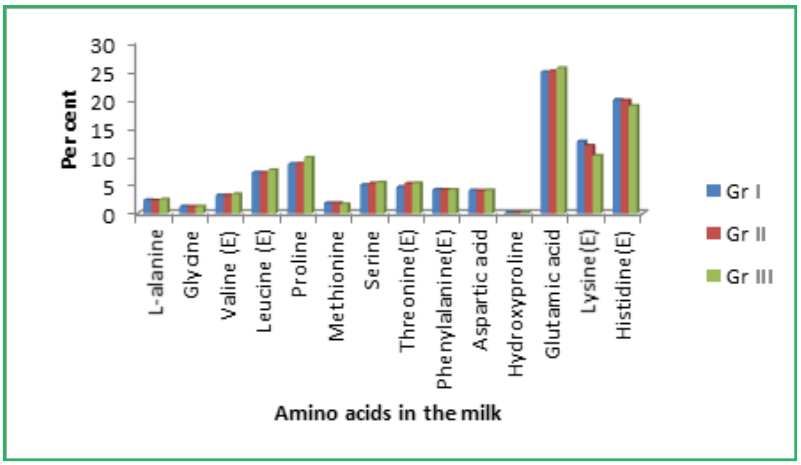


Fig 2: Milk amino acid profile in different group of lactating does

After 45 days of experimental feeding, a digestion trial of 6 days duration was conducted in the metabolic cages at the Experimental shed of Division. Animals were first adopted in metabolic cages for 2 days followed by 6 days of collection period for feed and faeces. No statistically (P>0.05) significant difference was reported on dry matter intake, digestibility of different nutrients.

Rumen liquor was collected in the last week of experimental feeding at 0 hr post feeding to study the rumen pH and fermentation metabolites. Ruminal pH was within normal range of 6-7 and other metabolites like total volatile fatty acids, ammonia nitrogen, total nitrogen, TCA-ppt nitrogen, NPN was statistically (P>0.05) similar among all three groups.

DNA was extracted from the rumen liquor to quantify the rumen microbes on different feeding regime. Species specific primer of bacteria, protozoa, fungi and methanogens were used to quantify their populations using real time PCR. No significant difference in the population of all these microbes reported.

Blood sample was collected into a K_2 EDTA vacutainer tubes (BD, Franklin lakes, USA) from all the experimental animals in the morning (before feeding) by jugular vein puncture. Centrifugation was performed at 2000 X g for 10 min and plasma was separated and stored at -20°C for further estimation of hormones and other metabolites assays. The whole blood was analyzed for hematological parameters using hematology analyzer from MeletSchloesing Laboratories, France standardized for goats as per manufacturer protocol. Total blood cell count and differential blood cell counts were statistically similar among all the groups of lactating goats. Haemoglobin (g/dl) was 7.01 for Gr I, 7.04 for Gr II and 7.6 for Gr III respectively showing no significant difference among groups.

(Institute project; Development of economical pellet feed using unconventional protein source for goats (PI: Ravindra Kumar, Co-PIs Drs. U.B. Chaudhary, Arvind Kumar, Nitika Sharma, A.K. Dixit, Chetna Gangwar)

6.4.2 Development and evaluation of potato silage (*Solanum tuberosum*) in the ration of goat

Preparation of potato silage was standardized. At laboratory scale silage of potato (*Solanum tuberosum*) and paddy straw *(Oryza sativa*) was prepared in airtight plastic Jar. Three combinations of these were prepared in triplicate. The type of silage prepared was as follows:

S. No.	Silage	Ingredients
1.	Silage	Potato (*Solanum tuberosum*) +Paddy(*Oryza sativa*) straw
2.	Silage I	Potato (*Solanum tuberosum*) +Paddy(*Oryza sativa*) straw+ DCP
3.	Silage 2	Potato (*Solanum tuberosum*) +Paddy(*Oryza sativa*) straw+ Urea

After 60 days of anaerobic fermentation these silage was evaluated for their physical properties and composition. The physical properties and composition of these silage were studied and is presented in Table 2.

Table 2. Physical properties and Composition of silage.

Attributes	Silage	Silage I	Silage II	Sig
Colour/ appearance	Brown	Brown	Brown	
Smell	Pleasant aroma Sweet	Pleasant Sweet aroma	Pungent Slightly ammonical	
Texture	Soft	Soft	Soft	
Mouldiness	No sliminess	No sliminess	No sliminess	
DM (%)	40.29±1.59	45.96±1.01	44.08±1.88	0.098
CP(%)	10.01±0.41b	9.71±0.71b	14.33±0.58a	0.002
NDF (%)	48.00±4.58	52.00±3.21	49.66±2.90	0.748
ADF (%)	27.66±2.02	33.00±2.08	28.66±0.88	0.153
Amm. N (mg/g)	1.14±0.14b	1.26±0.03b	3.02±0.09a	0.000
Nitrogen (%)	1.59±0.06b	1.55±0.11b	2.28±0.09a	.003
Amm. N (% of N)	7.15±0.86b	8.18±0.59b	13.20±0.50a	.003
Sugar (%)	1.16±0.20	1.69±0.11	1.31±0.10	0.105
Lactic acid (mg/100gm)	17.13±0.73	17.84±2.00	16.14±1.32	0.718
pH	4.84±0.03b	4.69±0.15b	5.41±0.01a	.003

On the basis of the quality of the prepared silage in the plastic jar, bulk quantity of silage I (Potato (*Solanum tuberosum*) +Paddy (*Oryza sativa*) straw+ DCP) was prepared in the plastic silage bags. This silage was anaerobically fermented for 60 days and this will be fed to the growing goats. Feeding cum growth trial on this silage will be conducted.

potato & paddy straw filage

prearation of potato & paddy straw filage

(Pilot project: Development and evaluation of potato silage (*Solanum tuberosum*) in the ration of goat, PI: Ravindra Kumar)

6.4.3 Evaluation of developed power weeder

A power operated weeder was designed and developed for weeding in *Moringa* and other similar fodder crops. Due to restricted use of chemicals for weed control and high cost of manual weeding, mechanical weeding is considered as suitable measure for economic weed control. The developed power weeder has two sets of rectangular blades (90×35 mm size 6 blades in each set) fitted on two rotary discs, 2.0 hp two stroke petrol engine as prime mover (engine) and speed reduction gear box, a pair of ground wheels, handle and frame. Weeder has a working width of 230 mm.

Field performance testing of developed power weeder was done in *Moringa* cultivated as fodder crop. The crop was sown at 300 mm row spacing. Weeding was done 25 to 35 days after sowing. Observations on area covered, time taken (including losses), fuel consumed and plants damaged due to operation of weeder were recorded. Weed intensity was noted using quadrant method before and after weeding operation.

Table 3. Field performance testing of power weeder

Particulars	Value
Area covered, ha/day	0.67
Time required to cover 1 ha area, h	11.90
Field capacity, ha/h	0.084
Weeding efficiency, %	71
Operation cost, Rs/h	507
Weight, kg	23
Estimated cost of weeder, Rs.	35,000

Cost of operation of weeder was calculated based on total fixed cost (depreciation and maintenance cost) and variable/ operation cost (fuel, lubricant and operator cost). Depreciation was estimated considering the life of machine 10 years and annual use as 30 days. There was no damage to crop canopy, which could be achieved due to fitting of safety board at the front and both sides of the weeder. Safety board diverts the crop canopy away from the blade and other moving parts. Field capacity and weeding efficiency were determined as per the standard procedure as given below.

$$S = \frac{A}{T_p + T_l} \quad \text{.....Eq. 1}$$

Where, S is effective field capacity (ha/h), A is area covered (ha), Tp is productive time (h) and T_1 is non-productive time (time loss) (h). The average field capacity achieved was 0.084 ha/h considering actual operating time and time loss during operation.

$$\eta = \frac{W_1 - W_2}{W_1} \times 100 \quad \text{.....Eq. 2}$$

Where, η is % weeding efficiency, W_1 and W_2 are number of weeds per unit area before and after weeding respectively. Average weeding efficiency achieved was 71% with left out weeds within the crop row which is out of the reach of the machine.

Field performance testing of power weeder has shown proper cutting of weeds and soil turning without any damage to crop if the crop is sown with uniform row spacing. The weeder has been send to ICAR-IGFRI, Jhansi for third party evaluation.

Fig.4 Developed power weeder operating in the crop field

Project: Design and development of power weeder for improving economic fodder production of goats (Dr. Arvind Kumar, U. B. Chaudhary , M.K. Singh ,M. Arif, A. K Dixit)

6.4.4 Cultivation and evaluation of Moringa as goat feed

Moringa was sown in the area of 15 acres at Agriculture Farm section of CIRG from 4th July 20- 12th August ,2019 though the time of sowing in some of the plots was late on account of erratic distribution of monsoon and other reason. The seed rate in different plots was 20 kg /acre and sowing was done at 30 cm plant to plant and 30 cm row to row distance in 12 acres whereas, 03 acres of area was sown at plant of plant distance of 6"x 6" and 2' (Row to row). The research data was collected from an area of 3.0 acres. The first cutting of the biomass was taken at 90 days interval of the sowing and at this stage the plants attained an average height of > 7.0 feet. The harvesting was done manually and plants were cut from the height of 1 feet from the surface. Since crop was sown late, hence tit was not possible to get II nd cut before April, 2020 as there was no growth of the plants between Nov.-March on account of low ambient temperature . The observation in terms of plant population, average height of the plants, biomass production and leaf: stem ratio is presented in table1. The plant population was observed reduced remarkably during IInd cut in comparison to Ist cut may attributed to the normal reason that some of the plants may not compete with the dense population and high infestation of weeds. A total green biomass yield was found 117.00 & 179.28 Qts./ acre in first and second cut respectively. The quantum of biomass yield of moringa was found quite (Table 4) encouraging on account of poor soil health infested with high intensity of weeds.

The harvested biomass of moringa was transported to the animal shed and after chaffing and sun drying and stored for preparation of feed pellets.

Moringa dry biomass based complete feed was prepared using the mixture of 70% moringa biomass and 30% concentrate (Ground barley 97%, Min.Mix ,2.0%and salt,1.0%) sprinkled with water (5%). The mixture was fed in an electrical operated feed pelleted machine and the pellets of 8-10 mm were prepared and stored for feeding of experimental goats.

Table 4.Particulars of plant at Ist and IInd cut

Particulars	Ist cut (90 days)	IInd cut (26.5.2020)
Pants population (Nos./acre)	52000	28520
Average height (feet)	7.84	7.73
Average wt.(g/plant)	0.226	0.682
Green biomass production (qts./acre)	117.00	179.28
Leaf : stem ratio	-	1:7 (12.% Leaf and 87.5% stem)

The Proximate composition of moringa biomass (table.5) indicated high concentration of Protein and fat in leaves stem and in whole pant. Feeding of this rich protein biomass to the goats was found highly palatable, economic and productive for meat production.

Table 5. Proximate composition of moringa biomass at IInd cut

Parameters	Leaves	Stem	Leaves+ Stem
DM	19.34±**0.45**	14.40±**0.28**	16.64±**0.18**
CP	28.05±**0.25**	5.83±**0.05**	12.31±**0.32**
Ash	10.15±**0.246**	5.98±**0.36**	8.97±**0.14**
Fat	7.54±**0.28**	1.11±**0.13**	3.27±**0.015**

The detail of input and output activities cost wise are presented under table 6. The cost of weeding was found very high since the field was full of different weeds. It was found essential to remove the weeds twice before first cutting. This single factor caused very high cost of biomass production. The cost of other input was found within the normal range

Table 6. Economics of moringa for plot no.1 (expenditure /acre) at first & IInd cutting

Activities	Ist Cut	IInd cut
Land prep. Seed, Fertilizer, Sowing , irrigation , harvesting ,chaffing and drying+ weeding	26,850+ 39500 66,350	6200
Total production (t) at Ist year	117.00 qts	179.28 qts
Cost (Rs.)of production /qt. biomass	Rs.567	34.58 or 0.34 /kg
Cost of production /qt. in two cuttings	Rs. 244.86	

Evaluation of potentiality of cultivated moringa biomass as goat feed

Two separate experiments were conducted on growing Mujaffar Nagri lambs and growing female Barabri goats to evaluate the effect of moringa based complete feed as ration for sheep and goats . Thirty Mujaffarnagri lambs at 4 months of age were divided in to control (10) and treatment (20) groups. The control sheep were were fed Gram straw ad lib, concentrate – 600-700g/ and green fodder (App.500g) where as the treated sheep were given Moringa based pelelted feed (70:30) daily.

The experimental data were collected for a period of 135 days.

During whole experimental period the data in terms of DM intake (daily) and body weight gain were recorded.

The blood samples were collected from these animals for estimation of blood parameters, stress related enzymes, antioxidant property, blood glucose and protein and other biochemical parameters.

Table-7. Body wt. gain of lambs at the 8.5 months of age

Attributes	Control	Treatment
Initial Body wt. (Kg)	22.1±0.58	19.3±0.44
Final body wt. (Kg)	34.54±0.56	36.28±0.85
Weight gain (Kg)	12.44	16.98
Growth rate	92.15	125.81
Comp. Increase in body wt. (%)	-	36.5

Result indicated higher body wt gain in treated goats were observed higher (16.98kg) than the control (12.44 kg). The growth rate (g/d) was also found higher (125.81) in treated goats than control (92.15)(Table 7).

Table.8.DM intake and of lambs at the 8.5 months of age

Attributes	Control	Treatment
Total intake/animal (kg)	206.63	169.40
Intake (kg)/day/animal	1.48	1.21
FCR	16.61	9.97
Cost of feed	2213.90 (Rs.10.70/kg)	1694.40 (Rs. 10/kg)
Cost of body wt. gain(@250/kg)	3,110	4,245
Net profit (Cost of feed- cost of B.wt.)	698	2,550

Lower values of total and Daily DM intake and better feed conversion efficiency was observed in treatment goats (Table 8.) than control. Based on the feed cost and cost of the body wt. gain the feeding of moringa based complete feed was found highly economic in comparison to the traditional ration fed to the lambs.

2. Performance of poor growing female goats under moringa feeding

Fourteen poor growing female Barbari goats at the age of 9 months and carrying the average body wt. of only 10.41 kg were selected with the view if these animals can be recovered their normal growth fed moringa based complete feed. Prior to initiation of the experiment, these goats were receiving the traditional ration as per their requirement but not performing normally. These animals were maintained under intensive system of feeding management and were fed moringa based complete feed containing 70% moringa dry biomass and 30% concentrate (Ground barley 97%, Min.Mix ,2.0%and slat,1.0%). The observation in terms of body wt. gain,and intake parameters were recorded during the experimental period of 150 days.

Table.9.Body wt.gain and DM intake

Attributes	
Initial Body wt. (Kg)	10.41±0.41
Final body wt. (Kg)	17.45±0.57

Attributes	
Weight gain (Kg)	7.04
Growth rate	47.00
FCR	14.13
DM intake (Kg)/d	0.64
Total DM intake (kg) / animal (150 days)	99.53
DM intake /100 kg	3.66

The blood samples were analyscel from these animal for estimation of blood parameters, stress related enzymes, antioxidant property, blood glucose and protein and reproductive hormones. Analysis of these parameters is in progress.

Table.10. Haematological parameters

Animals	WBC	RBC	HCT	Hb
Barbari female moringa	14.24±0.57	16.12±0.49	22.1±0.57	7.84±0.17

The results of 150 days of study indicated average wt. gain of 7.04 kg and growth rate of 47g/d which seems to be satisfactory and improved . Over the entire period animal are healthy and as evidenced by the blood parameters (Table.10) and looking shiny and active.

Fig.5.Crop of PKM2 variety of Moringa at ICAR-CIRG

Fig 6 Moringa based complete feed

Fig 7 : Visit of Hon'ble Minister of Fisheries, Dairying and Animal Husbandry Govt. of India at Moringa field

(Project: Cultivation and evaluation of Moringa as goat feed, P.I-U.B. Chaudhari, Co-PI Arvind Kumar, M.K. Singh, A.K. Dixit, V. Rajkumar, Ashok Kumar, M. Arif)

6.4.5.Rumen microbes identification and repository

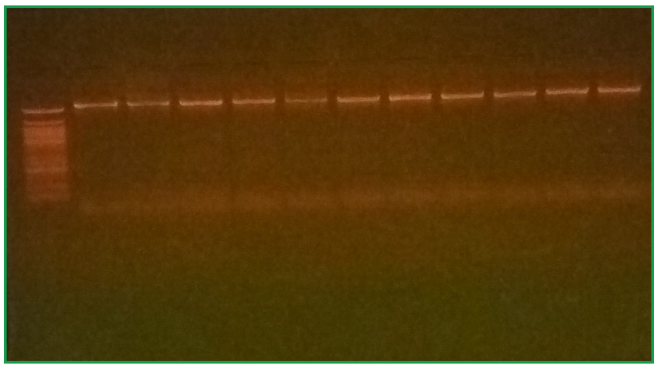
Rumen bacteria were isolated from the rumen of goats maintained under intensive and semi intensive system of feeding management. Non defined and defined media were used for cultivation of bacteria under anaerobic condition. Hungate roll tube and anaerobic chamber were used for maintaining anaerobic conditions. The cultivated rumen bacteria were identified and characterized using molecular techniques. Thirty isolates of rumen bacteria, isolated from goats, were identified and characterized on the basis of 16S rRNA gene amplification using F –F8 and R- 1492 primers and sequencing of the amplified product. Out of these 30 isolates, nine were selected and submitted to submit to NIANP Bangaluru along with detail about the method of cultivation and feeding status of host goats. The selected 9 cultures were screened for Carboxymethylcellulase and Avicelase enzymes activities in the supernatant of three days old cultures to ascertain the efficiency of rumen bacteria for cellulose digestion. (Table 11&12) Based on the concentration of Carboxymethylcellulase and Avicelase enzymes the identified culture may prove efficient for cellulosic activity in the rumen.

Table.11 Rumen bacteria isolated from the goats

S.No	Bacteria name	Isolate no	RR.No
1	*Desulfovibrio piger*	RV-3(19-20)	363
2	*Bacteroides fragilis*	RV-7(19-20)	364
3	*Clostridium sartagoforme*	BK-10(19-20)	365
4	*Clostridium saccharolyticum*	BK-13(19-20)	366
5	*Clostridium boliviensis*	BK-15(19-20)	367
6	*Psedobutyrivibrio ruminis*	BK-16(19-20)	368
7	*Butyrivibrio hungatei*	BK-18(19-20)	369
8	*Lactobacillus vitulinus*	BK-19(19-20)	370
9	*Oribacterium SPG40*	BK-22(19-20)	371

Table. 12. Enzyme activity of isolated bacterial cultures

S.No	Bacteria name	Isolate no	CMC (µmolglu/min/ml)	Avicelase (µmolglu/min/ml)
1	*Desulfovibrio piger*	RV-3(19-20)	1.24	1.72
2	*Bacteroides fragilis*	RV-7(19-20)	1.89	2.28
3	*Clostridium sartagoforme*	BK-10(19-20)	1.50	3.29
4	*Clostridium saccharolyticum*	BK-13(19-20)	1.21	2.34
5	*Clostridium boliviensis*	BK-15(19-20)	0.94	3.59
6	*Psedobutyrivibrio ruminis*	BK-16(19-20)	0.68	0.77
7	*Butyrivibrio hungatei*	BK-18(19-20)	0.71	1.62
8	*Lactobacillus vitulinus*	BK-19(19-20)	1.43	2.99
9	*Oribacterium SPG40*	BK-22(19-20)	2.90	2.05



The PCR product run on agrose shows clear band

(Project : NCVTC (Rumen microbes) Project P.I U.B. Chaudhary, Co- PI Ravindra Kumar)

6.5 ADOPTIVE STRATEGIES TO MITIGATE OF AFFECTED CLIMATE CHANGE

During the reported period, three major activities, effect of feeding of moringa oleifera on productivity and humid stress in goats, effect of moringa biomass feeding on milk production in goats and organization of Awareness programme under SCSP component were undertaken.

6.5.1. Effect of feeding of moringa oleifera on productivity and humid stress in goats

The experiment was under taken for a period 153 days on growing female goats of Barbari breed. Ten kids were equally divided in two groups (Control and treatment) and were maintained under intensive feeding condition. The control animals were given Straw (gram/arhar) adlib + 300g concentrate per animal/ day whereas , animals under moringa fed group were given pellets containing Moringa biomass,87%,Min.mix.2%, Salt 1% and Barley grain,10%. The feeding was continued for a period of 153 days and during these period observations in terms of body weight gain, hematological and biochemical parameters and HSP 70 (A stress marker) were recorded from all animals during the whole experimental period. Result indicated no significant effect of feeding moringa biomass based complete feed (87:13) on productivity and reducing the humid stress in goats as evidenced by no significant change in the values of body weight, blood & biochemical parameters and concentration of HSP 70 between treatment and control group.(Table 13&14)

Table.13. Effect of feeding moringa on Body wt and growth rate of growing goats

Parameters	Control	Treatment
Initial Body wt. (Kg)	8.08±0.05 [a]	8.36±0.16 [a]
Final Body wt. (Kg)	14.64±0.31 [a]	13.20±0.65 [a]
Growth rate (g/day)	42.88	31.63

Table.14.Effect of feeding moringa on Biochemical parameters of growing goats

S.No	Parameters	Control	Treatment
1.	Glucose(mg/dL)	60.10±1.30 [a]	68.30±2.19 [a]
2.	Total Protein	6.50±0.33 [a]	5.13±0.15 [a]
3.	SOD %	36.42±1.88 [a]	39.38±2.06 [a]
4.	HSP70	66.94±1.04 [a]	67.50±2.10 [a]

6.5.2. Effect of moringa biomass feeding on milk production in goats

The experiment was undertaken during the winter season, for a period of 90 days. Twelve lactating goats of Barbari breed were divided equally in to two groups (treatment and control) and were maintained under intensive system of feeding management. The control animals were given Straw (gram/arhar) adlib + 300g concentrated per animal/ day whereas, animals under moringa fed group were given moringa biomass based complete feed (70:30). During the experimental period, observation in terms of weight gain (fortnightly), DM intake (daily) were recorded from all animals during the whole experimental period. Total 90 days milk yield and chemical composition of milk was recorded and the blood samples were collected for estimation of hematological & biochemical parameters. Result s indicated no significant effect of feeding of moringa biomass based complete feed (70:30) to the lactating goats on the milk yield and its chemical constituents, Dry matter intake, blood and other biochemical parameters. Although the total milk yield under treatment group was recorded higher than the control goats but due to variation in the values the difference was not found significant.(Table 15&16)

Table.15. Effect of feeding of moringa based feed on Milk yield & intake of goats

Parameters	Control	Treatment
Milk produced (ml/day/goat)	678.78±35.99 [a]	1032.68±63.84 [a]
Total (90days) milk yield litre/goat	61.09	92.94
Intake (kg/day/goat)	0.81±0.02 [a]	1.39±0.03 [a]

Table.16. Effect of feeding of moringa based feed on Milk composition and physical parameters of goats

S.No	Parameters (unit)	Control	Treatment
1	Temp (°C)	19.12±0.85[a]	19.69±0.94[a]
2	Fat (%)	3.06±0.34[a]	3.23±0.30[a]
3	Density (%)	30.6±0.67[a]	31.42±0.56[a]
4	Lactose (%)	4.87±0.08[a]	5.04±0.075[a]
5	SNF (%)	8.78±0.15[a]	9.10±0.131[a]
6	Protein (%)	3.15±0.06[a]	3.21±0.06[a]
7	Freezing point	-0.56[a]	-0.56[a]
8	Soluble salts (%)	0.73±0.016[a]	0.75±0.01[a]

*NICRA Project: Adaptation strategies in goats to environmental stress through nutretional Monipulation (PI U.B. Chandhary Col I: P. K. Roat, Ashok Kumar, N Ramachndran, M.K. Singh, V. Rajkumar, Ravindra Kumar, S. P. Singh.

6.5.3 Organization of awareness/ Training programme under SCSP component

Three awareness/Training programmes under SCSP component of NICRA were organized at Daulatpur, village, Farah, Mathura on 31.10.2019, at village Nagla Amra, Mathura on 03.01.2020, and at CIRG Makhdoom on 18.02.2020. The programme was attended by approximately 70 SC goat farmers at DaulatPur and 50 at Nagla Amra (All women goat farmers). At CIRG 160 women goat farmers attended the programme. Awareness with regard to the climate change and its impact on livestock productivity was created among all the farmers attended the meeting through different lectures delivered by Scientist and experts of the subject.

In addition to the scientist of NICRA team, Director CIRG, Vet. Officer of state Animal Husbandry department and DDM NABARD imparted training to the farmers related to the suitable measures to be taken to cope up the adverse effect of sudden climate change and to maintain the productivity of livestock. Farmers expressed their views in relation to the problem being faced due to adverse climate. The quarries of the farmers were addressed by experts suitably. At the end of the programme, farmers were given health kits containing the some of the medicines and feed supplements for goats, iron made feeders for maintaining the hygiene and reduced feed wastage of and other items to help the goat farmers in improving the productivity of livestock. Overall the organization of the camps was use full for creating the awareness among the goat farmers with respect to the preparedness to face the adverse effect of climate change.

Fig 1. Awareness / Training programme at Nagla Amra 03.01.2020 & Distribution of feeders to the goat farmers

6.6 DISEASE SURVEILLANCE, MOLECULAR ETIO-PATHOLOGY AND DIAGNOSTICS DEVELOPMENT

6.6.1 Zoonotic potential of *Mycobacterium avium* subspecies *paratuberculosis*, as the cause of Inflammatory Bowel Disease (Crohn's Disease) in human beings

i) MAP detection in lactating animals from field and organized farms

One of the important risk factors for the human infection of MAP and Crohn's diseases is milk, besides fecal and other handling by the animal handlers. Milk is one of the important sources of diet in adults, elders and kids. Immuno-compromised and convalescence patients who consume the MAP contaminated milk are at much higher risk than other healthy subjects. A sampling plan was executed in which 20 lactating does were randomly selected per herd from ten different farms (goat population >100) spanning five districts of Uttar Pradesh. A total of 200 lactating does were sampled for microscopy of ZN stained faecal smear, faecal TaqMan® probe real time PCR, milk smear microscopy, iELISA and TaqMan® probe PCR, serum iELISA and Blood TaqMan® probe real time PCR for establishing the status of MAP infection, which may possibly act as a source for human infection. The incidence rate was higher by iELISA with sera and milk, but lesser by microscopy (milk, fecal) and by IS900 TaqMan® probe real time PCR.

Table. 1. Presence of MAP in faecal, milk and blood samples of lactating does from farmer's flock (>100) of five districts of Uttar Pradesh during 2019-20

District	Farm (Lactating does, n=80)	Positives % *(n)*						
		Faeces		Milk			Blood	
		Microscopy	TaqMan® probe	Microscopy		iELISA	iELISA	TaqMan® probe
				Milk pellet	Direct smear			
Mathura	Farm A (n=20)	20 (4/20)	5 (1/20)	0 (0/20)	0 (0/20)	15 (3/20)	15 (3/20)	5 (1/20)
	Farm B (n=20)	10 (2/20)	5 (1/20)	0 (0/20)	0 (0/20)	5 (1/20)	5 (1/20)	0 (0/20)
Agra	Farm-C (n=20)	25 (5/20)	10 (2/20)	20 (4/20)	5 (1/20)	25 (5/20)	30 (6/20)	5 (1/20)
	Farm-D (n=20)	15 (3/20)	5 (1/20)	5 (1/20)	5 (1/20)	15 (3/20)	20 (4/20)	5 (1/20)
Orai	Farm E (n=20)	40 (8/20)	15 (3/20)	15 (3/20)	5 (1/20)	45 (9/20)	40 (8/20)	10 (2/20)
	Farm F (n=20)	30 (6/20)	10 (2/20)	5 (1/20)	0 (0/20)	25 (5/20)	20 (4/20)	5 (1/20)
Firozabad	Farm G (n=20)	15 (3/20)	10 (2/20)	0 (0/20)	0 (0/20)	15 (3/20)	20 (4/20)	0 (0/20)
	Farm H (n=20)	25 (5/20)	5 (1/20)	10 (2/20)	5 (1/20)	20 (4/20)	20 (4/20)	5 (1/20)
Etawah	Farm I (n=20)	35 (7/20)	10 (2/20)	5 (1/20)	0 (0/20)	40 (8/20)	45 (9/20)	10 (2/20)
	Farm J (n=20)	20 (4/20)	10 (2/20)	5 (1/20)	5 (1/20)	15 (3/20)	20 (4/20)	0 (0/20)
Total	**200**	**23.50 (47/200)**	**8.50 (17/200)**	**6.50 (13/200)**	**2.50 (5/200)**	**22.00 (44/200)**	**23.50 (47/200)**	**4.50 (9/200)**

Two types of herds were selected, one of which is unorganized (Table. 1) with extensive rearing system and sometimes migratory in nature. The lactating animals are grazed, but maintained in a makeshift housing. Another study was conducted in organized farm where semi-intensive/intensive type of rearing was practiced (Table. 2). In the unorganized flock, the farmers sell excess raw milk, besides domestic consumption. The MAP infection was found very high and the handlers and consumers of milk from these animals are at high risk. In organized herds sampled for MAP, the infection is very low, which is due to the fact that they are regularly screened for

Johne's disease and the infected are quarantined and removed from herd. This indicates that organized farms with good health management coupled with laboratory diagnosis can reduce the MAP infection thus reducing the risk of spread to humans.

Table. 2. Presence of MAP in faecal, milk and blood samples of lactating does from organized goat farms

Farm	Farm (Lactating does, n=90)	Positives % *(n)*						
		Faeces		Milk			Blood	
		Microscopy	TaqMan probe	Microscopy		iELISA	iELISA	TaqMan probe
				Milk pellet	Direct smear			
ICAR-CIRG Mathura	Barbari (n=20)	0 (0/20)	0 (0/20)	5 (1/20)	0 (0/20)	10 (2/20)	5 (1/20)	0 (0/20)
	Jamunapari (n=20)	15 (3/20)	5 (1/20)	10 (2/20)	5 (1/20)	15 (3/20)	20 (4/20)	5 (1/20)
	Jakhrana (n=20)	15 (3/20)	5 (1/20)	5 (1/20)	0 (0/20)	15 (3/20)	15 (3/20)	0 (0/20)
	APR experimental shed (n=10)	20 (2/10)	0 (0/10)	0 (0/10)	0 (0/10)	20 (2/10)	10 (1/10)	10 (1/10)
	Health Experimental shed (n=10)	20 (2/10)	10 (1/10)	10 (1/10)	0 (0/10)	15 (3/10)	15 (3/10)	0 (0/10)
	Nutrition experimental shed (n=10)	0 (0/10)	0 (0/10)	0 (0/10)	0 (0/10)	10 (1/10)	10 (1/10)	0 (0/10)
Private Farm, Vrindavan	10	10 (1/10)	0 (0/10)	10 (1/10)	10 (1/10)	20 (2/10)	20 (2/10)	0 (0/10)
Total	**100**	**11.00 (11/100)**	**3.00 (03/100)**	**6.00 (06/100)**	**2.00 (02/100)**	**16.00 (16/100)**	**15.00 (15/100)**	**2.00 (02/100)**

ii) MAP detection in dairy cows from various Gaushala's of Mathura-Vrindavan and Agra

Gaushalas are other important places where milking cows are maintained, where closely packed animals in the vicinity might augment the spread of Johne's disease. A sampling strategy was designed in which 20 milch animals were randomly selected from 8 Gaushalas from Braj region for detecting the presence of MAP in dung, milk and blood samples with the same battery of diagnostic tests. Proper suggestion has been given to improve the overall hygiene and health management with ample provision of space for animals. MAP infection is very high with the risk of spread to the animal handlers, dairy workers, processors and domestic consumers of infected cow's milk.(Table 3)

Table. 3. Presence of MAP in Dung, milk and blood samples of lactating cows from Gaushalas

Farm	Farm (Lactating does, n=60)	Positives % *(n)*						
		Dung		Milk			Blood	
		Microscopy	TaqMan probe	Microscopy		iELISA	iELISA	TaqMan probe
				Milk pellet	Direct smear			
Agra	Gaushala A (n=20)	15 (3/20)	5 (1/20)	5 (1/20)	0 (0/20)	30 (6/20)	25 (5/20)	0 (0/20)
Mathura/ Barsana	Gaushala B(n=20)	30 (6/20)	10 (2/20)	5 (1/20)	5 (1/20)	35 (7/20)	40 (8/20)	5 (1/20)
	Gaushala C (n=20)	20 (4/20)	5 (1/20)	5 (1/20)	5 (1/20)	25 (5/20)	25 (5/20)	5 (1/20)

Farm	Farm (Lactating does, n=60)	Positives % *(n)*						
		Dung		Milk			Blood	
		Microscopy	TaqMan probe	Microscopy		iELISA	iELISA	TaqMan probe
				Milk pellet	Direct smear			
	Gaushala D(n=20)	10 (2/20)	5 (1/20)	0 (0/20)	0 (0/20)	15 (3/20)	10 (2/20)	0 (0/20)
Vrindavan	Gaushala E(n=20)	40 (8/20)	15 (3/20)	5 (1/20)	10 (2/20)	30 (6/20)	25 (5/20)	5 (1/20)
	Gaushala F(n=20)	45 (9/20)	15 (3/20)	10 (2/20)	15 (3/20)	25 (5/20)	30 (6/20)	1 (0/20)
	Gaushala G(n=20)	5 (1/20)	0 (0/20)	0 (0/20)	5 (1/20)	5 (1/20)	0 (0/20)	0 (0/20)
	Gaushala H(n=20)	15 (3/20)	0 (0/20)	10 (2/20)	0 (0/20)	10 (2/20)	15 (3/20)	0 (0/20)
Total	**160**	**21.86 (35/160)**	**6.88 (11/160)**	**3.75 (8/160)**	**5.00 (08/160)**	**21.86 (35/160)**	**21.25 (34/160)**	**1.88 (03/160)**

iii) Passive sampling of Johne's disease suspected animals from various farms:

As a part of screening of JD suspected animals, microscopic examinations of ZN stained fecal smears were examined for presence of MAP infection (Table. 4). The animals which are unthrift, presence of chronic intermittent diarrhea are usually screened for MAP infection and JD positive animals are subsequently suggested for culling based on health grounds. Suspected animals showed higher presence of MAP bacilli, and some were negative by microscopy due to the non-shedding status of MAP, but showed higher titer for Johne's disease Indirect ELISA. The field animals showed higher incidence of Johne's disease, which may be due to inappropriate housing and health management measures. Besides testing, appropriate interpretation and measures to check the spread of MAP bacilli and the zoonotic risk involved has been made aware to the livestock owners.

Table. 4. Screening of MAP in JD suspected animals

S.No	Sample source	Positives *n* (%)								
		Fecal			Milk				Serum	
		Total	Micro scopy	PCR	Total	Microscopy		PCR	iELISA	Total	iELISA
						Direct	Pellet				
1	**CIRG livestock units**	107	31.77 (34/107)	-	-	-	-	-	-	7	14.28 (1/7)
2	**Barka nagla village/ Mathura**	23	26.08 (6/23)	0 (0)	12	0 (0/12)	0 (0/12)	0 (0/12)	58.33 (7/12)	25	60.0 (15/25)
3	**Bhadawari farm, Etawah**	40	17.01 (7/40)	-	-	-	-	-	-	40	60.97 (25/40)
4	**Vrindavan**	11	36.36 (4/11)	0 (0)	11	18.1 (2/11)	18.1 (2/11)	0 (0/11)	63.63 (7/11)	-	-
5	**Sonkh/ Mathura**	17	29.41 (5/17)	0 (0)	16	12.5 (2/16)	6.25 (1/16)	0 (0/16)	43.75 (7/16)	17	58.82 (10/17)
6	**Orissa**	44	18.18 (8)	-	-	-	-	-	-	-	-
7	**Aligarh**	10	50 (5/10)	0 (0)	-	-	-	-	-	11	63.63 (7/11)
8	**Indore (M.P.)**	21	33.33 (7/21)	0 (0)	-	-	-	-	-	-	-

S.No	Sample source	Positives *n* (%)								
		Fecal			Milk				Serum	
		Total	Micro scopy	PCR	Total	Microscopy		PCR	iELISA	Total	iELISA
						Direct	Pellet				
9	**Raebarelli (U.P.)**	10	80 (8/10)	10 (1/10)	-	-	-	-	-	8	75 (6/8)
	Total fecal	283	29.68 (84/283)	0.35 (1/283)	**Total milk** (n=39)	10.25 (4/39)	7.69 (3/39)	0 (0/39)	53.84 (21/39)	**Sera** (n=108)	59.26 (64/108)

iv) Risk analysis based on the presence of MAP in the milk products sold in the local market and certain commercial milk products

A study was carried out to assess the presence of MAP bacilli by three different diagnostic techniques in milk and milk products sold in the local market from Agra and Mathura. Two types of milk and products were selected viz., loosely sold unpasteurized/unprocessed items and packaged pasteurized items from commercial brands. The loosely sold milk, paneer and curd samples are pooled from a single source and like that pooled samples are collected from various outlets for used for detection of MAP. Similarly packaged milk, flavoured milk, curd, ice-cream and paneer were collected from various brands sold at the outlets as replicates from several batches and used for detection of MAP. The presence of MAP in the loosely sold unpasteurized unprocessed milk was very high and even some were detected by ZN microscopy of de-fattened milk smear. In case of commercial products only few samples could be detected for MAP antibodies and none was positive by either PCR or microscopy, but on the contrary, some of the loosely sold items could be demonstrated for MAP by these tests. (Table 5)

Table. 5. Presence of MAP in market sold unpackaged and commercially packaged milk and milk products from Agra and Mathura

S.N	Sample source Total sample iELISA			Positives *n* (%)			
				PCR	Microscopy		
1.	**Milk vendors (unpackaged/unpasteurized)**			25 pooled milk samples	52.0 (13/25)	8 (2/25)	4 (1/25)
2.	**Market products**	Flavoured Milk	4 Brands	36	5.56 (2/36)	0 (0/36)	0 (0/36)
		Ice-cream	6 Brands				
		curd	8 Brand				
3.	**Local Market**	Dairy 1	Pooled Curd samples **(loose/ unpasteurized)**	27	22.22 (6/27)	0 (0/27)	3.70 (1/27)
		Dairy 2					
		Dairy 3					
4.	Local Market	Unpacked Paneer	11 outlets	22	9.09 (2/22)	0 (0/22)	0 (0/22)
5.	Paneer (Packed)	4 Brands	6 samples/brand	24	0 (0/24)	0 (0)	0 (0)

(Project: (ICAR_OPZD): Zoonotic potential of *Mycobacterium avium* subspecies *paratuberculosis*, as the cause of Inflammatory Bowel Disease (Crohn's Disease) in human beings **PI:** K. Gururaj, Co-PIs: Anil Kumar Mishra and Anu Rahal)

6.6.2 Development of DIVA for Mycobacterium paratuberculosis:

During the current reporting period, two important technical programmes were conducted viz., i) Transcriptome analysis by RNA sequencing and its validation by qRT-PCR for identification of early biomarkers followed by ii) validation of DIVA ELISA for MAP.

For identification of molecular biomarkers in experimentally MAP infected Goats

- Transcriptome analysis –NGS RNA-Seq

- Validation of candidate genes by studying gene expression analysis using qRT PCR
- Infected (INF) and vaccinated (VAC) were compared with time point samples starting from day 0, 7, 15, 30,60 and 90 days post treatment (dpt)
- Identification of Biomarkers from RNA-Seq and its validation by qRT-PCR

A. RNA -seq analysis

The first step in the workflow involves purifying the poly-A containing mRNA molecules using poly-T oligo attached magnetic beads. Following purification, the mRNA is fragmented into small pieces using divalent cations under elevated temperature. The cleaved RNA fragments are copied into first strand cDNA using reverse transcriptase and random primers. Strand specificity is achieved by replacing dTTP with dUTP in the Second Strand Marking Mix (SMM), followed by second strand cDNA synthesis using DNA Polymerase I and RNase H. The incorporation of dUTP in second strand synthesis quenches the second strand during amplification, because the polymerase used in the assay is not incorporated past this nucleotide. The addition of Actinomycin D to First Stand Synthesis Act D mix (FSA) prevents spurious DNA-dependent synthesis, while allowing RNA-dependent synthesis, improving strand specificity. These cDNA fragments then have the addition of a single 'A' base and subsequent ligation of the adapter. The products are then purified and enriched with PCR to create the final cDNA library. Quality control analysis and quantification of the DNA library templates were performed to create optimum cluster densities across every lane of the flow cell. The reference genome and annotation used for mapping sample reads is given below.

Organism: [[Capra hircus]]

Reference genome: [[ARS1]]

Annotation reference: [[Ensembl]]

Genome Link:

[[ftp://ftp.ensembl.org/pub/release-95/fasta/capra_hircus/dna/Capra_hircus.ARS1.dn

a.toplevel.fa.gz]]

Annotation Link:

[[ftp://ftp.ensembl.org/pub/release-95/gtf/capra_hircus/Capra_hircus.ARS1.95.gtf.gz]]

v) Data analysis workflow using iDEP

iDEP (integrated Differential Expression and Pathway analysis) seamlessly connects 63 R/Bioconductor packages, 2 web services, and comprehensive annotation and pathway databases for 220 plant and animal species is used. The workflow was reproduced by downloading customized R code and related pathway files (Fig.1-8).

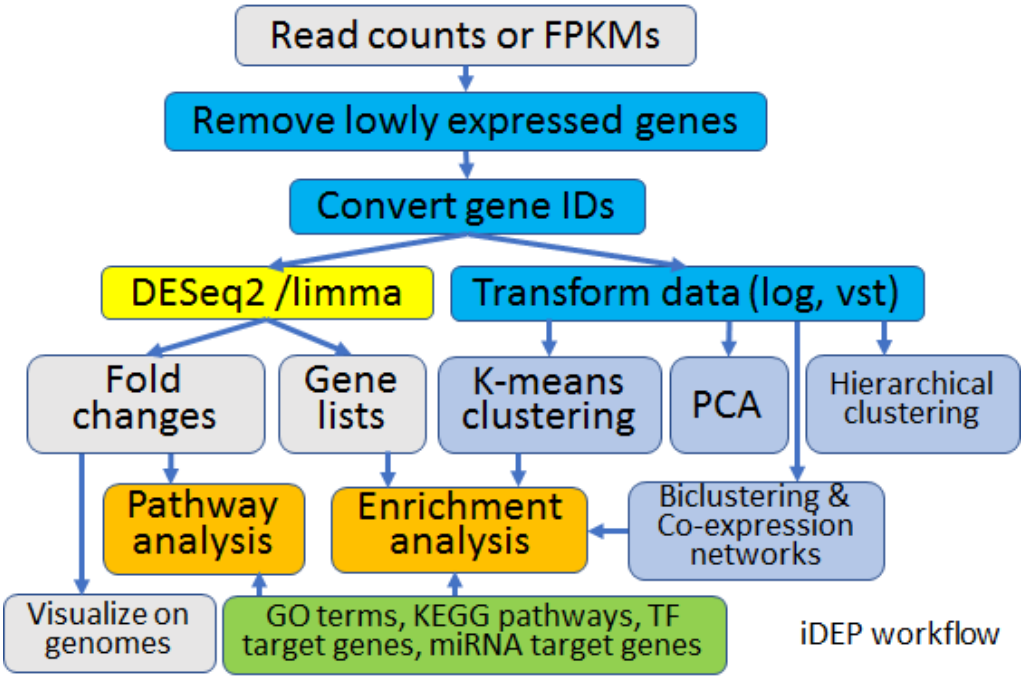


Fig. 1. Work flow using iDEP for detailed Transcriptome analysis based on FPKMs of experimental Johne's disease infected and vaccinated animals.

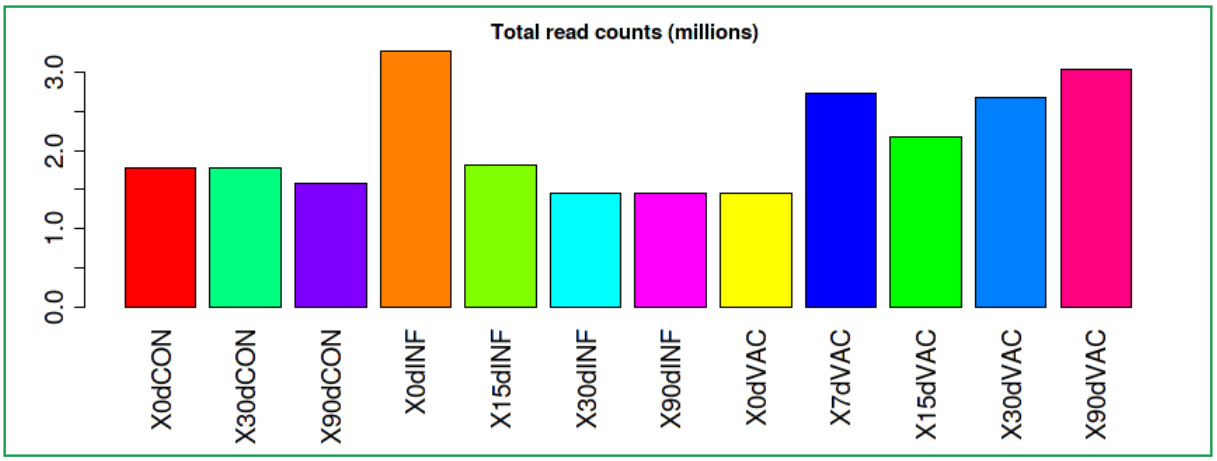


Fig.2.Total read counts in experimental groups (MAP infected/Vaccinated) collected from various days post treatment

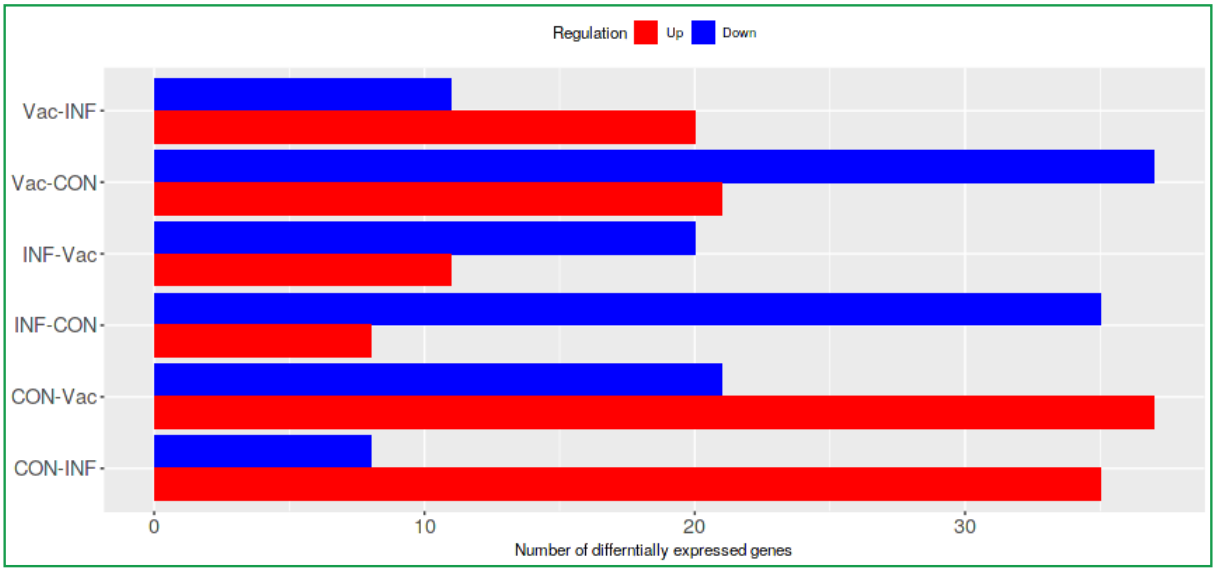


Fig.3. Histogram of Differentially expressed genes (DEGs) at various days post treatment in different treatment groups.

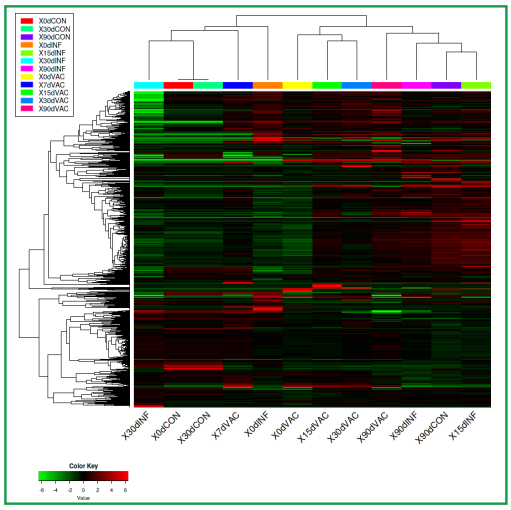


Fig.4. Heat map generated for various experimental groups to represent the differential gene expression at various time points of experiment

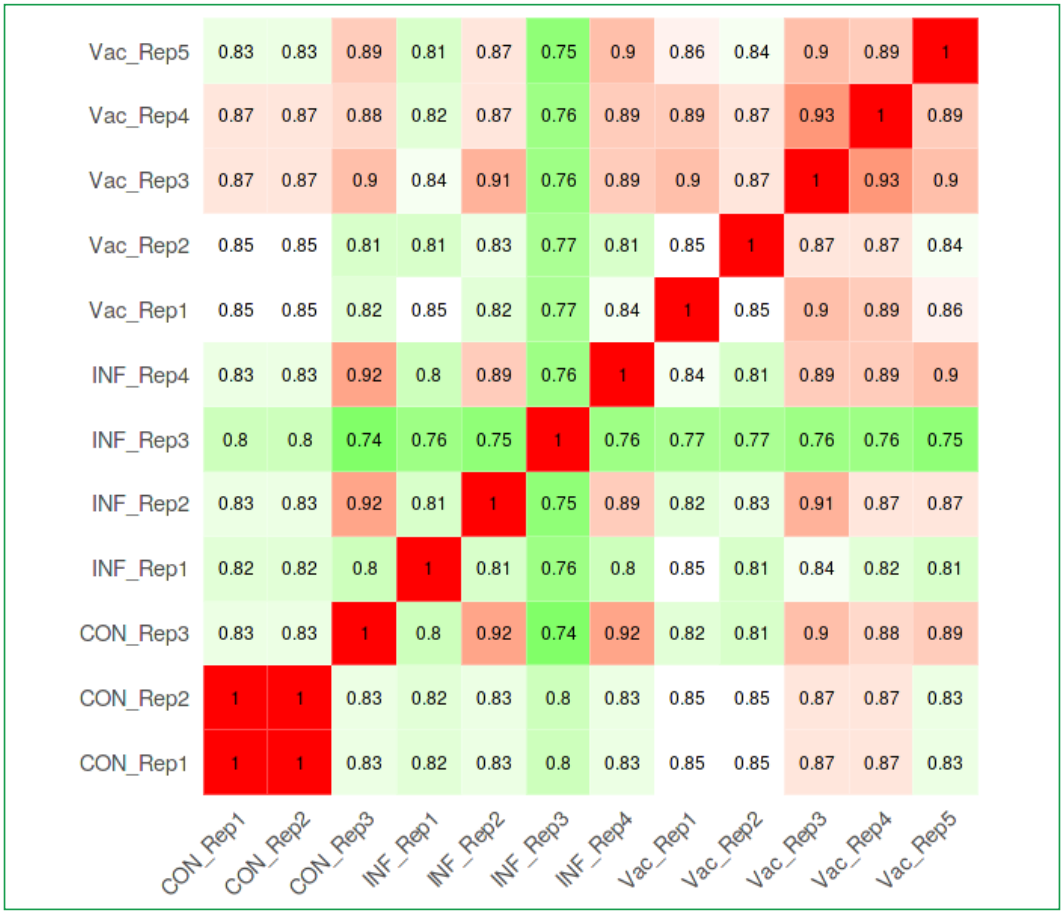


Fig.5.Matrix representing comparisons on differential gene expression between various MAP INF/VAC/CON experimental groups

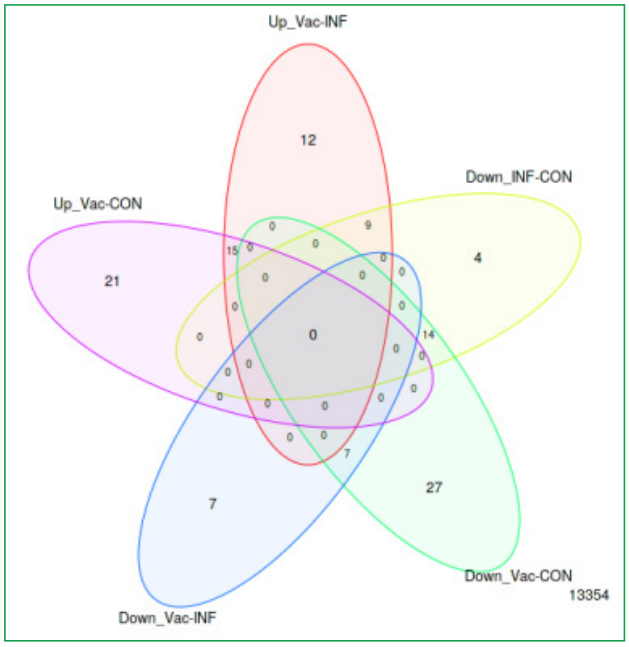


Fig.6. Venn Diagram shows the genes overlapping between various combinations of Vaccinated, Infected and Control group

vi) Data analysis for RNA Seq based Transcriptome analysis

RNA sequencing was planned and executed for the PBMCs total RNA which was analyzed previously by QC based on BioAnalyzer. Total RNA was used from JD vaccinated, infected and control groups with a sample size of 5 each for treatments and 2 for control group respectively. The sample RNA was subjected NGS based work-flow initially followed with library preparation using first strand cDNA synthesis followed by DNA polymerase I, actinomycin to aid in RNA-dependent second strand synthesis, purified and enriched by PCR to create final cDNA library and then to QC analysis for library validation by normalization and pooling. This is followed by NGS sequencing by Illumina platform and generation of raw data as FASTq file. The raw data is then subjected to data analysis, data check, read mapping to *Capra hircus* (goat) reference genome using ***Hisat2*** (hierarchical indexing of spliced alignment of transcripts) fast spliced aligner package. This is followed by differential expression analysis conducted using the ***Cuffdiff*** platform of cufflinks package to calculate the number of FPKMs (Fragments per kilobase of transcript per million mapped transcripts) and test for significant change in transcript expression across the sample at different levels. Annotations for gene ontology were conducted by specialized Uniprot analysis.

At 90 day post treatment, higher numbers of genes were transcriptionally modulated while compared to the controls. The 90day infected showed upregulation of IL-18 and IL2, while the 90 day vaccinated showed higher IFNα, ILIβ, TLR1,TLR3 and NOD2. A detailed work-flow on the basis of FPKMs and gene IDs for representation of pathway analysis, Gene ontology, KEGG analsysis is provided in Table.6, 7 &9. Instead of using selected DEGs that are sensitive to arbitrary cut-offs, pathway analysis can use fold-change values of all genes to identify coherently altered pathways. We used the GAGE (generally applicable gene set enrichment) as a method and KEGG as gene sets (Table 8 & 10).

Table.6. Transcriptional modulation and marker gene candidates at 90 days post treatment

	Comparison	Up-regulated genes	Down-regulated genes	Marker candidates with high significance
1.	90day CON Vs 90 day INF	7133	7622	IL-18, IL-2
2.	90day CON Vs 90 day VAC	7027	6755	IFNα, TLR-1,3 IL1β and NOD2

Table.7. Upregulated pathways at 90 days post treatment for Johne's disease Vaccinated Vs Infected animals

Direction	adj.Pval	nGenes	Pathways
Up regulated	5.0e-06	5	Nucleoside monophosphate metabolic process
	5.0e-06	4	Electron transport chain
	7.3e-06	7	Carbohydrate derivative metabolic process
	7.9e-06	4	Proton transmembrane transport

Table.8. GAGE analysis for 90 days post treatment

Direction	GAGE analysis: INF vs CON	statistic	Genes	adj.Pval
Down	Mitochondrial protein complex	-3.6343	181	6.9e-02
	Mitochondrial part	-3.1649	412	1.7e-01

Table.9. Modulated pathways (Upregulated/Downregulated) at 90 days post treatment for Johne's disease Vaccinated Vs Control animals

Direction	adj.Pval	nGenes	Pathways
Down regulated	3.5e-07	4	Antigen processing and presentation
Up regulated	2.0e-05	4	Antigen processing and presentation
	3.8e-05	4	Proton transmembrane transport
	1.4e-04	4	Nucleoside monophosphate metabolic process
	1.4e-04	3	Electron transport chain

Table.10. GAGE analysis for INF Vs CON - 90 days post treatment - Molecular function

Direction	GAGE analysis: INF vs CON	statistic	Genes	adj.Pval
Down	Oxidoreductase activity	-3.6775	459	6.6e-02

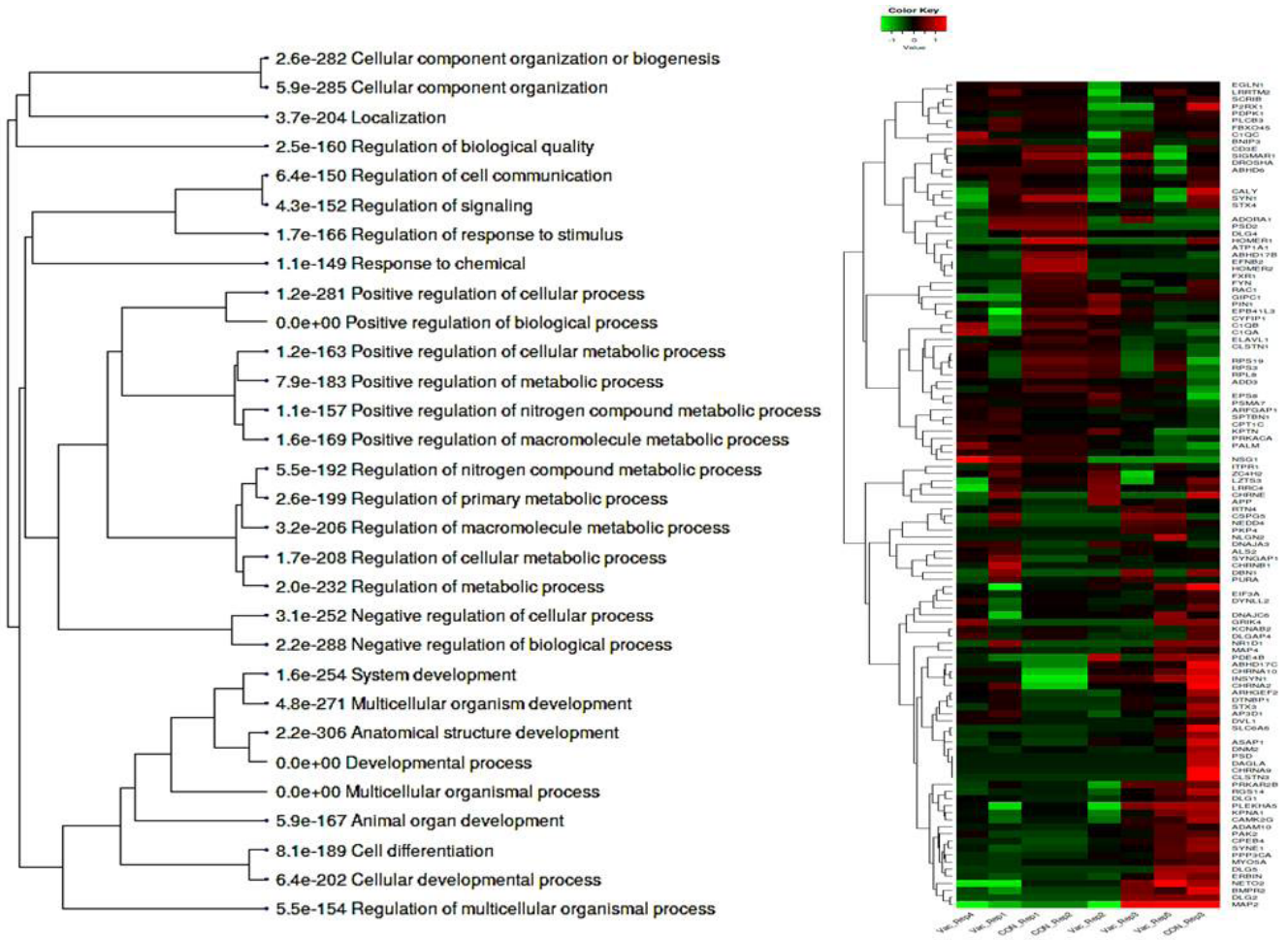


Fig.7. GO (Gene ontology) analysis for differentially expressed genes (DEGs) related to various cellular and metabolic process in control, MAP infected and MAP vaccinated groups.

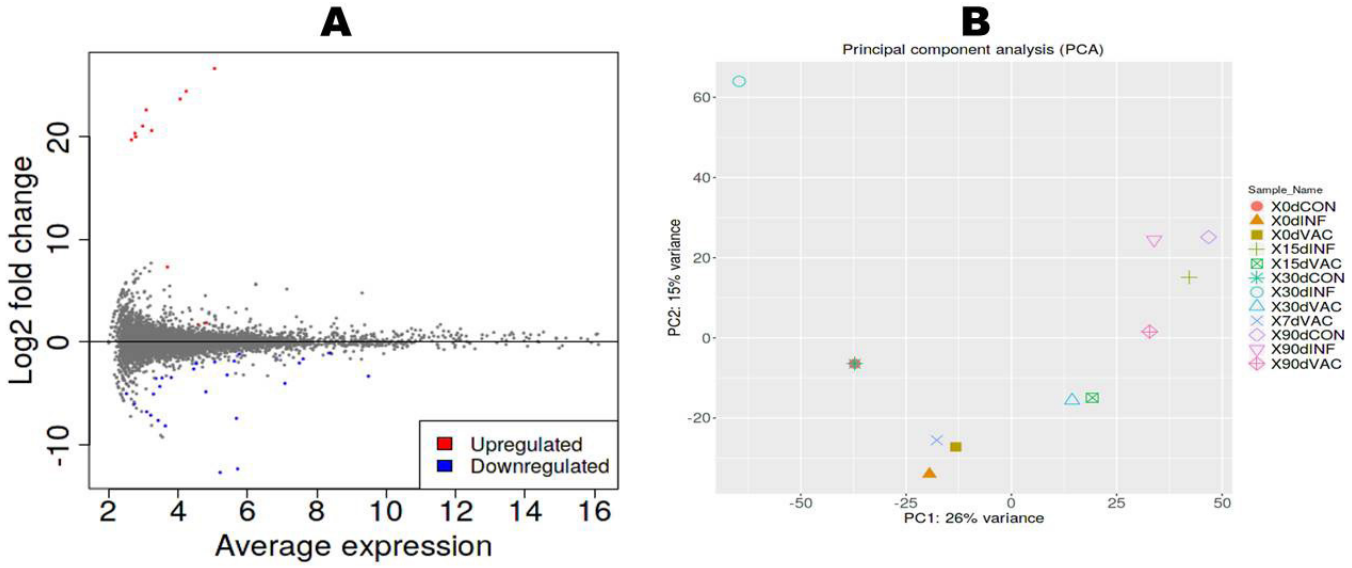


Fig.8. A. MA plot showing differential expression analysis using DESeq2, B. Principal component analysis (PCA) showing 26% variance among DEGs in various treatment groups.

vii)Pathway analysis of experimental groups

In heat maps the data is displayed in a grid which illustrates the expression differences of all mRNAs between the control, infected and vaccinated at the different time points of pathways (Fig.9,10,11). In the map, each row represents a gene and each column represents a sample at different pathways. The colour and intensity of the boxes is used to represent changes (not absolute values) of gene expression. In the above figure, red represents up-regulated genes and blue represents down-regulated genes. White represents unchanged expression.

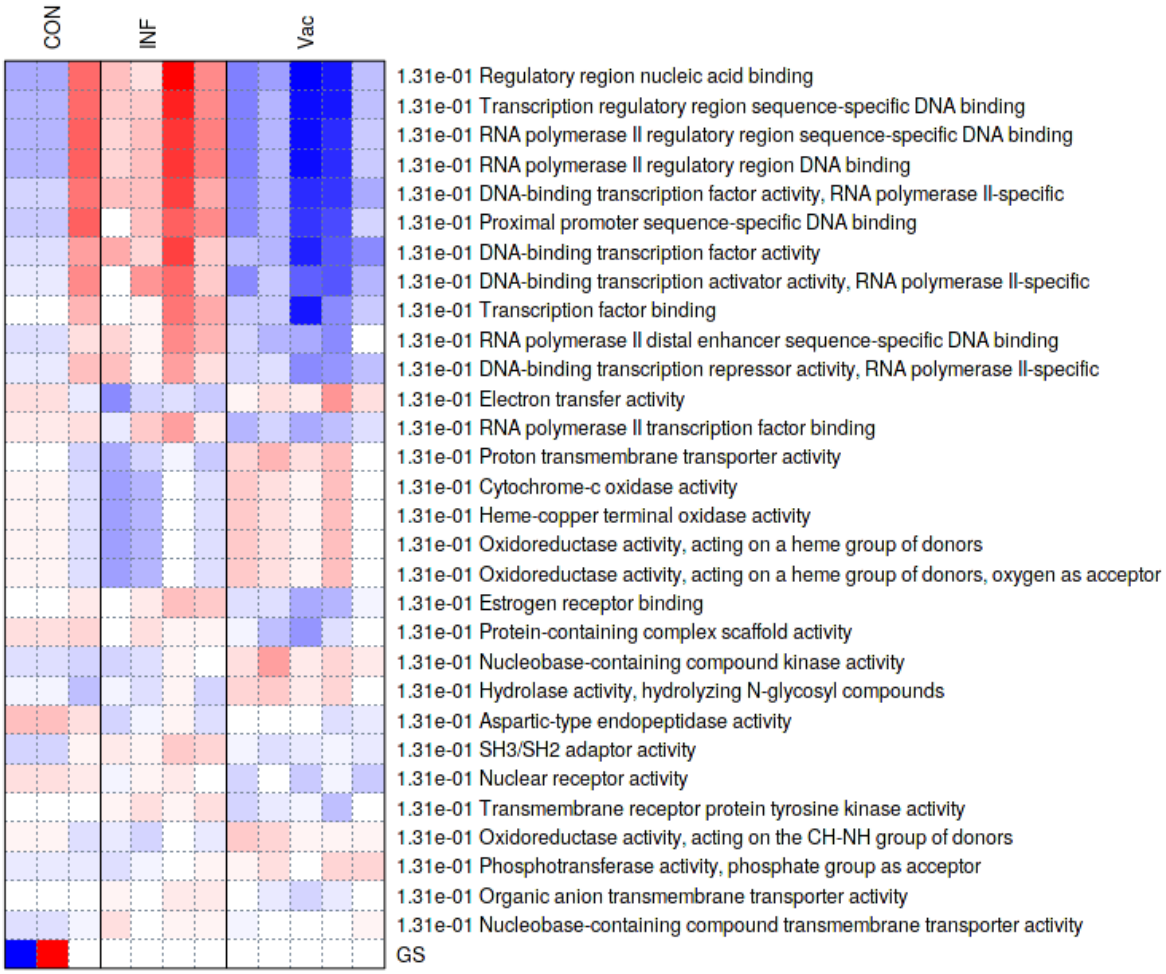


Fig.9 Pathway analysis using PGSEA on KEGG gene sets

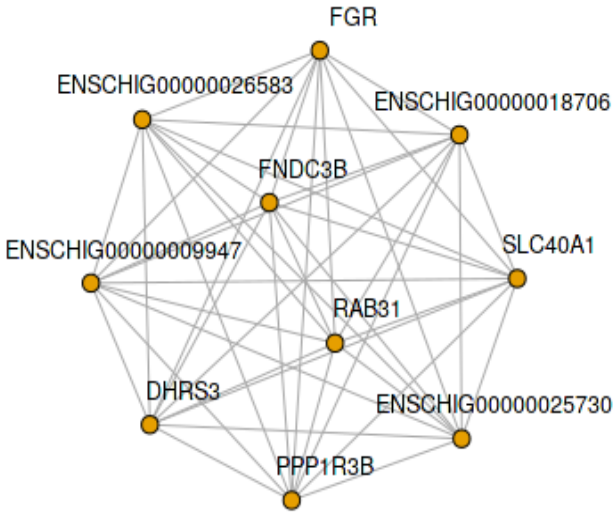


Fig.10. Protein interactome for top 10 up-regulated genes, where the protein-protein interactions (PPI) are enriched compared to background

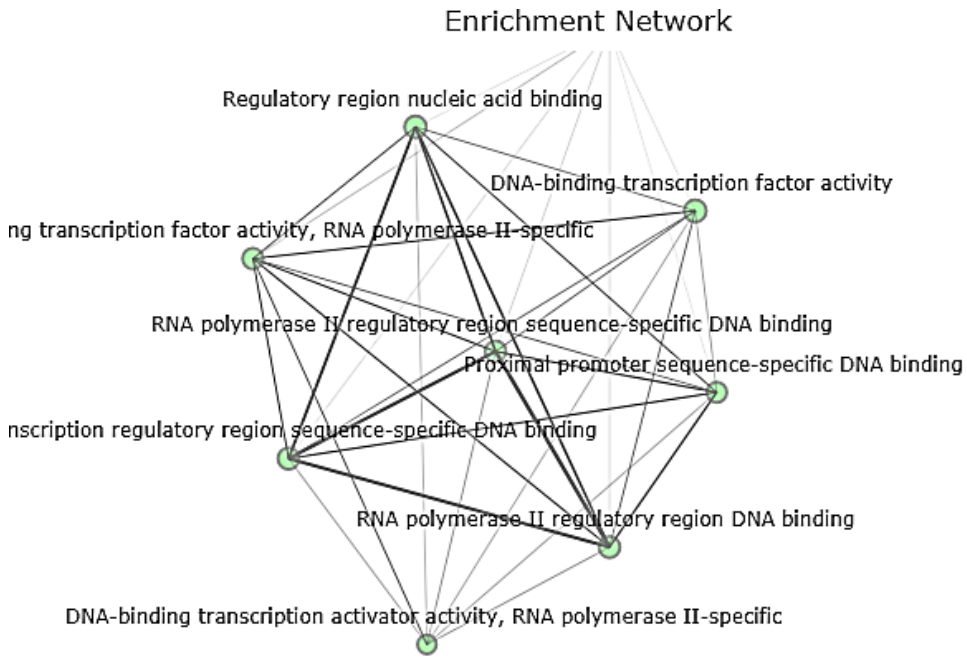


Fig.11. Enrichment network of top10 genes Protein-protein interactions (PPI) of molecular pathway.

viii) Differentially expressed genes– Major candidate genes

Some of the important genes like IL18, IL1 and IFNγ families and their extended network were analysed for significant differential expression between MAP Infected, vaccinated and uninfected control groups by using iDEP platform (Fig.12, 13 and 14).

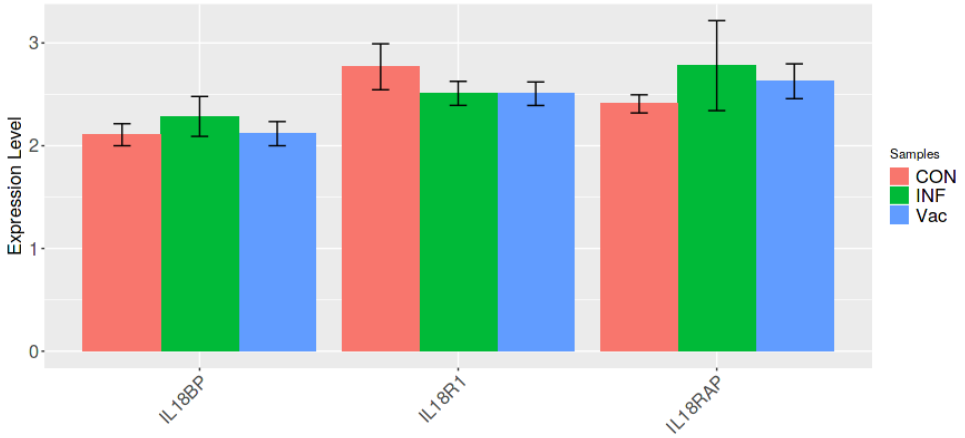


Fig.12. Expression patterns of Interleukin 1gene families generated by iDEP

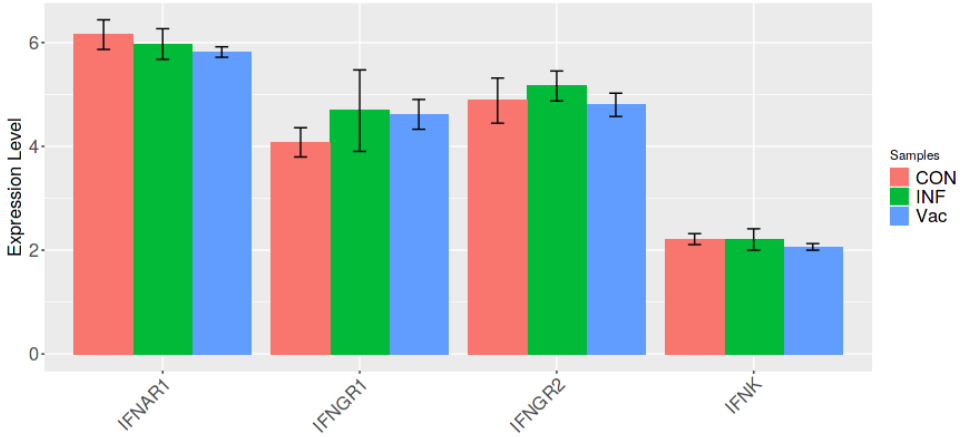


Fig.13. Expression patterns of Interferon-α gene families generated by iDEP

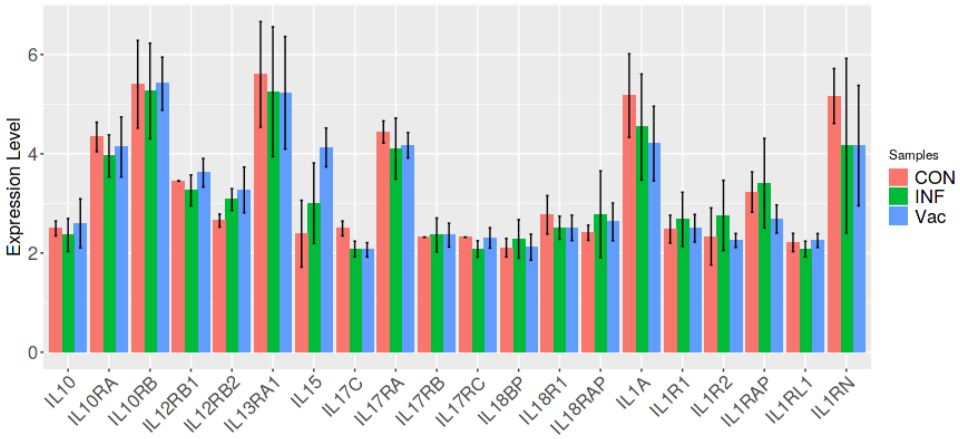


Fig.14.Expression patterns of extended Interleukin 1and 10 gene families generated by iDEP

ix) Weighted gene co-expression network analysis (WGCNA) for the gene sets of various pathways modulated in MAP experimental animals

WGCNA is a systems biology method for describing the correlation patterns among genes across transcriptome samples. Weighted correlation network analysis (WGCNA) can be used for finding clusters (modules) of highly correlated genes, for summarizing such clusters using the module eigengene or an intramodular hub gene, for relating modules to one another and to external sample traits (using eigengene network methodology), and for calculating module membership measures. Correlation networks facilitate network based gene screening methods that can be used to identify candidate biomarkers or therapeutic targets. WGCNA starts from the level of thousands of genes, identifies clinically interesting gene modules, and finally uses intramodular connectivity, gene significance (e.g. based on the correlation of a gene expression profile with a sample trait) to identify key genes in the disease pathways for further validation. WGCNA alleviates the multiple testing problem inherent in microarray data/ transcriptome analysis. Instead of relating thousands of genes to a microarray sample trait, it focuses on the relationship between a few (typically less than 10) modules and the sample trait. Toward this end, it calculates the eigengene significance (correlation between sample trait and eigengene) and the corresponding p-value for each module. The module definition does not make use of a priori defined gene sets. Instead, modules are constructed from the expression data by using hierarchical clustering. Modules are clusters of highly interconnected genes. In an unsigned coexpression network, modules correspond to clusters of genes with high absolute correlations. In a signed network, modules correspond to positively correlated genes.(Table 11)

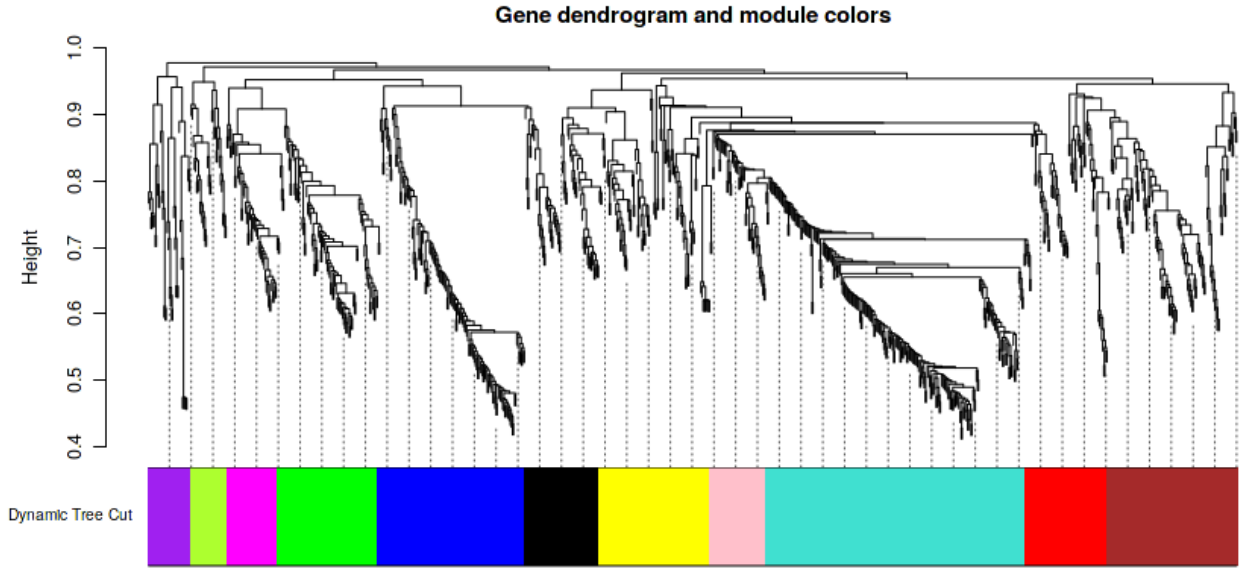


Fig.15 WGCNA dendrogram for top 500 differentially expressed genes in the MAP experimental groups: Module based analysis by dynamic tree cut.

Table.11. WGCNA enriched pathways among all genes in selected module for the MAP experimental groups

adj.Pval	Genes	Pathways
8.3e-10	33	Response to external stimulus
7.9e-08	24	Defense response
3.8e-07	18	Response to external biotic stimulus
2.7e-06	4	RAGE receptor binding
1.7e-04	32	Response to stress
2.1e-04	4	Heterotrimeric G-protein complex
2.1e-04	22	Multi-organism process
2.2e-04	18	Immune response
3.8e-04	11	Response to bacterium
3.8e-04	5	Neutrophil chemotaxis
4.3e-04	4	Neutrophil activation
4.3e-04	8	Chemokine signaling pathway

x) Gene ontology (GO) KEGG analysis for MAP experimental (Infected/Vaccinated/Control) animals

Gene expression data were interpreted using gene ontology (GO) categories and metabolic pathways containing multiple differentially expressed (DE) genes. Up-regulated genes are related to regulation of cell proliferation, locomotion, and response to endogenous stimuli. The down-regulated genes are significantly enriched with cell cycle-related genes. Functional categorization of the DE genes in each comparison was performed using the ShinyGO v0.61 software to identify biological process (BP), cellular pathway (CP) and molecular pathway (MP). While in the samples we identified several significantly expressed GO, where eighteen GOs were significantly enriched in the samples of the animals. Out of these eighteen GO; 4 were BP, 11 were CP and 3 were MP majorly (Fig 15-18). The four identified BP viz., Calcium signalling pathway, MAPK signalling pathway, focal adhesion and axon guidance were majorly related to the immune response, defence response, and positive regulation of neutrophil chemotaxis. The significantly higher expressed CP identified in the samples mainly were the nuclear part, cytosol, organelle lumen and plasma membrane region. In MP, enzyme and protein binding region were expressed significantly higher than others.

In detail of Biological process pathway, the Calcium signalling (CS) pathway was strongly activated in the early stage for MAP infected host, suggesting MAP infection has influence on this process during invasion and possibly related to MAP persistence. Calcium signalling plays an important role in a broad range of regulatory effects on enzymes and proteins and influence on other major pathways including MAPK Signalling, Apoptosis, Long-term Potentiation, Long-term Depression, Phosphatidylinositol Signalling and others. It has been reported earlier that mycobacterial toxin may inhibit Ca signalling which may lead to decreased phagosome-lysosome fusion and results in increased survival within human macrophages. Also,

for MAPK signalling pathway MAP2K1 is an essential component, involved in many cellular processes such as proliferation, differentiation, transcription regulation and development and also be important for eosinophil chemotaxis.

It was also suggested that MAP manipulates the cell adhesion processes of the host as evident by the early stage reversed states of perturbation of the Gap Junction, Adherens Junction, and Focal Adhesion junction pathways as well as the MAP condition's unique repressed state of the Tight Junction pathway and the GO term "cell-cell adhesion mediated by integrin". This suggests that MAP host invasion may be modulating critical cell adhesion processes in a complex manner. Along with the Tight Junction, the Gene Ontology (GO) term "cell-cell adhesion mediated by integrin" was also significantly repressed at the early stage for the MAP condition. Cell adhesion serves to facilitate trafficking and migration of T lymphocytes into sites of inflammation, movement of lymphocytes within the rich environment found in extravascular tissue, and the physical interaction between antigen-reactive T cells and antigen-presenting cells that is required for efficient T-cell activation. The repressed junction/adhesion related pathways and their associated genes suggest that MAP may disrupt T lymphocyte recruitment that helps explain the lack of chronic inflammation observed in the MAP infected ileal loops and subvert mucosal healing.

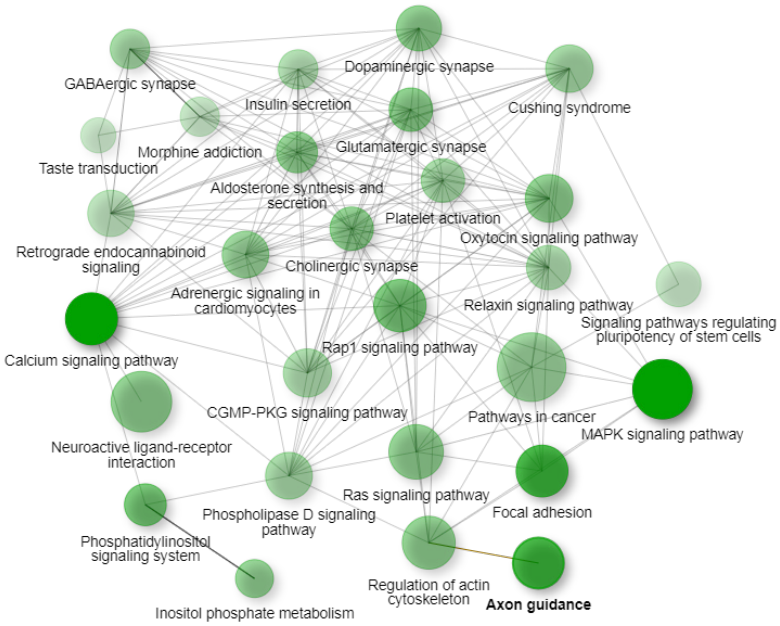


Fig.16. Infected/Vaccinated Vs Control -90 days : Gene ontology KEGG analysis –Biological process

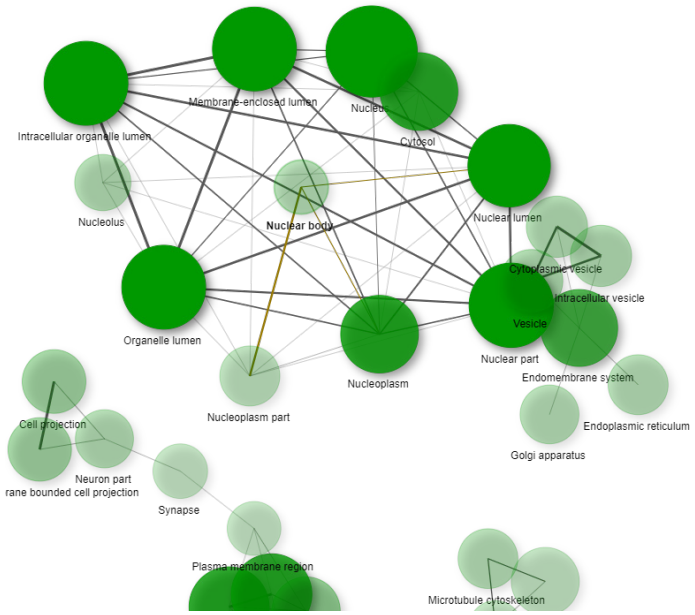


Fig.17. Infected/Vaccinated Vs Control -90 days : Gene ontology KEGG analysis –Cellular pathway

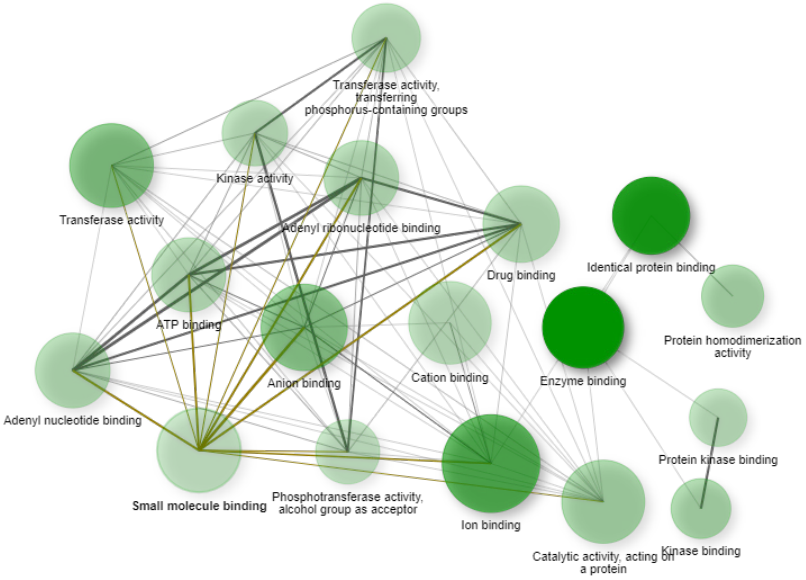


***Fig.18. Infected/Vaccinated Vs Control -90 days : Gene ontology KEGG analysis - Molecular Pathway* Validation by qRT-PCR**

Key genes identified in the various major pathways analysed by RNA-Seq Transcriptome analysis were studied representatively using quantitative reverse transcription real time PCR (qRT-PCR) to validate the formers findings. The data validated based on the various MAP experimental groups and their relevance with regard to RNA-Seq Transcriptome analysis is presented in the Table 12 below.

Table.12. Validation of gene expression – qRT PCR

Gene upregulated	Time point (days post treatment; dpt)	Group
IL-2	7 dpt	Infected
TLR2	30 dpt	Vaccinated
IL8	30 dpt	Vaccinated
IL18	30 dpt	Both Vaccinated and Infected
IFNγ	30 dpt	Vaccinated
CuZnSOD	60 and 90 dpt	Vaccinated
IL1β	30 dpt	Vaccinated

B. Development and validation of DIVA_ELISA to differentiate between the MAP-infected and vaccinated animals.

xi) Standardization of DIVA ELISA using truncated rMce (MAP2191c) protein:

Standardization and validation of the recombinant r*Mce* based DIVA ELISA was carried out using known positive and negative sera samples. The known vaccinated animals and known infected animals were selected from the previous experiment which were vaccinated with the 2ml s/c of indigenous JD (Killed MAP Indian Bison type S5 strain) and inoculated with $3x10^8$ MAP S5 culture respectively. Standard protocols were applied in the development of plate ELISA in indirect format, with 100ng of coated rMce protein per well followed by

overnight incubation at 4°C, washing with PBST, blocking using 3% skimmed milk, addition of sera @ 1:50, rabbit anti-goat IgG HRP@1:5000, colour development using 3% hydrogen peroxide substrate and OPD tablet and the plates were read at 495nm using microplate reader. The optical density obtained were blanked, calibrated with controls like serum control, antigen control, conjugate control and substrate controls. To reduce the errors in handling and optimization of protocol using various reagents, an inter-plate and intra-plate variation assay has been conducted to fine-tune the DIVA ELISA protocol. The standard deviation values between the OD values with respect to inter-plate and intra-plate taken at three different instances replicating the said protocol is being presented at Table. 13.

Table. 13. Inter-plate and Intra-plate Standard Deviation for MAP DIVA-ELISA developed at Microbiology lab, Division of Animal Health, ICAR-CIRG under NASF-DIVA project

Standard Deviation Infected		First instance		Second instance		Third instance	
		Vaccinated	Infected	Vaccinated	Infected	Vaccinated	
Inter Plate Variation	Plate 1	0.264966	0.065669	0.189129	0.04907	0.051647	0.028274
	Plate 2	0.317209	0.065264	0.245618	0.071987	0.07595	0.033068
Intra Plate Variation		0.305127	0.065211	0.225632	0.068031	0.125587	0.045507

Sensitivity and specificity of the rMce protein based DIVA-ELISA:

Development of any diagnostic assay requires high sensitivity and specificity, which is the life-line of the diagnostic interpretation. Both the parameters have equal significance in the sensible application of the diagnostic assay, given that DIVA-ELISA, which makes even more crucial. Based on the repeat testing of Vaccinated, known infected and unknown animals sera, we have subject to Receiver operating characteristics (ROC) curve to predict the sensitivity and specificity. The hypothesis here is that the r*Mce* protein could detect the infected animals and not the vaccinated ones, based on which the score set for infected is '1' (one) and for vaccinated, 'Zero' (0). The OD values for respective groups are entered in *Medcalc* software, and the ROC curve is generated (Fig. 19) , with an Area under curve (AUC) value of 0.936 (desired, >0.6) with high significance (P<0.001). The criterion has been calculated and interpreted as Youden index. The associated criterion which corresponds to the best fit was selected as >0.476 with a Youden Index J value of 0.9333, at which the specificity value is 100 % and sensitivity of 93.33% (Refer Annexure I & II for detailed ROC analysis report at the end of the document).

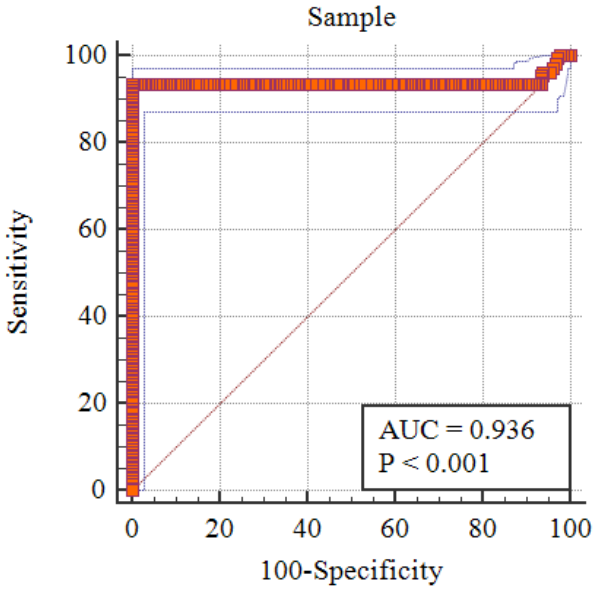
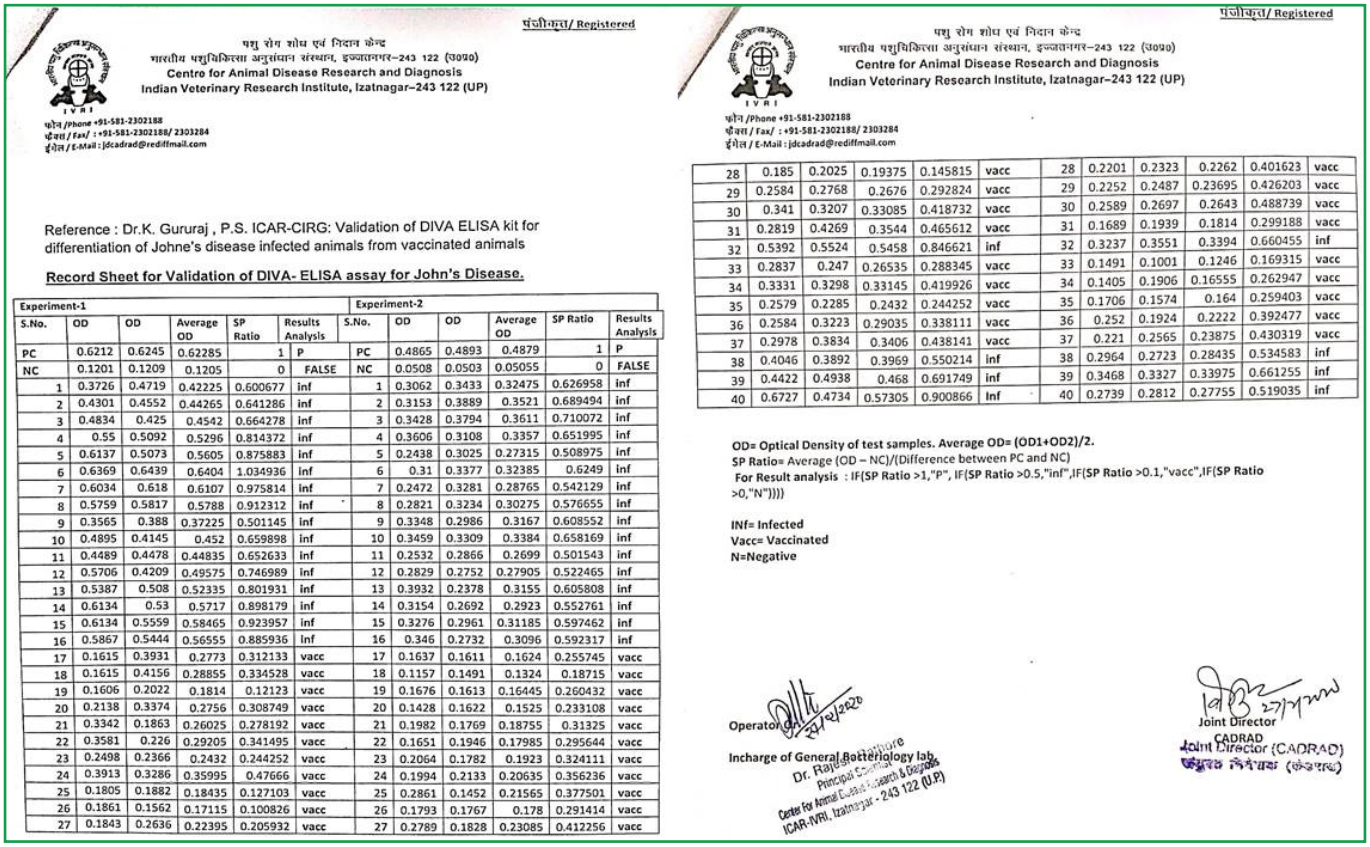


Fig. 19. Receiver operating characteristic (ROC) curve for the rMce based DIVA-ELISA for Johne's disease in domestic animals. AUC is area under curve with a value of 0.936 (P<0.001), with 100% specificity and 93.33% sensitivity at a set criterion of >0.476

xii) On-site Validation of DIVA-ELISA kit developed for Johne's disease in domestic animals

For onsite validation of DIVA-ELISA developed at the Microbiology laboratory of Animal Health Division, ICAR-CIRG, was conducted at CADRAD, ICAR-IVRI, Izatnagar, Bareilly. The validation report is generated based on microplate based DIVA-ELISA test conducted at CADRAD, which produced higher accuracy along with the desired specificity and sensitivity achieved earlier for this test.(Fig.20)



पंजीकृत/ Registered

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Reference : Dr.K. Gururaj , P.S. ICAR-CIRG: Validation of DIVA ELISA kit for differentiation of Johne's disease infected animals from vaccinated animals

Record Sheet for Validation of DIVA- ELISA assay for John's Disease.

Experiment-1						Experiment-2					
S.No.	OD	OD	Average OD	SP Ratio	Results Analysis	S.No.	OD	OD	Average OD	SP Ratio	Results Analysis
PC	0.6212	0.6245	0.62285	1	P	PC	0.4865	0.4893	0.4879	1	P
NC	0.1201	0.1209	0.1205	0	FALSE	NC	0.0508	0.0503	0.05055	0	FALSE
1	0.3726	0.4719	0.42225	0.600677	inf	1	0.3062	0.3433	0.32475	0.626958	inf
2	0.4301	0.4552	0.44265	0.641286	inf	2	0.3153	0.3889	0.3521	0.689494	inf
3	0.4834	0.425	0.4542	0.664278	inf	3	0.3428	0.3794	0.3611	0.710072	inf
4	0.55	0.5092	0.5296	0.814372	inf	4	0.3606	0.3108	0.3357	0.651995	inf
5	0.6137	0.5073	0.5605	0.875883	inf	5	0.2438	0.3025	0.27315	0.508975	inf
6	0.6369	0.6439	0.6404	1.034936	inf	6	0.31	0.3377	0.32385	0.6249	inf
7	0.6034	0.618	0.6107	0.975814	inf	7	0.2472	0.3281	0.28765	0.542129	inf
8	0.5759	0.5817	0.5788	0.912312	inf	8	0.2821	0.3234	0.30275	0.576655	inf
9	0.3565	0.388	0.37225	0.501145	inf	9	0.3348	0.2986	0.3167	0.608552	inf
10	0.4895	0.4145	0.452	0.659898	inf	10	0.3459	0.3309	0.3384	0.658169	inf
11	0.4489	0.4478	0.44835	0.652633	inf	11	0.2532	0.2866	0.2699	0.501543	inf
12	0.5706	0.4209	0.49575	0.746989	inf	12	0.2829	0.2752	0.27905	0.522465	inf
13	0.5387	0.508	0.52335	0.801931	inf	13	0.3932	0.2378	0.3155	0.605808	inf
14	0.6134	0.53	0.5717	0.898179	inf	14	0.3154	0.2692	0.2923	0.552761	inf
15	0.6134	0.5559	0.58465	0.923957	inf	15	0.3276	0.2961	0.31185	0.597462	inf
16	0.5867	0.5444	0.56555	0.885936	inf	16	0.346	0.2732	0.3096	0.592317	inf
17	0.1615	0.3931	0.2773	0.312133	vacc	17	0.1637	0.1611	0.1624	0.255745	vacc
18	0.1615	0.4156	0.28855	0.334528	vacc	18	0.1157	0.1491	0.1324	0.18715	vacc
19	0.1606	0.2022	0.1814	0.12123	vacc	19	0.1676	0.1613	0.16445	0.260432	vacc
20	0.2138	0.3374	0.2756	0.308749	vacc	20	0.1428	0.1622	0.1525	0.233108	vacc
21	0.3342	0.1863	0.26025	0.278192	vacc	21	0.1982	0.1769	0.18755	0.31325	vacc
22	0.3581	0.226	0.29205	0.341495	vacc	22	0.1651	0.1946	0.17985	0.295644	vacc
23	0.2498	0.2366	0.2432	0.244252	vacc	23	0.2064	0.1782	0.1923	0.324111	vacc
24	0.3913	0.3286	0.35995	0.47666	vacc	24	0.1994	0.2133	0.20635	0.356236	vacc
25	0.1805	0.1882	0.18435	0.127103	vacc	25	0.2861	0.1452	0.21565	0.377501	vacc
26	0.1861	0.1562	0.17115	0.100826	vacc	26	0.1793	0.1767	0.178	0.291414	vacc
27	0.1843	0.2636	0.22395	0.205932	vacc	27	0.2789	0.1828	0.23085	0.412256	vacc
28	0.185	0.2025	0.19375	0.145815	vacc	28	0.2201	0.2323	0.2262	0.401623	vacc
29	0.2584	0.2768	0.2676	0.292824	vacc	29	0.2252	0.2487	0.23695	0.426203	vacc
30	0.341	0.3207	0.33085	0.418732	vacc	30	0.2589	0.2697	0.2643	0.488739	vacc
31	0.2819	0.4269	0.3544	0.465612	vacc	31	0.1689	0.1939	0.1814	0.299188	vacc
32	0.5392	0.5524	0.5458	0.846621	inf	32	0.3237	0.3551	0.3394	0.660455	inf
33	0.2837	0.247	0.26535	0.288345	vacc	33	0.1491	0.1001	0.1246	0.169315	vacc
34	0.3331	0.3298	0.33145	0.419926	vacc	34	0.1405	0.1906	0.16555	0.262947	vacc
35	0.2579	0.2285	0.2432	0.244252	vacc	35	0.1706	0.1574	0.164	0.259403	vacc
36	0.2584	0.3223	0.29035	0.338111	vacc	36	0.252	0.1924	0.2222	0.392477	vacc
37	0.2978	0.3834	0.3406	0.438141	vacc	37	0.221	0.2565	0.23875	0.430319	vacc
38	0.4046	0.3892	0.3969	0.550214	inf	38	0.2964	0.2723	0.28435	0.534583	inf
39	0.4422	0.4938	0.468	0.691749	inf	39	0.3468	0.3327	0.33975	0.661255	inf
40	0.6727	0.4734	0.57305	0.900866	Inf	40	0.2739	0.2812	0.27755	0.519035	inf

OD= Optical Density of test samples. Average OD= (OD1+OD2)/2.
SP Ratio= Average (OD – NC)/(Difference between PC and NC)
For Result analysis : IF(SP Ratio >1,"P", IF(SP Ratio >0.5,"inf",IF(SP Ratio >0.1,"vacc",IF(SP Ratio >0,"N"))))

INf= Infected
Vacc= Vaccinated
N=Negative

Operator

Incharge of General Bacteriology lab
Dr. Rajesh
Principal Scientist
Centre for Animal Disease Research & Diagnosis
ICAR-IVRI, Izatnagar - 243 122 (U.P.)

Joint Director
CADRAD
Joint Director (CADRAD)

Fig.20.Validation report of DIVA-ELISA kit developed for Johne's disease developed under NASF-DIVA project communicated by CADRAD, ICAR-IVRI, Izatnagar.

(NASF Project: Identification of biomarkers for early diagnosis of MAP infection and development of a test to differentiate between Johne's disease infected and vaccinated animals (DIVA) PI: K. Gururaj, Co-PI: Dr. AK Mishra)

6.6.3 Antimicrobial drug resistance:

INFAAR, ICAR-CIRG centre has processed 159 biosamples from milk, fecal, nasal origin from all the specified domestic species as per the SOPs for the reporting period. *Staphyloccus aureus* and *Escherichia coli* has been isolated following the SOPs from the biosamples collected. In the reporting period, 90 samples were collected from Mathura district and 69 samples from Etawah district (Table 14). In the Quarter-2 (Apr-Jun, 2019), 87 isolates were obtained with 50 confirmed *E.coli* isolates and 37 *S. aureus* isolates, and in Quarter-2 (Jul-Sep, 2019), 1 isolate of *E.coli* and 4 isolates of *S. aureus* were used for AMR studies, and in the Quarter-3 (Oct-Dec, 2019), 11 isolates with 01 *E.coli* isolate and 10 *S. aureus* were obtained and processed further. (Table 15) (Figure 21 - 26)

Table.14. Total Bio-samples processed quarterly collected from two districts of Uttar Pradesh during the reporting period

Total no. of sample collected (n= 159)			
Quarter	Districts		Total
	Mathura	Etawah	
Apr-Jun	26	69	95
Jul-Sep	28	-	28

Total no. of sample collected (n= 159)			
Quarter	Districts		Total
	Mathura	Etawah	
Oct-Dec.	36	-	36
Total	90	69	159

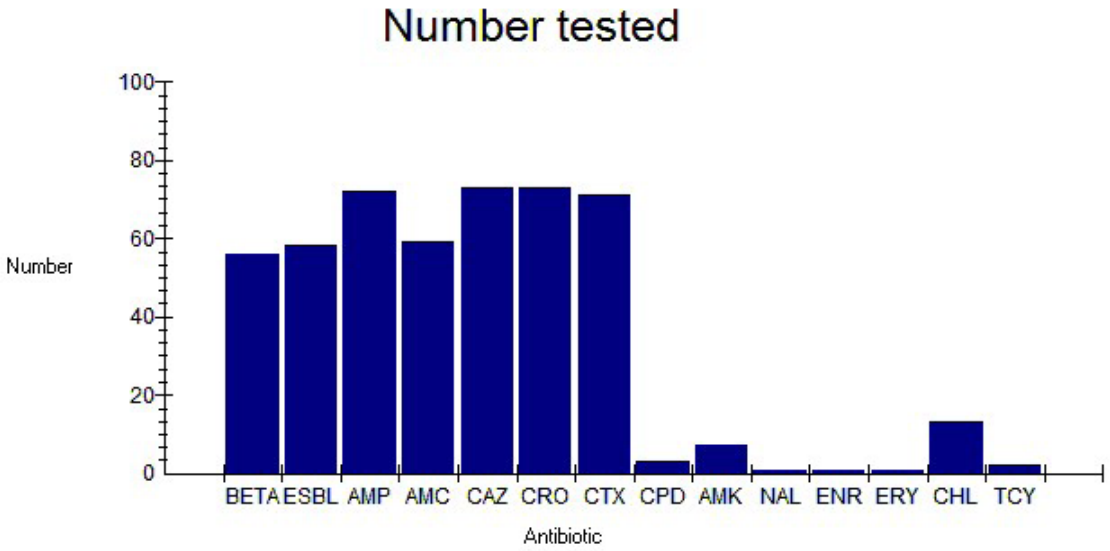


Fig.21. Total isolates tested during the reporting period for various antibiotics by disk diffusion method as per CLSI standards

Table.15. Total *E.coli* and *S. aureus* isolates processed in various quarters during the reporting period

Quarter	*E.coli*	*S. aureus*	Total no. of isolates
Apr-Jun	50	37	87
Jul-Sep	01	04	05
Oct-Dec.	01	10	11
Total	52	51	103

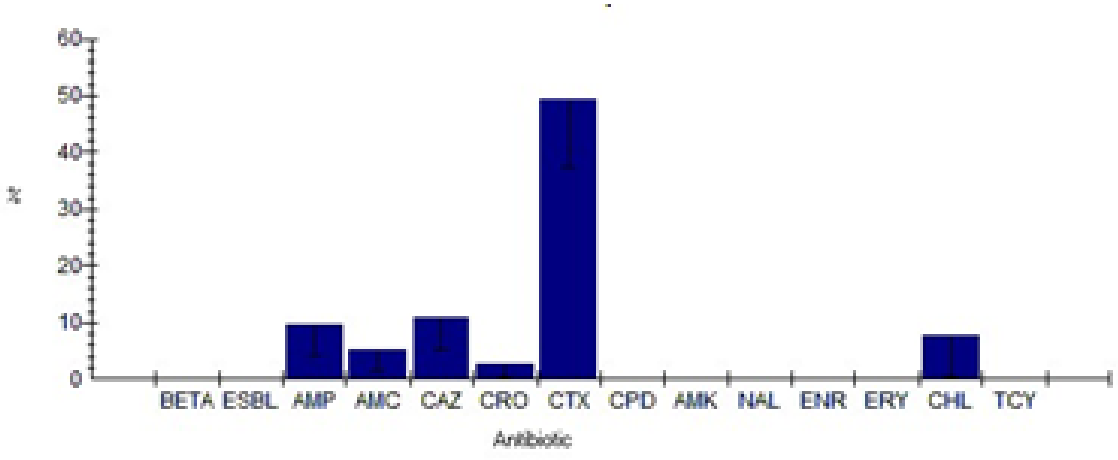


Fig.22. Resistant isolates of *Escherichia coli* obtained by disk diffusion method of AST to each antibiotic tested during the reporting period

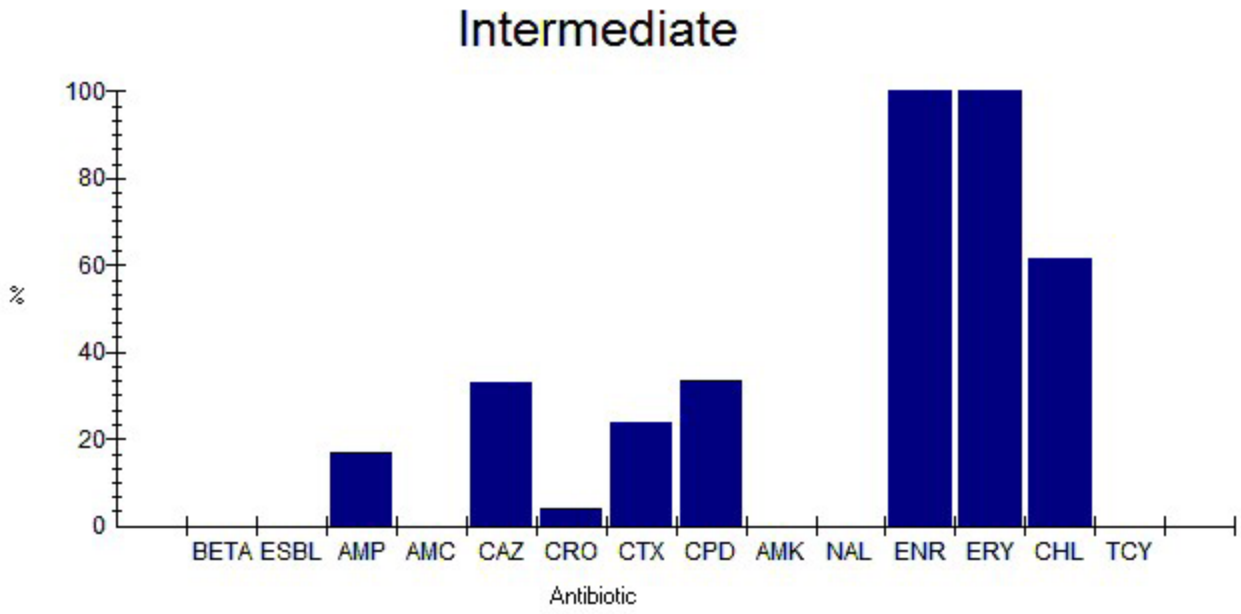


Fig.23. Intermediate sensitive isolates of *Escherichia coli* obtained by disk diffusion method of AST to each antibiotic tested during the reporting period

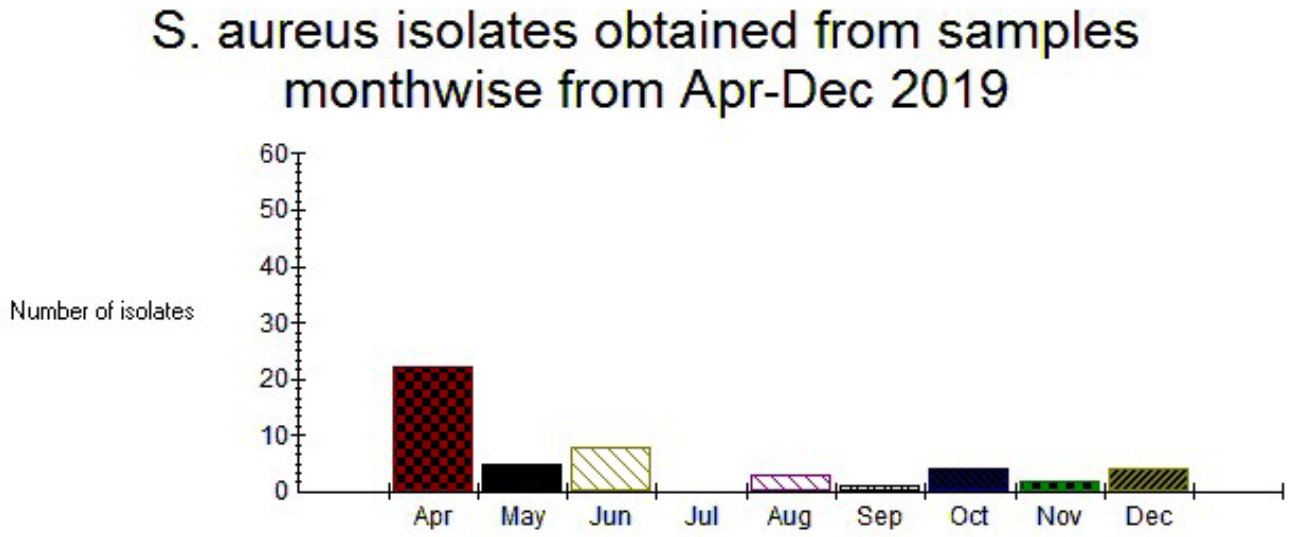


Fig.24. Month-wise representation of number of *Staphylococcus aureus* isolates obtained from various biosamples during the reporting period

Characterization of bacterial isolates using biochemical and molecular tests

Finally, 52 isolates of *E.coli* and 51 isolates of *S. aureus* were characterized by preliminary biochemical tests and confirmed by conventional PCR as per the SOPs. *E.coli* isolates were confirmed using multiplex PCR with the genes viz., lacz, lacy, cydA, uidA, phoA. Further NDM genotyping was conducted using the specific NDM-1 gene PCR. Similarly *S. aureus* and other *Staphylococcus* species were confirmed using multiplex PCR using 23S rRNA, *sodA*, *Gap*, *rdr* and *nuc* genes. Currently, the *S. aureus* was confirmed based on *Nuc* gene and/or 23srRNA genes.

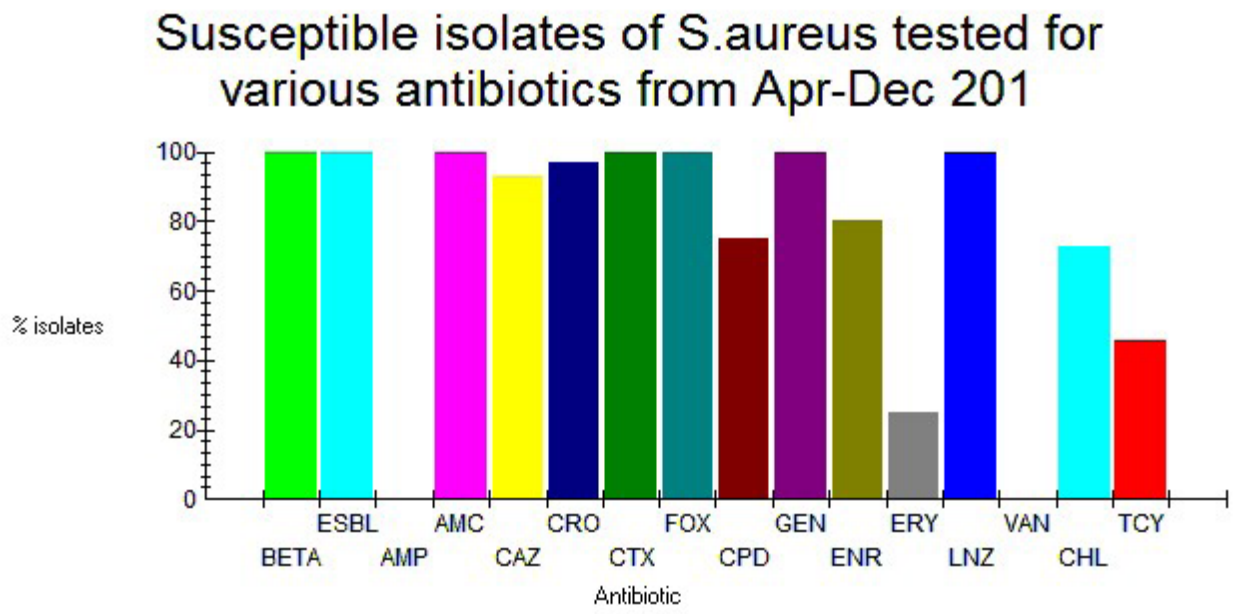


Fig.25. Susceptible isolates of *S. aureus* obtained by disk diffusion method of AST to each antibiotic tested during the reporting period

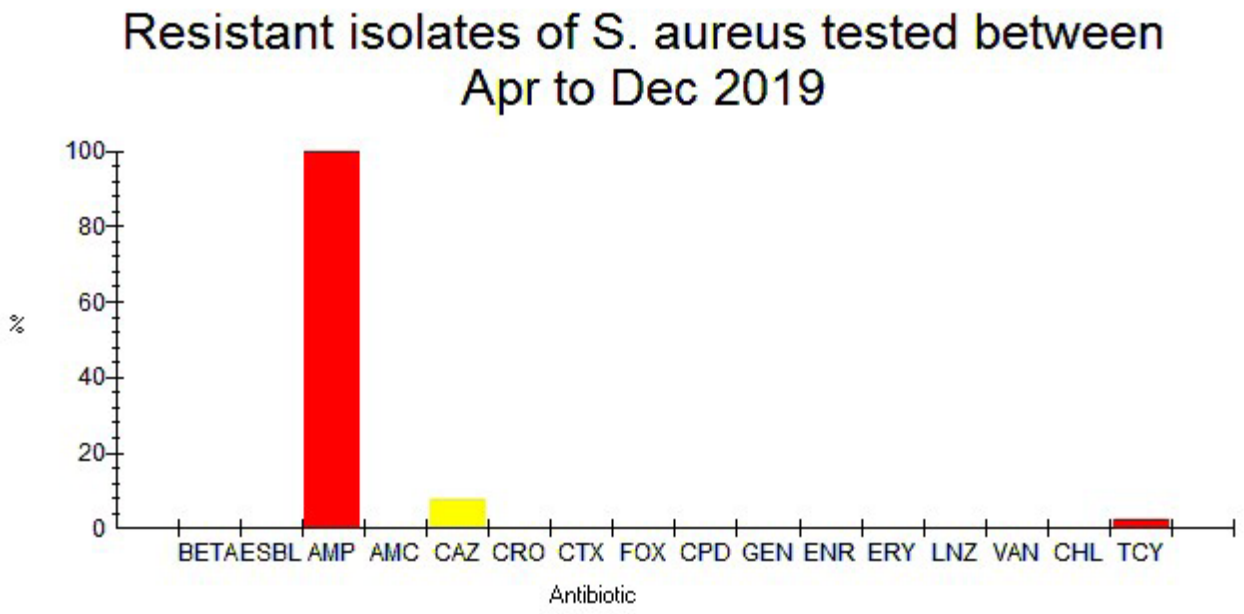


Fig.26. Resistant isolates of *S. aureus* obtained by disk diffusion method of AST to each antibiotic tested during the reporting period

Antimicrobial sensitivity testing (AST) of the isolates using disk diffusion method

All the isolates were subjected to antimicrobial sensitivity tests using disk diffusion method according to the CLSI standards (CLSI VET 01-S-Ed-3) (Fig. 27, 28 & 29). Further, ESBL test for *E.coli* isolates were tested using Cefpodoxime, ceftazidime, Aztreonam, cefotaxim and ceftriaxone. Certain isolates of E.coli were also subjected to combined disk method using ceftazidime/ceftazidime+Clavulanic acid disks and Double disk synergy test using cefoxitin/ cefoxitin-cloxacillin as per the SOPs. But of all the isolates tested phenotypically, none of them were positive for ESBL *E.coli*. The Carbapenem resistant isolates could not be screened phenotypically, but genotypically *NDM-1* gene could be detected in certain isolates of *E.coli*,

which will be screened for carbapenamase activity. *S. aureus* isolates were tested for AMR using AST and other phenotypic tests. Mainly beta-lactamase (disk diffusion using penicillin G) and MRSA based *Staphylococcus aureus* (Oxacillin and cefoxitin) were screened using the phenotypic tests. Beta lactamase test for S. aureus isolates was conducted using penicillin disk and were identified based on sharp and fuzzy edges. Sharp edges (Cliff) are considered as beta-lactamase positive, while fuzzy edges (Beach) are considered negative. Phenotypically, MRSA tests were conducted using Cefoxitin (30µg) and oxacillin (1µg) disks. For *S. aureus*, Cefoxitin is used to detect the MRSA, in which a zone of 21mm and below are considered as MRSA positive isolates and a zone of 22 mm and above are considered negative for MRSA. So far, MRSA isolates were not obtained in the current isolates of Staphylococcus spp. obtained in the study (Fig. 30-33).

Fig.27. Petriplate showing phenotypic ESBL test for detection of ESBL producing *E.coli* using five disks viz., Cefpodoxime, ceftazidime, Aztreonam, cefotaxim and ceftriaxone conducted as per SOP

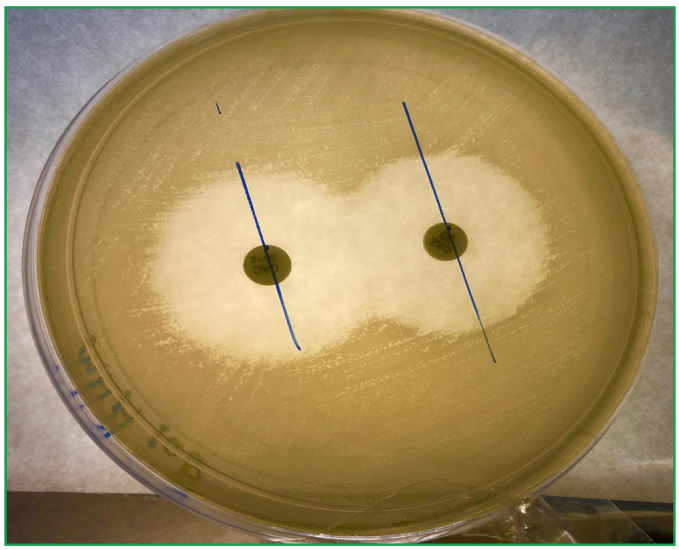


Fig.28. Combined disk test for identification of ESBL producing *E.coli* using ceftazidime/ ceftazidime+Clavulanic acid disks

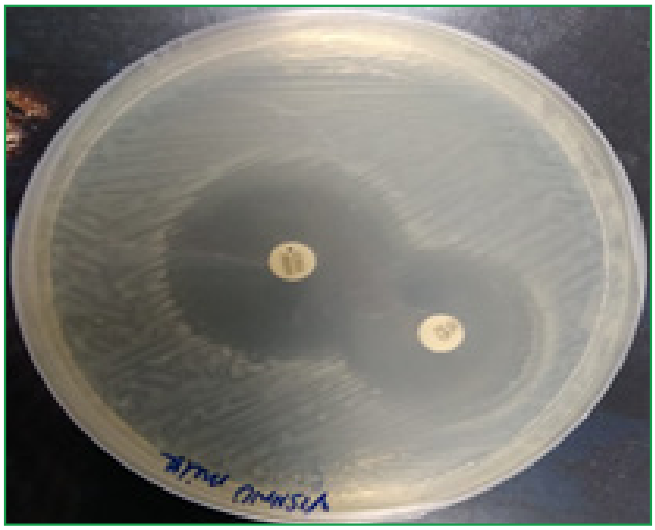


Fig. 29. Double disk synergy test using cefoxitin/cefoxitin-cloxacillin for detection of ESBL producing *E.coli*

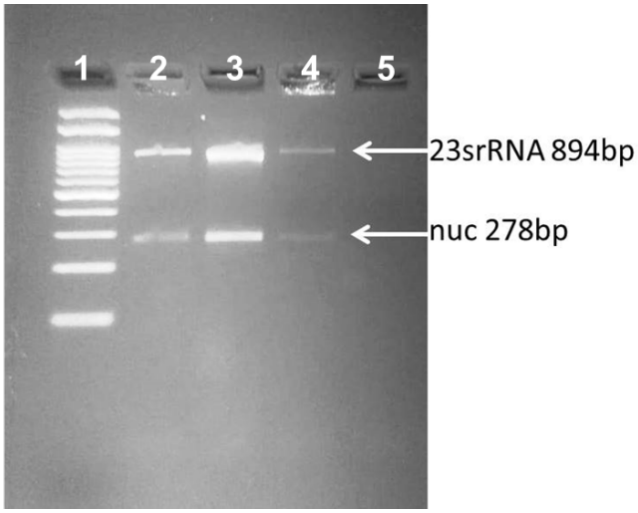


Fig. 30. *S. aureus* isolates detected genotypically using 23srRNA and Nuc genes

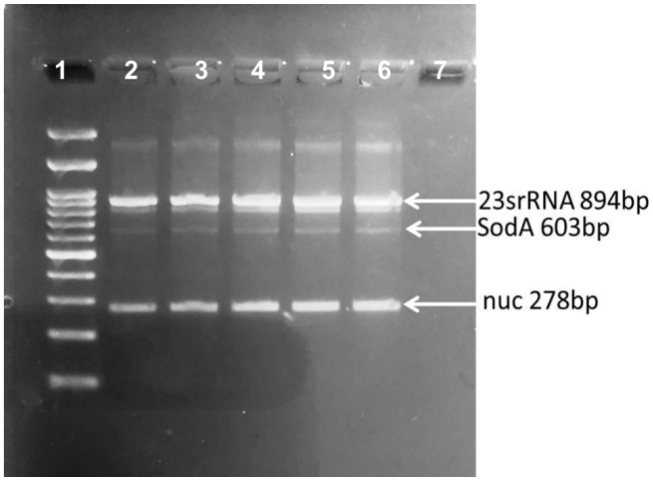


Fig.31. *S. hemolyticus* (Coagulase negative staphylococcus, CoNS) detected using 603bp *Sod*A gene as per the SOPs

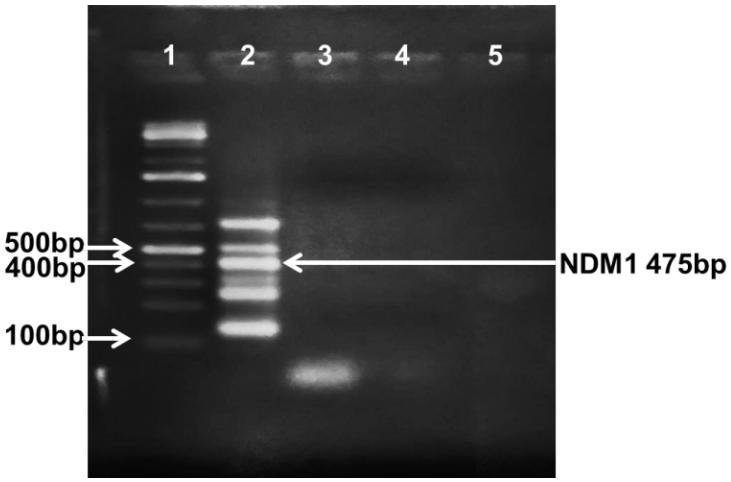


Fig.32. *E. coli* strain detected using 621bp NDM1 gene for carbapenem resistance as per the SOPs

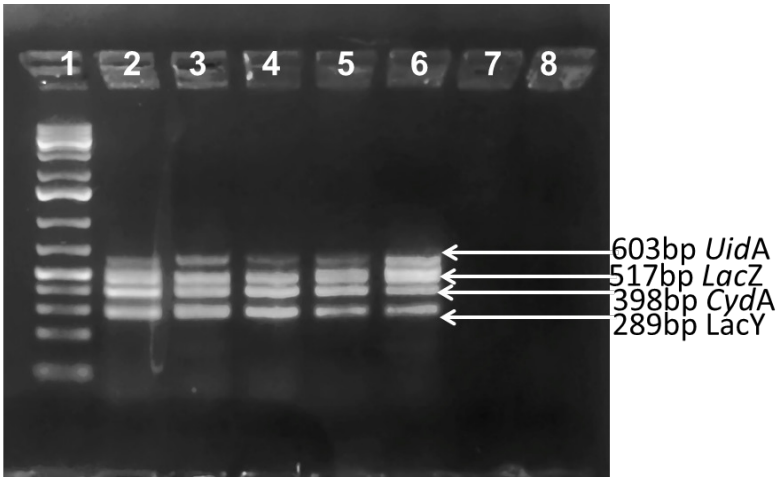


Fig.33. Confirmatory multiplex PCR for confirmation of *E. coli* isolates

World Antibiotic Awareness week -2019 celebrations by ICAR-Central Institute for research on Goats, Makhdoom

ICAR- Central Institute for research on Goats, Makhdoom has celebrated the WAAW-2019 with much fervour and enthusiasm. The theme of the celebration was 'Antimicrobial resistance – One Health Perspective'. Under this theme a seminar was arranged for 22 Veterinarians including Assistant directors, Livestock development officers, Laboratory officers, Farm managers and Veterinary assistant surgeons of State animal husbandry departments, Assistant professors of SAUs, Subject matter specialists from KVKs, spanning across 9 states of India starting from Jammu & Kashmir to Kerala by Division of Animal Health, ICAR-CIRG. Out of these 7 Veterinarians were from Maharashtra, 5 from Andhra Pradesh, 3 from Chhattisgarh, 2 from Jammu and Kashmir, 1 each from Goa, Karnataka, Kerala, Himachal Pradesh and Telangana. The Seminar was organized on 23rd November, 2019 under the aforementioned theme (Fig 34).

Fig. 34. World antibiotic awareness week celebrated at ICAR-CIRG attended by 22 veterinarians from 9 states under the theme 'Antimicrobial resistance – One Health Perspective'

(Project: ICAR-FAO Joint project network "Indian network for fisheries and animals antimicrobial resistance" (INFAAR) - ICAR-CIRG collaborating centre **PI:** K. Gururaj Co-PIs: D.K. Sharma, Anil Kumar Mishra Ashok Kumar and Nitika Sharma)

6.6.4 Development of single tube test for quick detection of Group A Rota virus (GARV) and Bovine corona virus (BCoV):

Viral agents can predispose the young animals to secondary infections in the gastrointestinal tract, especially in lambs and goat kids younger than 21 days. Hence, in the current study molecular diagnostics were developed as a tool to carry out epidemiological investigations with the aim of detecting rotavirus and coronavirus prevalence in goat kids and lambs and its association with viral enteritis.Our current study has been designed for detection of enteric viruses using molecular assays, to produce accurate, quick with highly sensitive and specific reproducible results. Hence two genes viz. VP6 & NSP4 were targeted for GARV and Nucleocapsid for Bovine corona virus. All the assays were set-up using SYBR green Reverse transcriptase real time PCR.

A total of 304 diarrhoeal and non-diarrhoealfaecal samples of animals (goat kids and lambs) were collected from Mathura, Etawah and Agra districts of Uttar Pradesh and Bharatpur of Rajasthanfrom April to December 2019. Samples were collected between the age group of 0-3 months. Out of 304 faecal samples, 254 were diarrheal samples (goat kids -232, lambs- 22) and 17 tissue samples (Intestinal loop from suspected necropsy cases) from different outbreaks and farms. The swab samples were suspended in 2.0 ml sterile double glass distilled water and stored in microfuge tubes at 4˚C for RNA isolation.

Primers were designed in-house based on the sequencing from the native isolates and identification of conserved sequences from other strains of GARV and BCoV from nucleotide database of NCBI. Two primer sets targeting VP6 and NSP4 were designed for GARV and one set of primer targeting NP gene of BCoV were designed and synthesized as tabulated below.

S. No.	Name of Primer	Sequence (5'→3')
1.	GARV-VP6-F	GCYAGAGACAARATTGTCGAAG
2.	GARV-VP6-R	YCTARTYGGNARRTTACCRATTCTTCC
3.	GARVNSP4_F-RT	GACAGAGTCGTTAAAGAAATGAGACG
4.	GARVNSP4_R-RT	TCCACTCTCCCATTCTTCTAGCG
5.	BCoVNP_F-RT	CATCCCGCTTCACTGATCTCTTG
6.	BCoVNP_R-RT	ACTGCCTAGGATACAACACGTCC

Out of 254 diarrheic neonate fecal samples tested 28(11.02%) were positive for GARV VP6 real-time RT-PCR (Fig.35.), 21 positive (8.27%)for NSP4 real-time RT-PCR (Fig.36.). These samples were detected with very high sensitivity and specificity for GARV. The NSP4 gene detection is considered as an active infection and not mere presence of GARV. The non-structural proteins are expressed only during active infections, which can correlate with the actual disease and the pathogenicity. Out of 17 intestinal tissue samples tested, 6 showed positive by GARV VP6 real time RT-PCR (35.29%) and 2 (11.76%) showed positive by NSP4 real time RT-PCR.

While Nucleoprotein real-time RT-PCR for detection of BCoV revealed 17 positive (6.69%) out of 254fecal swab samples tested and 2 were positive (11.76%) out of 17 tissue sample tested (Fig.37.).

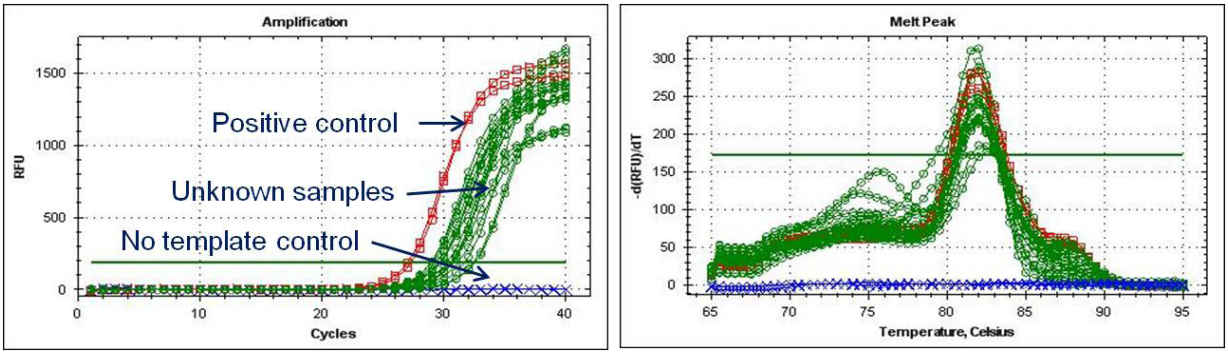


Fig. 35. Cycle quantification and Tm calling of the VP6 gene amplicon of GARV analyzed using SYBR-Green qRT-PCR assay

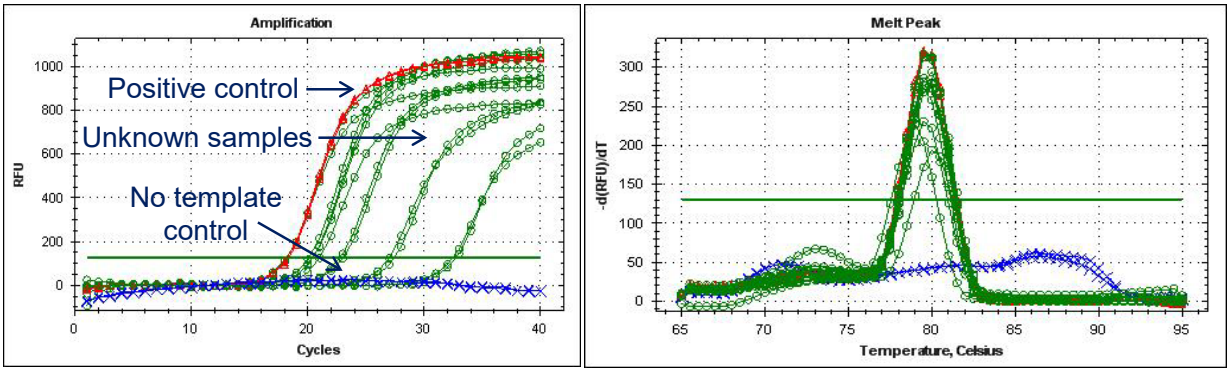


Fig. 36. Cycle quantification and Tm calling of the NSP4 gene amplicon of GARV analyzed using SYBR-Green qRT-PCR assay

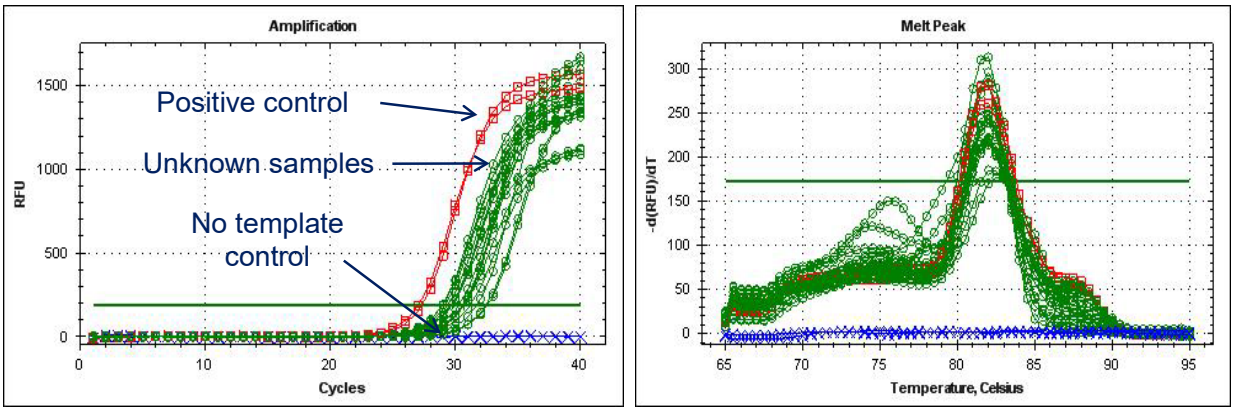


Fig. 37. Cycle quantification and Tm calling of the Nucleocapsid gene amplicon of BCoV analyzed using SYBR-Green qRT-PCR assay

Economics of kid mortality:

The present study was conducted in 10 states and UTs covering 395 goat rearing households having 6107 goat population. To study the mortality among kids with different dimensions like season, cause of death, flock size and breed, a standard tabular analysis has been carried out. To get the effect of flock size on kids mortality, complete set of household has been divided into four categories with different flock size on the basis of mean and standard deviation. The estimation of economic losses due to kids mortality are based on some assumptions like the kid would have survived and sold at its commercial age i.e. 10 - 11 months and expected body weight would be 20 kg irrespective of breed. Moreover, it has assumed that 90% of study goats were maintained under extensive management system and only 10% were under semi -intensive or intensive management system. Per goat rearing cost upto 10 months under extensive management system was calculated Rs. 1800 whereas Rs. 3000 was assumed for kids reared under semi intensive or intensive management system. The sale price of the goat varied from Rs. 300 to 375 per kg of live weight (collected through personal communication with traders/ butchers) Finally, net economic loss has been estimated as a difference between gross economic loss and cost of maintenance of kid upto10 months. The details of the expected economic losses has been portrayed in Table no 16. The losses per households was calculated with average figure of Rs 14589.00 .

Table 16: Expected economic losses (rupees) per HH due to kid mortality.

States	No. of goat rearing HHs	Mortality	Gross Economic losses	Cost of management upto 10 months	Net economic losses	Losses per HHs
Andaman & Nicobar	14.0	28.0	210000.0	53760.0	11160.0	11160.00
Andhra Pradesh	20.0	56.0	392000.0	107520.0	14224.0	14224.00
Haryana	47.0	120.0	720000.0	230400.0	10417.0	10417.02

States	No. of goat rearing HHs	Mortality	Gross Economic losses	Cost of management upto 10 months	Net economic losses	Losses per HHs
Karnataka	19.0	83.0	539500.0	159360.0	20007.4	20007.37
Kerala	85.0	238.0	1785000.0	456960.0	15624.0	15624.00
Madhya Pradesh	20.0	62.0	403000.0	119040.0	14198.0	14198.00
Rajasthan	52.0	109.0	708500.0	209280.0	9600.4	9600.38
Tamil Nadu	29.0	97.0	727500.0	186240.0	18664.1	18664.14
Uttar Pradesh	83.0	323.0	1938000.0	620160.0	15877.6	15877.59
West Bengal	26.0	103.0	679800.0	197760.0	18540.0	18540.00
All State	395.0	1219.0	8103300.0	2340480.0	14589.4	14589.42

(Project: ICAR- All India Network Project on Neonatal Mortality in Farm animals PI: Ashok Kumar Co-PI R.V.S. Pawaiya, A.K. Mishra, K. Gururaj)

6.6.5 Molecular epidemiology and Mapping of Cryptospridiosis

Healthy kidding and survival of neonatal kids for successful and productive goat farming

Diarrhoea is a serious problem in goats especially in kids of less than one month of age. Among, various neonatal diarrhoea causing pathogens Cryptosporidium sp. infection is very important as it leads to morbidity and mortality in them. Cryptosporidiosis results in diarrhoea, weakness, reduced growth and delayed maturity in kids. Though infection is not uncommon in higher age groups yet it can play havoc in neonates of less than one month of age with concurrent infections if any.

Under the project during reported period i.e. from April –December 2019, faecal samples were collected from scouring neonatal goat kids from ICAR-CIRG goat sheds and outbreak. A total 152 faecal samples were collected, processed using NSS sedimentation technique. The faecal smears were prepared, which were then stained by modified Ziehl-Neelsen, Modified Kinyoun and Negative staining techniques. A novel spore staining technique developed last year is being further refined. Overall incidence of Cryptosporidium in neonates of different farms at ICAR-CIRG by screening with microscopic methods was 50.0% (76/152). However, a total of 67.1% faecal samples of neonates were found positive when screened with PCR method. Out of 19 dams (of oocyst shedding kids) 17 (89.47 %) were found positive for *Cryptosporidium* oocysts in faecal smears. Breed-wise observations on prevalenc of Cryptosporidium oocysts revealed that Barbari had higer prevalence than Jamunapari and it was also high as seen in field outbreak. PCR method of screening was found to be more efficient in diagnosis/detection (Table-17).

DNA extraction protocol developed at ICAR-CIRG was standardized. Nested PCR of 18 S ssu rRNA and HSP 70 were standardized. Out of 152 samples 102 samples were found positive in PCR for 18 S ssu rRNA and HSP 70. Molecular characterization of the Cryptosporidium sp in positive samples based on the PCR results is in progress. For this, purified PCR amplicons of 18 S ssu rRNA and HSP 70 genes were sent for sequencing and the nucleotide data will be subsequently included (Fig.38).

Table 17 : Prevalence of Cryptosporidiosis in organized and field goat kids

S.N.	Sampling	Number of Samples	Microscopy, % (N)			PCR, % (N)	
			mZN Staining	Kinyoun Staining	Negative Staining	18s RNA	HSP70
1.	Barbari	83	54.21 (45)	54.21 (45)	46.98 (39)	73.49 (61)	73.49 (61)
2.	Jamunapari	47	40.42 (19)	40.42 (19)	36.17 (17)	53.19 (25)	53.19 (25)
3.	Outbreak	22	54.54 (12)	54.54 (12)	45.45 (10)	72.72 (16)	72.72 (16)
	Total	152	50.0 (76)	50.0 (76)	43.42 (66)	67.10 (102)	67.10 (102)

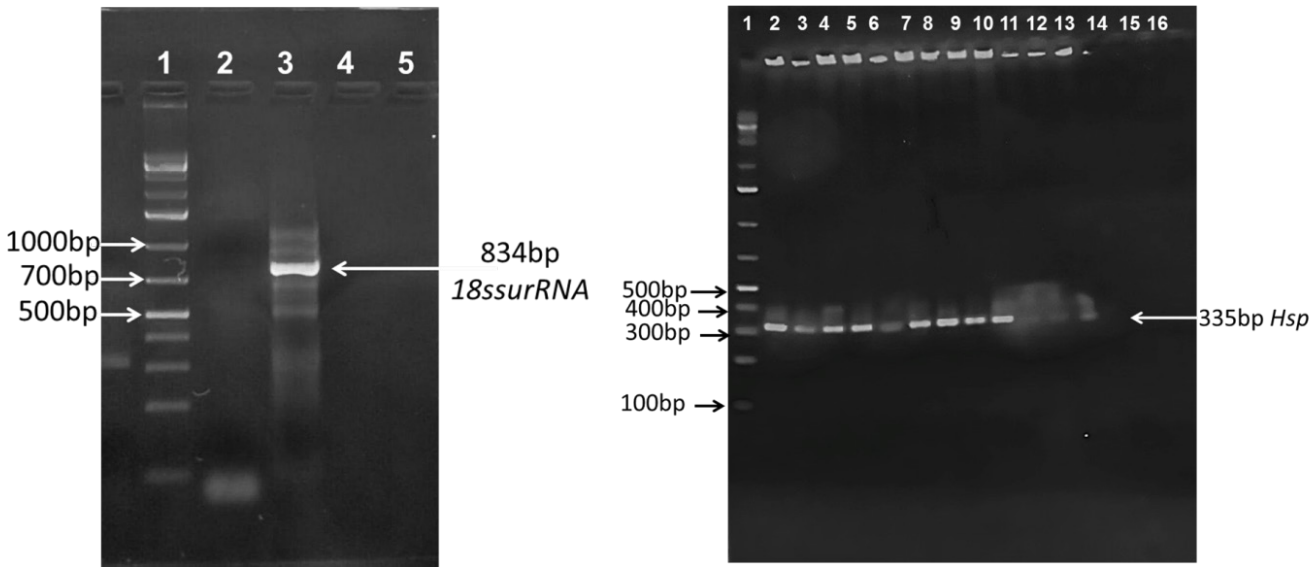


Fig.38.A- Gel Picture of 18ssurRNA nested PCR with a amplicon size of 834bp, Lanes: 1- 1Kb DNA ladder, 2-4 unknown samples, 5-No template control. B- Gel picture of HSP70 gene PCR with amplicon size of 335bp, Lanes: 1-1Kb DNA ladder, 2- positive control, 3-15- Unknown samples, 16-No template control.

(DBT Project: Molecular epidemiology and mapping of Cryptospridiosis in Tripura

PI: Souvik Paul, Co-PIs: Dinesh Kumar Sharma and K. Gururaj)

6.6.6 Sero-prevalence, diagnosis and investigation of goat diseases.

This Institute service research project envisages the systemic studies on the prevalence and monitoring of goat diseases by collection of biosamples, definitive diagnosis of disease/infection and compilation, maintenance and communication of precise information on these diseases. Major objectives are: i) Surveillance and investigation of goat diseases, and ii) Study on causes and pattern of mortality in goats.

SEROSURVEILLANCE AND DISEASE INVESTIGATION STUDIES

A total of 1060 biosamples from goat and sheep comprising of faeces, sera, milk, swabs, tissues etc. were collected from different locations including Bihar, Madhya Pradesh, Odisha, Uttar Pradesh and CIRG, Makhdoom.

Disease outbreak investigations were carried out in 3 villages of Mathura and 1 village of Aligarh District of Uttar Pradesh, and 1 village of Bharatpur district of Rajasthan affecting a total of 266 goats. The diseases diagnosed were mainly PPR, pneumonia, posterior paralysis, brucellosis and malnutrition/weakness.

Laboratory investigation of biosamples showed that overall, 22.45% (238/1060) samples were found to be positive for various diseases, including 59.26% (64/108) sera and 30.95% (91/294) faecal samples and 53.84% (21/39) milk samples positive for JD, 8.96% (13/145) positive for brucellosis, and 6.16% (21/341) positive for coenuroses.

From 16 biosamples, collected from 16 animals (12 goats, 4 sheep), (including blood, semen, liver, lung, kidney tissues, mastitis milk etc.) subjected to microbiological isolation studies, organisms such as *Corynebacterium ovis* (from milk) *Staphylococci* spp. From lung and liver tissues (2), *Streptococci* spp. from lung tissue (1) were isolated.

Of 393 faecal samples subjected for parasitological examination, 87.27% were positive for coccidia, 16.79% for strongyles, and 4.32% for Moniezia species.

STUDY ON CAUSES AND PATTERN OF MORTALITY IN GOATS

A total of 142 animal carcasses (120 goats & 22 sheep) were necropsied during the period from 1st April, 2019 to 31st December, 2019. Of these, 43 (30.29%) were from Jamunapari Unit, 25 (17.60%) from AH Div. Expl. Shed, 22 (15.49%) each from Barbari Unit and Sheep Unit, 16 (11.26%) from APR Div. Expl. Shed, 10 (7.04%) from ANPT Div Expl. Shed, and 4 (2.81%) were from Jakhrana Unit.

The causes of deaths diagnosed were pneumonia (19.7%), enteritis (19.0%), anaemia/weakness (10.5%),

autolysis (10.5%), septicaemia (7.7%), toxaemia (7.0%) haemonchosis (7.0%), coenurosis (4.2%), internal injury (2.1%), electrical shock (2.1%) and others (9.1%) (including mastitis, hepatitis, asphyxia, tympany, hypothermia etc.).

Age-wise, highest mortality was recorded in Adults (33.09%), followed by 3-6 months (25.35%), 6-12 months (21.83%) and 0-3 months (19.71%) age group. Sex-wise, overall mortality was higher in females (60.56%) than males (39.44%). However, sex-wise mortality pattern differed in different age groups, with female mortality dominating in adult (87.23%) and 0-3 months (53.57%) age groups; whereas, male mortality was higher in 3-6 months (55.55%) and 6-12 months (54.83%) age group.

Representative tissue specimens were collected for laboratory examinations including microbiological isolation, histopathological and molecular diagnosis studies.

A total of 85 samples were processed for histopathological studies. Histopathological diagnosis revealed cases of aspiration pneumonia, suppurative pneumonia, haemorrhagic enteritis, chronic enteritis, nephritis, hepatitis etc.

Among health activities, 4648 deworming, 3253 dipping, 517 drenching with coccidiostat, 12919 vaccination, and 4363 treatments were performed in the institute farm animals. Of morbid animals, the highest animals were affected with diarrhoea (66.77%) followed by fever/ anorexia (10.31%), wound/abscess (9.05%), lameness (6.44%), Udder impetigo (1.42%), Mange/dermatitis (0.96%), Udder oedema (0.85%), bloat/tympany (0.78%), pneumonia (0.71%), and others.

BRUCELLA SCREENING OF SMALL RUMINANTS BY VARIOUS LAB DIAGNOSTIC TESTS

For serological based tests like Serum agglutination test (SAT) and iELISA, *Brucella melitensis* based antigens are used as per the OIE (2012) prescribed protocols. For brucellosis, two states (UP and Bihar) were offered the services during the reporting period using SAT, ELISA and OMP31 TaqMan® probe qRT PCR. A total of 145 sera samples were subjected to SAT, of which 12.41% were positive for brucellosis, and 85 sera were subjected to iELISA which showed a positivity of 15.29%. Genital swabs were screened for shedding of Brucella using OMP31 TaqMan® probe qRT PCR and of the 32 samples tested, 9.38% were positive for Brucella. The results are tabulated in Table.18.

Table 18. Brucellosis screening by SAT, iELISA and OMP31 TaqMan® probe real time PCR from various livestock units and field cases.

S.No.	Livestock unit/herd	SAT		Indirect ELISA		OMP31 TaqMan® probe qRT PCR	
		Sample tested (n)	Positives (%)	Sample tested (n)	Positives (%)	Sample tested (n)	Positives (%)
1.	Jamunapari	8	4 (50.00)	-	-	11	0
2.	Jakhrana	17	7(41.17)	-	-	-	-
3.	Barbari	6	2 (33.33)	3	1 (33.33)	5	2 (40.00)
4.	Sheep	25	4 (12.50)	1	1 (100.00)	4	1 (25.00)
5.	AP&R	4	0	4	0	4	0
6.	ANM&PT	8	0	-	-	8	0
	Field samples						
7.	Bhadawari (Goats)	49	2 (4.08)	49	6 (12.24)	-	-
8.	Aligarh	10	0	10	1 (10.00)	-	-
9.	Raebareilly	8	0	8	2 (25.00)	-	-
10.	RCER, Patna	10	0	10	1 (10.00)	-	-
	Total	**145**	**18 (12.41)**	**85**	**13 (15.29)**	**32**	**3 (9.38)**

MYCOBACTERIUM AVIUM SUBSPECIES *PARATUBERCULOSIS* (MAP) SCREENING IN JOHNE'S DISEASE (JD) SUSPECTED ANIMALS

A total of 294 fecal samples, 39 milk samples and 108 sera samples were screened for MAP from Johne's disease suspected animals across three states viz., Uttar Pradesh, Odisha and Madhya Pradesh using fecal microscopy, fecal IS900 TaqMan® probe real time PCR,

milk smear microscopy, milk IS900 TaqMan® probe real time PCR, milk Indirect ELISA, serum iELISA. Indirect detection tests like iELISA revealed more occurrence of MAP in serum (59.26%) followed by milk (53.84%), followed by microscopy (fecal - 30.95%; milk - 10.29%) and PCR (fecal-0.35%; milk-0%). Complete information of the results for MAP from JD suspected animals are represented in Table. 19.

Table 19. Screening of MAP in JD suspected animals using various diagnostic tests.

S.No	Sample source	Positives *n* (%)								
		Fecal			Milk				Serum	
		Total	Micro scopy	PCR	Total	Microscopy		PCR	iELISA	Total	iELISA
						Direct	Pellet				
1	**CIRG livestock units**	107	31.77 (34/107)	-	-	-	-	-	-	7	14.28 (1/7)
	Field samples (Uttar Pradesh)										
2	**Barka nagla village/Mathura**	23	26.08 (6/23)	0 (0)	12	0 (0/12)	0 (0/12)	0 (0/12)	58.33 (7/12)	25	60.0 (15/25)
3	**Bhadawari farm, Etawah**	40	17.01 (7/40)	-	-	-	-	-	-	40	60.97 (25/40)
4	**Vrindavan**	11	36.36 (4/11)	0 (0)	11	18.1 (2/11)	18.1 (2/11)	0 (0/11)	63.63 (7/11)	-	-
5	**Sonkh/Mathura**	17	29.41 (5/17)	0 (0)	16	12.5 (2/16)	6.25 (1/16)	0 (0/16)	43.75 (7/16)	17	58.82 (10/17)
6	**Aligarh**	21	57.14 (12/21)	0 (0)	-	-	-	-	-	11	63.63 (7/11)
7	**Raebarelli (U.P.)**	10	80 (8/10)	10 (1/10)	-	-	-	-	-	8	75 (6/8)
	Field samples (Other states)										
8	**Odisha**	44	18.18 (8/44)	-	-	-	-	-	-	-	-
9.	**Indore (M.P.)**	21	33.33 (7/21)	0 (0)	-	-	-	-	-	-	-
	Total fecal	**294**	30.95 (91/294)	0.35 (1/283)	**Total milk (n=39)**	10.25 (4/39)	7.69 (3/39)	0 (0/39)	53.84 (21/39)	**Sera (n=108)**	59.26 (64/108)

SCREENING OF COENUROSIS (GID) USING IN-HOUSE DEVELOPED TM16P iELISA

Quick and early detection of coenurosis was done using TM16p-iELISA, which was developed using a 16 amino acid peptide from oncosphere antigen of *Taenia multiceps* at Animal health division. A total of 341 sera samples were subjected to TM16p-iELISA, of which 6.16% were positive for coenurosis. A detailed summary of the results were tabulated in Table. 20 below.

Table 20. Coenurosis screening by TM16p-iELISA from various livestock units.

S.No.	Livestock unit/herd	TM16p-iELISA	
		Sample tested (n)	Positives (%)
1.	Jamunapari	6	2
2.	Jakhrana	-	-
3.	Barbari	11	3 (27.27)
4.	Sheep	2	1 (50.00)
5.	AP&R	2	2(100.00)
6.	ANM&PT	1	0

S.No.	Livestock unit/herd	TM16p-iELISA	
		Sample tested (n)	Positives (%)
	Field samples		
7.	Mathura	270	11 (4.07)
8.	Bhadawari	49	4 (8.16)
Total		**341**	**21 (6.16)**

(Project: Sero-prevalence, diagnosis and investigation of goat diseases

PI: RVS Pawaiya, **Co-PIs:** DK Sharma, Ashok Kumar, Anu Rahal, K Gururaj, AK Mishra, Nitika Sharma, Souvik Paul, VK Chaturvedi)

6.6.7 Diagmostic development for Enterotoxaemia in Goats

Sampling and isolation of *Clostridium perfringens* from cases of necropsy suspected for E.T. based on gross lesions

A total of 133 animals were necropsied, of which 72 (54.13%) were suspected for ET and included in the study for confirmation of ET. Total number of goats affected and incidence percentage (%) of disease conditions in suspected spontaneous cases of enterotoxaemia (ET) in 0-6 months, 6-12 months and >12 months age group on the basis of post mortem (PM) findings are presented in Table. 21. Number of isolates of *C. perfringens* obtained from various age groups of goats necropsied is given in Table. 22. A detailed toxinotypes of *C. perfringens* obtained based on toxinotyping multiplex PCR is also presented in Table. 23.

Table. 21. Necropsy cases with various lesions suspected for Enterotoxaemia (n=133).

S. No.	Disease	0-6 months age goats	6-12 months age goats	> 12 months age goats	Total
1.	Enteritis	17 (12.78%)	9 (6.77%)	26 (19.55%)	52 (39.10%)
2.	Pneumo-enteritis	2 (1.50%)	2 (1.50%)	7 (5.27%)	11 (8.27%)
3.	Septiceamia	3 (2.26%)	2 (1.50%)	0 (0%)	5 (3.76%)
4.	Toxaemia	1 (0.75%)	0 (0%)	3 (2.26%)	4 (3.01%)
Incidence (%)		21 (15.79%)	12 (9.02%)	39 (29.32%)	72 (54.13%)

Table. 22. Incidence percentage (%) of *Clostridium perfringens* infection in goats on the basis of isolation and identification (n=133).

S. No.	*C. perfringens*	Age group of goats necropsied			Total
		0-6 months	6-12 months	>12 months	
1.	No. of positive samples	7	3	11	21
Incidence (%)		5.26%	2.26%	8.27%	15.79%

Table. 23. Identification of *C. perfringens* toxinotypes using by toxinotyping multiplex PCR intestinal samples of goats (n=133).

Toxinotype	Toxin gene(s) detected	No. of isolates and incidence % in 0-6 months age group	No. of isolates and incidence % in 6-12 months age group	No. of isolates and incidence % in >12 months age group	Total no. of isolates and incidence %
Type A	*cpa*	1 (0.75%)	0	1 (0.75%)	2 (1.50%)
Type D	*cpa, etx*	2 (1.50%)	2 (1.50%)	2 (1.50%)	6 (4.51%)
	cpa, etx, cpb2	4 (3.00%)	1 (0.75%)	10 (7.52%)	15 (11.27%)

Toxinotype	Toxin gene(s) detected	No. of isolates and incidence % in 0-6 months age group	No. of isolates and incidence % in 6-12 months age group	No. of isolates and incidence % in >12 months age group	Total no. of isolates and incidence %
Total		7 (5.26%)	3 (2.26%)	13 (9.77%)	23 (17.29%)

In this study, the incidence percentage (%) of *C. perfringens* in necropsied goats was 17.29%. In necropsied cases, 8.70% isolates were toxinotype A and 91.30% were toxinotype D, indicating the exclusive prevalence of *C. perfringens* type D toxinotype in goats. The minor toxin, β2-toxin, encoding gene (*cpb2*) was present in 11.27% of necropsied cases suggesting its strong association with *C. perfringens* isolates recovered from ET cases.

Molecular characterization of CIRG-isolates of *C. perfringens* type D

A. Sequencing analysis

All the isolates were codenamed according to the toxinotyping, post mortem number, date and origin of isolation. Among the 23 isolates, four from adult goats and one additional isolate from lamb were sequenced for epsilon toxin genes.

Following isolates were sequenced:

- *C. perfringens* Type D Strain 3319 (Lamb origin)
- *C. perfringens* Type D strain 13018 (Adult goat origin)
- *C. perfringens* Type D strain 14018 (Adult goat origin)
- *C. perfringens* Type D strain 19318 (Adult goat origin)
- *C. perfringens* Type D strain 3919 (Adult goat origin)

The 16 strains including 5 currently sequenced CIRG strains were compared in-line for the forward strand DNA of the epsilon toxin gene. The fifteen sequences were plotted against the NCTC strain 8533.

B. Phylogenetic analysis

Phylogenetic analysis was conducted for the ETX gene coding region of 16 different strains of *C. perfringens* including the 5 current CIRG strains, viz., 13018, 3319, 3919, 14018 and 19318 by ME method using Mega 6.0 software. The phylogenetic tree is comprised of two major branches, with first branch consisting of two distinct clades with the first clade containing the taxa CIRG 13018 closely related to NCTC strains 8533 and 6121, and previously studied CIRG strain 1816 isolated from goat kid. The second clade has the current strains 3319 (lamb) and 3919 goat placed along with the CIRG 2016 taxa.

The second branch has a single clade consisting of all the present and previous CIRG strains including strain 14018, NK and 7916. The minor branch has no clades with only individual taxa placed together including currently studied CIRG strain 19318, CIRG 3716 (lamb), Belgian and Iranian strains. The IVRI strains 149 and Vac1 were distantly related to all the current strains or overall CIRG strains studied (Fig. 39).

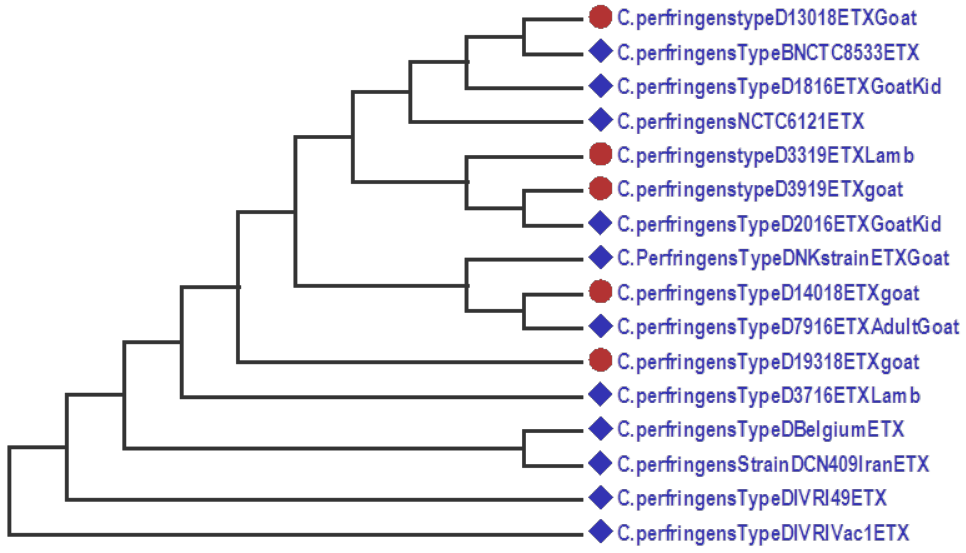


Fig.39. Phylogenetic analysis of epsilon toxin gene coding regions of native CIRG isolates (Red bullets) versus reference strains of *C. perfringens* using minimum evolution method.

3. Experimental study

The experimental study was conducted as per Uzal and Kelly (1998) to study the host-pathogen interaction and pathogenicity analysis of selected isolate. A characterized *cpb2* positive *C. perfringens* type D isolate, CIRG-14018 was used in experimental study. In experimental study, laparotomy was conducted and the inoculums were administered in duodenum to prevent its degradation in the upper gut. The pathogenic effect of different inoculums on goats was then studied. Institutional animal ethical committee (IAEC) approval (file no. 25/9/2019 – CPCSEA) was obtained to conduct the experiment in post weaned goats. The current study was broadly divided into two major entities; spontaneous and experimental study. The spontaneous study was undertaken to determine the patho-epidemiology of ET at field level. Different samples collected from necropsied goats were subjected to bacteriological, pathological (histopathology and immunohistochemistry) and molecular studies (qRT-PCR).

A. Experimental design

Twelve healthy Barbari breed goats of 3-6 months age of either sex weighing 10-16 kg were used for study. They were divided into three groups.

- Group I- Treated with whole culture (WC)
- Group II- Treated with trypsin activated culture supernatant (TACS)
- Group III- Treated with only RCM medium (control)

All the animals were acclimatized for 10 days before commencement of experiments. They were kept in experimental shed of Animal Health Division, ICAR-CIRG, Makhdoom. They were given adequate concentrate diet, green forages and *ad libitum* water.

B. Clinical findings

In group I (WC), out of 5 animals, four animals showed inappetance, depression, diarrhoea, dypnoea while one animal did not showed any clinical abnormality. The diarrhoea was characterized by loose formed faecal pellets to dark green pasty faeces. Out of 5 animals, three animals were died spontaneously within 24 hpi while rest two was euthanized.In group II (TACS), out of 5 animals, four animals showed dullness, depression, dark green diarrhoea and mild to moderate dyspnoea. Out of 5 animals, one animal died spontaneously after 10.5 hours post inoculation while rest other animals were euthanized. After 24 hours, there was 83% survivability in TACS group. In group III (control), none of the animals showed any clinical abnormality and both of the animals survived during experimental period. After 24 hours, the % lethality in WC group (60%) and TACS groups (17%) was statistically significant ($p<0.05$). The survival percentage was more negatively correlated with time in WC group ($r = -0.936$) than TACS group ($r = -0.822$).

C. Necropsy findings

In group I (WC), spontaneously died animals externally showed soiled perianal region. The severity scores of clinical signs, gross lesions and microscopic lesions are illustrated in Fig. 40. Main gross lesions were intestinal congestion, renal haemorrhages, severe pulmonary oedema, meningeal congestion and exudation of clear to sero-sanguineous fluid in thoracic and abdominal cavities. In group II (TACS), the perianal region of diarrhoeic animals was soiled with faeces. The congestion was seen in intestine, lungs, heart and cortico-medullary region of kidneys. The intestine revealed the presence of yellowish fluidy content. In heart, petechial haemorrhages were seen on epicardium along with congested epicardial blood vessels. In control group, no gross lesion was found at necropsy.

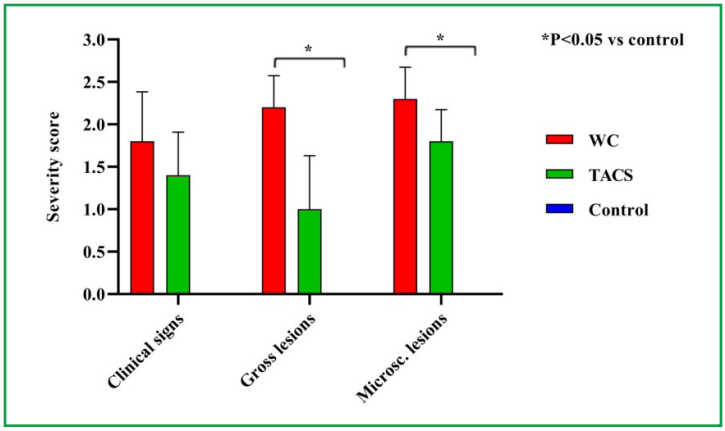


Fig. 40. Mean ± SD values of severity scores of clinical signs, gross and microscopic lesions in WC (n=5), TACS (n=5) and control (n=2) groups. A significant difference in gross and microscopic lesions scores were seen between WC and control group.

D. Culture and isolation findings

In group I (WC), out of 5 animals, *C. perfringens* type D was isolated from intestinal loops of four animals after preliminary isolation in RCMM, CLS-BBA, EYA followed by Gram's staining and finally confirmed by toxinotyping multiplex PCR (TmPCR). However, no growth was found in above mentioned culture from intestinal loops of TACS and control groups. They were found negative in TmPCR also.

Gene expression studies in spontaneous and experimental ET

Gene expression study was undertaken for the purpose of exploring the molecular pathogenesis of enterotoxaemia in goats using total RNA of PBMCs and Ileum by quantitative reverse transcription real time PCR (qRT-PCR). The expression of various genes important in inflammation (IL-1β, IL-2, IL-6, IL-8, IL-10, TNF-α and IFN-γ), innate immune response (TLR2 and TLR4) and cellular stress (Cu Zn superoxide dismutase, glutathione peroxidase and Cathepsin L) were studied. The expressions of these genes were studied in peripheral blood mononuclear cells (PBMCs) of experimental animals while in ileum; the expression was studied in experimental animals as well as in spontaneous ET cases. GAPDH, a house-keeping gene, was taken as internal control in gene expression studies.

E. Transcriptional response in PBMCs

All 12 target genes showed variability in relative expression between treatment groups as well between time intervals (detailed illustration in Fig.41, 42, 43). With the exception of IL-2, the overall expression of pro-inflammatory genes, such as IL-1β, TNF-α, IFN-γ, IL-6 and IL-8 was significantly high in treatment groups. The expression of most of the up-regulated pro-inflammatory genes (except IL-1β) was more prominent in WC group than TACS. The expression of anti-inflammatory gene, IL-10 in both groups was initially down-regulated at 24 hr (WC>TACS) and then remained up-regulated during rest of the experimentation period (TACS>WC). Among host-pathogen interaction genes, TLR-2 was considerably up-regulated in both treatment groups, while TLR-4 was up-regulated for first 24 hr in both treatment groups. Among cellular stress genes, most significant change was seen in CatL followed by CuZnSOD and GPx. Overall, most of the genes were up-regulated at 48 hr, while most of them were down-regulated at 24 hr post inoculation.

F. Transcriptional response in ileum

The expression of most of the genes was found highest in field cases except IL-2 and IL-1β, whereas TACS and WC group animals showed highest fold change (Table 24). All pro-inflammatory genes (IL-1β, IL-6, IL-8, IL-2, IFN-γ and TNF-α) were found highly up-regulated in study groups with few exceptions. The expression of IL-6 and TNF-α was found comparatively low. The expression of anti-inflammatory gene, IL-10 was high in field cases and TACS group. Among host-pathogen interaction genes, the relative expression of TLR-2 and TLR-4 was found highest in field cases of ET. Among cellular stress genes, most significant change was seen in CatL, followed by GPx and CuZnSOD in study groups. The expression of these genes was found highest in field cases, followed by TACS and WC groups. In general, there was trend of up-regulation of most of the inflammatory genes in ileum of animals of various study groups (Fig. 44).

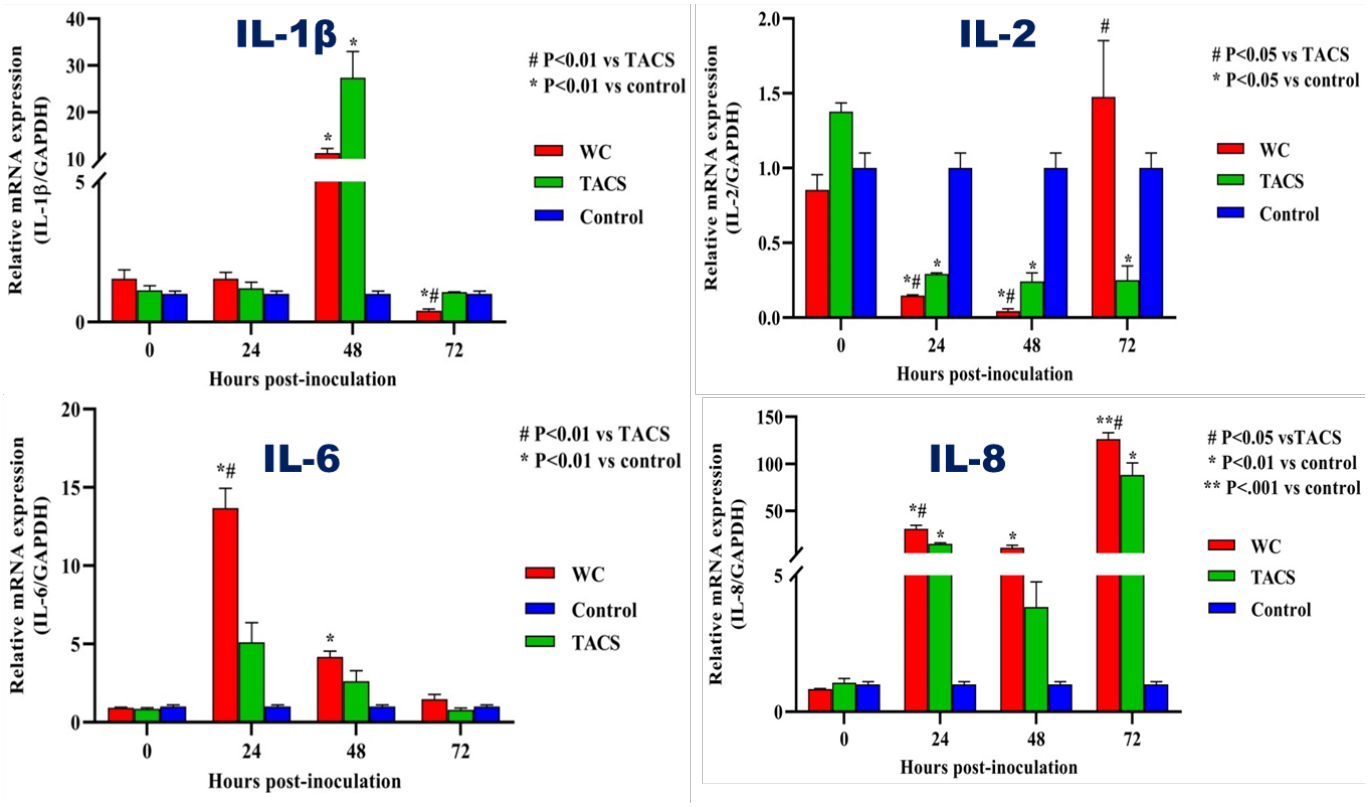


Fig. 41. Mean ± SD values of fold change in IL-1β, IL-2, IL-6 and IL-8 in PBMCs of experimental groups over time are shown. The variations in fold change of these genes were significant between treatment groups (WC and TACS) and control group.

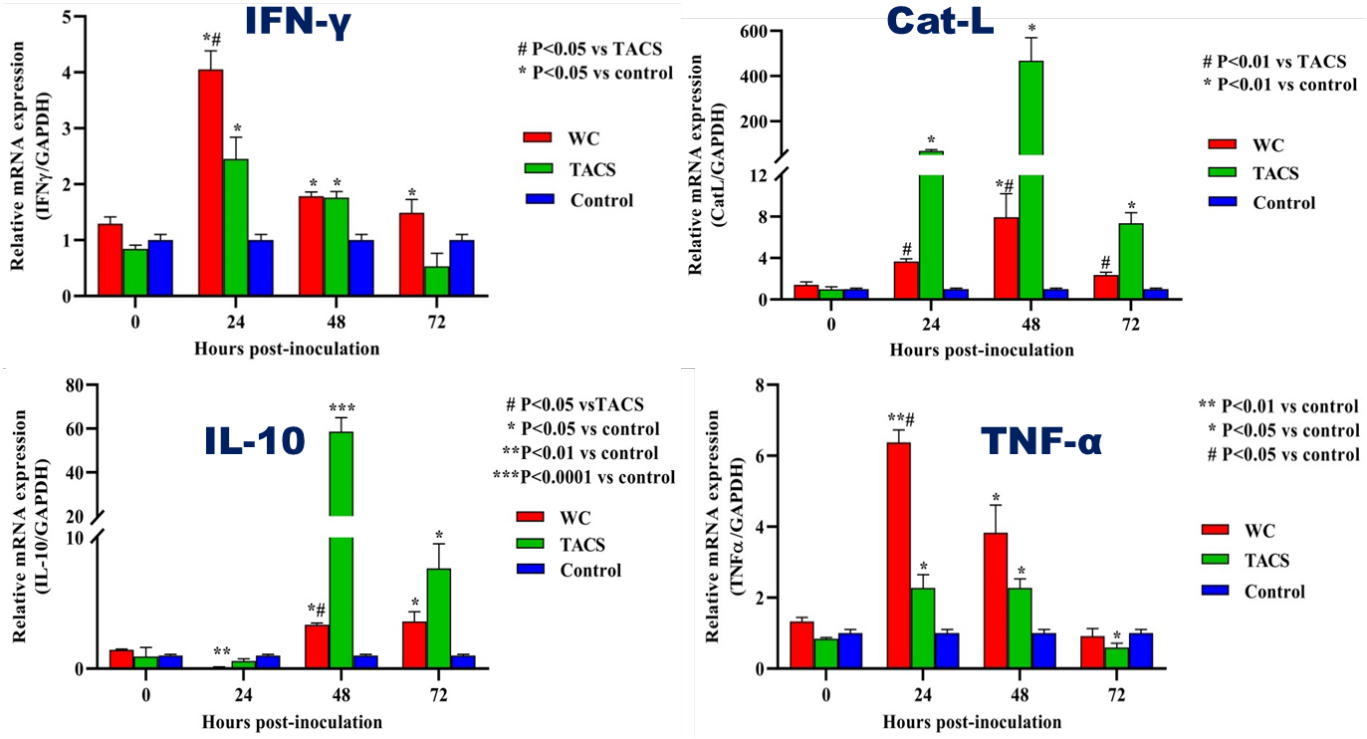


Fig. 42. Mean ± SD values of fold change in IFNy, Cat-L, IL-10 and TNF-α in PBMCs of experimental groups over time are shown. The variations in fold change of these genes were significant between treatment groups (WC and TACS) and control group.

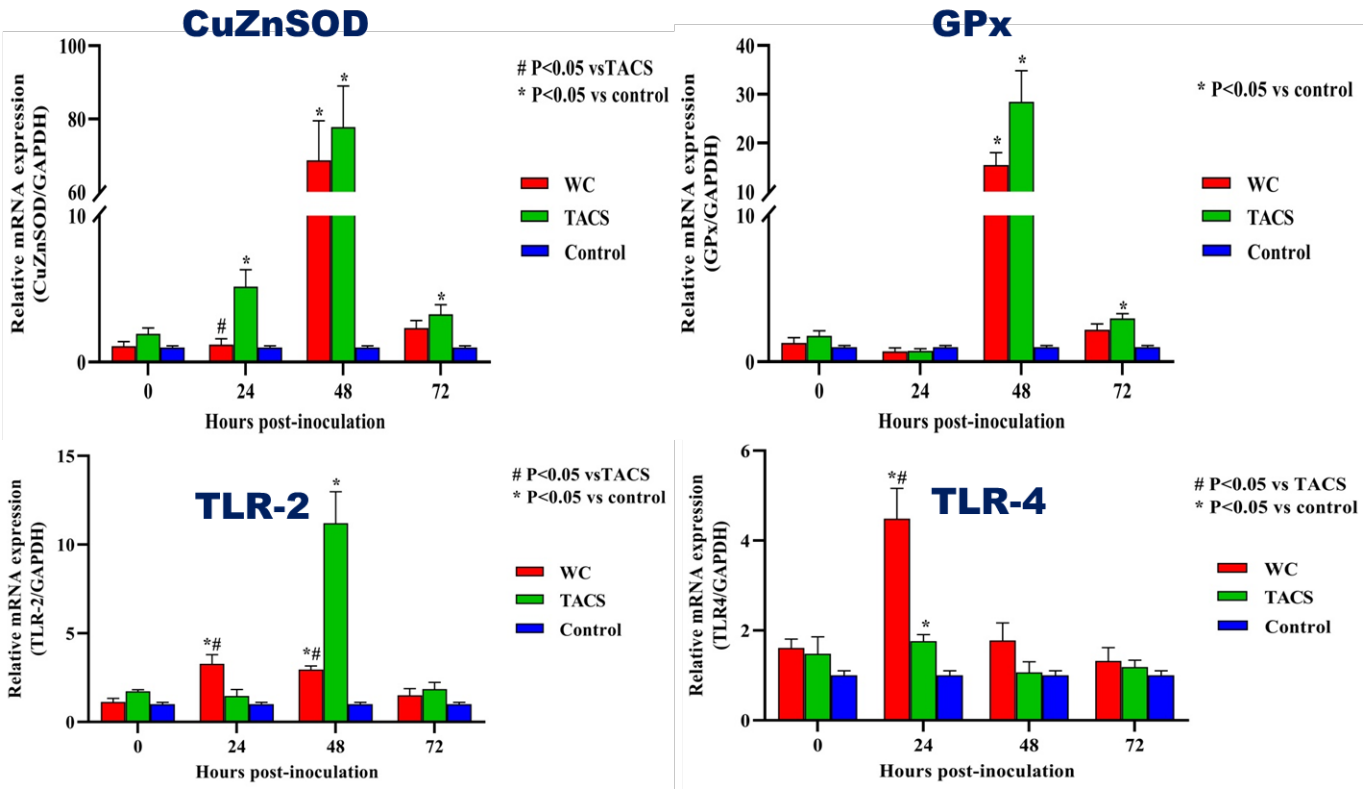


Fig. 43. Mean ± SD values of fold change of CuZnSOD, GPx, TLR-2 and TLR-4 genes in PBMCs of experimental groups over time are shown. The variations in fold change of these genes were significant between treatment groups (WC and TACS) and control group.

Table. 24. Fold change (Mean ± S.D.) in mRNA expression of various target genes in ileum of different groups.

Target genes	Fold change (Mean ± S.D.)			
	WC	TACS	Field	Control
IL-1β	6.28 ± 0.72	1.28 ± 0.47	4.49 ± 1.17	1 ± 0.71
IL-2	2.41± 0.11	30.83 ± 2.86	8.46 ± 0.77	1 ± 0.33
IL-6	2.83 ± 0.44	0.07 ± 0.01	5.32 ± 0.03	1 ± 0.08
IL-8	10.07 ± 1.17	9.70 ± 0.73	17.56 ± 1.57	1 ± 0.52
IL-10	1.65 ± 0.66	11.73 ± 1.80	18.47 ± 1.41	1 ± 0.24
TNF-α	2.57 ± 0.36	0.68 ± 0.11	2.97 ± 0.18	1 ± 0.16
IFN-γ	1.83 ± 0.23	0.76 ± 0.10	7.86 ± 0.86	1 ± 0.34
TLR-2	4.71 ± 0.64	2.70 ± 0.47	7.87 ± 0.81	1 ± 0.21
TLR-4	1.24 ± 0.33	1.54 ± 0.06	2.87 ± 0.47	1 ± 0.13
CatL	167.42 ± 8.06	224.20 ± 20.00	244.64 ± 16.82	1 ± 0.88
CuZnSOD	1.68 ± 0.22	4.36 ± 0.82	15.14 ± 1.53	1 ± 0.27
GPx	3.27 ± 0.50	17.76 ± 1.47	24.44 ± 1.57	1 ± 0.56

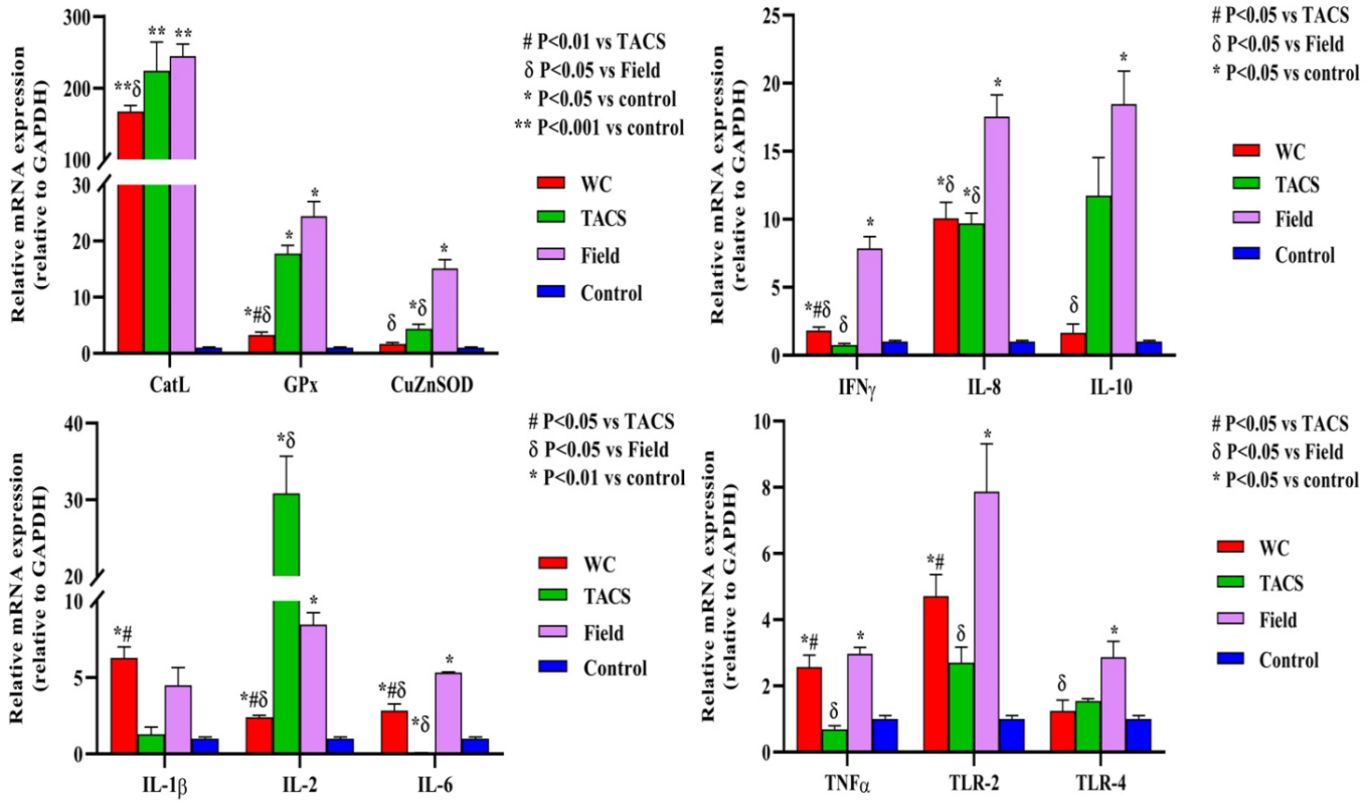


Fig. 44. Mean ± SD values of fold change in various target genes in ilea of experimental groups are shown. The variations in fold change of these genes were significant between treatment (WC and TACS), field and control groups.

G. Cues to be taken from the transcriptional response to enterotoxaemia in goats

Gene expression study revealed the differential expression of target genes (PIF cytokines, AIF cytokines, IIR and CS genes) in PBMCs and ileum of experimental and spontaneous ET cases. In PBMCs and ileum, higher expression of PIF cytokine genes over AIF gene (IL-10) showed the dominance of Th1 response over Th2 response in enterotoxaemia. The higher expression of IL-10 in ileum and PBMCs signifies the importance of both local and systemic immune system in development of adaptive immune response against *C. perfringens* and its exotoxins. Higher expression of TLR-2 and TLR-4 depicts the cross-talk between bacterial moieties and host cells (PBMCs and intestinal epithelial cells) and subsequent activation of downstream cytokine signaling pathways which resulted in differential expression of PIF and AIF cytokine genes. Pronounced expression of CS genes (CatL, CuZnSOD and GPx) may be the result of exotoxin (alpha, epsilon, cpb2 toxins etc.) mediated disruption of cellular homeostasis leading to cellular stress and the subsequent cell death. Hence, the effect of exposure of *C. perfringens* and its exotoxins in the context of cell death has been occurred in present study and could be attributed in pathogenesis of ET.

The current study was designed with the fact to understand the molecular events in the pathogenesis of enterotoxaemia in goats. The paramount intervention that could obtain the tones in this aspect is to conduct an experimental study, which was conducted with the components of *C. perfringens* viz., Whole culture (WC) and Trypsin activated culture supernatant (TACS) containing the activated epsilon toxin. Notwithstanding the fact that the various components produced categorically distinctive effects in the gross pathological as well as microscopic lesions, the whole crux is to unravel the changes at the tissue level. This has resulted in the distinctive molecular signatures at the mRNA level amounting to differential transcriptional response of the target genes related to pro-inflammatory, anti-inflammatory cytokines, cellular stress and innate immune response. What can be construed as the major finding of the current study is that the, higher magnitude of PIF gene expression over AIF genes like IL-10, clearly depicts the dominance of cell-mediated immune response over adaptive immune response in enterotoxaemia. The toxaemic lesions observed in the experimental and spontaneous ET-affected animals is

perhaps due to increased vascular permeability caused by the combined effect of epsilon toxin and TNF-α. All these pathological lesions relating to acute phase reaction are probably due to the effect of TNF-α mediated vascular leakage of plasma proteins and importantly manifesting as pulmonary oedema with fibrinogenic transudates in thoracic and abdominal cavities of experimental animals.

Another important factor that could have significant role in the interplay of the dominant PIF response is attributable to the higher expression of pattern recognition receptor genes or innate immune response genes like TLR-2 and TLR-4. This portrays the clear interaction of various pathogen associated molecular patterns (PAMPs) like lipoteichoic acid with the host-cell downstream cytokine signaling pathways culminating into inflammatory responses observed in the pathological lesions. The same are the reason for the higher expression of important bio-markers of cellular stress (CS) viz., CatL, GPx and CuZnSOD in combating the effect of ROS to maintain the cellular homeostasis. This response can also be supported by the findings observed in immunohistochemistry revealing the presence of *C. perfringens* and its components (including epsilon toxin) on cell membrane and cytoplasm of intestinal epithelial cells in ileum of the targeted animals in the study.

6.6.8 Identification of heat stress/tolerance genes through transcriptomics approach in Goats.

Selection of Experimental Animal and Recording of Physiological Parameters

The Jamunapari goat breed maintained at ICAR- Central Institute for Research on Goats, Makhdoom, Farah, Mathura were selected for the study. Animals belonging to same age (1-2 year), sex (doe) and breed (Jamunapari) were selected for present study. Physiological responses to the environmental stresses such as rectal temperature (RT), body surface temperature, respiration rate (RR) and heart rate (HR) were recorded in extreme hot and humid environmental conditions i.e May-June months of the year. These animals were reared in similar management conditions during the experimental period and regularly monitored. The animals were allowed for grazing (exposed to radiation) from 9.00AM to 13.00PM and then they were brought back to shed at 13.00hr. The climatological data and physiological parameters during the experimental period were recorded. The RT, RR and HR were recorded during the highest temperature of the day, ranging from 13.30 hrs to 14.30 hrs in summer. These parameters were also recorded in comfortable period of the year i.e Feb- March.

The mean environmental conditions during collection of the samples are given in table below:

Experimental period	Average Temperature (°C)	Average THI	DBT	WBT	Surface Temp° F
Hot & Humid climate (May-June)	42.96 ± 0.13 °C(42-44)	85.06± .94% (81.784-93.793)	38.15± 0.98 (34.4-47.2)	23.6 ± 0.33 (22.2- 26.6)	103.96± 0.54 (100-110)

Grouping of contrasting phenotypes

Adult females of 1-2 year age group were selected for present study. Heat stress- tolerant, Heat stress susceptible and intermediate phenotype was identified by observing the animal having heat stress and normal in summer period. The phenotypes were identified on the basis of the distribution of RR and HR values across the breed in the population. The classification, i.e. Normal RR and Normal HR (Heat stress tolerant), High RR and high HR (heat stress susceptible), phenotypes was done.

Collection of blood samples and Isolation of total RNA

Immediately after recording of the physiological parameter blood samples were collected and processed for PBMC culture in the laboratory. The RNA was isolated from PBMC. The total RNA was isolated by TRIzol protocol with little modification. The quality of RNA was checked by agarose gel electrophoresis and the purity of total RNA by Biophotometer. The RNA samples, having the optical density (O.D.) ratio (260/280) ranging from 1.8-2.0, were included for further analysis. The RNA was obtained without contamination of DNA and the bands obtained over the gel showed the purity of RNA. The high quality of RNA isolated is evident from the resolution of RNA on 1% agarose gel as a two band which were 18s and 23s and the concentration of RNA was 90-100ug/mL.

High-throughput transcriptome sequencing (RNA-Seq)

The RNA samples from each group were send for RNA sequencing

i. Library QC Report:

The samples having good RIN values were selected for futher processing.

The quality report of each sample is given below:

S. No.	AnimalNo	Sample Identity	Qubit concentration (ng/ul)	Nanodrop concentration (ng/ul)	Total Conc	RIN value
01	9159-HS	Succeptible	252	707.68	5040	9.2
02	9182-HS	Succeptible	191	1486	3820	9.2
03	8958-HS	Succeptible	142	1003	2840	9.7
04	9180-HS	Succeptible	119	1698	2380	9.8
05	9147-HS	Succeptible	197	8841	3940	9.6
06	9192-HS	Succeptible	352	1894	7040	9.0
07	8481-HS	Tolerant	624	1017	12480	8.0
08	8562-HT	Tolerant	Too high	2480	>5000	8.4
09	8461-HT	Tolerant	Too high	1171	>5000	8.7
10	8593-HT	Tolerant	Too high	2320	>5000	9.6
11	9020-HT	Tolerant	262	1648	6550	9.6
12	9017-HT	Tolerant	304	622.1	>5000	9.7
13	9036-HS	Tolerant	184	1418	4600	9.7
14	9039-HS	Tolerant	244	1159	6100	9.7
15	8993-HS	Tolerant	390	1629	>5000	9.3
16	9476	Control	158	912.7	3160	9.0
17	9367	Control	107	102.1	2140	9.6
18	9394	Control	122	541.5	2440	9.2
19	9276	Control	128	702.4	2560	9.4
20	9314	Control	208	823.5	4160	9.1
21	9456	Control	125	663.5	2500	9.2
22	9464	Control	150	507.1	3000	9.2
23	9153	Control	658	1112	13160	8.4

Library preparation:

A key element of next-generation sequencing (NGS) is high-quality library preparation. TruSeq stranded mRNA sample preparation protocol was used to capture both coding RNA and multiple forms of non-coding RNA that are polyadenylated. The first step in the workflow involves purifying the poly-A containing mRNA molecules using poly-T oligo attached magnetic beads. Following purification, the mRNA is fragmented into small pieces using divalent cations under elevated temperature. The cleaved RNA fragments are copied into first strand cDNA using reverse transcriptase and random primers. Strand specificity is achieved by replacing dTTP with dUTP in the Second Strand Marking Mix (SMM), followed by second strand cDNA synthesis using DNA Polymerase I and RNase H. The incorporation of dUTP in second strand synthesis quenches the second strand during amplification, because the polymerase used in the assay is not incorporated past this nucleotide. The addition of Actinomycin D to First Stand Synthesis Act D mix (FSA) prevents spurious DNA-dependent synthesis, while allowing RNA-dependent synthesis, improving strand specificity. These cDNA fragments then have the addition of a single 'A' base and subsequent ligation of the adapter. The products are then purified and enriched with PCR to create the final cDNA library. Quality control analysis and quantification of the DNA library templates were performed to create optimum cluster densities across every lane of the flow cell.

(**ICAR- Cabin project: Deciphering health biomarkers and thermo- tolerant traits by computational genomics approach in goats"** under the "Network project for Agricultural Bioinformatics and Computational Biology" of Centre for Agricultural Bioinformatics (CABin) Scheme. **CPI:** RVS Pawaiya, **Component PIs:** K Gururak, MS Dige,**Co-PIs:** K Mishra, PK Rout, AR Rao (IASRI, New Delhi)

6.7. ALTERNATIVE DRUG DEVELOPMENT AND THERAPEUTICS

6.7.1 HERBAL DRUG FOR NEONATAL DIARRHOEA

Herbal Prototype selection for Kid diarrhea:

Diarrheic fecal samples collected from nearby villages and CIRG farms from goat kids (0-3months).E. coli isolates tested for their pathotypes and antibiotic sensitivity sensitivity. 13 plants selected for screening against the multi-drug resistant E. coli pathotypes, which were collected from Institute medicinal garden and rest were procured from the market. Dried and powdered plants were extracted in methanol as solvent.

14 plants used for this study were *Aconitum heterophyllum* (Var name , Atees), *Anacyclus pyrethrum* (Var name , Akarakara), *Asparagus racemosus* (Var name , satavar), *Azadirachta indica* (Var name , Neem), *Acacia leucophloea* (Var name , Remza),*Acacia nilotica* (Var name , babool), *Allium cepa* (Var name , onion), *Aegle marmelous* (Var name , bel), *Catharanthus roseus* (Var name , Sadabahar),*Helicteres isora* (Var name , Maror),*Holarrhena pubescens* (Var name , Indrajau),*Punica granatum* (Var name , Anar),*Piper longum* (Var name , fruit) and *Vitex nigundo* (Var name , nigundi)

The plant concentration of 500, 250, 125 and 62.5mg/ml were tested and evaluated based on zone of Inhibition (mm) measured by antibiotic zone scale against E. coli. The activity rated as poor (less than 10 mm) , moderate (10-13mm) , good (14-19mm) and Excellent (above 20 mm) .

Table: 1-Result of antibiogram of herbal Extracts against characterized multi drug resistant pathotypes of *E. coli*.

Level of sensitivity	Plant names with their parts
Poor sensitivity (≤10mm)	*Anacyclus pyrethrum, Asparagus racemosus, Helicteres isora and Holarrhena pubescens*
Moderate(10-13mm)	*Acacia nilotica, Catharanthus roseus, Punica granatum(Peel), Vitex nigundo and Aconitum heterophyllum(Table2)* *Piper longum and Aegle marmelous(Table 3)*
Good (14-19mm)	*Acacia leucophloea* in methanolic extract and *Punica granatum(leaves)* in methanolic and water extract *(Table2)* *Allium cepa* in methanolic extract *(Table 3)*
Excellent (above 20 mm)	*Acacia nilotica(Table 3)*

Asparagus racemosus, Anacyclus pyrethrum, Helicteres isora and Holarrhena pubescens methanolic plant extracts showed no sensitivity on *E. coli* isolates. *Aconitum heterophyllum,* methanolic plant extracts showed moderate sensitivity and no sensitivity in water extract. *Acacia leucophloea* (water) and *Punica granatum* both (methanolic and water) plant extracts (Table1) showed good sensitivity in both extract while in Table 2, *Allium cepa* **(Fig.1)** methanolic extract showed good sensitivity. *Acacia nilotica, Catharanthus roseus, Punica granatum (Peel), Vitex nigundo, Aconitum heterophyllum (Table2) and Piper longem and Aegle marmelous (Table 3)* showed moderate sensitivity. Whereas, *Acacia nilotica* exhibited excellent effect on multi drug resistant *E. coli pathotypes* (Table 2&3).

Punica granatum (water) and *Vitex nigundo* (methanolic) both plant extracts showed sensitivity on *E. coli* pathotypes in a single plate.

Table: 2-Result of antibiogram of herbal Extracts against characterized shigatoxic and enteropathogenic *E. coli*.

Pathotypes	Conc. (mg/ml)	*A. leucophloea* (water) (mm)	*P. granatum* (leaves) (water Ext.)	*A. heterophyllum*(MeOH)	*Vitex nigundo* (MeOH)	*P. granatum* (leaves) (MeOH)	*P. granatum* (peel) (MeOH)	*C. roseus* (MeOH)	*A. indica* (MeOH)
STEC (GM,F/M 300)	500	16	17	10	13	16	11	12	11
	250	14	14	≤10	10	15	11	10	10
	125	10	11	≤10	≤10	12	10	≤10	≤10
	62.5	≤10	≤10	0	0	<10	10	≤10	0
EPEC (CPD,F/ M300)	500	15	15	0	14	18	18	≤10	10
	250	12	14	0	13	14	12	≤10	≤10
	125	10	12	0	10	13	<10	≤10	≤10
	62.5	≤10	10	0	≤10	0	0	0	0

Table: 3-Result of antibiogram of herbal Extracts against characterized (enterotoxigenic and enteropathogenic) *E. coli and* enteroinvasive *E. coli*.

Pathotype	Conc.(mg/ml)	*A. nilotica* (MeOH)	*A. cepa* (MeOH)	*A. marmelos* (MeOH)	*P. longum* (MeOH)
ETEC (LT,ST), EPEC (bfpA)	500	24	16	11	11
	250	15	14	10	10
	125	14	12	≤10	≤10
	62.5	10	10	0	0
EIEC	500	19	15	12	10
	250	17	13	≤10	≤10
	125	10	11	≤10	≤10
	62.5	≤10	≤10	0	0

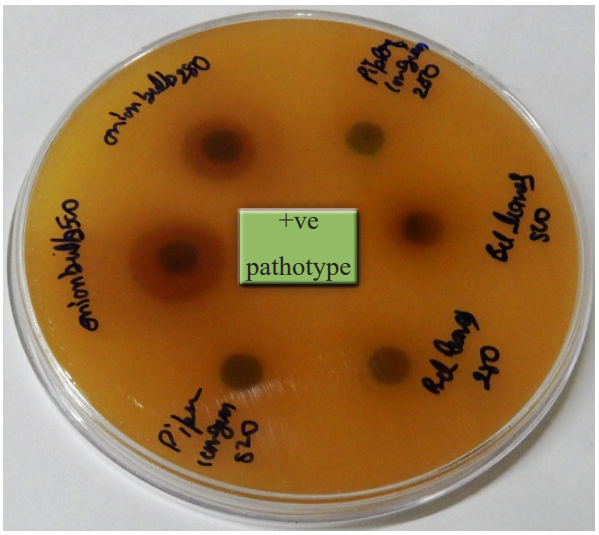


Fig.1 Antibiogram of *Allium cepa*, *Piper longum* and *Aegle marmelous* at 500and 250 mg/ml concentrations

Qualitative analysis and GCMS analysis of plant extracts: Qualitative test of plant extracts was performed for the presence of alkaloids, proteins and sugars.

Test	Compounds	*P. granatum* (bark)	*C. roseus* (leaves)	*A. leucophloea* (leaves)	*H. pubescens*
Mayer's	Alkaloids	+	+	-	+
Wagner's		+	+	-	+
biuret	Proteins	+	-	-	+
Ninhydrin test		+	+	+	+
Benedict's test	Carbohydrates	+	+	+	+

GC-MS chromatogram of two plant extracts showed the peaks of chemicals presents. **(Fig 2 and 3)**

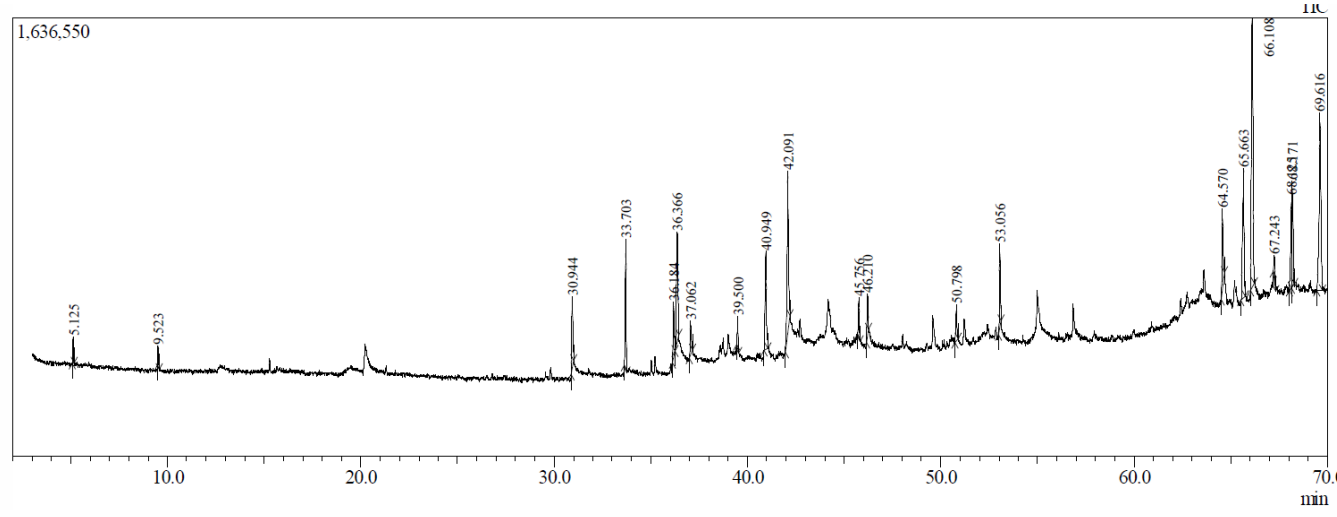


Fig.2 GC MS Chromatogram of *Holarrhena pubescens*

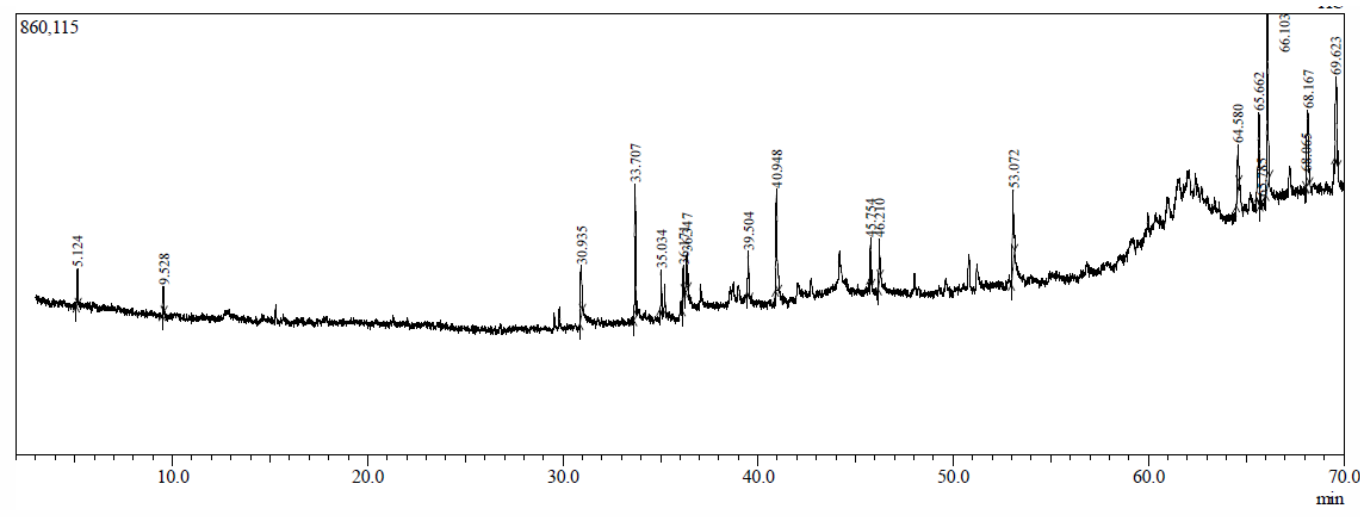


Fig.3 GC MS Chromatogram of *Helicteresisora*

Prototype formation for clinical trials : Four plant extracts were used for prototype formation and prepared as Tablet for clinical trial (Fig. 4).

Fig 4 Prototype of herbal antidiarrheal tablet .

(ICAR- All India Network Project on Neonatal Mortality in Farm animals

Ashok Kumar, R.V.S. Pawaiya, A.K. Mishra, K. Gururaj)

6.7.2 Development of Phyto-pharmaceutical product for Bovine mastitis.

The present project aims to prove the efficacy of a polyherbal product in clinical and subclinical mastitis in goats. In 2019-20, 158 milk samples from the ICAR-CIRG sheds (Jamunapari-118, and Jakhrana-40) were screened for subclinical mastitis on the basis of California mastitis Test (CMT test), Somatic Cell Count (SCC) and Bacterial isolation from milk. The CMT positive milk samples were collected for Somatic cell count (using Newmanns stain) and bacterial isolation. Out of 158 samples, 26 were found positive for subclinical mastitis suggesting 16.5% prevalence rate of subclinical mastitis among goats. Out of 118 Jamunapari goat samples, 16 were found positive for subclinical mastitis suggesting 13.6% prevalence of subclinical mastitis. Out of 40 Jakhrana goat samples, only 10 were found positive for subclinical mastitis suggesting 25% prevalence rate of subclinical mastitis among Jakhrana goats. The overall incidence of mastitis (clinical + subclinical) was calculated as 20.5% in the ICAR-CIRG herd. No case of

clinical mastitis was reported in Jakhrana goats.

Subclinical Mastitis (Oral Product) trial

The CMT positive milk samples were taken for bacterial isolation. The bacterial isolates were subjected to microbiological, biochemical and molecular characterization and isolates of *Staphylococci*, *Streptococci*, *Actinobacillus*, *E. coli*, diptheroids, Micrococcus, Actinomycetes and other gram positive cocci were obtained from the clinical and subclinical mastitic milk samples in case of Jamunapari and Barbari goats. Concurrent multiple infections in the milk sample were a common observation and the infections differed among the samples from the two teats of same animal.

In the subclinical mastitis study, the affected animals were selected and categorized randomly into three groups (Product, Mastilep and Mastitic) and healthy animals from the same herd were taken as negative control. The oral product provided by IIM, Jammu was fed to the goats of Product group, topical application of mastilep in Mastilep group and collection of blood and milk samples from all the four groups.

The SCC (Fig. 5) was almost similar at 0 day for all three subclinical groups which decreased for oral product fed group and reduced to less than1,50,000 cells per ml milk by 15th day. In all other groups, SCC increased indicative of pathologically active conditions in udder. It was highest on 15th day in mastilep treated goats which is undesirable. In addition to this, the SCC value was non-significantly higher for the right teat compared to left half of the udder in general with few exceptions.

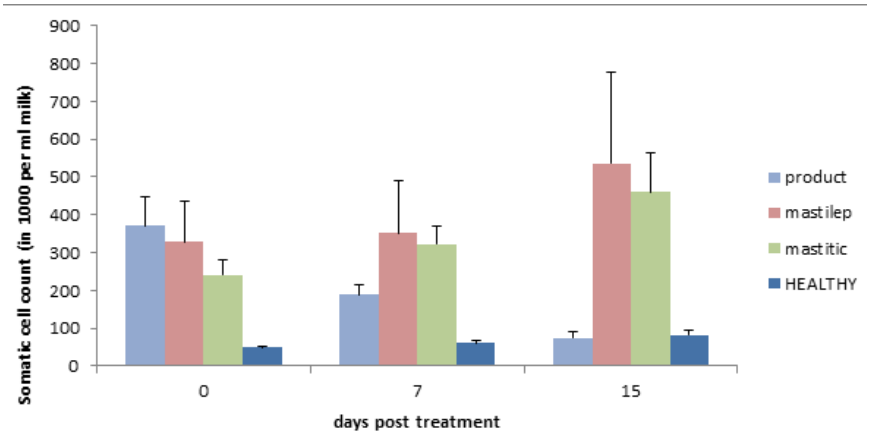


Fig 5: Change in SCC observed in milk of treated, untreated and healthy goats

In the present study, Haptoglobin was lowest for the oral product group followed by Mastilep treated goats and Healthy animals (Figure 6).

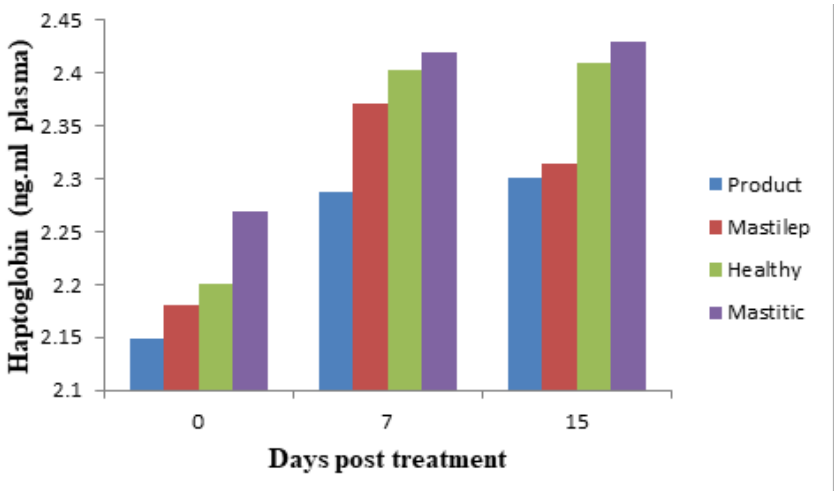


Fig 6: Change in Haptaglobin levels observed in plasma of treated, untreated and healthy goats

The SAA was markedly reduced in oral product treated goats compared to Mastilep treated, healthy and mastitic goats indicative of absence of oxidative crisis or inflammatory burst in product fed goats(Fig. 7) .

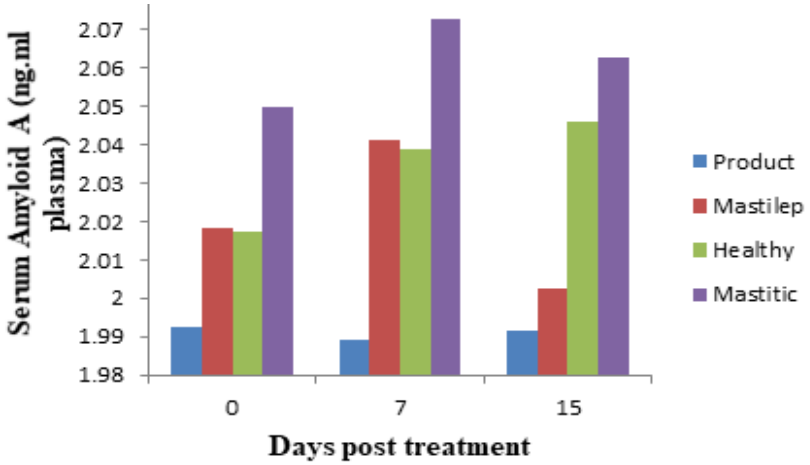


Fig 7: Change in Serum Amyloid A levels observed in plasma of treated, untreated and healthy goats

C-reactive protein is the universal serum APP that responds most quickly to any state of emergency. It was minimal in product fed animals. C-reactive protein increase in healthy group may be attributed to rise in milk production (Fig. 8).

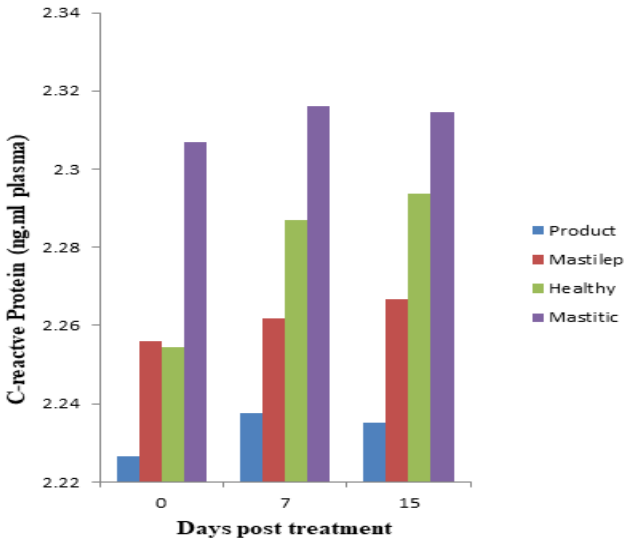


Fig 8: Change in C-reactive protein levels in plasma of treated, untreated and healthy goats

The somatic cell count was directly related to the inflammatory markers (Fig. 9).

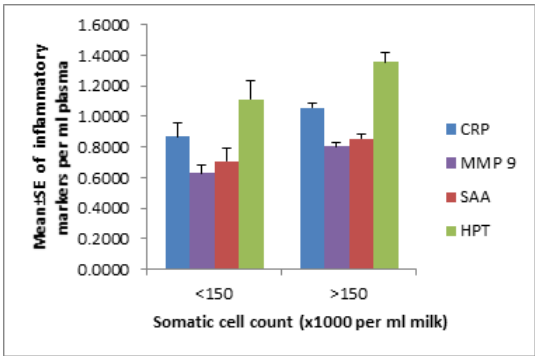


Fig 9: Relationship between SCC and different inflammatory markers

Clinical Mastitis (Topical application) trial

The therapeutic clinical mastitis trial was conducted in three mastitic goats (parturated in February and March 2019) and 8 mastitic goats in year 2019-2020. Milk samples of the lactating goats were collected and SCC was estimated. The blood samples of the normal goats, disease control, treated with Mastilep (topically applied on entire udder) and test product (topically applied on entire udder) were collected and plasma samples were collected for the evaluation of inflammatory markers.

All the three animals, studied in 2018-19, had *S. aureus* infection which was nonresponsive to beta-lactum antibiotics. Out of these three, one animal received topical application of test product for 5 days while the rest two could receive only for three days. Signs of disease advancement were observed and immediately antibiotic therapy was added to the herbal treatment and two animals recovered.

Out of the eight mastitic goats studied in 2019-2020, three were subjected to topical application of test product, three to topical application of Mastilep and two were included in the mastitic group. None of the goats from test product or mastilep group responded to treatment and showed signs of disease advancement.

(DBT **Project:** Development of Phyto-pharmaceutical product for Bovine mastitis **PI: Anu Rahal Co-PI: Nitika Sharma)**

6.8 VALUE ADDED MILK AND MEAT PRODUCTS

6.8.1. Nutritional characterization of goat milk of different breeds

Effect of breed and milking time on fatty acid profile of goat milk during summer season

In this study fatty acid profile of Barbari and Jakhrana goat milk from our Institute goat units and field, were evaluated during summer season. In the CIRG samples, evening milk from both Barbari and Jakhrana goats had significantly higher medium chain triglycerides (C6-C12) but lower palmitic and stearic acid with respect to the morning milk (Table 1). The morning milk samples from Barbari goats had significantly higher oleic acid and lower α-linolenic acid values than the evening samples. The effect of breed was observed on myristic acid, stearic acid and α-linolenic acid values. Barbari milk samples had lower myristic acid (evening), higher stearic acid (morning) and α-linolenic acid (evening) as compared to Jakhrana goat milk samples. The α-linolenic acid content in the Jakhrana morning milk samples was significantly higher as compared to the Barbari morning milk.

Table 1: Effect of breed and milking time on fatty acid profile of CIRG goat milk during summer season

Fatty acid	Bar_Morning	Bar_Evening	Jak_Morning	Jak_evening
C6:0	1.59±0.12b	2.56±0.22a	1.86±0.19b	2.18±0.32ab
C8:0	2.87±0.24b	3.98±0.29a	3.08±0.27ab	3.43±0.38ab
C10:0	11.75±0.78b	14.95±1.13a	12.64±0.88ab	13.11±0.79ab
C12:0	4.96±0.20b	6.30±0.56a	5.39±0.21ab	6.17±0.32a
C14:0	12.86±0.51ab	12.56±0.59b	13.34±0.18ab	14.05±0.08a
C16:0	28.21±0.78a	22.90±0.79b	28.43±1.26a	27.26±1.11a
C18:0	7.35±0.18a	4.06±0.30c	6.24±0.42b	4.21±0.43c
C18:1C	21.19±0.41a	17.49±1.96b	17.83±0.97ab	19.64±0.30ab
C18:1T	3.41±0.18	3.67±0.19	3.05±0.41	2.84±0.42
C18:3	3.46±0.12c	6.72±0.34a	4.73±0.46b	3.84±0.42bc

In the field samples, the evening milk also had significantly higher content of medium chain triglycerides (C6-C12 in Barbari and C6-C10 in Jakhrana) as well as α-linolenic acid however; the amounts of palmitic acid, stearic acid and oleic acid were lower with respect to the morning milk (Table 2). The breed differences were observed on the amount of capric acid, lauric acid and myristic acid. Morning milk samples from Jakhrana goats had significantly higher content of these fatty acids as compared to the morning milk samples from Barbari.

Table 2: Effect of breed and milking time on fatty acid profile of field goat milk during summer season

Fatty acid	Bar_Morning	Bar_Evening	Jak_Morning	Jak_evening
C6:0	1.36±0.11b	2.75±0.19a	1.64±0.10b	3.03±0.40a
C8:0	2.16±0.21b	3.92±0.14a	2.71±0.15b	4.32±0.46a
C10:0	8.47±0.96c	13.39±0.32a	10.92±0.80b	14.52±0.84a
C12:0	3.23±0.32b	4.67±0.09a	4.99±0.47a	4.76±0.10a
C14:0	9.48±0.51b	10.36±0.22b	13.01±0.60a	10.77±0.84b
C16:0	31.39±1.12a	25.68±0.95b	30.39±1.48a	27.20±0.36b
C18:0	10.90±1.11a	6.93±0.02a	5.43±0.25b	4.78±0.82b
C18:1C	22.62±1.77a	18.80±0.64bc	21.57±0.69ab	16.32±0.73c
C18:1T	2.67±0.14	2.74±0.08	3.01±0.17	3.21±0.62
C18:2C	1.10±0.12	1.08±0.12	1.06±0.18	1.19±0.05
C20:0	1.00±0.16b	0.87±0.12b	1.06±0.16ab	1.45±0.09a
C18:3	1.50±0.28c	4.42±0.60a	2.82±0.13b	4.21±0.29a

Effect of breed and milking time on amino acid profile of goat milk during summer and monsoon season

In this study, amino acid profile of Barbari and Jakhrana goat milk from our Institute as well as from field, were evaluated during summer and monsoon seasons. In the summer season amino acid profiling of milk samples showed that milking time and breeds influenced the amino acid composition (Table 3). In CIRG Barbari goat morning milk proline, leucine and serine were significantly higher while glutamic acid was lower than the evening milk. In the Jakhrana morning milk alanine, glycine, valine and methionine were significantly lower while tyrosine was significantly higher with respect to the evening milk. Methionine, threonine, lysine and histidine were significantly higher in Barbari milk whereas glutamic acid, valine and tyrosine were higher in the Jakhrana milk samples.

Table 3: Effect of breed and milking time on amino acids (gm %) of CIRG goat milk during summer season

Amino acids	Bar_Morning	Bar_Evening	Jak_Morning	Jak_evening
Non-essential				
Alanine	2.83±0.11a	2.66±0.04a	2.10±0.04c	2.33±0.01b
Glycine	1.58±0.08a	1.48±0.04ab	1.13±0.04c	1.37±0.01b
Proline	6.84±0.17a	**5.58±0.26b**	7.04±0.23a	6.76±0.46a
Serine	**6.79±0.74a**	5.37±0.31b	4.80±0.13b	4.72±0.04b
Aspartic acid	3.17±0.19b	3.49±0.26ab	3.65±0.08ab	3.84±0.10a
Glutamic acid	20.54±1.56c	**24.33±0.25b**	27.48±0.74a	26.03±0.03ab
Essential				
Valine	3.24±0.01c	3.24±0.05c	**3.37±0.06b**	**3.56±0.03a**
Leucine	8.03±0.12a	**7.64±0.07b**	7.48±0.12b	7.68±0.10b
Methionine	**2.37±0.13a**	**2.17±0.06ab**	1.62±0.12c	1.94±0.09b
Threonine	**5.59±0.30a**	**5.23±0.07ab**	4.89±0.12b	4.91±0.12b
Phenylalanine	4.87±0.09a	4.69±0.05ab	4.55±0.03b	4.75±0.06a
Lysine	**11.45±0.11ab**	**12.67±0.43a**	10.72±0.66b	10.87±0.46b
Histidine	**19.45±0.37a**	**18.59±0.50a**	15.09±0.95b	16.54±0.19b
Tyrosine	3.08±0.14c	2.78±0.05c	**5.96±0.30a**	**4.72±0.10b**

In the field samples Barbari morning milk had significantly lower proline, valine and leucine while tyrosine was higher as compared to the evening milk (Table 4). Jakhrana morning milk samples had significantly higher histidine and lower glutamic acid than the evening milk. Influence of breed was observed on the amino acids tyrosine, leucine and valine.

Table 4: Effect of breed and milking time on amino acids (gm %) of field goat milk during summer season

Amino acids	Bar_Morning	Bar_Evening	Jak_Morning	Jak_evening
Non-essential amino acids				
Alanine	2.37±0.10	2.35±0.01	2.26±0.06	2.18±0.09
Glycine	1.07±0.08	1.07±0.01	1.00±0.08	1.11±0.11
Proline	6.87±0.15b	7.49±0.09a	7.18±0.15ab	7.46±0.08a
Serine	4.90±0.02	5.00±0.07	4.99±0.06	5.00±0.11
Aspartic acid	3.78±0.06ab	3.67±0.01b	3.80±0.02a	3.70±0.06ab
Glutamic acid	23.99±0.39b	25.15±0.17ab	24.10±0.52b	25.72±0.75a

Amino acids	Bar_Morning	Bar_Evening	Jak_Morning	Jak_evening
Essential amino acids				
Valine	3.04±0.04b	3.34±0.01a	3.34±0.04a	3.49±0.11a
Leucine	7.22±0.04b	7.70±0.04a	7.32±0.05b	7.32±0.17b
Methionine	1.70±0.10	1.63±0.04	1.31±0.09	1.36±0.23
Threonine	5.80±0.10	5.79±0.17	6.39±0.15	6.06±0.49
Phenylalanine	3.92±0.07	4.14±0.02	3.87±0.02	4.08±0.22
Lysine	12.35±0.44ab	11.51±0.17b	12.76±0.12a	12.45±0.61ab
Histidine	17.29±0.34a	15.89±0.26ab	16.60±0.32a	14.88±0.80b
Tyrosine	5.56±0.07a	5.11±0.03b	4.93±0.07b	4.99±0.10b

In the monsoon season, there were no significant differences in the various amino acids between CIRG Barbari morning and evening milk samples except tyrosine, which was significantly higher in the evening samples (Table 5). In the Jakhrana goats evening milk samples had significantly higher alanine, glycine, phenylalanine and tyrosine as compared to the morning milk samples. As regards the effects of breeds on amino acids, significant differences were observed in alanine, proline, serine (evening), aspartic acid (morning), leucine (morning), phenylalanine (morning), histidine (evening) and tyrosine between Barbari and Jakhrana goat milk samples.

Table 5: Effect of breed and milking time on amino acids (gm %) of CIRG goat milk during monsoon season

Amino acids	Bar_Morning	Bar_Evening	Jak_Morning	Jak_evening
Non-essential amino acids				
Alanine	2.65±0.15a	2.62±0.00a	1.97±0.06c	2.33±0.06b
Glycine	1.39±0.08a	1.40±0.01a	0.99±0.04b	1.28±0.05a
Proline	6.42±0.40b	6.64±0.02b	9.32±0.32a	8.52±0.43a
Serine	4.52±0.31ab	3.89±0.01b	5.15±0.08a	4.95±0.39a
Aspartic acid	4.31±0.20a	4.01±0.01ab	3.65±0.08c	3.94±0.02bc
Glutamic acid	25.33±0.17	25.19±0.03	25.27±1.43	25.26±0.43
Essential amino acids				
Valine	3.19±0.10	3.22±0.01	3.11±0.04	3.24±0.05
Leucine	7.54±0.35a	7.30±0.02a	6.66±0.09b	7.20±0.05ab
Methionine	2.01±0.18	1.85±0.01	1.49±0.06	1.75±0.06
Threonine	3.49±0.31b	3.22±0.04b	5.32±0.07a	4.80±0.58a
Phenylalanine	4.59±0.23a	4.27±0.00ab	3.81±0.03c	4.18±0.02b
Lysine	11.29±0.43	11.23±0.22	12.76±0.99	11.66±0.67
Histidine	19.00±0.83ab	19.39±0.11a	16.78±0.73c	17.02±0.86bc
Tyrosine	4.21±0.12b	5.65±0.02a	3.55±0.26c	4.33±0.31b

Milk samples from field also showed significant effects of milking time and breeds on amino acid profile (Table 6). Barbari evening milk samples had significantly higher proline, serine and threonine while lower lysine as compared to the morning milk. In Jakhrana goats evening milk samples had significantly higher proline, serine, aspartic acid, leucine and threonine while lower valine, phenylalanine and tyrosine than the morning milk. Histidine was observed significantly higher in Barbari goat milk as compared to the milk from Jakhrana goats.

Table 6: Effect of breed and milking time on amino acids (gm%) of field goat milk during monsoon season

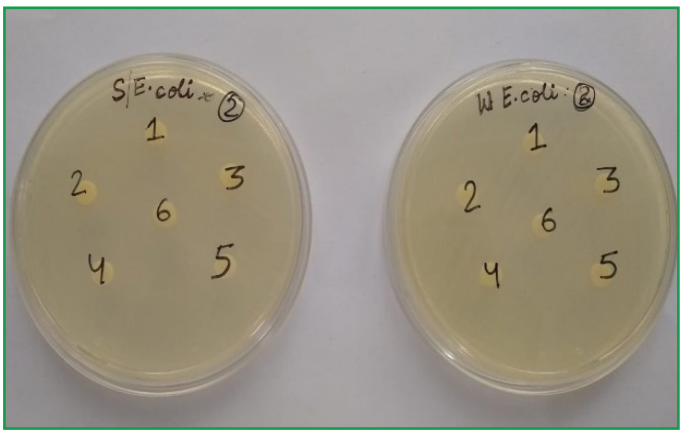
Amino acids	Bar_Morning	Bar_Evening	Jak_Morning	Jak_evening
Non-essential amino acids				
Alanine	2.35±0.09ab	2.49±0.03a	2.18±0.08b	2.29±0.13ab
Glycine	1.27±0.05	1.37±0.02	1.45±0.06	1.27±0.10
Proline	6.42±0.21c	7.12±0.33b	7.11±0.11b	9.34±0.07a
Serine	4.06±0.26b	5.09±0.06a	3.49±0.46b	5.32±0.07a
Aspartic acid	3.81±0.06ab	3.90±0.01a	3.40±0.12c	3.69±0.02b
Glutamic acid	23.38±0.08	23.21±0.29	23.80±0.81	22.84±0.36
Essential amino acids				
Valine	2.94±0.07b	3.03±0.05b	4.39±0.49a	3.40±0.17b
Leucine	6.71±0.09a	6.73±0.07a	6.01±0.34b	7.14±0.24a
Methionine	1.53±0.10	1.70±0.06	1.49±0.17	1.70±0.10
Threonine	3.47±0.11c	4.36±0.13b	3.59±0.31c	5.70±0.32a
Phenylalanine	3.85±0.03b	4.05±0.01b	6.08±0.90a	4.06±0.10b
Lysine	13.58±0.38a	11.55±0.18b	11.71±0.20b	11.87±0.18b
Histidine	21.25±0.39a	20.08±0.60a	17.68±0.41b	17.00±0.34b
Tyrosine	5.27±0.12b	5.22±0.03b	7.63±0.28a	4.26±0.18c

Evaluation of antimicrobial properties of Barbari and Jakhrana goat milk

In this study pooled goat milk samples (skimmed and full fat) were pasteurized (63°C/30 min) and be tested against *Salmonella* Typhimurium, *Staphylococcus aureus, Listeria monocytogenes and E. coli.*

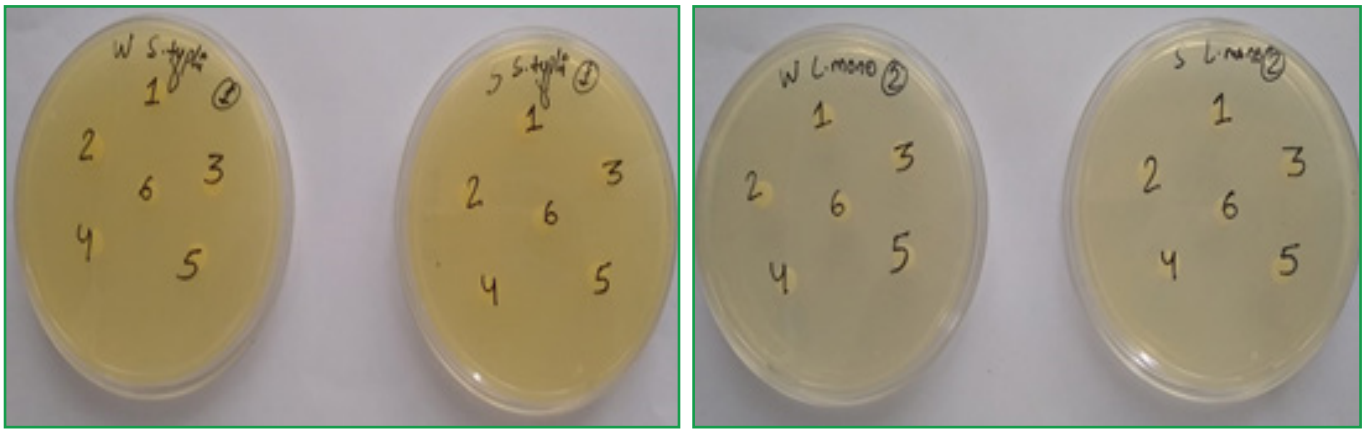
Milk samples were prepared by pasteurizing around 250 ml of pooled milk sample by heating it up to 63°C and holding for 30 minutes followed by immediate cooling to 4°C. Milk was allowed to come to room temperature. Arranged 6 tubes and labelled them 1-6. Serially diluted milk samples to get a range of dilution from 50% to 100% (2 ml each) using 0.85% NSS.

Antimicrobial activity of milk samples were assessed by both disc diffusion test and well diffusion on Müeller-Hinton Agar inoculated with the common food borne pathogens. After incubation at 35°C for 24 h petri plates were observed for zone of complete inhibition. Both Barbari and Jakhrana goat milk (full fat and skimmed) samples did not show any zone of complete inhibition against the studied food borne pathogens. Thus, Barbari and Jakhrana goat milk sample do not have antimicrobial activity against *E. coli, S. aureus, S. typhi and L. monocytogenes.*(Fig 1)



***E. coli* NCTC 12923**

***S. aureus* NCTC 10788**



S. typhimurium NCTC 12023 *L. monocytogenes* NCTC 11994

Fig. 1. Antimicrobial activity of Barbari goat milk against *E. coli, S. aureus, S typhi and L. monocytogenes*

(Project; Nutritional characterization of goat milk of different breeds, A.K. Verma, V. Rajkumar, M. Suman Kumar, Anu Rahal,)

6.8.2 Designer Goat Meat Products with Non refrigeration Quality

Shelf life study of Goat meat Sausage in retort processing

After retort processing the goat meat sausage was analyzed for the physico-chemical, texture and colour characteristics (Table 7, 8). Testing of characteristics was performed at 0 day and 2nd month to monitor the changes in the physicochemical characteristics. Control goat meat sausage was processed with the same method as retort processing and stored in frozen condition to compare the products of retort processing during storage period. There were slight differences found in the physico-chemical characteristics between control and retorted meat products and from 0 day to 2nd month. Due to retort processing the colour values were slightly changed between control and retort and 0 day to 2nd month. Texture characteristics were severely affected. The thermal stress on the products may be the reason for such changes and it has been reported earlier also.

Table 7: Effect of retort processing on physico-chemical, texture and colour characteristics of goat meat Sausage

Parameters	Sausage (Control)		Sausage (Retorted)	
	0 Day	2nd Month	0 Day	2nd Month
Moisture (%)	62.98±0.26	61.89±**0.48**	61.93±**0.27**	60.87±**0.13**
Fat (%)	14.34±0.15	16.30±**0.84**	14.91±**0.18**	17.38±**0.24**
Ash (%)	2.30±**0.01**	1.87±**0.05**	2.09±**0.01**	1.83±**0.04**
Protein (%)	13.9±**0.00**	16.7±**0.00**	14.3±**0.00**	17.0±**0.00**
pH	6.9±**0.00**	6.45±**0.03**	6.89±**0.01**	6.38±**0.00**
Lightness	44.61±0.31	41.21±0.05	41.67±0.26	44.13±0.39
Redness	10.39±1.14	6.27±2.20	13.38±1.10	12.79±0.57
Yellowness	9.28±0.37	8.70±0.54	9.8±0.32	10.32±0.08
Hardness	30.16±3.25	48.62±0.90	12.95±0.71	28.38±1.38
Springiness	0.69±0.11	0.84±0.009	0.35±0.02	0.86±0.02
Cohesiveness	0.46±0.12	0.41±0.017	0.79±0.012	0.41±0.03
Gumminess	13.01±0.60	20.33±1.09	10.31±0.43	11.87±1.42
Chewiness	8.68±1.31	17.19±1.08	3.67±0.39	10.28±1.36

Microbial counts were well within the limits after storage under room temperature.

Table 8: Microbial status of retort processed Goat meat Sausage

	0 Day		2nd Month	
	Control	Retort	Control	Retort
Total Viable Count	Within acceptable limit	Within acceptable limit	Within acceptable limit	Within acceptable limit
Yeast and Mold Count	Within acceptable limit	Within acceptable limit	Within acceptable limit	Within acceptable limit
Coliform Count	None Detected	None Detected	None Detected	None Detected

Shelf life study of Goat meat Kebab in retort processing

Moisture content in the goat meat Kebab was higher at the 0 day in both control and retorted product as comparison to 2nd month. Protein content was slightly high in control Kebab and fat content was increased from 0 day to 2nd month in both control and retorted product. No significant difference between the control and the retort processed products was found except the shear force values were very much affected. Color properties were slightly changed from 0 to 2nd month in both control and retorted product.(Table 9, 10)

Table 9: Effect of retort processing on physico-chemical, texture and colour characteristics of goat meat Kebab

Parameters	Kebab (Control)		Kebab (Retorted)	
	0 Day	2nd Month	0 Day	2nd Month
Moisture (%)	58.30±0.57	54.27±**0.71**	59.20±**0.21**	57.20±**0.80**
Fat (%)	15.61±0.28	18.98±**0.64**	15.59±**0.17**	16.48±**0.46**
Ash (%)	3.30±**0.05**	3.31±**0.02**	3.20±**0.02**	3.14±**0.04**
Protein (%)	15.2±**0.00**	18.1±**0.00**	14.8±**0.00**	17.4±**0.00**
pH	6.97±**0.00**	6.54±**0.00**	6.89±**0.01**	6.16±**0.02**
Lightness	34.55±0.43	36.21±0.21	35.47±0.13	34.72±0.74
Redness	12.10±1.62	8.53±0.63	14.12±0.73	12.81±0.57
Yellowness	7.52±0.94	7.97±0.18	7.77±1.04	8.80±0.24
Hardness	13.49±0.74	51.4±1.05	52.35±4.04	68.27±2.75
Springiness	0.86±0.45	0.88±0.00	0.99±0.08	0.91±0.00
Cohesiveness	0.80±0.04	0.50±0.01	0.52±0.07	0.48±0.00
Gumminess	10.78±0.35	25.67±0.51	26.71±1.71	46.30±2.01
Chewiness	9.30±4.84	22.70±0.48	26.09±1.08	42.54±1.82

Microbial counts were well within the limits after storage under room temperature.

Table 10: Microbial status of retort processed Goat meat Kebab

	0 Day		2nd Month	
	Control	Retort	Control	Retort
Total Viable Count	Within acceptable limit	Within acceptable limit	Within acceptable limit	Within acceptable limit
Yeast and Mold Count	Within acceptable limit	Within acceptable limit	Within acceptable limit	Within acceptable limit
Coliform Count	None Detected	None Detected	None Detected	None Detected

Standardization and Shelf life study of Goat meat LSO+GF+SO (Linseed Oil + Goat Fat + Soybean Oil) Nuggets in retort processing

Moisture content was higher in retorted product as comparison to control and increased from 0 day to 1st month in both control and retort. In both the cases control and retort ed produce fat content was decreased from 0 day to 1st month. Protein content was slightly high in retorted nuggets and increased from 0 day to 1 month in both the cases. Slight differences were observed in the textal proparties (such as hardness, gumminess and chewiness values) and colour properties (Lightness, Redness and Yellowness). Colour properties were slightly higher in retorted product as compared to control and decreased from 0 day to 1 month in both control and retort processed product (Table 11,12).

Table 11: Effect of retort processing on physico-chemical, texture and colour characteristics of goat meat LSO+GF+SO Nuggets

Parameters	LSO+GF+SO Nuggets (Control)		LSO+GF+SO Nuggets (Retorted)	
	0 Day	1st Month	0 Day	1st Month
Moisture (%)	57.08±3.70	62.31±**0.48**	60.19±**0.71**	63.39±**0.11**
Fat (%)	15.07±1.07	13.68±**0.28**	15.18±**0.29**	12.87±**0.05**
Ash (%)	2.87±**0.04**	2.72±**0.02**	2.88±**0.02**	2.76±**0.00**
Protein (%)	10.6±**0.2**	12.2±**0.00**	10.9±**0.00**	11.3±**0.00**
pH	6.75±**0.00**	6.71±**0.01**	6.70±**0.00**	6.62±**0.01**
Lightness	47.96±0.04	41.18±1.66	42.36±0.27	41.54±0.45
Redness	13.35±0.40	13.37±0.86	13.87±0.20	13.99±1.5
Yellowness	8.72±0.05	7.93±0.67	8.90±0.17	8.49±0.40
Hardness	12.98±0.75	11.00±0.88	15.78±0.82	15.72±1.11
Springiness	0.42±0.02	0.69±0.08	0.54±0.07	0.77±0.10
Cohesiveness	0.67±0.03	0.58±0.08	0.71±0.01	0.45±0.09
Gumminess	8.66±0.34	6.26±0.46	11.20±0.59	7.21±1.5
Chewiness	3.63±0.11	4.29±0.52	6.12±0.75	5.15±0.35

Microbial counts were well within the limits after storage under room temperature.

Table 12: Microbial status of retort processed Goat meat LSO+GF+SO Nuggets

	0 Day		1st Month	
	Control	Retort	Control	Retort
Total Viable Count	Within acceptable limit	Within acceptable limit	Within acceptable limit	Within acceptable limit
Yeast and Mold Count	Within acceptable limit	Within acceptable limit	Within acceptable limit	Within acceptable limit
Coliform Count	None Detected	None Detected	None Detected	None Detected

Standardization of Goat meat mini Patties in retort processing

Non-curry based products were believed to be not suitable for retort processing. In our lab we standardized the protocol for the non-curry based products like patties, kebab and nuggets. Moisture content in the control patties was higher in comparison to the retorted patties. There were slight differences found in the physico-chemical characteristics between control and retorted meat products. Though the texture and colour values were affected due to retorting, the products are well within the acceptable limits. Hardness, gumminess and chewiness were severely affected.(Table 13, 14, 15)

Table 13: Effect of retort processing on physico-chemical, texture and colour characteristics of goat meat mini Patties.

Parameters	Mini Patties (Control)	Mini Patties (Retorted)
Moisture (%)	58.12±0.32	54.68±0.27
Fat (%)	19.41±0.16	20.80±0.16
Ash (%)	2.98±0.02	2.97±0.03
Protein (%)	11.69±0.00	11.93±0.10
pH	6.29±0.00	6.42±0.01
Lightness	45.79±0.68	42.05±0.33
Redness	9.68±0.87	10.75±1.12
Yellowness	7.95±0.29	8.11±0.60
Hardness	17.35±0.34	8.29±0.64
Springiness	0.85±0.01	0.35±0.12
Cohesiveness	0.69±0.00	0.51±0.17
Gumminess	12.05±0.27	10.27±0.08
Chewiness	4.52±1.69	2.26±0.96

Moisture and texture characteristics of Retorted Amul Paneer v/s* CIRG *Goat Paneer

Moisture content and texture values were higher in Amul paneer as compared to CIRG Goat paneer.

Table 14: Moisture and instrumental texture characteristics of Retorted Paneer

Parameters	Amul Paneer (Retorted)	Goat paneer (Retorted)
Moisture (%)	53.18±**0.88**	48.6±**0.35**
Hardness	19.11±**0.12**	8.874±0.01
Springiness	0.712±**0.02**	0.596±0.00
Cohesiveness	0.5345±**0.00**	0.574±0.00
Gumminess	10.213±**0.16**	5.134±0.00
Chewiness	7.277±**0.13**	3.05±0.04

Table 15: Moisture and instrumental texture characteristics of Fresh Paneer

Moisture content was high in amul fresh paneer, whereas the hardness and gumminess values were high in fresh goat milk paneer.

Parameters	Amul Paneer (Fresh)	Goat paneer (Fresh)
Moisture (%)	53.27±**0.06**	48.50±**0.31**
Hardness	10.90±0.52	15.77±1.34
Springiness	0.80±**0.01**	0.80±**0.01**
Cohesiveness	0.435±0.01	0.463±0.00
Gumminess	4.74±**0.25**	7.32±0.64
Chewiness	3.80±**0.23**	5.932±0.60
Resilience	0.15±**0.00**	0.17 ±0.00

(Project : Designer Goat Meat Products with Non refrigeration Quality, V. Rajkumar, Co-PIs Arun K. Verma and M. Suman Kumar)

6.9. EXTENSION INTERVENTIONS FOR SUSTAINABLE GOAT PRODUCTION SYSTEM

6.9.1 Transfer of Technologies for Livelihood Security

During the period under report, three farmers scientists interactions, three health camps, one demonstration on goat milk paneer, three Swachchh Bharat Mission Programmes, three mineral mixture distribution program were conducted and provided advisory services to 32 farmers in the adopted villages. A program on Parthenium awareness week was also conducted in the adopted village. Leaflets on scientific goat farming were distributed among the farmers of adopted village. The schedule for impact assessment was prepared and tested.

Goat Reproduction Component

The farmers were advised for better reproductive health management, for this purpose breeding calendar developed by the CIRG was distributed among the farmers. Artificial Insemination technology in goats was demonstrated. The farmers were also told about the benefits of artificial insemination in goats and shown Interest to adopt this newer technology. Farmers were also discussed infertility problems in goats and their solutions with the experts.

Feeding Management Component

The prime objective of the nutritional component was to transfer nutritional technologies developed by ICAR-CIRG at farmer's level with the aim to improve the goat productivity. The importance of balanced nutrient, concentrate feeding for different age group animals, importance of feeding area specific mineral mixture for improving the productivity of goats were discussed with the farmers. A total of 32 goat farmers were provided also area specific mineral mixture. Advisories were provided to farmers on different aspects of feeding management.

Breeding Management Component

Importance of high quality breeding buck was emphasized to the farmers. It was suggested to practice scientific breeding and mate the animals during two breeding seasons viz. April to June and October-November months of the year to address the kid mortality issue. Importance of properly feeding the pregnant animal thereby leading to increased milk yield was suggested to farmers to reduce kid mortality.

Goat Milk Component

Demostration was carried out on the processing of goat milk paneer. Farmers were first briefed about the significance of value addition of goat milk. The various raw materials required and precautions need to be taken while goat milk paneer preparation was discussed. Processing of goat milk paneer to the farmers was demonstrated. Yield of the prepared paneer was recorded as 13.46%. The prepared paneer was also served to the famers for consumer evaluation and it was very much liked. The sample of the prepared paneer was brought to Goat Products Technology Laboratory for nutritional and fatty acid analysis. The amounts of moisture, protein, fat and ash in goat milk paneer were 44%, 21%, 28% and 1.6%, respectively. In the gas chromatography the paneer sample was analysed for saturated fatty acids, medium chain tryglycerides, monounsaturated fatty acids and polyunsaturated acids after preparation of fatty acid methyl ester.

ICT Component for Popularizing Goat Production

Under this component, the folders on various improved goat production practices were uploaded at institute website for farmer's and stakeholders use. A Mobile app entitled Goat Farming was developed and launched in four languages i.e., Hindi, English, Tamil and Kannada for benefit of the farmers across the country.

Goat Management Component

During the village visit, farmers were advised about scientific way of housing the goats and general care and management of goats. The importance of providing adequate space for housing and low cost shelters for goats was discussed. The goat rearers were advised about importance of following improved management practices like regular vaccination, deworming, hoof trimming, castration etc.

Goat Health Component

CIRG team has provided the detailed information regarding the vaccination of goats, deworming of goats and major health issues. We also distributed the health calendar as well as breeding calendar developed by the CIRG. A total of three health camps were conducted in adopted villages. The goats were vaccinated against ET, deworming was done in both pre and post monsoon season. A total of 38 goats were treated for diarrhoea, enteritis, pneumonia, mastitis, mange, foot rot and anorexia.

Parthenium Awareness Week

An awareness week was celebrated from 16th - 22nd August, 2019 at ICAR- Central Institute for Research on Goats (CIRG), Makhdoom, Mathura to aware the CIRG staff, nearby villagers, farmers *etc.* about the harmful effects of parthenium and to motivate them to uproot the parthenium and make the country parthenium free. In this week, one day parthenium awareness camp was also organized at Gausana village (Raya, Mathura) and about 75 villagers participated in this programme. The harmful effects of parthenium like skin inflammation, eczema, asthma, allergic rhinitis, hay fever in human being and systemic toxicity, loss of skin pigmentation, dermatitis, diarrhoea *etc* in livestock were explained and also motivate them to uproot the parthenium.

(Project: Multi-disciplinary Approaches for Transfer of Technologies for Livelihood Security of Goat Keepers. PI Braj Mohan Co-PIs A.K. Dixit, Vijay Kumar, R. Pourouchottamane, A.K. Goel, U.B. Chaudhary, Ashok Kumar, N. Ramachandran, A.K. Verma M.S. Dige and Chetna Gangwar

6.9.2 Technological and Livelihood Improvement of Goat Farmers in Uttarakhand

Socio-economic status of goat farmers

As per the activities earmarked for reporting period, a baseline was conducted in 114 goat rearing households (HHS) in Dehradun and Pauri Gharwal districts of Uttarakhand. Out of which 39 HHS were from control villages and 75 were from intervention villages. Analysis of intervention villages indicated that the share of goat rearing households to the total household was about

23% with an average flock size of 23 goats, the family size of the study household was 5.6 with the equal share of male and female members. The distribution of goat rearing household according to social class indicated that out of total study households 63% were belong to general category, 29% SC/ST and 8% belonged to OBC class. The education status of goat farmers was low, merely 8 years of education. Goat rearing was identified as major activity in terms of contribution (32%) to the total household income followed by casual labour and salaried/ regular service each contributed 21%. Agriculture was also reported to be an important activity with 17% contribution to the total household income. Majority of goat farmers (80%) belong to marginal category and 10% were landless labourers. Employment generation under goat rearing household found to be more than 300 mandays. Grazing of animals required maximum number of mandays followed by lopping tree leaves and gleaning grasses. Flock dynamics has been calculated considering animal's purchase, animal sold,

kids born and animal died. During the reported period, only one kid/goat has been added to flock keeping initial flock constant. The stock and flow ratio remain constant across the year. This may be due to lack of space, labour, feed fodder availability and associated risk are some of the attributes which restricts the flock size.

Production performance

Production performance of the goats indicated that the average body weight at 3 month, 6 month, 9 month and 12 months were 6.13 kg, 11.20 kg, 14.47 kg and 17.99 kg respectively in the sample household in dehradun and pauri district however, the avarage body weight of castrated male was 33.22 ± 1.60 kg.

Similarly, avarage milk yield (Lit/day) was estimated to be 0.315 lit and 0.218 lit in Dehradun Pauri districts respectively.

Shelter Management

Interventions suggested for improvement in existing housing structures

First of all, the research team created awareness on scientific goat rearing practices for improving their income through goat rearing by arranging Off-Campus trainings, kisan gosthis, and health camps etc. in all adopted villages. Few cost effective technologies were demonstrated to them for adoption of scientific goat husbandry practices. The importance of adequate floor space for each animal (1-1.5 m^2/goat) were sensitised for

raising goats healthy and producing maximally in terms of weight gain and multiple births. Due to absence of facilities for cross ventilation, the floor was in wet condition

in most households. Therefore, goat keepers were advised to clean the floor daily and through the manure away from paddocks. Then the importance of dusting lime in floor after cleaning and the necessity of periodical removal of hardened soil and the top surface materials

in excessively wet surface and their replacement with fresh soil fortnightly during winter and rainy months inside the paddocks were demonstrated to goat keepers for maintaining the floor dry and hygienic conditions. The farmers were suggested to provide windows in shelters having poor cross ventilation, wherever possible without compromising winter protection and predation.

Nutrition Management

Chemical Composition of Tree Leaves used in Goat Feeding

The importance of tree leaves in animal nutrition is continued to be strong in Uttarakhand. Tree leaves (eighteen in number) generally used by the local farmers for feeding of goats were collected from the Garhwal region of Uttarakhand. The chemical composition and the fibre fractions of these tree leaves were analysed at Animal Nutrition Lab of ICAR-CIRG. The chemical composition of the tree leaves is presented in the table . The organic matter (%) of tree leaves varies from 83.68 (Kaabal) to 93.88 (Banjh). The crude protein content (%) of the tree leaves range from 6.30 to 24.77. On the basis of chemical composition, Shahtoot, Baakhli, Bhimal, Guryaal, Seeras and Tunn were found to be promising tree leaves for feeding of goats.

Table-1 Chemical composition of tree leaves (on dry matter basis) collected from Garhwal region of Uttarakhand.

S. No.	Local name	OM (%)	Ash (%)	Crude Protein (%)	NDF (%)	ADF (%)	Cell (%)	Lignin (%)	Acid insoluble Ash (%)
1.	**Banjh**	93.88	6.12	14.00	71.09	55.70	33.40	25.47	1.40
2.	**Karinda**								
3.	**Haldu**	93.02	6.98	7.27	34.16	25.74	14.55	12.67	1.52
4.	**Trifala**								

S. No.	Local name	OM (%)	Ash (%)	Crude Protein (%)	NDF (%)	ADF (%)	Cell (%)	Lignin (%)	Acid insoluble Ash (%)
5.	**Kadu**	91.82	8.17	6.30	55.45	24.65	16.73	10.89	1.02
6.	**Goolar**								
7.	**Shahatoot (Mulbury)**	89.81	10.19	6.93	43.20	30.90	23.80	7.94	3.23
8.	**Neem**	93.63	6.37	11.43	58.60	38.60	25.40	12.80	1.08
9.	**Baakhli**	86.46	13.54	14.70	61.00	55.00	29.80	23.20	3.68
10.	**Kingda**	91.33	8.66	16.10	45.00	30.40	23.00	6.90	0.72
11.	**Aseev**								
12.	**Bhimal**	90.75	9.25	14.55	42.72	31.06	21.16	10.29	0.44
13.	**Jaamun**	90.29	9.71	18.55	42.02	29.29	23.23	6.46	0.88
14.	**Kaabal**	90.31	9.69	9.70	58.00	60.00	23.00	36.40	1.46
15.	**Guryaal**	89.83	10.16	9.45	43.73	30.00	22.45	7.75	2.27
16.	**Sal**	89.64	10.36	18.73	46.07	33.33	25.49	8.33	1.08
17.	**Seeras**	91.91	8.09	21.09	60.00	50.10	30.10	25.50	0.32
18.	**Tunn**	83.68	16.32	11.20	43.00	26.30	17.10	12.40	3.86

Photo of tree leaves

Health Management

Herd health management strategies are less adopted in goat production system in hilly regions due to lack of knowledge and awareness. Health interventions like vaccination, deworming and dipping can play an important role in reducing the morbidity and mortality of goats and thereby increase the goat productivity and income from goat production. Two health cum awareness camps were organised at Vikasnagar block of Dehradun district. The goat health calendar developed by ICAR-CIRG was disseminated among the farmers during the health camps. Medicine kit containing dewormers, ectoparasiticides, anticoccidial drugs, oral antibiotics,

rumenotorics and other commonly used drugs were distributed to 60 goat keepers. Area specific mineral mixture and molasses brick (chattan –bheli) were also distributed to the 60 farmers in the health camps. Vaccination will be carried out as per the schedule in the adopted villages. Under the screening of animals, nine (9) breeding bucks were screened for brucellosis, Johne's disease (JD), ecto-parasitic infestation and endoparasitic diseases. All the bucks were found negative for brucellosis and JD. Regular examination of faecal sample of the goats revealed oocysts of *Eimeria* and eggs of *Haemonchus contortus* and *Moneizia*. Dewormers and anticoccidial drugs were suggested/ provided for the affected flocks. Young kids affected with orf (contagious ecthyma) at Koti village were administered standard antibiotic therapy and oral salves.

A total of 750 goats of different age groups and physiological states (breeding bucks, bucks, lactating goats, dry females and weaned kids) from the adopted

flocks were assessed for their general health and nutritional status by using body condition scoring (BCS) method. Various point systems were used to score the animals ranging from 1 to 5 (5-excellent, 4-very good, 3-good, 2-average and 1-poor). Fat deposition at lumbar and sternal regions was taken as indicator of good scoring. Based on this, 24% (180/750) revealed BCS of 4 followed by 54.67% (410/750) of BCS 3 and 21.33% (160/750) of BCS 2. This study revealed that the majority of the animals in the herd were in good nutritional and health status reflecting better management practices. However, the animals with excellent BCS- 5 were not present in observed flocks and the animals with very good BCS- 4 were only 24%. The reason of lesser number of animals in the excellent BCS -5 and very good BCS-4 groups might be due to the grazing stress in the animals of hilly terrain. Hence, for better carcass yield from these animals, there is a need for improved nutrition and management of grazing stress.

Economic Losses Due to Disease and Predations

The overall mortality was reported to be 4.39 goats which include 25% kids. Overall economic losses due to mortality has been estimated to be Rs. 18228 which includes Rs. 17697 as direct loss and Rs. 532 were spent on veterinary care during the disease incidence. Predation was also found to be a major cause of economic losses to the goat farmers in Gharwal region. A Total of 76 goat rearing HHS were interviewed in Dehradun and Paudi districts analysis indicated that average loss of goat due to predates was 2.95 and 2.33 goats in Dehrdun and Paudi district respectively, the economic losses atributed to goat loss was Rs 12565 and Rs 8467 respectively in

study. Overall, goat mortality loss per household due to predation reported to be Rs.6000 to 10,000.

Other extension activities performed

- Complete feed in pellet form (18% CP) were distributed to goat farmers.
- Area specific mineral mixture were distributed
- Medicine kits containing important medicines were distributed to the goat farmers
- Molasses brick (*Chatan Bheli*) was also given to goat farmers for the goats.
- Distributed extension material on "good Practices"
- Distribution of breeding bucks of Barbari breed in Chiliyo village Vkasnagar block of Dehradun.
- Five *Kisan Gosthis* were organised in Dehradun and Pauri districts.
- Goat farmers were appraised on utility of housing, feeders and other best practices of goat management.
- Farmers were also sensitized on *Swacch Bharat Abhiyan.*
- Mid-term appraisal of interventions and baseline in Almora district.
- Survey of existing goat shelters was conducted and their management tips were suggested under low cost intervention.
- Supply of *moringa oliefera (Sahjan)* saplings to USWDB, Dehradun for their plantation in study districts.
- Development of extension material for dissemination among goat farmers (in press).

(DST Funded Project: Goat Based Technological and Livelihood Improvement in Uttarakhand State PI A.K. Dixit Co-PIs M.K. Singh, Ravindra Kumar, V. Rajkumar, N. Ramachandran, Souvik Paul (up to 20th November 2019) and Nitika Sharma)

6.9.3 Technology impact and livelihood improvement

A Study was conducted in five villages of the Bareilly district of Uttar Pradesh to assess the impact of CIRG supplied germplasm in farmer's flock. There was 500 households in the study villages out of which 143 (29%) were Goat rearing households with a goat population of 400 headcounts. Socio economic analysis of goat rearing households reveals that 38% of goat farmers were belong to minority class while 24% and 33% were belong to SC and OBC class respectively. The average family size was 7.43 members. Majority (67%) of goat farmers were illiterate, rest farmers were educated with an average of 8 years. The main occupation was farming and wages. Goat rearing was the most preferable (66.6%) subsidiary occupation. Moreover, goat rearing contributes about 30% to the total farm family income. In goat rearing, 204 mandays of labour were employed, out of which women's contribution was about 45% to the total mandays employment annually. Economic analysis of goat rearing households revealed that per goat per year net income over variable cost was Rs.5655.00, the average flock size was 6.05 goats.

Sustainable improvement in productivity and farm family income emphasize the role of ICAR-CIRG technologies. Lack of veterinary services for goats, lack of finance for further expansion of goat business, non availability of critical input and knowledge gap are some of the constraints reported by the local goat keepers. On the other hand, a study was also conducted in in sheep rearing villages in Bareilly districts who received rams and ewes from CIRG in the year 2017 under Farmers' First programme. To assess the impact of CIRG germplasm this study has been carried out. Socio- economic analysis of sheep rearing households reveal that majority off (71%) farmers were illiterate and the average year of education was merely 5 years. Sheep farming was the main occupation followed by wages. All the study households belong to OBC social class and they were engaged with sheep rearing for last 17 years which reflect their experience in sheep business. Average landholding size was 1.45 acres. The annual household income was reported to be Rs. 76,500 out of which sheep rearing contributed about 66.5% to total household income. The average flock size was 40 sheep. More than 70% households were having 'Kaccha' shed and overstocking was observed in more than 64% households. Like goat sheep rearing was found relatively more employment generating activity. The average number of mandays labour were employed in sheep rearing was estimated to be 262 days. Grazing was the major time consuming activity. An economic analysis of sheep rearing indicated that per animal per year net income (over variable cost) was Rs.4046 the average flock size was 39 sheep.

Impact assessment of CIRG supplied rams and ewes of Muzaffarnagari sheep revealed that there was a significant improvement were observed in farmers flock. Number of kids born per year (in two kidding)

has increased by 20%. The body weight has increased by 33%, 11%, 18%, 18% and 27% at the age of 3, 6, 9 and >12 months respectively. Moreover, mortality among kids has declined by 31%, this may be due to better management practices and maintaining cleanliness and deworming two times. Age at first kidding was also reduced by 5.45%. The market prices of male and female kids and adult male females have also improved from 13 to 36%. Net income per sheep per year was increased by 33.33%. However, net income per goat was reported 35%. The goat and sheep farmers from other villages also learning improved practices and enhancing their income and livelihood.

To examine the factors influencing household income from sheep and goat production, log linear multiple regression involving income from goat and sheep farming as dependent variable. Age of the farmer, education, land holding, family size, breedable population and variable cost (per goat/sheep) were considered as independent variables. The determinants of income from sheep and goat rearing analysis revealed that, the age and education of the farmers were not influenced on income from sheep rearing however; education was significantly influenced income from goat farming whereas, family and land holding size were negatively influenced. In other words larger family size and land holding discourages income from sheep and goat farming. From the foregoing results, it is clear that more age which reflects experience, more number of breedable population and low per animal variable cost have influenced income from goat and sheep rearing. Therefore, in order to improve livelihood security of the sheep and goat farmers, there is immediate need to provide training on scientific goat farming, availability of quality animals and short and medium term institutional credit.

ICAR-Central Institute for Research on Goats (CIRG) organises national training programmes on commercial/ scientific goat farming for goat farmers and other stakeholders to enables them to add their knowledge and skills they already have. These programmes are designed according to trainees' requirement and focus on goat breeding, feeding, health, housing, reproduction, value addition, economics and marketing. After completion of this programme, trainees improve their goat rearing practices and take initiatives to start goat farming at commercial level.

A study on impact assessment of training programme on commercial goat farming was conducted. To get the more reliable information on impact assessment parameters, a total of 3080 participants were listed who imparted training on commercial goat farming between 2010 and 2019. A well-structured schedule was developed to collect the information from the trainees. Trends in participation in training programme between 2010 and 2019 has increased from 226 to 477 (more than double) with the growth rate of 8.65%. This may be due to increasing popularity of this program across the country and goat farming is considered to be a commercial venture among all other agriculture and allied activities. The prediction of the participants in years to come indicated that if the present trends remain continue, the number of trainees in 2020, 2021 and 2022 will be 518, 563 and 611 respectively. The demand for on scientific goat farming is increasing across the country. Fig 1 indicated that maximum numbers of participants (41%) were from Uttar Pradesh followed

by Madhya Pradesh (9%), Bihar (8.7%), Haryana (7%), Rajasthan (6%), Delhi (4.6%) and Maharashtra (4%). These state together constituted about 80% of total participation during the study period. The other states and union territories (UTs) have their representation with less number of participants. Age wise distribution

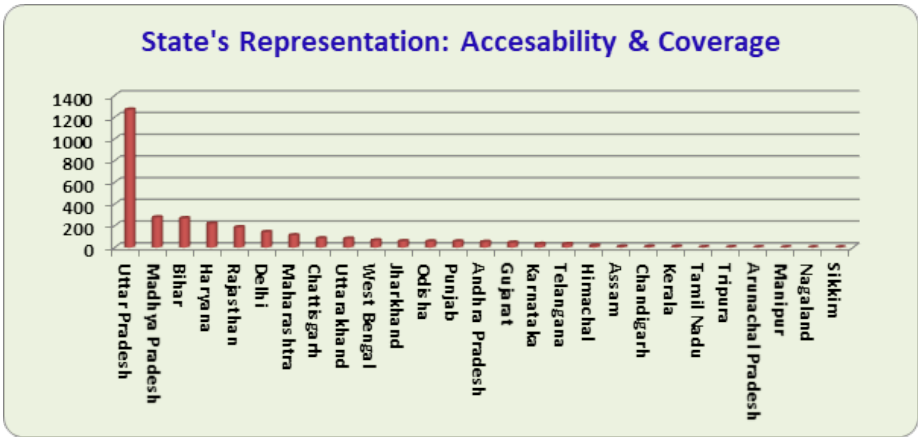


Fig.1 : State's representation in training programme

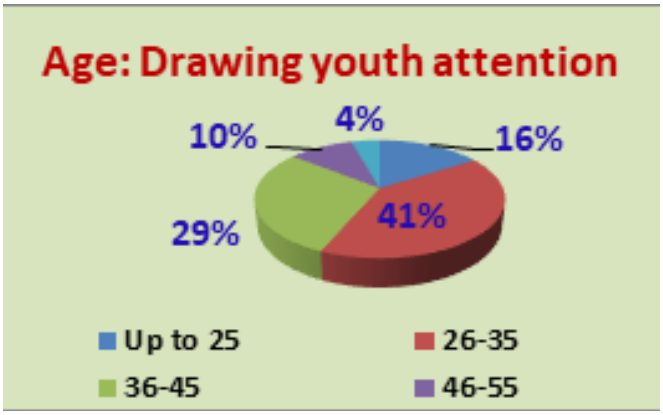


Fig.2 : Age wise distribution of trainees

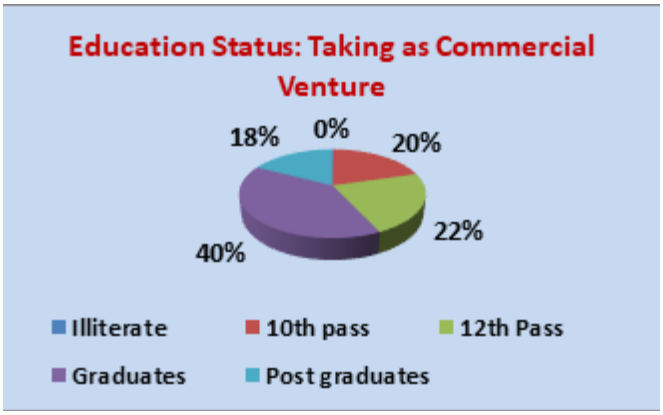


Fig.3 : Education level of the trainees

of trainees indicated that about 86% belonged to age up to 45 years (Fig.2). However, 4% were of age more than 56 years. This may be due to better business perspectives in goat sector. Moreover, majority of participants were educated. Education status of the trainees indicated that 58% of trainees were graduate and postgraduate, 20% training were educated up to 12th class and less than 1%

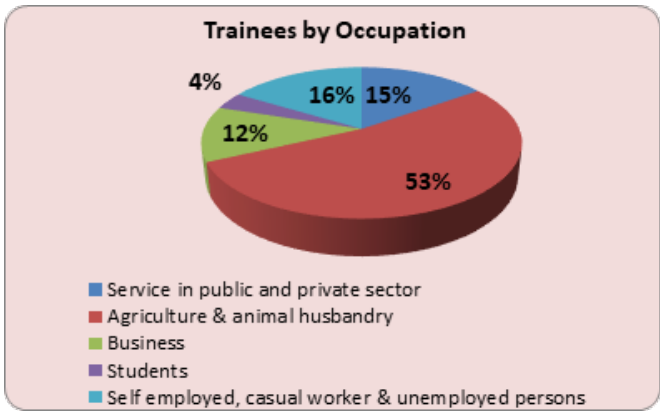


Fig.4 : Occupational status of trainees

were uneducated (Fig. 3). It is worthwhile to mention here that among the graduate and postgraduate, large number of trainees were technically educated B.Tech, M.Tech, MBA, MCA and working in private sector. Occupation wise distribution of trainees indicated that 53% were

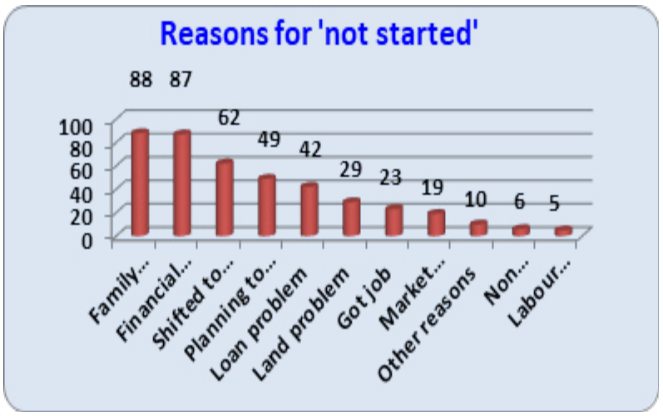
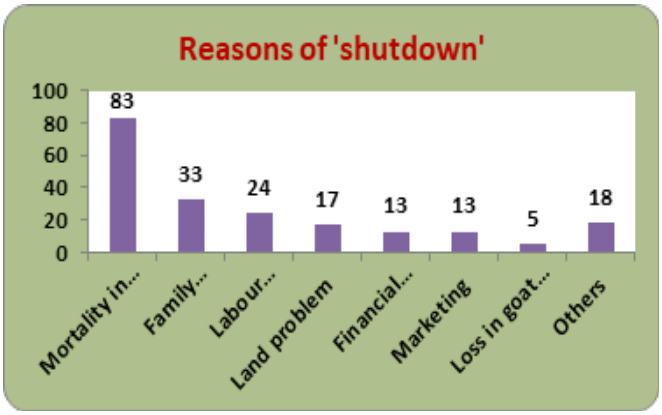


Fig.5 : Reasons for not started goat farm

having agriculture and animal husbandry as primary occupation, 15% working in public or private sector 16% work as self-employed casual worker ,4% were students and 12% were engaged with some kind of business (Fig.4). Out of 1375 trainees, 927 (67%) were interviewed online on starting goat farming and the reasons for 'not started' and 'started but closed'. Out of 927 trainees 294 (32%) trainees started their goat farm, 420 (45%) 'not started'. Family problems, financial problem, shifted to other business, loan problem and land problem were some of reasons reported for not started goat farm. However, 206 (22%) reported 'started but closed'. According to their feedback, they started their goat farm but closed due to heavy mortality at early stage, family problem, got jobs, land problem, financial problem. Interesting to note that only 5 (2%) trainees responded started but closed due



to loss in goat farming. Finally, out of 927 trainees 507 (54.6%) started their farm after training program.

To study the impact of training programme, adoption rate of 'good practices' were examined. A sum of 136 goat farmers were interviewed for detailed information on socio-economic status, flock composition, adoption of best practices taught during training programme, economics and marketing of goats.

Most of the good practices listed under different area of management have shown moderate to high adoption level. However, practices listed under institutional

linkages have shown low adoption rate. Furthermore, an economic analysis of commercial farms revealed that per goat per year net income (over variable cost) for small, medium and large farms was estimated to be Rs.6360.00, Rs. 6526.00 and Rs. 7754.00 respectively. However, the overall net gain was estimated to be Rs.6880.00.

(Impact Assessment of ICAR-CIRG Supplied Germplasm and Imparted Trainings in Farm Conditions PI A.K. Dixit Co-PIs M.K.Singh, Braj Mohan, Gopal Das, R. Pourouchottamane , M.S.Dige (up to 2nd December 2019).

6. 9.4 Development of Model Goat Village

Development of Field Demonstration Unit of Scientific Model Goat House

The development of model goat village project was initiated with the hypothesis of developing the goat husbandry based village nearby the ICAR-CIRG institute. The operation definition of model village was aimed that improvement of local goats with purebred Barbari bucks, goat mortality to <10%, adoption of ICAR-CIRG developed goat production technology with the rate of >70% and finally increment in goat based income by 20%. As a result of continuous effort, technology adoption rate with their cost effectiveness has been increased by 67-82% from base line technology adoption level of merely 30%. One of the major constraints in goat production in rural households was observed to be poor housing and unhygienic conditions. Overcrowding/overstocking of all goats in single enclosures irrespective of age, sex and body size was the common practice followed. To promote scientific housing of goats to increase productivity and income of goat keepers, awareness programmes and filed demonstrations on scientific housing management practices were carried out periodically in the village. One progressive farmer from Daulatpur Village, Farah Mathura was selected as beneficiary for construction of model goat shelter for 20 +1 goat unit along with followers. A model field demonstration unit of goat shelter with the dimension of 42 feet x 12 feet has been constructed with three paddocks/partitions to accommodate 20 goats ($25m^2$), 25 kids ($12.6m^2$) and 4 bucks ($12.6m^2$) separately as per scientific recommendation. The layout is being prepared based on the available of space with the selected beneficiary. The plot was already covered by boundary wall on all four sides with main gate. The research team developed a scientific design with available materials for construction of different structures of shelter like wall, roof, supporting structures in participatory mode.

Then beneficiary opted shelter structures of permanent nature rather than temporary -structures. The 2" angle iron was fixed 2 feet below ground using PVC pipe filled with RCC mixture to the height of 9.5 feet from rear side and 8.5 feet from front side. The partitions and side wall are made of iron and stainless sheets up to 4

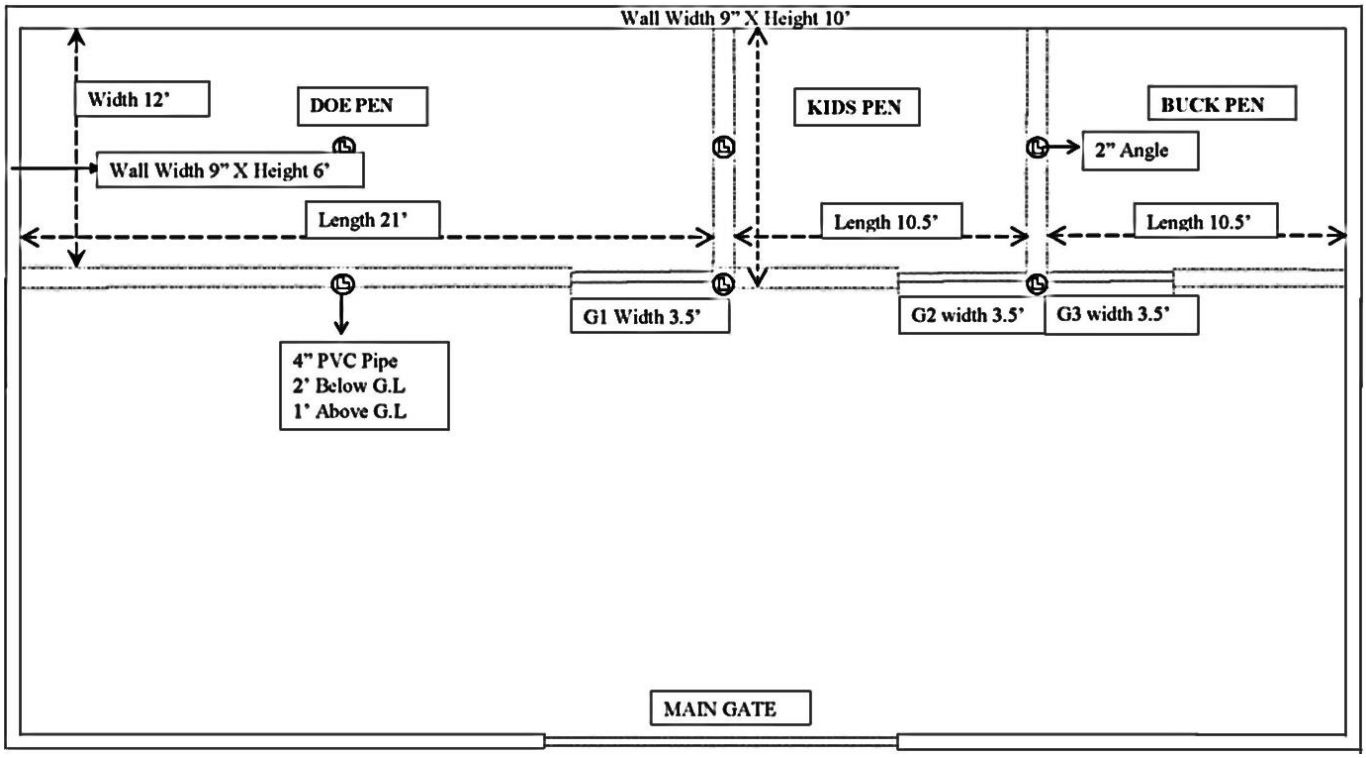


Fig : Design of goat house

feet and thereafter 1" iron wire mesh up to four feet. The corrugated cement sheets were used as roofing materials. The three pens each for females, kids and bucks are fixed with 3.5' wide iron gates.

Economics of construction:

Though the beneficiary had constructed boundary wall for the selected site, the cost of construction of brick wall like bricks, sand, cement, gravel, masonry charges

etc used for erecting the boundary wall have been considered for calculation of model goat house.

The institute supported financially 26.51% of total expenditure incurred on development of rural model goat house just to promote adoption of scientific goat shelter technology among the rural goat keepers to

increase their family income through goat rearing. The remaining amount was borne by beneficiary in participatory mode. The beneficiary is further sensitised to follow the economic housing management practices like daily cleaning of floor and disposal of waste, lime dusting in floor during peak winter and rainy days once in 15 days, loosening the soil floor once in three months, removing the cake formed in floor and replacing them with fresh soil during peak summer months annually to keep the floor in dry condition and the winter protection of side openings by using gunny bags and thatch panels protection for keeping the goats healthy and more productive. The total cost of construction of the goat sheel was estimated to be Rs. 94,320.00.

Impact and Practical Utility:

It's a unique structure for goats in the model village and centre of attraction for many goat keepers in the same as well as nearby villages, who visits the model goat house often and gets motivation to construct similar type of model house for goats. Presently, the beneficiary has started to keep the goats in the constructed model goat house and perceived lower morbidity in goats as the structure is easier to clean and maintain hygienically. The beneficiary is able to understand the advantage of housing goats in different paddocks as per sex and age wise and he is reported that aggressive behaviour among goats in his flock is reduced after housing them separately. Further, the beneficiary was sensitised for the advantage of keeping bucks in separate enclosure so that the mating plan with record keeping would be possible in his flock which will pave way for selling the surplus purebred Barbari kids at one year age for purpose of rearing as foundation stock for double the normal rate on live weight basis. By this way, the goat based income of goat keepers can easily be doubled by adopting the simple housing technology and this model goat house will act as demonstration unit to other goat keepers.

(Project : Development of Model Goat Village Project ,PI- N. Ramachandran, CO-PIs Vijay Kumar, Braj Mohan, A K Dixit, R Pourouchottamane and Ashok Kumar)

7 RESEARCH PROJECT

A. INSTITUTE FUNDED PROJECTS

Sl.No.	Project No.	Title of the Project	Scientist Team
1.	ANSC CIRG SI 2017 008 00269	Genetic Improvement of Jakhrana goat of milk production in field conditions	Saket Bhusan, Gopal Das, B. Rai, Vinay Chaturvedi.
2.	ANSC CIRG SI 2017 007 00268	Optimization of Semen Freezing Protocol and Artificial Insemination in Goats	Ravi Ranjan, ,S.D. Kharche, N. Ramachandran, Saket Bhushan, M. K. Singh, M.S. Dige, Chetna Gangwar
3.	ANSC CIRG SI 2017 011 00272	Sero-prevalence, diagnosis and investigation of goat's diseases	RVS Pawaiya ,D.K. Sharma, Ashok Kumar, Anu Rahal, K Gururaj, A.K. Mishra, Nitika Sharma, Souvik Paul, V.K. Chaturvedi
4.	ANSC CIRG SI 2017 006 00267	Nutritional characterization of goat milk of different breeds	Arun Kumar Verma, V. Rajkumar, Anu Rahal, M. Suman Kumar
5.	ANSC CIRG SI 2017 012 00273	Development of economical pellet feed using unconventional protein source for goats.	Ravindra Kumar, Nikita Sharma, U.B. Chaudhary, Arvind Kumar, A. K. Dixit, Chetna Gangwar
6.	ANSC CIRG SIL 2016 006 00255	Development of model goat village	N. Ramachandran ,Vijay Kumar, , A.K. Dixit, BrajMohan, Ashok Kumar,U.B.Chaudhary, M.K. Singh, R. Pourouchottamane
7.	ANSC CIRG SI 2017 010 00271	Multi-Disciplinary approaches for Transfer of Technologies for Livelihood security of goat keepers	Braj Mohan, R. Pourouchottamane, A.K. Dixit, Vijay Kumar,U.B. Chaudhary, Ashok Kumar, N. Ramachandran, A. K. Verma, M S Dige ,Chetna Gangwar
8.	ANSC CIRG SIL 2018 004 00279	Impact assessment of ICAR-CIRG supplied Germplasm and imparted training in farm condition	A K Dixit, Braj Mohan, M K Singh, Gopal Das, R. Pourouchottamane, M S Dige
9.	ANSC CIRG SIL 2018 003 00277	Cultivation and evaluation of Moringa as a goat feed	U.B. Chaudhary, Arvind kumar, M. K. Singh, A.K. Dixit, Mohd. Arif ,V. Rajkumar,
10.	ANSC CIRG SIL 2018 004 00278	Design and Development of power weeder for improving economic fodder production of goat	Arvind kumar, U. B. Chaudhary, M. K. Singh, Mohd. Arif, A.K. Dixit

B. AICRP PROJECTS:

S No.	Project No.	Title of the Project	Scientist Team
1.	ANSC CIRG COL 2012 021 00232	Improvement of Sire evaluation of Jamunapari goats for milk & meat production (AICRP Jamunapari Unit)	M.K. Singh, Mahesh Dige, P K Rout, Gopal Dass, R. Pourouchottamane, ,K. Gururaj, Vijay Kumar
2.	ANSC CIRG COL 2012 022 00233	Genetic improvement of Barbari goats for milk and meat production (AICRP Barbari Unit)	M.K. Singh, Mahesh Dige, Souvik Paul, A.K. Dixit, S. P. Singh, Ravindra Kumar, N. Ramachandran, V. Rajkumar, R. Pourouchottamane

S No.	Project No.	Title of the Project	Scientist Team
3.	ANSC CIRG COP 2012 023 00234	Network on Sheep Improvement – Muzaffarnagri Unit	Gopal Dass, Nitika Sharma, Vinay Chaturvedi, S.D. Kharche, Saket Bhusan,
4.	ANSC CIRG COP 2015 001 00243	**ICAR-PET Project** Component I- Assessment of plastic based structures of shelters and appliances on goat production Component II- Development and evaluation of portable plastic enclosure for improved kid/lamb rearing	N Ramachandran, Arvind Kumar, R. Pourouchottamane, S. P. Singh, B. Rai, Ravi Ranjan.

C. ICAR- FUNDED PROJECTS:

S No.	Project No.	Title of the Project	Scientist Team
1.	ANSC CIRG COL 2017 002 00263	"ICAR-NASF" Study the effect of mesenchymal stem cell transplantation on ovarian function and fecundity in goats	S. D. Kharche, M. S. Dige, Ravi Ranjan, M.S. Chauhan, S.P. Singh
2.	ANSC CIRG COP 2016 011 00260	Enhancing Livelihood Security of Farming Community through Livestock and crop Integration using Proven Technologies	Manoj Kumar Singh, A.K. Dixit M. S. Dige, Gopal Dass
3.	ANSC CIRG SOL 2018 008 00282	Genome-wide transcriptomic investigation for idententification of genes involved in the fecundity of Goats.	M. S. Dige, P. K. Rout M.K. Singh
4.	ANSC CIRG COL 2017 005 00266	ICAR-NASF Genetic variability of milk protein and its characterization by proteomic approach in Indian Goats"	Pramod Kumar Rout , M. S. Dige
5.	ANSC CIRG COP 2012 030 00242	"ICAR" Veterinary Type Culture-Microbes (NAINP Bangalore, CIRG Makhdoom Collaboration)	U.B. Chaudhary Ravindra Kumar
6.	ANSC CIRG COP 2015 007 00249	"NICRA Project" Adaption strategies in goats to environmental stress through nutritional manipulation	U.B. Chaudhary, P.K. Rout, Ashok Kumar, N. Ramachandran, M. K. Singh, V. Rajkumar, Ravindra Kumar, S. P. Singh
7.	ANSC CIRG COP 2012 024 00235	Outreach Programme on Zoonotic Diseases	K. Gururaj , A. K. Mishra, Anu Rahal
8.	ANSC CIRG COP 2015 004 00246	"ICAR-AINP-NM" Neonatal Mortality in Farm Animals	Ashok Kumar, R.V.S. Pawaiya, A.K. Mishra, K. Gururaj
9.	ANSC CIRG COP 2015 005 00247	"ICAR Cabin Project: Deciphering health biomarkers and thermotolerant trait by computational genomics approach in goats Component I- Host transcriptome analysis for identification of biomarkers and epitope mapping assisted diagnostics development for enterotoxaemia in goats Component II –Identification of Heat stress / Tolerance genes through transcriptomics approach in goats	CPI: R.V. S. Pawaiya PI: K. Gururaj Co PI: R.V. S. Pawaiya, A. R. Rao, PI: M. S. Dighe Co PI. P. K. Rout

S No.	Project No.	Title of the Project	Scientist Team
10.	ANSC CIRG COL 2017 004 00265	"ICAR-NASF" Identification of bio-markers for early diagnosis of Mycobacterium avium subspecies Para tuberculosis (MAP) infection and development of test to differentiate between Johne's Disease Infected and Vaccinated Animals (DIVA)	K. Gururaj ,A. K. Mishra
11.	ANSC CIRG CIL 2019 002 00284	ICAR- FAO Joint project network "Indian network for fishery and animal antimicrobial resistance" (INFAAR) - ICAR- CIRG Collaborating centre.	CPI- Dr. K. Gururaj (Drs.) D.K. Sharma, Ashok Kumar, A.K. Mishra, Nitika Sharma

D. EXTERNALLY FUNDED PROJECT:

S No.	Project No.	Title of the Project	Scientist Team
1.	ANSC CIRG COP 2017 001 00262	"DST" Isolation, Characterization and Development of a culture method for long term preservation of spermatogonial stem cells from doom pig	M.S. Chauhan, S.D. Kharche, S.P. Singh
2.	ANSC CIRG SOL 2018 002 00276	"DST" Transcriptome profiling of spermatozoa for development of biomarker for selection of fertile bucks	Sonia Saraswat Mentor- S. D. Kharche
3.	ANSC CIRG SOL 2018 007 00281	"DST" Establishment of efficient culture and transplantation system for goat germ-cells	S. P. Singh, S. D. Kharche, Ravi Ranjan and M. K. Singh, M.S. Chauhan
4.	ANSC CIRG COP 2017 003 00264	"DBT" Development of Phytopharmaceutical product for Bovine Mastitis	Anu Rahal , Nitika Sharma
5.	ANSC CIRG 2018 006 00280	"DST" Molecular mapping and package of practices for controlling caprine cryptosporidiosis	Souvik Paul ,D K Sharma, K Gururaj
6.	ANSC CIRG SOL 2017 013 00274	"DST" Designer Goat meat products with non refrigeration quality	V. Raj Kumar, Arun Kumar Verma, Suman Kumar
7.	ANSC CIRG SOL 2018 001 00275	"DST" Goat Based Technological and Livelihood Improvement in Uttarakhand State	A. K. Dixit Manoj Kumar Singh Ravindra Kumar, N. Ramachandran, V. Raj Kumar, Nitika Sharma
8.	ANSC CIRG SOL 2019 001 00283	"DST" Minimizing the mitochondrial and DNA cryodamages of goat sperm by modified dilutor	Pallavi Singh (Mentor Ravi Ranjan)
9.	ANSC CIRG SOL 2020 001 00285	Development of novel semen extender to optimize post thaw quality for enhancement of productivity and multiplication of superior goat germplasm	Ravi Ranjan, Dr. S.D. Kharche, Dr. S.P. Singh, Dr. M.S. Chauhan

8 PATENTS,TECHNOLOGIES DEVELOPED, COMMERCIALIZATION AND CONSULTANCIES (ITMU UNIT)

8.1 PATENT GRANTED: This year one patent granted

S. No.	Title	Name of Inventors	Patent application No.	Date of Grant
1.	An Anti-bacterial herbal Composition for animals.	Dr(s). Ashok Kumar, Deepak Kumar Dwivedi,Vivek Kumar Gupta , Vijendra singh Vihan, Devendra Swarup	Patent No.327196 Application No. 2839/ DEL/2010	11.12.2019

8.2 MOU SIGNED WITH NATIONAL BIODIVERSITY AUTHORITY CHENNAI FOR RESEARCH:

S. No.	Title	Patent application No.	Date of Submission	Date of NBA MOU Signed
1.	Ajas Antiseptic- goat milk based natural herbal antiseptic soap (3256/Del/2014)	1874 (NBA , Chennai) 14.02.2018	Date of Submission : 24-9-2018	Date of NBA MOU: 17-09-2019
2.	Ajas Green-goat milk based natural herbal beauty soap (3257/DEL/2014	1872 (NBA , Chennai) 14.02.2018	Date of Submission : 24-9-2018	Date of NBA MOU: 13-12-2019
3.	A Herb based antibacterial Preparation for Veterinary use. (2841/DEL/2010)	1977 (NBA , Chennai) 21.03.2018	Date of Submission : 24-9-2018	Date of NBA MOU: 24-12-2019

8.3 SCIENTIST INDUSTRY MEET:

Two Scientist industry interface meeting were organised at Institute to present institute commercializable technologies.

Programme Organized for Technology Commercialize/ Transfer	Number of Participants	Date of Event
Scientist Industry Meet	ITMU –Industry meeting With **Genomix Carl Pvt. Ltd**. to discuss about transfer of technologies for diagnostic Kit This Discussion was attended by: Dr. P.V. Janardhan Reddy Ph.D. (Senior Scientist) and associates	17-06-2019
Scientist Industry Meet	ITMU –Industry meeting With **Virbac Animal Health India Pvt. Ltd.** to discuss about transfer of technologies for diagnostic Kit This Discussion was attended by **Mr** Manoj Mehra (Sr. Regional Business Manager) and associates	21-06-2019

Fig1- Scientist Industry Meeting at ICAR – CIRG Makhdoom on 21-06-2019

8.4 FOUR KISAN / ENTERPRENEUR MEETINGS WERE ORGANISED AT INSTITUTE TO PRESENT COMMERCIALIZABLE TECNOLOGIES

Fig 2- Kisan/entrepreneur meeting on Institute goat production technologies for opportunity in commercialization.

8.5 TECHNOLOGIES UNDER COMMERCIALIZATION

- BRUCHEK: A Dot-ELISA Kit for detection of brucellosis in goats and Sheep
- Diagnosis of para tuberculosis ELISA KIT (Serum and Milk)
- Stressol-G: An Herbal Antistress Formulation
- Goat meat Pickle
- Goat meat Nuggets
- Herbal Goat meat Nuggets
- Goat meat Sausage
- Goat meat Patties
- Meat Shami Kebab
- Meat Murukku
- Meat Nimkee
- Meat/Milk Biscuits
- Goat Feeders for Better Feed Utilization
- Pelleted Complete Feed Technologies for Sustainable Goat Production under intensive feeding system
- Intra vaginal sponge for Induction and Synchronization of estrus.
- Economic complete pellet feed formulation with Azolla for ruminant feeding.
- PARACHEK CARD-An eye mucosa colour based targeted selective treatment chart for goats.
- Retort processed non –curry based goat products.
- Retort processed goat meat curry Products.
- Low salt shelf stable chevon pickle.
- Gluten free goat meat product.
- Chevon nuggets with healthier and balanced fat and fatty acids.

9 EDUCATION AND ACADEMIC COLLABORATIONS

9.1. EDUCATION

During this year 05 Ph.D. (03 GLA, 02 Amity University) students were guided for conducting research under different Divisions/Sections of the Institute. ICAR-IVRI, Izatnagar, scientists also taught various courses to the PG & PhD students. The final year B.V.Sc. & A.H. students of College of Veterinary Science and Animal Husbandry, DUVASU, Mathura successfully completed the internship programme. Field project under the course "Certified Livestock Advisor" MANAGE Hydrabad was completed, On the project Constraints fated by Farmar & feasible practices to mitigate same in the context of goat rearing in Karbi Anglong district, Assam India. This Project was Carried out by Dr. David Bordoloi, Veterinary officer A. H. Assam Under the supervision of Dr A.K. Dixit Principal Scientist (Ag. Economics) CIRG Mathura.

Students of different academic colleges and veterinary colleges visited the institute laboratory and livestock Units. Presently, this institute has academic and research collaboration with following institution:

1. DUVASU, Mathura
2. GLA, Mathura
3. IVRI, Izatnagar
4. NDRI Karnal
5. Kamdhenu University, Gujarat
6. Banda University of Agriculture & Technology, Banda
7. Amity University Rajasthan (Jaipur)
8. R.B.S College Agra
9. SRR PG College under (HNB Garhwal central University, Srinagar)
10. Rajiv Gandhi Institute of veterinary education and Research (RIVER) ,Puducherry

Fig 9.1 Official on the occasion of MoU signed with GLA University, Mathura

10 TRAINING AND SKILL DEVELOPMENT

10.1. NATIONAL TRAINING PROGRAMMES:

Six National training programmes were organised on Scientific Goat farming, which were attended by farmers , unemployed youth, retired professionals and entrepreneurs.

S. No.	Name of Training and Duration	Sponsoring Agency	Nature of Participants	Number of Participants	Duration
1	82nd National Training Programme	Self-financed	Farmers, Entrepreneur	79 trainees (77 Male & 03Female) from 17 States	24-30 July, 2019 (7days)
2	83rd National Training programme	Self-financed	Farmers, Entrepreneur	73 trainees (69Male & 04 Female) from 12 States	28-03 September, 2019 (7 days)
3	84th National Training Programme	Self-financed	Farmers, Entrepreneur	54 trainees (54 Male) from 12 States	18-24 September, 2019 (7days)
4	85th National Training Programme	Self-financed	Farmers, Entrepreneur	86 trainees (83 male & 03 female) from 14 States	16-22 October, 2019 (7 days)
5	86th National Training Programme	Self-financed	Farmers, Entrepreneur	64 trainees from 13 States	31st January- 6th February 2020 (7 days)
6	87th National Training Programme	Self-financed	Farmers, Entrepreneur	72 trainees from 14 States	12-18, February 2020 (7 days)

10.2. SPONSORED TRAINING PROGRAMME:

S. No.	Name of Training	Sponsoring Agency	Nature of Participants	Number of Participants	Duration
1	Scientific goat farming	NIRPHAD, Chattikara, Virandavan, Mathura, U.P.	Farmers (specially abled person)	30 (24 male +06 female)	06 -10 May, 2019 (5 days)
2	Scientific goat farming	ATMA, Darbhanga, Bihar	Farmers	20 male	08-12 July, 2019 (5 days)
3	Scientific goat farming	Dept. of A.H. and Dairying, Udaipur, Rajasthan	Farmers	40 participants (38 ST women and 02 staff men)	17-19 July, 2019 (3 days)
4.	Scientific goat farming	CBM, India Trust in collaboration with NIRPHAD, Mathura	Farmers	30 specially abled people (28 male +02 female),	05-09 August, 2019 (5 days)
5.	Scientific goat farming	BAIF, Munger, Bihar	Farmers	20 farmers (03 male +17 female)	05-06 September, 2019(2 days)
6.	Scientific goat farming	ICAR-DRMR, Bharatpur, Rajasthan	Farmers	48 (Male)	11- 13 September, 2019 (2 days)
7.	Scientific goat farming	KVK-II, Sitapur, U.P.,	Farmers	20 (Male)	27-28 September, 2019 (2 days)
8.	Scientific goat farming	ATMA, Madhubani, Bihar	Farmers	22 (Male)	19-23 November 2019 (05 Days)
9.	Scientific goat farming	ATMA, Sitamari, Bihar	Farmers	20 (Male)	12-16 December, 2019 (05 Days)

S. No.	Name of Training	Sponsoring Agency	Nature of Participants	Number of Participants	Duration
10	Model Training Course' on "Model Goat Management Practices and Value Addition in Goat products"	ICAR-CIRG	Veterinary Officers and Livestock Development Officers	15 Veterinary Officers	12-19 December, 2019 (07 Days)
11	Scientific goat farming	Uttarakhand Gramin Vikas Samiti, Dehradun (Uttarakhand)	Farmers	22 farmers (09 male+13 female)	17-21 December, 2019. (05 days).
12.	Scientific goat farming	Atma, District- Sagar (MP	Farmer	20 farmers	January 23-27, 2020

Fig 3 - Photos on Scientific goat farming Training programmes at ICAR-CIRG (2019-20)

10.3 ARTIFICIAL INSEMINATION TRAINING PROGRAMME

S. No.	Name of Training and Duration	Sponsoring Agency	Nature of Participants	Number of Participants	Duration
1.	Hands on Training on "Semen Freezing and Artificial Insemination in Goats	ICAR-CIRG	Veterinary officer and professionals	18 participants from 09 States	23-29 April, 2019 (07 Days)
2.	Artificial Insemination and Health Management in Goats	ICAR-CIRG	Farmer	30 SC women farmers	10 Feb ,2020 (01 Days)

10.4: WINTER SCHOOL:

21 days winter school on "Stem cell Technologies for Augmentation, Restoration and Enhancement of Male and Female Fertility and Its Clinical Application" held from 1-21 Nov 2019.

Fig 1- Training on "Semen Freezing and Artificial Insemination in Goats at CIRG

Fig 2- 21 days winter school organised at Institute

11 TRAINING AND CAPACITY BUILDING 2019-20

Training and Capacity Building: Under HRD programme, as the annual training programme, different categories of staff were provided training in referral institution in the country.

11.1. CATEGORY: SCIENTISTS

S. No.	Name of employee	Designation	Name of the training program	Duration (days)	Organizing Institution
1	Dr. M. S. Dige	Scientist A G & B Division	Hospitality Management	19-25 June 2019 (7 days)	ICAR-NAARM, Hyderabad
2	Dr. Ashok Kumar	Pr. Scientist In-charge PME	Priority setting, Monitoring and Evaluation (PME)	18-23 July 2019 (6 days)	ICAR-NAARM, Hyderabad
3	Dr. M. S. Dige	Scientist A G & B Division	Recent Bioinformatics tools for genome and proteome analysis	17-21 September 2019 (5 days)	ICAR-NAARM, Hyderabad
4	Dr. M. K. Singh	Pr. Scientist A G & B Division	Stress Management	26-29 June 2019 (4 days)	ICAR-NAARM, Hyderabad
5	Dr. S. P. Singh	Sr. Scientist A P & R Division	Recent Bioinformatics tools for genome and proteome analysis	17-21 September 2019 (5 days)	ICAR-NAARM, Hyderabad
6	Dr. S. D. Kharche	Pr. Scientist A P & R Division	Workshop for vigilance Officers of ICAR Institute	31st October & 1st November 2019 (2 days)	ICAR-NAARM, Hyderabad
7	Dr. S. P. Singh	Sr. Scientist A P & R Division	Application of research techniques to access male reproductive functions	21-25 October 2019 (5 days)	National institute of health and family welfare, New Delhi
8	Dr. Vijay Kumar	Scientist EE&SE	Innovative Practices in Extension Research and Evaluation	18-21 September 2019 (4 days)	ICAR-NAARM, Hyderabad
9	Dr. Anu Rahal	Sr. Scientist Animal Health Division	Socio Economic Impact assessment of S&T Outcome	18-22 November 2019 (5 days)	Human Resource Development Centre, Ghaziabad, U.P.
10.	Dr. A. K. Dixit	Pr. Scientist EE&SE	ILRI-ICAR Joint training programme on Animal Disease Economics	8-10 January 2020 (3 days)	ICAR-IVRI Izatnagar, Bareilly
11.	Dr. A. K. Dixit	Pr. Scientist EE&SE	IFRI sponsored Training on Impact Assessment	16th December 2019	Punjab Agriculture University (PAU), ludhiana
12.	Dr. K Gururaj	Sr. Scientist Animal Health Div	"Risk factors and economic Impact analysis of zoonotic diseases"	18-20th of December 2019	ICAR-National Institute for veterinary epidemiology and disease informatics, Ramagondanahalli, Bengaluru

11.2 CATEGORY: ADMINISTRATIVE

S. No.	Name of employee	Designation	Discipline/ Section	Name of the training program	Duration (days)	**Organizing Institution**
1	Sh. Sumit Kumar Jindal	Sr. Administrative Officer	Administration	MDP on Administrative and Financial Management for Deputy Secretaries	24-27 September 2019 (4 days)	ICAR-NAARM, Hyderabad

11.3 CATEGORY: TECHNICAL STAFF

S. No.	**Name of employee**	**Designation**	**Discipline/ Section**	**Name of the training program**	**Duration (days)**	**Organizing Institution**
1	Mr. Khursheed Ahmad	Technical Officer	Technician	Automobile Maintenance, Road Safety and Behavioral Skill	26th July to 1st august 2019 (7 days)	ICAR-CIAE, Bhopal
2	Mr. Ranvir Singh	Technical Officer	Technician	Automobile Maintenance, Road Safety and Behavioral Skill	26th July to 1st august 2019 (7 days)	ICAR-CIAE, Bhopal

12 RESEARCH PUBLICATIONS

12.1 RESEARCH ARTICLES:

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3. Antil M, Rai B, Ramachandran N, Gangwar C and Somagond A. (2019). Hemato-biochemical and physiological response of Barbari kids to different bedding materials during winter. International Journal of Current Microbiology and Applied Sciences 8(2): 1819-1836.
4. Antil M, Rai B, Ramachandran N, Gangwar C and Yadav S. (2019). Effect of bedding materials on growth and FCR in Barbari kids during winter season. International Journal of Current Microbiology and Applied Sciences 8(2): 1930-1935.
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13. Gururaj, K., Pawaiya, R.V.S., Kumar, A., Mishra, A.K., Paul, S., Sharma, N., Rahal, A. and Sharma, D.K., (2019). Role of biotechnology in the development of animal disease diagnostics: A Review. Indian Journal of Veterinary Pathology, 43(3), pp.155-164. (NAAS rating: 5.48)
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12.2 POPULAR ARTICLES

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12.3 ABSTRACTS

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12.8 GENE BANK ACCESSION:

VTCC Accessions

1. VTCCBAA1423 (*E. coli* O157)
2. VTCCBAA1424 (*E. coli* O157)

13 PARTICIPATION IN WORKSHOPS/ TRAINING/SEMINARS/ SYMPOSIA/ CONFERENCES

1. 1st Annual Convention of Veterinary Internal and Preventive Medicine Society (VIPM) & National Symposium on "Sustainable Improvement in Animal Health and Production-Bridging Science and Policy for Economic Upliftment of Farmers" at Department of Veterinary Medicine, College of Veterinary Science & Animal Husbandry, DUVASU, Mathura, U.P., on November 8-9, 2019, PP: 140-141.
2. Veterinary Pathology Congress-2019 held at Central Agricultural University, Aizawl, Mizoram on Nov 6-8, 2019. Abstract, pp. 198.
3. 27th Annual Conference of Agricultural Economics Research Association (AERA) on "Changing Landscape of Rural India" held at Punjab Agricultural University, Ludhiana on 17-19 December, 2019
4. Annual Review Meeting of "Net Work Project on Sheep Improvement" and "Mega Sheep Seed Project" held at NASC Complex, New Delhi from, 24-25 November, 2019.
5. National Seminar on "Prospects of Goat Husbandry in India: A Pathway for Sustainable Livelihood Security" organised by Nanaji Deshmukh Veterinary Science University, Jabalpur, Madhya Pradesh on 14th November, 2019.

14 RECOGNITIONS/AWARDS/ PRIZES/HONOURS

1. NATIONAL AWARD :

Dr. S. D. Kharche, Principal Scientist has awarded with Fellow of NAVS for the year 2019 during 18th Annual Convocation-cum Scientific Convention of National Academy of Veterinary Sciences (NAVS) on "Futuristic Technologies in Animal Health and Production" scheduled during December 26-27, 2019 at Gandhinagar, Gujarat.

Fig 1 - Dr. S. D. Kharche, Principal Scientist received Fellow of NAVS

2. SOCIETY FELLOWSHIP AWARD:

Dr. S. D. Kharche, Principal Scientist has awarded as Fellow of Indian Society for the Study of Animal Reproduction (FISSAR) for the year 2019 during 35th Annual Convention at of ISSAR and International Symposium on "Global perspectives to enhance livestock fertility through modern reproductive techniques for doubling farmer's income" at Veterinary College and Research Institute (VCRI), Namakkal, Tamil Nadu during Dec.18-20, 2019.

Fig 2 - Dr. S. D. Kharche, Principal Scientist awarded with Society fellowship Award (FISSAR)

3. YOUNG SCIENTIST AWARD-2019:

Dr. Nitika sharma Scientist (Veterinary Medicine) awarded in recognition of superior performance and meritorious contribution in the field of veterinary medicine and best oral presentation in recognition of research paper during VIPM Conference-2019 held at DUVASU, Mathura on Nov 9-10, 2019.

Fig 3 - Dr. Nitika Sharma has awarded with Young Scientist award 2019

4. APPRECIATION AWARD:

Dr. M.K Singh, Principal Scientist for Outstanding Contribution in Barbari Goat Farm Development by Director ICAR-CIRG on Institute Foundation Day i.e.12th July 2019.

Dr. Ashok Kumar Principal Scientist and incharge PME for Outstanding Contribution in PME cell by Director ICAR-CIRG on Institute Foundation Day i.e.12th July 2019.

5. Dr. Ravi Ranjan awarded NAAS Associate 2019, National Academy of Agriculture Science and Prof S. S. Guraya Young Scientist Award 2019 from Indian Society for Study on Reproduction and Fertility (ISSRF).

Fig 4 - Dr. Ravi Ranjan awarded Prof S. S. Guraya Young Scientist Award 2019

6. PAPER PRESENTATION AWARD:

a. Dr. S D Kharche Awarded best oral presentation (second) on "Oestrus Induction and Synchronization in Anoestrus Ewes" at National Seminar on "Current Scenario & Future Strategies for Augmenting Productivity of Small Ruminants, ISSGPU Conference, 14-16 February 2019, at Bihar Animal Science University, Patna (Bihar) pp.74.

b. Dr. Ravi Ranjan Best Oral Presentation Award 2019, at Society of Animal Physiologists of India" (SAPI).

c. Dr. Chetna Gangwar Best oral presentation Award

in the VIPM Conference on National Symposium on Sustainable Improvement in animal Health and Production-Bridging science and policy for economic Upliftment of Farmers held on 8-9 Nov, 2019 at DUVASU, Mathura.

d. Dr. S. P. Singh Best Oral Presentation Award, at "Society of Animal Physiologists of India" (SAPI), 2019.

e. Dr. Ravindra Kumar received Reviewer excellence award from Agriculture Research Communication Centre (ARCC), Karnal.

f. Dr. N. Ramachandran: Conferred with "Certificate of Appreciation" for valuable contribution in service of scientific community as "Member of Scientific Advisory Board" of International Journal of Livestock Research in May, 2019.

g. Dr. Arun Verma received appreciation award from Director, ICAR-CIRG for outstanding contribution in establishing National Testing Lab with NABL certification.

h. Appreciation Award: Breed Conservation Award -2019: Mr. Radhey Shyam- Multiplier Flock Owner of Barbari Goat on 23rd December, 2019 by Director-NBAGR, Karnal. With the effort of Dr. M.K. Singh.

i. Geetika Gupta awarded Third Best Poster award for the poster presentation in recognition of research paper during VIPM conference held at DUVASU, Mathura on Nov 8-9, 2019.

15 AGRICULTURAL FARM AND AGROFORESTRY

Dr (S) M K Singh I/C , Arvind Kumar, Mohd Arif,

15.1. Achievements of Agricultural Farm and Agroforestry

Table 1. Details of activities in agriculture section

SUPPLY OF GREEN FODDER		
Through cultivation	374.90 MT	501.60 MT
Through lopping	126.70 MT	
SEEDS/GRAIN		
Barley seeds	36.10 MT	38.08 MT
Oat seeds	1.40 MT	
Berseem seed	0.18 MT	
Maize (QPM)	0.40 MT	
STRAW (BHOOSA)		
Barley& Oat	10.00 MT	16.00 MT
Guar	6.00 MT	
AGRO-FORESTRY		
Plantation and gap filling	Planted 3727 plant saplings of Aam, Neem, Peepal, Sahjan, Pakhar, Bargad, Goolar, Jamun, Ber, Deshi babool, Sahtut, Subabool etc. at Farm Area , Barbari unit, Jamunapari unit, etc.	
Plants sapling	Produced 3500 plant saplings of Neem, Peepal, Sahjan, Pakhar, Bargad, Goolar, Jamun, Ber, Deshi babool, Sahtut, Subabool etc.	
Supply of plant saplings	Provided 1500 sapling of moringa to USWDB, Dehradun under DST project and other agencies.	
OTHERS		
Renovation and reclamation of farm laND	20 acre land (undulated) was renovated and reclaimed through JCB work	
Auction	Rs. 66000/- revenue generated through auction of Moonj-Phoos & Pamma	

MT – Metric tonne

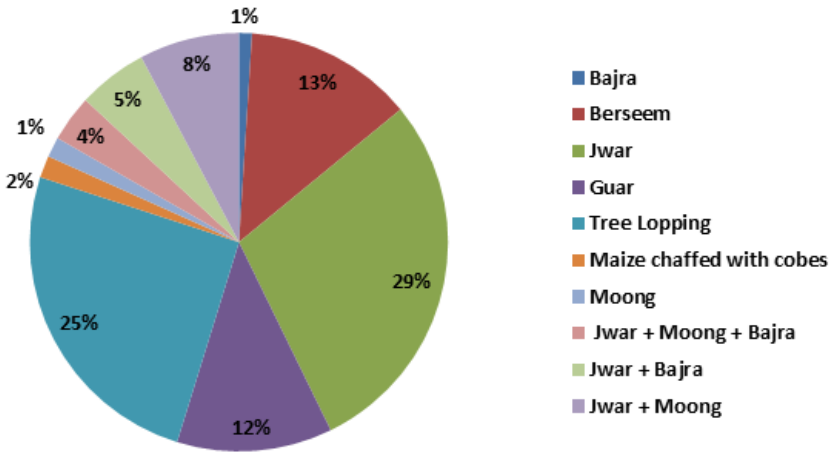


Fig. 1. Graph depicting crop wise supply of green fodder to Institute livestock units during April to December, 2019

Table 2. Status of forage crops sown during April to December, 2019

Sr. No.	Crops	Area in acres			
		Zaid	Kharif	Rabi	Total area
1.	**Moong**	**1.5**	**2.5**	-	**4.0**
2.	Jwar	**2.5**	**1.5**	-	**4.0**
3.	Jwar + Bajra	-	**1.5**	-	**1.5**
4.	Jwar + Bajra + Moong	-	**1.5**	-	**1.5**
5.	Jwar + Moong	**1.5**	-	-	**1.5**
6.	Guar	-	**43+22**		**65**
7.	Bajra	-	**1.5**	-	**1.5**
8.	Maize (QPM)	-	**2.0**	-	**2.0**
9.	Anjan and Dhaman Grasses	-	**10.0**	-	**10.0**
10.	Napier Bajra	-	**0.25**	-	**0.25**
11.	Dhaincha (Green Manure)	-	**8.0**	-	**8.0**
12	Moringa	-	**20.0**	-	**20.0**
13.	Barley	-	-	**39.0**	**39.0**
14.	Oat	-	-	**4.5**	**4.5**
15.	Berseem	-	-	**6.0**	**6.0**
16.	Rijka	-	-	**3.25**	**3.25**
Total Area		**5.5**	**113.75**	**52.75**	**172**

Table 3. Supply of feed grain and straw (bhoosa) during April to December, 2019

Sl. No.	Livestock unit	Grain in kg		Straw (Bhoosa) in kg	
		Barley	Oat	Barley	Berseem
1.	Jamunapari	**12500**	**500**	-	-
2.	Barbari	15500	**700**	-	**4000**
3.	Jakhrana	500	-	-	-
4.	Sheep unit	2500	-	1800	-
5.	ANM&PT	2000	-	-	-
6.	AP &R	700	-	-	-
7.	Animal Health	-	-	-	-
Total		**33700**	**1200**	**1800**	**4000**

15.2. OTHER ACTIVITIES

15.2.1. RESEARCH EXPERIMENTS:

1. QPM Maize Cultivation –The QPM maize was cultivated in 2 acres of farm area. The crop was sown in the month of August and harvested in November. It was cultivated to explore the utility of QPM grain as well as QPM silage on goat feeding and its productivity.

Fig. 2. Cultivation of QPM maize

2. The moringa (Moringa oleifera) as fodder crop has been cultivated in 20 acres of farm area. The first cutting of moringa was taken in October-November months and the subsequent cuts will be taken from March-April, 2020 onwards.


Fig. 3. Cultivation of moringa as fodder crop

15.2.2. Demonstration and Trainings

a. Parthenium Awareness Week was organized from 16th - 22nd August, 2019 at ICAR- Central Institute for Research on Goats (CIRG), Makhdoom, Mathura to aware the CIRG staff, nearby villagers, farmers etc. about the harmful effects of parthenium and to motivate them to uproot the parthenium and make the country parthenium. Free in this week, one day parthenium awareness camp was also organized at Gausana village (Raya, Mathura) and about 75 villagers participated in this programme. The harmful effects of parthenium like skin inflammation, eczema, asthma, allergic rhinitis, hay fever in human being and systemic toxicity, loss of skin pigmentation, dermatitis, diarrhea, etc in livestock were explained and also motivate them to uproot the parthenium.


Fig. 4. Organization of Parthenium Awareness Week

b. Demonstrations were conducted on cultivation of important fodder crops for goat and sheep production to the farmers and professional trainees of Scientific Goat Farming, sponsored training programmes and exposure visits. Demonstration included the appropriate techniques of fodder production from cultivated fodder crops and fodder trees along with non-conventional fodder sources such as azolla for sustainable goat farming. Crop varieties, cultivation season, agronomical practices, fodder yield and physical identification of fodder crops and grasses of fodder importance were explained to them. More than 2500 individuals were benefited from these demonstrations.

c. The hybrid napier bajra fodder crop is being cultivated in 0.25 acre farm area to assess the yield of fodder biomass and for the purpose of demonstration to farmers and other stakeholders.

Fig. 5. Cultivation of Hybrid Napier Bajra

15.2.3. Agro-forestry development and raising of nursery of fodder tree plants

Neem and Ber based agro-forestry being maintained by the section for lopping and providing tree fodder during lean period to different goat sheds. Nursery is also maintained for raising saplings of fodder trees such as Neem, Peepal, Sahjan, Pakhar, Bargad, Goolar, Jamun, Ber, Deshi babool, Sahtut etc, for plantation purpose. Two thousands sapling were provided to different sections of Institute and adopted farmers.

15.2.4. Installation of irrigation pipeline and renovation of farm land

This year 1500 feet underground PVC pipe line was installed at the agriculture farm to minimize the water loss, reduce channel maintenance cost and to bring more area under fodder cultivation. It has increased the fodder quality and productivity manifolds and access to irrigation in 20 acre rain-fed land of farm. Labour required to clean the channel and to watch the channel during irrigation has also been reduced for the pipe installed area (Fig. 6. a)

15.2.5. Development of 20 acres of waste/unused farm land. During the year 20 acre unused, undulating and not suitable for regular fodder cultivation land was renovated, reclaimed through JCB work and brought under cultivation. (Fig. 6. b)

Fig. 6. (a) Installed irrigation pipe and (b) renovation of farm land

16 METROLOGICAL OBSERVATION (2019-20)

MEAN MONTHLY METEOROLOGICAL OBSERVATIONS (APRIL 2019 TO MARCH 2020)

Month	Max. temp. (°C)	Min. temp. (°C)	Mean daily temp. (°C)	Vapour Pressure (mmHg)	Relative humidity (%)	Rainfall (mm)/ wet days	Sun shine (hr)
April, 2019	40.83	21.22	31.03	13.78	43.52	9.63 (1)	273.50
May, 2019	44.16	25.89	35.02	13.27	31.97	0.00 (0)	291.80
June, 2019	44.38	28.98	36.68	19.40	43.63	0.00 (0)	242.20
July, 2019	38.71	27.85	33.28	25.34	68.66	111.50 (9)	157.60
August, 2019	34.92	26.66	30.79	26.53	81.97	55.61 (11)	147.70
September, 2019	34.57	25.83	30.20	25.97	82.82	101.83 (9)	136.00
October, 2019	34.15	19.42	26.78	17.13	64.44	12.32 (1)	211.30
November, 2019	30.20	15.02	22.61	13.12	66.72	6.63 (1)	146.70
December, 2019	19.13	7.18	13.15	8.35	76.58	9.32 (1)	103.80
January, 2020	19.71	6.19	12.95	8.61	76.37	10.59 (3)	140.10
February, 2020	25.93	14.00	17.03	9.31	65.76	0.00 (0)	215.30
March, 2020	30.15	14.74	22.44	12.69	64.21	40.06 (6)	246.50

Maximum temperature: 50.0 ^{oC} on 11.06.2019.

Minimum temperature: 0.5^{oC} on 30.12.2019.

Annual Rain Fall: 357.49 mm in 42 Days.

High sunshine: 11.5 hrs. on 19.05.2019 and 28.05.2018.

Fig 1- Meteorological observatory at Institute

(Generated and Compiled by Dr Ramachandran N and Dr S. P. Singh Physiology & Management Lab)

17 RADIO TALK AND TELEVISION PROGRAMME

Scientists were participated in Doordarshan and All India Radio programme

- Dr. Ashok Kumar - "hello Kisan Vani programme" on 24th November, 2019 at 06.10.PM to 06.40.PM in Akashwani Mathura.
- Dr Ashok Kumar: Participated in Hello Kisan programme on DD Kisan Channel New Delhi on "Bakri Palan "on 29-11-2019.
- Dr. S. P. Singh participated in the Doordarshan (DD Kishan) programme 'Vichar Vimarsh' on 09.12.2019.

Fig : Scientists participating in Doordarshan Kisan Channel programme

18 PARTICIPATION IN EXHIBITION/KISAN MELA

1. Pashu Aarogay mela at DUVASU, Mathura, U.P., on 11-12 September, 2019 (02 days).
2. Krishi Avam Gramay Vikas Pradarshani at Pt. Deen Dayal Dham, Nagla Chandrabhan, Farah, Mathura, U.P., on 25-27 September, 2019 (03 days).
3. Doon Farm Fest at Parade Ground, Dehradun, Uttarakhand on 13-15 December, 2019 (03 days).

Technical Correspondence

In all 598 inquiry letters (including e-mails) were received from different categories of aspirants covering different parts of the country on various aspects of goat production and replied suitably

Visit Arrangement and Coordinator of the Farmer Single Window (A Service to Goat Farmers) at ICAR-CIRG, Makhdoom.

In all 2669 visitors were entertained and apprised them with research extension and development activities of the Institute.

Helpline Calls

In all 614 calls were received regarding various aspects of commercial goat farming, improved goat production technologies, elite germplasma and training programmes and replied suitably.

Other Extension Activities

(i) Two kisan Gosthi were organized in Udda and Kota village of Dehradun and Paudi Garhwal districts of Uttarakhand, under DST funded project " Goat based technologies and livelihood improvement in Uttarakhand State" on 26th and 27th June, 2019, respectively. About 50 goat farmers and other stake holders were participated in these events. Farmers were also sensitized on Swach Bharat Abhiyan and importance of cleanliness in daily life.

(ii) On 26th June, 2019 a Farmers-Scientists Interaction, Health Camp, Demonstration of Goat Milk Paneer Preparation, Swach Bharat Mission, Distribution of Mineral Mixture and other advisory services in adopted village, Lohawan, Raya, Mathura.

(iii) Under ICAR-ILRI Collaboration Project on Development of Goat Milk and Meat Value Chain in Bihar and Uttar Pradesh one mobile app (BAKRI-MITRA) developed and launched on 12th July, 2019.

(iv) Moringa sampling distribution to 500 farmers in Uttarakhand under DST project.

(v) ET Vaccination, Scientists –Farmers Interaction, Swachh Bharat Mission, Parthenium Eradication Programme and distribution of mineral mixture in adopted village Gausana, Raya, Mathura.

(vi) Under MGMG: Treatment of sick animals, distribution of mineral mixture and technical literature, parthenium Eradication Programme and Swachh Bharat Mission in adopted village and other advisory services.

(vii) Two Kisan-Gosthi conducted in Chiligo and Kol villages of Dehradun district of Uttarakhand under the DST Project at 14th and 16th October, 2019. About 50 participants were there in each programme.

(viii) Health Camp, Scientists-Farmers Interaction, Swachh Bharat Mission, distribution of Health Kit and ICAR-CIRG Rectangular feeder and awareness programme on Climate Change on 31st October, 2019 at adopted village Daulatpur.

(ix) Health Camp, Scientist-Farmers Interaction, Swachh Bharat Mission, Distribution of Mineral Mixture and advisory services on 15th November, 2019 at adopted village Lohavan.

Fig 1- Model Goat Village

Fig 2- Goat Product mobile app

Mera Gaon Mera Gaurav Scheme 2019

Coordinator: Dr. Braj Mohan

Co-coordinators:

- Dr. R. Pourouchottamane
- Dr. A.K. Dixit
- Dr. N. Ramachandran
- Dr. Vijay Kumar (10th December 2019)

As per the guidelines of Mera Gao 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. The details of the teams and adopted villages with their respective team leaders are provided in the table as given below:

A meeting between the members (Team-II) and farmers was organized at the adopted village Bati on 22nd June, 2019 under MGMG Programme. The meeting was attended by 37 farmers of the village. Secretary, ADO and Gram Pradhan were also present in the meeting, who highlighted the importance of conserving water and its judicious use. Importance of cleanliness for health benefits of human and animal was also told during meeting. During the interaction, the farmers raised different issues related to animal husbandry including goat rearing. The main problems associated with animal husbandry were non-availability of vaccines, diseases such as mastitis, haemorrhagic septicaemia, repeat breeding, anoestrous, PPR, ectoparasites etc. Their doubts were addressed by the expert scientists and the solutions were explained to them for their issues. Importance of hygiene, vaccination, deworming, dipping, nutrition etc. in case of goats waselaborated to the farmers. The scientists of the team also prescribed medical regimens for various ailments of the animals such as anorexia, mastitis, anoestrous, diarrhoea, ectoparasites etc. The farmers were briefed about the availability of vaccines and medicines for the animals.Healex FR ointment (10 tubes) and potassium permanganate (10 packets) were given to the goat farmers for management of different kind of wounds in animals including goats. Advantages of mineral mixture as feed supplement for the proper growth of animals were explained to the farmersand25 kg mineral mixture was distributed amongst the farmers.

This may help them to adopt mineral feed supplements on routine basis for higher productivity and better health of animals.

The importance of rearing goats and their management was scientifically explained to the farmers. Women involved in the livestock production also participated in the interaction, and showed interest to rear goat for livelihood security.

Fig 3 - Mera Gaon Mera Gaurav


Fig 3 - Mera Gaon Mera Gaurav

Team VI (July – September 2019)

The Team VI has following scientists members namely Dr. Braj Mohan (Team Leader), Dr. Saket Bhusan, Dr. N. Ramachandran and Dr. Souvik Paul. *Five villages were selected, namely, Lukhu Wali Garhi, Nagla Beech, Bhadaya Gangadhar, Hirawali Garhi, Nagla Dharampal* which comes under Bhadaya gram Panchayat, Farah Block, District Mathura. Team members visited the adopted village Nagla Dharampal on 26.8.2019 and visited the goat flocks of Sh. Ramesh S/o Ram Singh (60 goats) as well as Sh. Bahadur S/O Sh. Mansoram (25 goats). All goats are non-descript and are of mixed breed type mainly Sirohi, Barbari and few Batishi breeds. The body condition of one breeding buck were not satisfactory and suggested to use breeding buck having optimum body weight and body condition score of 3-4 on 1-5 scale. All goats were reared under zero input system having 6-8 hrs grazing in Yamuna ravine belt. After grazing, all adult goats were tied in open sky in front of their dwelling adjacent to Yamuna river and no supplementation is practiced. Hence the body condition of goats was about 2 on 1-5 scale and need supplementation. Therefore we have sensitized to give locally available grains to goats and given mineral mixture to all goats for improving the body condition and weight gain. Moreover, we have given dewormer bolus to goats at the end of rainy season. Further, the owner was asked to visit the institute periodically for technical help. Sh. Ramesh had shown one non-descript goat always giving triplets twice year in his flock. We suggested to retain male and female kids born out of this female for rearing purposes in the flock. He opined that he sold 25 kids and 10 goats this year and had a return of Rs. 1.5 lakhs. Further, we distributed Hindi literatures regarding goat rearing to the goat keeper and created awareness towards swachch bharat and on disadvantages of parthenium for human and animal health. We found that parthenium plants were enormous in and around in all adopted villages and asked the villagers to uproot and destroy before flowering stages and stressed to uproot during rainy season itself.




Fig – 4 Five villages were selected which comes under Bhadaya gram Panchayat, Farah Block, District Mathura

Dr. Braj Mohan

1. On 27.04.2019 attended celebration of 'World Veterinary Day' with a theme of 'Value of Vaccination' with meeting-cum-seminar at ICAR-CIRG, Makhdoom.
2. On 21.09.2019 attended Rajbhasa Adhiniyam ke Antargat Duwtiya Tremasik (July-September, 2019) AK Divasiya Hindi Karyashala at ICAR-CIRG, Makhdoom.
3. On 26.11.2019 attended a seminar on constitution of Republic of India at ICAR-CIRG, Makhdoom.

Fig- 5 –Participation in Exhibition/ Kisan Mela

Audio-Visual Aids Developed

1. Manoj Kumar Singh, R Pourouchottamane, B Rai and M S Chauhan. 2020. **Goat Breeds of India and their Improvement.** Android Mobile based-App in Hindi and English Developed by Director, ICAR-CIRG, Makhdoom, Mathura.

19 SWACHH BHARAT ABHIYAN ACTIVITIES

Coordinators: Dr(s) N. Ramachandran and Nitika Sharma

Institute staffs are being sensitized periodically for maintaining cleanliness in institute premises. Dr M S Chauhan, the Director of the institute continuously monitoring the cleanliness through the campus. Digital mode of communications is used sincerely to achieve the target of paperless office by institute staff. The messages, suggestions and ideas from staff are requested to share using whatsApp facilities for implementation and timely addressing of the cleanliness issues.

Swachtha Hi Seva (SHS)-2019 was celebrated from 11.09.2019 to 02.10.2019 with the theme "Plastic Waste Awareness and Management". On the occasion of the 150th Birth Anniversary of the 'Father of our Nation' Mahatma Gandhi Ji, several programmes were organized during the preceding week of Oct 2nd 2019 as per the directives of the of Hon'ble MoS (A&FW) and the Hon'ble Secretary, DARE and Director General, ICAR at the Institute level with the participation of Staff and residents of the campus. The celebrations included 6 events *viz*., extempore competition and quiz on various topics of Gandhian thoughts and *Swachhta* Campaign for staff, painting competition for children, *rangoli* competition for women of residential quarters, talks on Mahatma Gandhi and his ideals. As part of the celebrations, a presentation on single use plastic was given by Dr. Ramachandran, Sr. Scientist and Nodal Officer, *Swachh Bharat Abhiyan*, ICAR-CIRG. Dr. Ramachandran demonstrated samples of various single use plastics being used by us in daily life and explained about how to replace them. He also informed the audience the environmental threat of single use plastics and how the animals and plants are being affected by them.

Fig1 - Swachtha Hi Seva (SHS)-2019 was celebrated from 11.09.2019 to 02.10.2019

A campus wide *Swachhta* drive was organized on 30.09.2019 in the campus residential area. Preceding this activity, cleanliness drives were organized at each Division/Section of the Institute from 11.09.2019. The theme was ban on 'Single Use Plastics' and its harms. A large gathering of scientist, technical and administrative staff along with campus residents took part in the campaign. The movement was started in the *Bal Bhavan* area (Children's park) of the campus and continued till Institute main gate. An awareness movement was conducted in the residential area near the campus gate. The movement was continued till the laboratory complex building of the Institute. A total of approx. 75 staff participated in the campaign. Pamphlets (Hindi-English) on single use plastic were also distributed among the staff and campus residents.

Fig 2- Swachhta Pakhwara was celebrated with full fervor and enthusiasm at ICAR-CIRG

Swachhta Pakhwara from 16-31st December, 2019 was celebrated with full fervor and enthusiasm at ICAR-CIRG. All the institute staff as well as their families took part actively in the pakhwara. Brainstorming, awareness campaign and cleaning campaign were included in this pakhwara. Swachhta Pakhwara banners were displayed at prominent places in the main administrative building and main gate of the institute. Swachhta pledge was taken by the entire ICAR-CIRG staff. Plantation of trees was done in and around the institute building. Farmers and trainees visiting the institute were also sensitized about the significance of cleanliness, hygiene and sanitation.

Fig 3- Swachh Bharat Abhiyan in high spirits

Keeping the flame of Swachh Bharat Abhiyan in high spirits, ICAR-CIRG, Makhdoom left no-stone unturned in its drive to make the campus and its surroundings clean. All parts of the campus including office, corridor and premises were thoroughly cleaned. All the passages were made object/hindrance free for smooth commutation of staff and visitors. All the general orders/ circulars and all the information/ letters sent to ICAR headquarters were sent in e-mode only. All the old records were reviewed and accordingly deposited in the

Institute Record Room. Old and obsolete/ unserviceable material including furniture, equipment etc. has been centrally deposited/ arranged. Action for disposal of such unserviceable items, kept in stores is under process. Whole of the administrative wing was cleaned and white washed thereby giving a panoramic view and a cozy and comfortable working environment to its staff.

Thorough checking of ongoing cleaning and waste management activities was done on regular basis. People were sensitized on separation of dry and wet waste, so that composting could be done. Residents of the campus were advised not to burn waste. Thorough checking of on going cleaning sewerage and water lines was done. People were sensitized on proper management of sewerage and on the spot solutions were provided: the choked sewage lines were cleaned. Water lines were checked for any leakage so as water wastage may be curbed down. Campus residents were advised to recycle the water used for washing vegetable, utensils in kitchen garden. Removal of weeds and non-degradable waste in and around water harvesting bodies was also done to prevent their contamination.

Campus residents were advised to separate the bio degradable/non degradable waste and to recycle the kitchen waste and use it as manure in the kitchen gardens. Water used for washing vegetable, utensils in kitchen can be used to irrigate the garden. Generation of wealth from waste: The farmers/ entrepreneurs/ Veterinary officers were imparted training to utilize the excess milk, meat and offals for manufacturing products which can be preserved for later use during the lean periods when milk and meat are not available in ample amounts. The ICAR-CIRG staff was sensitized to reduce the use of polythene and use jute/cloth bags. Clean and green technologies and organic farming practices were adopted and promoted in kitchen gardens of residential colonies / parks and gardens of the institute. Inspection of waste management was done.

Fig 4 - Kisan Diwas was celebration at ICAR-CIRG

Kisan Diwas (Farmer's Day) was celebrated with great pomp and show and ICAR-CIRG on 23rd December 2019. Around 100 goat keepers including 26 women attended the event. Scientific Goat farming practices were explained to the farmers in detail by the experts of various disciplines. The concept of Swachhta and its significance with respect to scientific and profitable goat farming was explained to the farmers. Medicine kits and mineral mixtures were distributed to the farmers. The gathering was informed on issues like the IMPORTANCE OF CLEANLINESS IN OUR SURROUNDINGS and demonstrations on composting and proper way to wash hand (among children) were done. Various issues raised by the farmers were also discussed. Enthusiastic farmer from the area were also felicitated by Director, ICAR-CIRG. Pamphlets were also distributed during the occasion.

Fig 5 (i)- swachhta pakhwara

Shri Mahinder Singh, Social activist, Mathura actively took part in swachhta pakhwara activities at ICAR-CIRG. He also sensitized the ICAR-CIRG staff as well as residents of Makhdoom village on the importance of

cleanliness and health in our daily lives. Director, ICAR-CIRG also guided the institute staff and residents about health, hygiene and sanitation. He also emphasized how a healthy citizen can contribute in the development of the nation. He also accentuated that cleanliness is be the base of scientific goat farming. The president of Women Club, Mrs Beena Chauhan along with other members actively participated in the swachhta pakhwara activities at CIRG. The press and media persons actively covered the events and activities of swachhta pakhwara at CIRG.

Fig 5 (ii)- swachhta pakhwara

20 INSTITUTE EVENTS

1. Foundation day of the Institute Celebration 12 July,2019

The ICAR-Central Institute for Research on Goats, Makhdoom was founded on 12th July, 2019. Therefore, Institute Foundation Day celebrated every year on 12th July.

Fig 1- Celebration of 40th Foundation Day of ICAR-CIRG, Makhdoom

2. Independence Day Celebration

Independence Day of the nation was celebrated on 15.8.2019 in the Institute with full vigour and fanfare. Dr. M. S. Chauhan, Director of the Institute unfurled the flag and addressed the employees of the Institute.

Fig 2 - Independence Day Celebration

3. Parthenium Awareness Week

was celebrated from 16th - 22nd August, 2019 at ICAR- Central Institute for Research on Goats (CIRG), Makhdoom, Mathura to aware the CIRG staff, nearby villagers, farmers *etc.* about the harmful effects of parthenium and to motivate them to uproot the parthenium and make the country parthenium. In this week, one day parthenium awareness camp was also organized at Gausana village (Raya, Mathura) and about 75 villagers participated in this programme. The harmful effects of parthenium like skin inflammation, eczema, asthma, allergic rhinitis, hay fever in human being and

systemic toxicity, loss of skin pigmentation, dermatitis, diarrhoea *etc* in livestock were explained and also motivate them to uproot the parthenium.

Fig 3 - Inauguration of the "Parthenium Awareness Week" at Mayurvan, CIRG, Makhdoom and aware the CIRG staff about the harmful effects of this weed plant.

4. Mahatma Gandhi, 150th Birth Anniversary:

The ICAR –CIRG, Makhdoom was celebrated 2nd October 2019 to commemorate the 150th Birth Anniversary of the Father of Nation Mahatma Gandhi in culmination of the year around programmes organized at the institute .focusing especially on banning the use of Single Use Plastic.

Fig 4- Mahatma Gandhi, 150th Birth Anniversary

5. Constitution Day:

The ICAR –CIRG, Makhdoom was celebrated Constitution Day from 26th November, 2019. Seminar on constitution of Republic of India by eminent speakers.

Fig 5 – Celebration of Constitution Day in Village Makhdoom, Farah Mathura

6. National Farmer day (23 December, 2019):

The ICAR –CIRG, Makhdoom was celebrated National Farmer Day from 23th December, 2019.

Fig 6. Celebration of National Farmer Day in ICAR-CIRG, Makhdoom

21 IMPORTANT MEETING

PRIORIZATION, MONITORING AND EVALUATION CELL

Dr **Ashok Kumar and Dr P.K. Rout**

A. Research management and coordination:

This is major activity relate to manage research projects (Institute / out funded project) and coordination of IRC, RAC and other related meetings. During the year institute is running 17 research projects funded Institute and 28 research projects with extra mural funding.

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) is being prepared as per the guideline of ICAR and executed it. Under Training cell, national training being organized for farmers and other sponsored programmes.

C. Institute Technical Management Unit (ITMU):

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. 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.

RESEARCH ADVISORY COMMITTEE (RAC)

The meeting of Research Advisory Committee (RAC) of CIRG was held on 03rd December, 2019 under the chairmanship of Dr. A.S. Nanda, members of RAC, Dr. M.S. Chauhan, Director, CIRG, Dr. S.N.S. Randhawa, Dr. A. S. R. Anjeyanulu, Ex. P.S. & Sci. ICAR NRC Meat, Dr. A. K. Rawat, Dr.Ashok Kumar ADG (AH) New Delhi, Dr. Sunil Chaturvedi, Progressive farmer, nominated were present. 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 2018-19 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. Dr. Ashok Kumar PS CIRG , Member Secretary RAC, and presented the action taken report on recommendation made by last RAC (2018-19). The Head of the division /sections presented the progress of last year , action taken on recommendations and nest year research programme. 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 2018-19 and emphasized that A.I. in goat should be taken on priority.

Fig.22.1 Meeting of Research Advisory Committee of CIRG being chaired by Dr. A.S. Nanda on 3 Dec, 2019

RESEARCH ADVISORY COMMITTEE
(03rd December, 2019)

COMPOSITION OF THE RESEARCH ADVISORY COMMITTEE

Chairman, Dr. A.S. Nanda, Vice Chancellor, Guru Angad Div. Veterinary & Animal Sciences University, Firozpur Road, Ludhiana-141004,Punjab

Members

- Dr. S.N.S. Randhawa, Ex- prof. and Head(Veterinary Medicine), Ex-Director (Research), Guru Angad Dev Veterinary & Animal Sciences University
- Dr. A. S. R. Anjeyanulu, Ex. P.S. & Sci. Err. ICAR NRC Meat
- Dr. A.K. Rawat, Director, Animal Biotechnology DBT, New Delhi.
- Dr. M. S. Chauhan, Director CIRG
- Dr. Sunil Chaturvedi, Progressive farmer, Mathura U.P
- Dr. Tej Pal Singh , Progressive farmer, Mathura U.P

Member Secretary:

Dr. Ashok Kumar, Principal Scientist and I/C PME CIRG

Institute Management Committee (IMC)

The Institute Management Committee meeting was held on 22nd August, 2019. Director, CIRG Dr. M.S. Chauhan chaired the meeting. The meeting was attended Dr. A. K. Tyagi, Head, Dairy Cattle Nutrition Division, NDRI, Karnal, Dr. P. S. Yadav, Principal Scientist and Head Physiology and Reproduction Division, CIRB, Hisar, Haryana Dr. Tejpal Singh, Dr. Sunil Chaturvedi, Dr. M. K. Singh, Principal Scientist AGB Div. CIRG, Makhdoom,. Sri R S Bhatt FAO, Dr V Rajkumar Sr Scientist, Sri S K Jindal SAO , Sri Agnivesh AO , Dr. Ashok Kumar, Principal Scientist. Dr. Ashok Kumar, I/C PME Cell, presented the research achievements during 18-19. 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

Fig 22.2 Institute Management Committee meeting of the Institute on 22 Augest, 2019

COMPOSITION OF THE INSTITUTE MANAGEMENT COMMITTEE

CHAIRMAN : DR. M.S. CHAUHAN, DIRECTOR, CIRG, MAKHDOOM

Members:

- Dr. P. S. Yadav, Principal Scientist and Head Physiology and Reproduction Division, CIRB, Hisar, Haryana
- Dr. Sai Kumar, Principal Scientist, PME Cell, IVRI, Izatnagar
- Dr. M. K. Singh, Principal Scientist AGB Div. CIRG, Makhdoom
- Dr. Tejpal Singh, 22 A. B. Krishna Nagar, Mathura UP - 281004
- Dr. Sunil Chaturvedi, 239 Sector -2, Kailash Nagar, Vrindavan, Mathura 281121 (UP)

- Dr. A. K. Tyagi, Head, Dairy Cattle Nutrition Division, NDRI, Karnal
- Sri S K Jindal , SAO CIRG Mathura , Member secretary

22.3. INSTITUTE RESEARCH COMMITTEE (IRC)

The Annual Institute Research Committee meeting of CIRG was held on 30 April to-1st May,2019 and 6-7 May 2019 and Half yearly IRC held on 15-17 October, 2019 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 welcome to the Director, that IRC is an important meeting at institute level to review and modify the technical programme, which can fulfill the expectation and commitment of ICAR and Government of India. The Director in his introductory address highlighted the importance of institute IRCs, 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.

Fig.22.3.Institute Research Council meeting in the KP Pant Committee Room of the Institute.

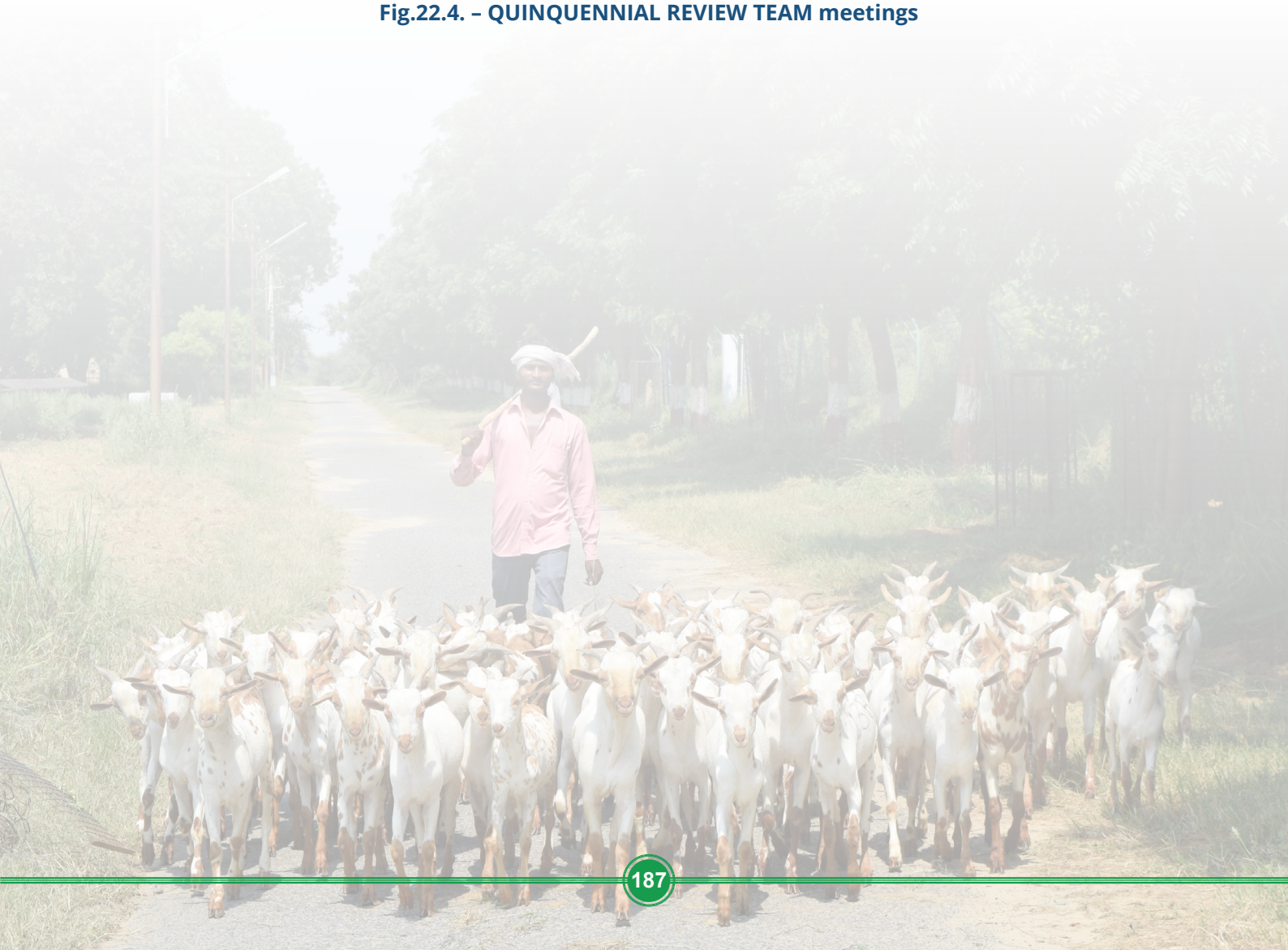
22.4 QUINQUENNIAL REVIEW TEAM:

The Indian Council of Agricultural Research (ICAR) appoints an external review committee of senior professionals called the Quinquennial Review Team (QRT) to carry out a comprehensive review (achievement audit) of the organization every five years. For conducting the Quinquennial review of Central Institute for Research on Goats, Makhdoom, Farah, Uttar Pradesh. ICAR constituted the Quinquennial Review Team vide office Order No. F.No.AS.18/6/2019-IA-I dated 23-9-2019.

Sl. No.	Name and Address of the Expert	Status
1	Dr. P. Thangaraju, Former Vice Chancellor, TANUVAS & Pro Vice Chancellor, SRM University Mob. 9444011997,E.mail.- ptrajuagb@ gmail.com	Chairman
2	Dr. D. Swarup, Former Director, ICAR, Makhdoom, Mathura Mob. 7829680777, Email- devendra.swarup@gmail.com	Member
3	Dr. B.S. Prakash, Former ADG (AN&P), ICAR, New Delhi. Mob.9999979013, Email- bsprakash1001@gmail.com	Member
4	Dr. K.T Samapth, Former Director, NIANP, Bengaluru Mob.9886617201,Email- ktsampath50@gmail.com	Member

Sl. No.	Name and Address of the Expert	Status
5	Dr. J.V. Solanki, Former Dean & Professor, Animal Genetics, Veterinary College, AAU, Anand, Gujarat. Mob. 7567710670, Email.-jvsolanki49@gmail.com	Member
6	Dr. Avinash Anand, CEO, Uttarakhand Sheep Development Board, Dehradun, Uttarakhand, Mob- 9358102780 Email. ceouswdb@gmail.com	Member
8	Dr. Ashok Kumar, In-charge, PME Cell, Central Institute of Research on Goats, Makhdoom-Farah. email: pmecirg@gmail.com	Member Secretary

Fig.22.4. – QUINQUENNIAL REVIEW TEAM meetings



22 DISTINGUISHED VISITORS

Name of Visitors	Address	Date of visit
Shri Sushil Kumar IAS	Additional Secretary, DARE & Secretary ICAR ,New Delhi	12April, 2019
Shri Giriraj Singh	Union Minister of fisheries , Animal Husbandry and Dairying Govt. of India	17 August,2019
Dr. Ashok Kumar	ADG (AH), ICAR	17 August,2019
Dr. Sanjeev Kumar Balyan	Mos Ministry of Animal Husbandry, Dairy and Fisheries	10 September,2019
Dr. Trilochan Mohapatra	DG, ICAR, New Delhi	11 September ,2019
Dr. Joykrushna Jena	DDG,ICAR, Animal Science, New Delhi	11 September ,2019
Dr. R.K Singh	Director IVRI	11 September ,2019
Captain Vikash Gupta	Chairman, U.P. Council of. Agricultural Research	25th November ,2019
Shri Atul Chaturvedi IAS	Secretary , Department of Animal Husbandry &dairying (DAHD) Govt of India	02 December ,2019

Fig 1 - Shri Giriraj Singh (Union Minister of fisheries, Animal Husbandry and Dairying Govt. of India) on visit at CIRG and releasing Bakri App on 17 August, 2019.

Fig 2 - Dr Ashok Kumar ADG (AH), ICAR visit at CIRG 17 August, 2019

Fig 3- Dr. Trilochan Mahaptra DG,ICAR; Dr. Joykrushna Jena , DDG (AS) ICAR and Dr R K Singh Director IVRI during visit at CIRG on 11.09.2019

Fig 23.4 Shri Atul Chaturvedi IAS, Secretary (DAHD) Govt. of India during his visit on 02 December, 2019

Fig 23.5 Shri Sushil Kumar IAS, Additional Secretary, DARE & Secretary ICAR , New Delhi during his visit on 12 April,2019

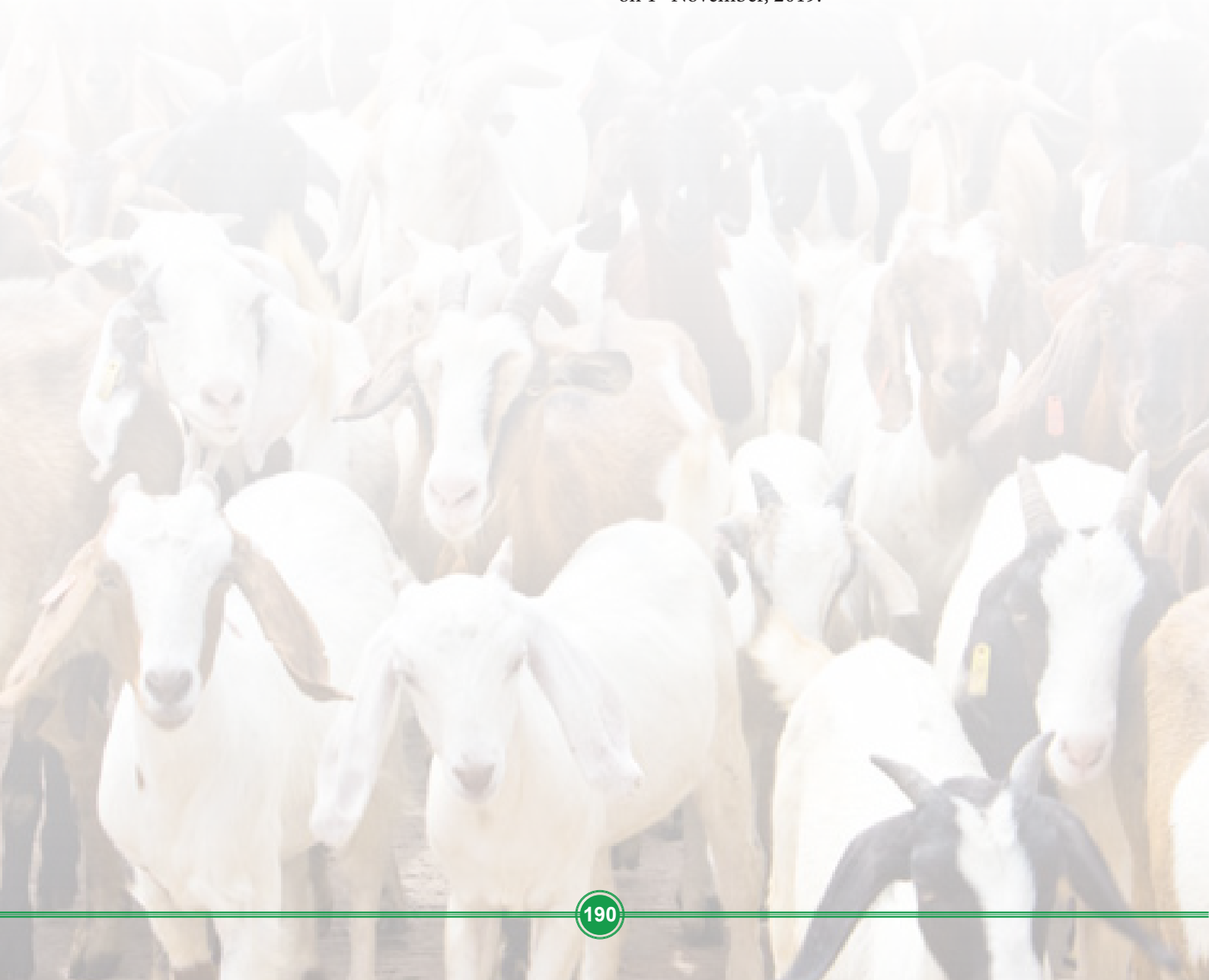
23 WOMEN CELL

WOMEN'S COMPLAINT COMMITTEE

Women's Complaint Committee is meant to redress the gender related grievances of the women employees of ICAR-CIRG under the Sexual Harassment of Women at Workplace Act, 2013 and to provide them a congenial environment at their workplace. The Women's Complaint Committee of ICAR-CIRG has been reconstituted on 25th October, 2019 with following members:

1. Dr. Anu Rahal, Principal Scientist, ICAR-CIRG: Chair person
2. Dr. Nitika Sharma, Scientist, ICAR-CIRG: Member
3. Dr. Chetna Gangwar, Scientist, ICAR-CIRG: Member
4. Dr. Braj Mohan, Principal Scientist, ICAR-CIRG: Member (SC/ST Liaison Officer)
5. Mr. Agnivesh, AO, ICAR-CIRG: Member Secretary
6. Dr. Madhu Tiwari, DUVASU: External Member

No complaints were received during the Academic year 2019-20. A meeting cum awareness programme regarding their rights at their workplace was conducted on 1st November, 2019.



24 हिन्दी पखवाड़ा

संस्थान में वर्ष 2019 के दौरान हिन्दी पखवाड़ा के अन्तर्गत होने वाली गतिविधियां

हिन्दी पखवाड़ा

संस्थान में दिनांक 14.09.2019 (हिन्दी दिवस) के अन्तर्गत हिन्दी पखवाड़ा के कार्यक्रमों का आयोजन दिनांक 14.09.2019 से 28.09.2019 तक निम्नवत विवरण के अनुसार किया गया।

- दिनांक 14.09.2019 को राजभाषा से सम्बन्धित वृत्तचित्र, सेतु व हिन्दी गांधी और गुलामी का चलचित्र प्रदर्शन समस्त कर्मचारियों के लिए संस्थान में किया गया।
- दिनांक 16.9.2019 को एक विचार संगोष्ठी का आयोजन किया गया जिसमें संस्थान के विभिन्न वैज्ञानिकों, अधिकारियों,

कर्मचारियों व आमंत्रित अतिथियों द्वारा 'राष्ट्र विकास में हिन्दी का महत्व' 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 17.9.2019 को हिंदी टिप्पण एवं प्रारूप लेखन प्रतियोगिता का आयोजन किया गया, जिसमें संस्थान के अधिकारियों, कर्मचारियों एवं छात्र/छात्राओं ने सहभागिता की तथा श्री जितेन्द्र सिंह गेट, श्री मोहन लाल एवं श्री दीपक कुमार क्रमशः प्रथम, द्वितीय एवं तृतीय स्थान पर रहे व श्री यतेन्द्र कुमार गुप्ता, श्री राजकुमार शर्मा, श्री धर्मेन्द्र सिंह एवं श्री सतीश चन्द्रा को सांत्वना पुरस्कार से सम्मानित किये गये।

- दिनांक 18.9.2019 को हिन्दी निबन्ध प्रतियोगिता (विषयः सिंगल यूज प्लास्टिक और पर्यावरण संरक्षण) का आयोजन किया गया, जिसमें संस्थान के वैज्ञानिकों, अधिकारियों, कर्मचारियों एवं बच्चों द्वारा सहभागिता की। जिसमें डा. पल्लवी सिंह, श्री दीपक कुमार, श्री जितेन्द्र सिंह गेट क्रमशः प्रथम, द्वितीय एवं तृतीय

स्थान पर रहे व श्री पंकज शर्मा, श्री राकेश कौशिक, श्री बदन सिंह को सांत्वना पुरस्कार से सम्मानित किये गये।

- दिनांक 19.9.2019 को कंप्यूटर पर यूनिकोड में हिंदी टाइपिंग प्रतियोगिता का आयोजन किया गया जिसमें संस्थान के अधिकारियों, कर्मचारियों एवं छात्र/छात्राओं ने सहभागिता की तथा श्री अरूण कुमार सिंघल, श्री मोहन लाल एवं श्री उत्तम सिंह क्रमशः प्रथम, द्वितीय एवं तृतीय स्थान पर रहे व डा. पल्लवी सिंह, श्री राकेश कौशिक, श्री पवन कुमार, श्री निरंजन प्रसाद को सांत्वना पुरस्कार से सम्मानित किये गये।
- दिनांक 20.9.2019 को प्रश्न मंच प्रतियोगिता का आयोजन किया गया जिसमें 05 टीमों (प्रत्येक टीम में 03 प्रतिभागियों) जिसमें वैज्ञानिकों, अधिकारियों, कर्मचारियों, एवं छात्र/छात्राओं ने सहभागिता की। इस प्रतियोगिता में सहभागिओं से राजभाषा एवं सामान्य ज्ञान से सम्बन्धित प्रश्न पूछे गये तथा अधिकांश सही उत्तर देने वाली टीम–2, टीम–4, टीम–5 क्रमशः प्रथम, द्वि

तीय एवं तृतीय स्थान पर रही व पुरस्कृत किया गया।

- दिनांक 21.9.2019 को एक दिवसीय हिंदी कार्यशाला का आयोजन किया गया जिसमें संस्थान के समस्त वैज्ञानिकों, तकनीकी अधिकारी व कर्मचारी, प्रशासनिक अधिकारी, कर्मचारियों, आर.ए.,

एस.आर.एफ. व छात्र/छात्राओं ने सहभागिता निभायी, जिसमें डा. रघुवीरशरण तिवारी, पूर्व प्राध्यापक एवं सहसचिव, नगर राजभाषा कार्यान्वयन समिति, (नराकास) छटवां तल, आयकर भवन, आगरा द्वारा 'राजभाषा निति एवं अनुपालन' पर एक व्याख्यान दिया गया।

- दिनांक 23.9.2019 को वाद–विवाद प्रतियोगिता (विषय–संपोषणीय विकास में नवीन कृषि तकनीकियां कितनी कारगर) का

आयोजन किया गया, जिसमें संस्थान के अधिकारियों, कर्मचारियों एवं छात्र/छात्राओं ने सहभागिता की तथा कु. वैष्णवी गर्ग, डा. अनुज कुमार, श्री बदन सिंह क्रमशः प्रथम, द्वितीय एवं तृतीय स्थान पर रहे व डा. चेतना गंगवार, श्री सतीश चन्द्रा को सांत्वना पुरस्कार से सम्मानित किये गये।

- दिनांक 24.9.2019 को आशुभाषण प्रतियोगिता का आयोजन किया गया, जिसमें संस्थान के अधिकारियों, कर्मचारियों एवं

छात्र/छात्राओं ने सहभागिता की तथा डा. अनुज कुमार, डा. चेतना गंगवार, श्री पंकज शर्मा क्रमशः प्रथम, द्वितीय एवं तृतीय स्थान पर रहे व श्री धर्मेन्द्र सिंह, डा. विजय किशोर, श्रीमती रजनी सक्सैना, श्री राजू कुमार को सांत्वना पुरस्कार से सम्मानित किये गये।

- दिनांक 25.9.2019 को हिंदी काव्य पाठ प्रतियोगिता का आयोजन किया गया, जिसमें संस्थान के अधिकारियों, कर्मचारियों एवं

छात्र/छात्राओं ने सहभागिता कर काव्य पाठ किया तथा श्री हाकिम सिंह, डा. भावना कुशवाह, कु. वैष्णवी गर्ग क्रमशः प्रथम, द्वितीय एवं तृतीय स्थान पर रहे व श्री अतुल शर्मा, डा. पवन कुमार, श्री सुगड़ सिंह, डा. अनुपम कृष्ण दीक्षित को सांत्वना पुरस्कार से सम्मानित किये गये।

- दिनांक 28.9.2019 को हिन्दी पखवाड़ा समापान समारोह एवं प्रमाण पत्र वितरण का आयोजन किया गया, जिसमें संस्थान के समस्त वैज्ञानिकों, तकनीकी अधिकारी व कर्मचारी, वरिष्ठ

प्रशासनिक अधिकारी व कर्मचारियों ने सहभागिता निभायी एवं दिनांक 14 सितम्बर, 2019 से प्रारम्भ हुए इस हिन्दी पखवाड़े के दौरान समस्त सफल प्रतिभागियों को संस्थान के कार्यवाहक निदेशक डा. भुवनेश्वर राय एवं अन्य वरिष्ठ अधिकारियों द्वारा प्रमाण पत्र प्रदान किये गये। पुरस्कार राशि परिषद के

दिशानिर्देश अनुसार पुरस्कार राशि प्रथम 2000.00, द्वितीय 1500.00, तृतीय 1100.00 एवं सांत्वना 800.00 (चार पुरस्कार) विजयी प्रतिभागियों के खाते में स्थानांतरित किये जाने की घोषणा की।

इस अवसर पर कार्यवाहक 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 प्रमाण पत्र वितरण करते हुये संस्थान के कार्यवाहक निदेशक, डा. भुवनेष्वर राय एवं अन्य वरिष्ठ अधिकारीगण

25 STAFF POSITION, FINANCIAL STATEMENT AND REVENUE GENERATION

26.1. STAFF POSITION

S.No	Class of Posts	Total posts Sanctioned	Total employees in position	Total post Vacant
1	**Scientific Post**	**44+1= 45**	**27**	**18**
a	Scientist	32	18	
b	Sr. Scientist	08	07	
c	Pri. Scientist	04	02	
d	RMP	01	00	
2.	**Technical**	**55**	**29**	**26**
a	Category -I	50	26	
b	Category -II	02	02	
c	Category -III	03	01	
3.	**Administrative Posts**	**31**	**20**	**11**
a	Category "A" posts SAO/AO/F&AO	3	3	
b	Category "B" posts AAO/PS	4	2	
c	Category "C" posts Assistant/UDC/PA/JAO/Steno/ LDC	24	15	
4.	**Supporting Skilled Staff**	**101**	**86**	**15**
Total		**232**	**162**	**70**

26.2. BUDGET & UTILIZATION FOR THE YEAR 2019-20 (RS. IN LAKHS)

(Rs. In lakhs)

S. No.	Head	RE 2019-20	Utilization during the year 2019-20				
			Other than NEH & TSP	TSP	NEH	SCSP	Grand Total
1	2	3	4	5	6	7	8 (4+5+6+7)
1.	GIA-Capital	141.00	121.74	-	-	14.61	136.35
2.	GIA -Salary	2235.24	2235.21	-	-	-	2235.21
3.	GIA-General						
	(1) Others	630.00	580.89	-	-	48.88	629.77
	(2) Pension	484.13	484.10	-	-	-	484.10
	Grand Total	**3490.37**	**3421.94**	**-**	**-**	**63.49**	**3485.43**

BUDGET & UTILIZATION FOR THE YEAR 2019-20 IN RESPECT OF AICRP ON GOAT IMPROVEMENT, MAKHDOOM

(Rs. In lakhs)

S. No.	Head	RE 2019-20	Utilization during the year 2019-20				
			Other than NEH & TSP	TSP	NEH	SCSP	Grand Total
1	2	3	4	5	6	7	8 (4+5+6+7)
1.	GIA-Capital	115.00	84.53	-	-	15.00	99.53
2.	GIA –Salary	-	-	-	-	-	-
3.	GIA-General (Others)	458.00	337.84	64.00	23.00	33.00	457.84
	Grand Total	**573.00**	**422.37**	**64.00**	**23.00**	**48.00**	**557.37**

26.3. FINANCIAL STATEMENT FOR THE YEAR 2019-20 (RS. IN LAKHS)

INSTITUTE GRANT (Rs. In Lakhs)		
	RE/BE 2019-20	**Expenditure**
Recurring		
Establishment charges	178052000.00	178015842.00
Wages	45456000.00	45455307.00
Pension	48413000.00	48402491.00
OTA	16000.00	15740.00
TA	2500000.00	2449429.00
Other Charges	60202000.00	60091183.00
HRD	298000.00	296793.00
Total	**334937000.00**	**334726785.00**
Non Recurring		
Equipments	4000000.00	3970700.00
Information and technology	2500000.00	2461305.00
Furniture	2900000.00	2893312.00
Library Books& Journals	200000.00	199280.00
Vechicles & Vesseles	3500000.00	3111498.00
Livestock	0.00	0.00
Work	1000000.00	998948.00
Other	0.00	0.00
Total	**14100000.00**	**13635043.00**
Grand Total (A+B)	**349037000.00**	**348361828.00**

26.4. REVENUE GENERATION FOR 2019-20.

26.4.1. AS PER USUAL FORMATS

Sl. No.	Particulars	Amount (Rs.)
1	Sale of Farm Produce	3629515.73
2	Sale of Fish & Poultry	483729.5
3	Income from royalty/Sale of Publications and Advertisements	19573
4	License Fee	1029447
5	Interest earned on Loans and Advances	640877
6	Application fee from candidates	144500
7	Diploma Charges	294250
8	Interest Earned on short term deposits	6038887
9	Income generated from Internal Resource Generation	4056334
10	Miscellaneous Receipts	8819987.59
	Grand Total	**25157100.82**

26.4.2. AS PER NEW GUIDELINES ISSUED BY ICAR, THE REVENUE GENERATION FOR THE YEAR 2019-20 IS AS FOLLOW.

Sl. No.	Particulars	Amount (Rs.)
1	Income from Sale & Services	8188516
2	Income from Fee/ Subscription	352650
3	Income from Royalty /Publications	19573
	Grand Total	**8560739**

26 CIRG PERSONNEL

ADMINISTRATION AND MANAGEMENT

Dr. B. Rai	Director (acting)
Dr. S. D. Kharche	Vigilance Officer
Mr. Sumit Kumar Jindal	Sr. Administrative Officer
Mr. Agnivesh	Administrative Officer
Mr. A. K. Sharma	Asstt. Admn. Officer
Mr. Radhey Shyam Bhatt	Financial Account Officer
Mr. Roney Alfred	Private Secretary

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
Mr. V. K. Sharma	Technical Officer T-5
Mr. M. P. Agrawal	Technical Officer T-5

ANIMAL PHYSIOLOGY AND REPRODUCTION DIVISION

Dr. S. D. Kharche	Principal Scientist & Head
Dr. R Pourouchottamane	Principal Scientist
Dr. N. Ramachandran	Sr. Scientist
Dr. Ravi Ranjan	Sr. Scientist
Dr. Yogesh Kumar Soni	Scientist
Dr. S. P. Singh	Sr. Scientist
Dr. Chetna Gangwar	Scientist

ANIMAL NUTRITION & PRODUCT TECHNOLOGY DIVISION

Dr. B. Rai	Principal Scientist & Head
Dr. Ravindra Kumar	Sr. Scientist
Dr. V. Rajkumar	Sr. Scientist
Dr. Arvind Kumar	Sr. Scientist
Dr. A. K. Verma	Scientist
Dr. Mohd. Arif	Scientist
Mr. Dori Lal Gupta	Sr. Technical Officer T-6
Mr. Suraj Pal	Sr. Technical Officer T-6
Mr. Lal Singh	Technical Officer T-5

ANIMAL HEALTH DIVISION

Dr. D. K. Sharma	Principal Scientist and Head
Dr. Ashok Kumar	Principal Scientist
Dr. R. V. S. Pawaiya	Principal Scientist
Dr. Anu Rahal	Principal Scientist
Dr. K. Gururaj	Sr. Scientist
Dr. A. K. Mishra	Scientist
Dr. Nitika Sharma	Scientist
Dr. Vinay Chaturvedi	Sr. Technical Officer T-6
Mr. Vijay Kishore	Sr. Technical Officer T-6
Mr. T. K. Gautam	Sr. Technical Officer T-6

EXTENSION EDUCATION AND SOCIO- ECONOMICS SECTION

Dr. Braj Mohan	Principal Scientist & I/c
Dr. A. K. Dixit	Principal Scientist
Dr. Khushyal Singh	Sr. Scientist
Dr Vijay Kumar	Scientist

AICRP ON GOAT IMPROVEMENT

Dr. P. K. Rout	Principal Scientist & PC
Dr M K Singh	Principal Scientist
Dr. Gopal Das	Principal Scientist
Dr. M. S. Dige	Scientist

NETWORK PROJECT ON SHEEP

Dr. Gopal Dass	Principal Scientist
Mr. Rajendra Kumar	Technical Officer T-5

PRIORITIZATION, MONITORING AND EVALUATION (PME) CELL

Dr. Ashok Kumar	Principal Scientist & I/c
Dr. P. K. Rout	Principal Scientist
Dr. Nikita Sharma	Scientist

INSTITUTE TECHNOLOGY MANAGEMENT UNIT (ITMU)

Dr. Ashok Kumar	Principal Scientist & I/c

RTI Cell

Dr. A. K. Dixit	Principal Scientist & Transparency Officer
	Nodal Officer CPGRAM
Shri Sumit Kumar Jindal	Senior Administrative Officer &CPIO

FARMERS TRAINING CELL

Dr. Anupam Krishna Dixit	Principal Scientist & Nodal Officer
Dr. R. Pourouchottamane	Principal Scientist & Co-Nodal Officer

AGRICULTURE KNOWLEDGE MANAGEMENT UNIT (AKMU)

Dr. R. V. S. Pawaiya	Principal Scientist & I/c
Mr. Satish Chandra	Sr. Technical Officer T-6

HUMAN RESOURCE DEVELOPMENT (HRD) CELL

Dr. M. K. Singh	Principal Scientist & I/c
Dr. V. Rajkumar	Sr. Scientist

MAINTENANCE

Dr. A. K. Verma	Scientist & I/c
Mr. Indra Pal Sharma	Technical Officer T-5

SECURITY SECTION

Dr. V. Rajkumar	Sr. Scientist & I/c

MEDICAL DISPENSARY

Dr. Ashok Kumar	Principal Scientist & I/c
Mr. Mohan Lal	Technical Officer T-5

LIBRARY

Dr. R Pourouchottamane	Principal Scientist & I/c
Prem Babu	SS Gr- 1

AGRICULTURE FARM

Dr. M. K. Singh	Principal Scientist & I/c
Dr Arvind Kumar	Senior Scientist
Dr Mohamad Arif	Scientist
Mr. Hukam Singh	Technical Officer T-5

HORTICULTURE SECTION

Dr. Nitika Sharma	Scientist & I/c
Mr. Suraj	Technical Officer T-5
Mr. Hukam Singh	Technical Officer T-5

VEHICLE SECTION

Dr. K. Gururaj	Scientist & I/c
Dr. Vinay Chaturvedi	Sr. Technical Officer (T-6

SUPERANNUATION

Dr. A. K. Goel	Principal Scientist (APR Div.) Retired on 31.07.2019
Mr. Ram Babu	Assistant Retired on 31.01.2019
Mr. C.M. Sharma	Assistant Retired on 30.06.2019

Mr. C. S. Sagar	Asst. Admn. Officer Retired on 31.07.2019
Mr. A. K. Bhatia	Assistant Retired on 31.08.2019
Mr. Nanhey Khan	Technical T-1-3 Retired on 31.01.2019
Mr. B.L. Tarkar	STA Retired on 28.02.2019
Mr. H.K. Himkar	Technical Retired on 31.07.2019
Mr. I.P. Sharma	Technical Retired on 31.10.2019
Mr. Rajendra Kumar	Technical Retired on 31.12.2019
Mr. Govind Prasad	Technical Retired on 31.12.2019

TRANSFERS

Dr. Souvik Paul	Scientist transferred on 11.11.2019
Dr. M. S. Dige	Scientist transferred on 11.11.2019
Dr. M. Suman	Scientist transferred on 11.11.2019
Dr. Vijay Kumar	Scientist transferred on 11.11.2019

CAREER ADVANCEMENT/PROMOTION

Dr. Chetna Gangwar, Scientist (APR) promoted from to next Grade pay

Dr. K. Gururaj, Scientist (AH) promoted to Senior Scientist (Animal Health Division)

Dr. S.P. Singh, Scientist (APR) promoted to Senior Scientist (APR)

RESEARCH SCHOLARS AND YOUNG PROFESSIONALS

Sonia Saraswat	Women Scientist
Pallavi Singh	Women Scientist
Anuj Kumar	Research Associate
Mahima Verma	Research Associate
Juhi Pathak	Senior Research Fellow
Kamendra Sawrup	Senior Research Fellow
Deeksha Gupta	Senior Research Fellow
Parul Dubey	Senior Research Fellow
Atul Bhardwaj	Senior Research Fellow
Sandeep Kumar	Junior Research Fellow
Manish Kumar	Junior Research Fellow
Jay Shree	Junior Research Fellow
Bhawana Kushwah	Junior Research Fellow
Rakesh Kaushik	Young Professional-II
Dimple Anadani	Young Professional-II
Akhilesh Maurya	Young Professional-II
Geetika Gupta	Young Professional-I
Deendayal	Young Professional-I
Tanuja Kushwah	Young Professional-I
Shalini Verma	Young Professional-I

Ankit Bhardwaj	Young Professional-I
Uttam Singh	Young Professional-I
Praveen	Young Professional-I
Anjali Pachori	Young Professional-I
Vikram	Young Professional-I
Vashnavi Garg	Young Professional-I
Manvender Kumar	Young Professional-I
Deepak Sharma	Young Professional-I
Ashutosh Mishra	Young Professional-I
Narendra Pratap	Young Professional-I
Devki Nandan	Young Professional-I
Akriti Dixit	Young Professional-I
Amit Kumar	Field Assistant
Faheem	Field Assistant
Pankaj Sharma	Young Professional-I
Abhimanyu	Young Professional-I
Kamal Singh	Young Professional-I
Nitin Kumar	Young Professional-I
Dharmendra	Young Professional-I
Parmod	Young Professional-I

भा.कृ.अनु.प.-केन्द्रीय बकरी अनुसंधान संस्थान
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