19

ISSGPU

PATNA 14-16 Feb 2019

National Seminar

"Current Scenario and Future Strategies for Augmenting Productivity in Small Ruminants"

Organized by
Bihar Animal Sciences University, Patna, Bihar
&
Indian Society for Sheep and Goat Production and Utilization

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National Seminar
On"Current Scenario and Future Strategies for Augmenting Productivity in Small Ruminants"

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Indian Society for Sheep and Goat Production and Utilization

Bihar Animal Sciences University, Patna

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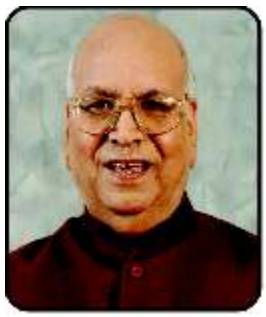

संदेश

मुझे यह प्रसन्नता हुई कि बिहार पशु विज्ञान विश्वविद्यालय, पटना और Indian Society for Sheep and Goat Production and Utilization के संयुक्त तत्वावधान में 'भेड़ एवं बकरियों की उत्पादकता बढ़ाने के लिए वर्तमान परिदृष्य एवं भविष्य की रणनीतियो' पर सम्यक विचार हेतु आगामी 14 से 16 फरवरी, 2019 तक एक राष्ट्रीय संगोष्ठी का आयोजन किया जा रहा है।

बकरियों को गरीब आदमी के लिए सबसे लाभकारी पशु माना जाता है। समाज के सर्वाधिक गरीब वर्गो की आजीविका में बकरियों का महत्वपमर्ण स्थान है। यह खुशी की बात है कि आयोजकों ने ग्रमीण समाज के कमजोर वर्गो की सामाजिक-आर्थिक स्थिति में सुधार के उद्देश्य से एक बहुत ही प्रासंगिक विषय को संगोष्ठी का केन्द्रीय विषय बनाया है। आशा है, संगोष्ठी के वैचारिक निष्कर्ष भेड़ और बकरी प्रजाति के विकास से संबधित कार्यक्रमों और नीतियों को भी मूर्त रूप देने में मदद करेगें ।

मैं इस राष्ट्रीय संगोष्ठी की सफलता की शुभकामना करता हूँ।

(लाल जी टंडन)

Message

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14-16 Feb 2019

Message

मुख्य मंत्री
बिहार

पटना
दिनांकः-02.02.2019

संदेश

यह प्रसन्नता की बात है कि Bihar Animal Sciences University, Patna एवं Indian Society for Sheep and Goat Production and Utilization के संयुक्त तत्वावधान में "Current Scenario and Future Strategies for Augmenting Productivity of Small Ruminants" विषय पर एक तीन दिवसीय राष्ट्रीय विज्ञानिक विचार संगोष्ठी एवं वार्षिक सम्मेलन का आयोजन दिनांक 14 से 16 फरवरी 2019 तक बिहार पशु विज्ञान विश्वविद्यालय, पटना में किया जा रहा है। इस अवसर पर एक स्मारिका का प्रकाशन भी प्रस्तावित है ।

कृषि राज्य की अर्थव्यवस्था का मेरूदण्ड है। राज्य की अधिकतर जनसंख्या ग्रामीण क्षेत्रों में निवास करती है और लगभग 76 प्रतिशत जनसंख्या कृषि एवं पशुपालन से संबंधी कार्यों से जुड़ी है। राज्य सरकार कृषि रोड मैप के माध्यम से गाय एवं भैंसों के अतिरिक्त बकरी एवं कुक्कुट पालन पर विशेष जोर देकर किसानों को खाद्य एवं पोषण सुरक्षा के साथ-साथ उनकी आय में वृद्धि कर खुशहाल बनाने के लिए चिंतित, प्रयासरत एवं दृढ़ संकल्पित है । मुझे विश्वास है कि तीन दिवसीय कार्यक्रम में हमारे राज्य के कृषकगण भाग लेकर लाभान्वित होंगे जिससे उन्हें गाय पालन, भैंस पालन, बकरी पालन एवं कुक्कुट पालन आदि की वैज्ञानिक विधि अपना कर आमदनी बढ़ाने मे सहायता मिलेगी। आशा है, स्मारिका में संकलित आंकड़े, जानकारियाँ एवं तथ्य किसानों एवं पशुपालकों के लिए ज्ञानवर्द्धक एवं कृषि एवं पशुपालन से संबंधित समस्याओं के निराकरण की दिशा में सार्थक सिद्ध होंगे।

आयोजन की सफलता, स्मारिका की उपयोगिता एवं किसानों के उज्जवल भविष्य हेतु मेरी शुभकामनाएँ।

(नीतीश कुमार)

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PATNA
14-16 Feb 2019

Sushil Kumar Modi
Deputy Chief Minister
Bihar

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0612-2674624(R)
0612-2217399(R)
0612-2217639(Fax)

Dated: 01/02/2019

संदेश

मुझे यह जानकर खुशी है कि बिहार पशु विज्ञान विश्वविद्यालय, पटना और Indian Society for Sheep and Goat Production and Utilization के प्रयास से "Current Scenario and Future Strategies for Augmenting Productivity of Small Ruminants" पर वैज्ञानिक विचार संगोष्ठी का आयोजन किया जा रहा है।

भेड़ एवं बकरियाँ मॉस, दुध एवं ऊन का उत्कृष्ट स्त्रोत है। बकरी पालन प्रायः सभी जलवायु में कम लागत, साधारण आवास, सामान्य रख-रखाव तथा पालन-पोषण के साथ संभव है। इन्ही कारणों से पशुधन में बकरी का एक विशेष स्थान है। उपरोक्त गुणों के आधार पर राष्ट्रपिता महात्मा गॉधी बकरी को 'गरीबों की गाय' कहा करते थे। बकरी पालन आजीविका एवं स्वरोजगार का एक प्रबल साधन है। साथ ही, यह किसानों एवं पशुपालकों के आय वृद्धि में सहायक हो सकता है।

यह बहुत खुशी की बात है कि इस संगोष्ठी के आयोजकों ने किसानों एवं गरीबों से जुड़े हुए एक प्रासंगिक विषय पर परिचर्चा का फैसला किया है। उम्मीद है, इस संगोष्ठी में भेड़ एवं बकरी पालन को और ज्यादा लाभप्रद एवं आय बढ़ाने वाला व्यवसाय बनाने के लिए किसानोपयोगी सुझावों पर चर्चा होगी।

मैं इस संगोष्ठी की अपार सफलता हेतु शुभकामनाएँ देता हूँ।

(सुशील कुमार मोदी)

विजय कुमार चौधरी
अध्यक्ष
बिहार विधान सभा

सत्यमेव जयते

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संदेश

प्रसन्नता की बात है कि बिहार पशु विज्ञान विश्वविद्यालय,पटना और Indian Society for Sheep and Goat Production and Utilization के संयुक्त तत्वावधान में दिनांक 14-16 फरवरी, 2019 को सम्मेलन का आयोजन किया जा रहा है एवं इस अवसर पर एक स्मारिका का भी प्रकाशन किया जा रहा है।

सम्मेलन की सफलता की कामना करते हुए मैं स्मारिका के प्रकाशक मंडल को अपनी शुभकामनाएँ प्रेषित करता हूँ।

(विजय कुमार चौधरी)

पशुपति कुमार पारस
मंत्री
पशु एवं मत्स्य संसाधन विभाग
बिहार,पटना

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दिनांकः 11/02/19

संदेश

यह जानकर मुझे बहुत खुशी है कि Indian Society for Sheep and Goat Production and Utilization का वार्षिक सम्मेलन एवं वैज्ञानिक विचार संगोष्ठी बिहार पशु विज्ञान विश्वविद्यालय, पटना में 14-16 फरवरी, 2019 को आयोजित हो रही है।

इस वैज्ञानिक विचार संगोष्ठी का शीर्षक "Current Scenario and Future Strategies for Augmenting Productivity of Small Ruminants"देखकर मुझे अपार प्रसन्नता हो रही है कि समाज के गरीब, सीमांत किसानों एवं पशुपालकों के कल्याण एवं उत्थान के लिए नव निर्मित बिहार पशु विज्ञान विश्वविद्यालय, पटना प्रयासरत है।

बिहार के विकास में पशुपालन का योगदान काफी महत्वपूर्ण है। अधिकांश लोगों की आजीविका कृषि एव पशुपालन संबंधित गतिविधियों पर निर्भर करता है।पशुपालन एवं उसके सहयोगी गतिविधियों से हमारे किसान भाईयों को नियमित आय प्राप्त होती है, जो उनकी आजीविका में महत्वपूर्ण है। वर्तमान में बिहार सरकार पशुपालन की गतिविधियों में दुग्ध उत्पादन, बकरीपालन, कुक्कुटपालन एवं अण्डा उत्पादन पर विशेष ध्यान दे रही है। फलस्वरूप उनके आजीविका एवं आय वृ) में पशुपालन सहायक सि) हो रहा है।

मुझे पूर्ण विश्वास है कि यह वैज्ञानिक विचार संगोष्ठी पशुपालक भाईयों के लिए अत्यंत लाभकारी होगा और राज्य को पशुपालन एवं संबंधित क्षेत्र में देश में महत्वपूर्ण स्थान प्राप्त करने में विशेष प्रदान करेगा।

इस संगोष्ठी की सफलता के लिए मेरी हार्दिक शुभकामनायें है।

(पशुपति कुमार पारस)

Message

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PATNA
14-16 Feb 2019

Message

डॉ. प्रेम कुमार
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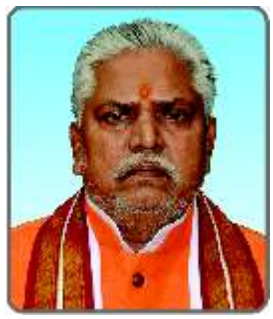

संदेश

यह बहुत खुशी की बात है बिहार पशु विज्ञान विश्वविद्यालय,पटना और Indian Society for Sheep and Goat Production and Utilization के संयुक्त तत्वावधान में भेड़ बकरियों के उत्पादकता बढ़ाने के लिए वर्तमान, परिदृश्य एवं भविष्य की रणनीतियों पर दिनांक 14-16 फरवरी, 2019 तक एक राष्ट्रीय संगोष्ठी का आयोजन किया जा रहा है।

बकरी पशुपालन में उपयोग होने वाले सबसे शुरूआती जानवरों में से एक है, जो मांस एवं दूध प्रदान करता है।भेड़ एवं बकरी पालन ग्रामीण क्षेत्रों में आबादी के एक बड़े हिस्से के लिए महत्वपूर्ण आर्थिक सहायता प्रदान करता है। बकरी को गरीब आदमी के गाय के रूप में जाना जाता है । बकरी का दूध औषधीय गुणों का वहन करता है एवं मानव स्वास्थ्य पर इसके लाभकारी प्रभावों के लिए जाना जाता है। हाल के वर्षों के दौरान बकरी के मांस की मांग बढ़ रही है। इन सभी कारणों से बकरियॉ, गरीब एवं सीमांत किसानों एवं पशुपालकों की आय वृद्धि में लाभकारी साबित हो सकते हैं।

इस संगोष्ठी में आये देश-विदेश के वैज्ञानिकों के द्वारा भेंड़ एवं बकरी पालन के विभिन्न पहलुओं पर वैज्ञानिक रूप से विचार-विमर्श किया जायेगा। मुझे यकीन है कि तीन दिवसीय संगोष्ठी से राज्य एवं देश के किसानों को भेड़ एवं बकरी की उत्पादकता बढ़ाने हेतु विशेष बल मिलेगा।

मैं इस संगोष्ठी की सफलता की कामना करता हूँ।

(डॉ. प्रेम कुमार)।

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कृषि वैज्ञानिक चयन मंडल
कृषि अनुसन्धान और शिक्षा विभाग, भारत सरकार
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सत्यमेव जयते

प्रोफ. (डॉ.) ए. के. श्रीवास्तव
अध्यक्ष
Prof. (Dr.) A.K. SRIVASTAVA
CHAIRMAN

सन्दर्भ सं. / Ref. No. PPS/CHAIRMAN/2019
दिनांक / Dated 23.01.2019

MESSAGE

I am happy to know that Bihar Animal Sciences University, Patna in collaboration with Indian Society of Sheep and Goat Production and Utilization is organizing a national seminar on "Current Scenario and Future Strategies for Augmenting Productivity of Small Ruminants" on February 14-16, 2019. Small ruminants play a pivotal role in the economy of socially marginalized population and contribute to the livelihood of millions of poor by offering immense opportunities and potential for enhancing income and employment in the country.

Sheep and goats are excellent source of meat, milk, fiber and leather, which are in high demand for various reasons. India occupies first position in terms of goat population and milk production. Chevon is the most preferred and widely consumed red meat in the country. Further, goat milk carries medicinal properties and known for its beneficial effects on human health. It can also be effectively utilized to produce some the best dairy products, which have high demand in the National and International markets. However, it is concerning that but the productivity of the small ruminants in India are considerably low. As such, now it is imperative to analyse, discuss and evolve strategies for augmenting productivity of small ruminants to harness the full potential of this sector.

I congratulate the organizers for selecting a very relevant theme and extend my warm greetings and felicitations to all those associated with the seminar.

I wish all success to this seminar.

(A.K. Srivastava)

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एवं गो-अनुसंधान संस्थान, मथुरा - 281001

Deen Dayal Upadhyaya
Veterinary & Animal Sciences University (DUVASU), Mathura-281001

Message

I am pleased to know that a national seminar is being organized during 14-16 February, 2018 in collaboration Bihar Animal Sciences University, Patna and Indian Society for Goat Meat Production and Utilization to discuss and suggest strategies for augmenting productivity of sheep and goat in India.

India has more than 200 million of small ruminant population of which sheep account for about one-third whereas remaining two-third is of goat. It is pertinent to understand that small ruminants play a very important role in providing livelihood options to millions of landless labourers, marginal, semi-marginal and small farmers who are constrained with economic resources. Small ruminants help them effectively manage their economic needs. There is tremendous demand for the products, which are obtained from the small ruminants. Meat, fiber and leathers obtained from small ruminants are widely preferred for various reasons. However, most of the species of small ruminants perform below their potentials. Scientific practices and improved production technologies are rarely used in the production of small ruminants. Dearth of information among the rearers due to weak association with extension services, poor institutional support and linkages, flock size, unscientific feeding, housing management are some of the factors which are reported to constrain the productivity of small ruminants.

I am extremely happy to find that the seminar intends to discuss, share and elicit the factors, which have strong bearing on the productivity of small ruminants. I am sure that the conference will provide valuable insights and come up with wonderful recommendations to prioritize and strengthen policies and research and development in this sector.

I extend my heartfelt congratulations to the organizers and wish this seminar an unprecedented success.

Dated : Feb 07, 2019

(K.M.L. Pathak)

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BIHAR ANIMAL SCIENCES UNIVERSITY
BIHAR VETERINARY COLLEGE CAMPUS, PATNA-800014

Dr. Rameshwar Singh
Vice-Chancellor

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Message

It is indeed a matter of privilege for Bihar Animal Sciences Universityto host the Annual Conference of 'Indian Society of Sheep and Goat Production and Utilization'and 'National Seminar on Current Scenario and Future Strategies for Augmenting Productivity of Small Ruminants'from February 14-16, 2019.

In Bihar, Animal husbandry is a core sector of State economy. It has enormous potential for development of rural economy, addressing rural unemployment and bridging the increasing gap between poor rural and affluent urban society. Among all species of farm animals, goats have the widest ecological range and have been poor people's most reliable livelihood resource since their domestication during Neolithic Revolution.Bihar stands fifth in goat population in the country. *Chevon* (goat meat) is most preferred and widely consumed meat in the country. Since ancient times goat milk has traditionally been known for its medicinal properties and has recently gained importance in human health due to its proximity to human milk for easy digestibility and its all-round health promoting traits. I hope the deliberations in this Seminar will give a new direction to ongoing research in field of genomics, production and productivity, processing and value addition, and innovations in livestock product utilization.

This Conference has great scope in elaborating and collaborating the ideas between scientists, professors, students and industry personnel in strengthening the small ruminant segment. I extend heartiest welcome to the delegates and invited experts to Patliputra.I hope the conference will give good exposure to our students and young faculty. The deliberations will lead to concrete recommendations to help identify research and policy issues to be further taken up by researchers, governments and development agencies.
I wish the Conference a great success

Dr. Rameshwar Singh

Message

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डॉ. जे.के. जेना
उप महानिदेशक (मत्स्य विज्ञान)
Dr J.K. Jena
Deputy Director General (Fisheries Science) & Animal Science

Message

I am happy to learn that the Bihar Animal Sciences University, Patna in collaboration with Indian Society for Sheep and Goat Production and Utilization is organizing a National Seminar on "Current Scenario and Future Strategies for Augmenting Productivity of Small Ruminants" at Patna during February 14-16, 2019.

Sheep and Goat plays an important role in providing source of livelihood to poor farmers, both in the plains and hilly regions of our country. Out of the total meat production of 7.4 million tonnes in the country, the contribution of goats and sheep is to the tune of 19% and 8%, respectively. Majority of the flocks being migratory, the sector is looking for technology infusion in terms of quality germplasm to improve productivity of field flocks, improving availability of feed resources like pastures and fodders trees on migratory routes and health coverage to improve productivity. Developing value chains for various agro-climatic regions is another important aspect to ensure the desired returns to the animal keepers.

I sincerely believe that the National Seminar will provide an appropriate forum to deliberate all relevant aspects by the players involved and come out with pragmatic roadmap for overall improvement of the sector.

I wish this Seminar a great success.

24/1/2019
(J.K. Jena)

भा.कृ.अ.प.- केन्द्रीय बकरी अनुसंधान संस्थान
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डा. मनमोहन सिंह चौहान
निदेशक
Dr. M.S. Chauhan
DIRECTOR

From the Desk of President

ISSGPU plays an important role in fast forwarding the research and development in small ruminant production and utilization of various products arising from them from the date of its inception.

Small ruminant production has brought the attention of policy makers due to its capability in mitigating the poverty in the country. To support that the country has number of goat and sheep breeds for different agro climatic regions. Scientific advancements are being supported through AICRP's for improvement and conservation in their breeding tract.

As all of us know that small ruminant meat production in the country is highly preferred and the demand is increasing rapidly. In particular, demand for goat meat have also increased both in quantitative and value terms. Major chunk of all meat including meat from sheep and goats in India is consumed in the form of fresh meat and only 1-2% of total meat is further processed. The unique properties in goat milk like naturally micronized fat, optimum amount of lactose, short and medium chain fatty acids and lower level of alpha S1 casein are indeed an advantage to be tapped to create a strong consumer clientele for goat's milk.

India has world's strongest consumer base and therefore has the potential for goat farming, for milk, meat and sin and fibre. The growing demand to feed a billion and above human population to meet out the energy and protein requirements of high quality can be a boon instead, to identify a consumer and market base for goat based products.

The National seminar to be held at this Bihar Animal Sciences University, Patna shall provide an opportunity and platform for interaction to all major stakeholders involved in small ruminant production and processing. It is expected that it will work out the strategies for healthy production, safe and quality products for both, domestic consumers as well as for exports.

On my behalf and on behalf of the organising committee of this seminar and members of ISSGPU, I extend my heart felt special thanks to the sponsors, collaborators and delegates.

I wish the deliberation in the National Seminar a grand success.

(M S Chauhan)
President ISSGPU

Message

भा.कृ.अनु.प.-केन्द्रीय भेड़ एवं ऊन अनुसंधान संस्थान
अविकानगर (तह. मालपुरा, जिला-टोंक) वाया-जयपुर, राजस्थान (भारत) 304501
ICAR-CENTRAL SHEEP & WOOL RESEARCH INSTITUTE
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डॉ. अरुण कुमार तोमर
निदेशक
Dr. Arun Kumar Tomar
Director (Act.)

ICAR-Central Sheep & Wool Research Institute
Avikanagar, Rajasthan-304501

Dated: 31/08/2018

Message

Dear Colleagues,

I am very happy to share with you that Indian Society for Sheep and Goat Production and Utilization (ISSGPU) is organizing a National Seminar on 'Improvement of Small Ruminant Production System for Livelihood Security' in collaboration with Bihar Animal Sciences University, Patnaon 8-9 Feb, 2018 at Patna, Bihar. This seminar will provide a platform to scientists, research workers, students, livestock farmers, entrepreneurs/industrialists, management personnel, extension workers, planners, decision makers, NGOs and other stake holders and related agencies from all over the country to share their experiences and deliberate on issues related to small ruminant production.

Small ruminants are the key component among the livestock sector that plays a significant role in sustainable livelihood of landless and small holder farmers in India. The total sheep in the country is 65.06 million that accounts for nearly 12.7% of total livestock population in India. The value of output from the livestock sector is 28.6% of total value of output from agricultural and allied sectors and sheep and goat constitute a significant proportion of that. They are the most adapted species for efficient utilization and conversion of sparse and poor-quality vegetation into meat, wool, milk, and manure, etc. However, the productivity of our indigenous sheep and goats under the prevailing production system are of major concern to meet the growing demands for different animal produces in the country. There is a need to bring required changes in their rearing system to intensify their production performances through awareness among farmers for adoption of new technologies. The coming seminar will certainly present an opportunity to the scientists, academicians, planners, entrepreneurs and farmers concerned with small ruminant production to devise suitable strategies for augmentation of small ruminant productivity. thus, improving the livelihood security of the farmers.

I extend my sincere thanks to all associated with the organization of the National Seminar of ISSGPU on behalf of Organizing Committee.

I convey my best wishes for the success of the seminar.

(A.K. Tomar)

ISSGPU 19 PATNA 14-16 Feb 2019

Dipak Kumar Singh
I.A.S.
Principal Secretary
Labour Resources Department
Government of Bihar

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MESSAGE

I am delighted to know that a National Seminar on 'Current Scenario and Future Strategies for Augmenting Productivity of Small Ruminants" is being organized on 14 th-16 th February, 2019 by the Bihar Animal Sciences University, Patna in collaboration with Indian Society significant important in the livelihood of some of the poorest segments of our society and play an important role in providing incomeand nutritional security to millions of poor households in the country.

What is heartening to note is that the organizers have very meticulously chosen a very pertinent theme that has sustantial significance for improving the socio- economic status of numerous vulnerable sections of society including resources poor nomadic population. I expect that the outcome of the seminar would help shaping the programmes and policies pertaining to sheep pertaining to sheep and goat development and promoting goat farming amongst the youth with technical skills.

I am sure the seminar will bring forth well-conceived recommendations to develop and implement R&D endeavours considering small ruminants as the vehicles of economic growth and social change of the small ruminant producers.

I wish all success to this seminar.

9/2/19

(Dipak Kumar Singh)

Message

डॉ. एन विजय लक्ष्मी
भा.प्र.से., पी.एच.डी.
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पशु एवं मत्स्य संसाधन विभाग
fcgkj ljdkj
Dept. of Animal & Fisheries Resources
Govt. of Bihar

fnukd% 05@02@2019

MESSAGE

I am happy to learn that Bihar Animal Sciences University, Patna and Indian Society for Sheep and Goat Production and Utilization are jointly organizing a National Seminar on Current Scenario and Future Strategies for Augmenting Productivity of Small Ruminants during 14th-16th February, 2019 in Patna Bihar.

Small ruminants, particularly goats are reared for their unique meat quality and goat meat is the only red meat which is consumed by all the communities. Besides meat, goats provide products like milk, skin, and fibre, which have high market demand. Goats are important component of rural economy, particularly in the marginal areas like arid, semi-aridand mountainous regions sheep and goats play a vital role in the sustenance of rural economy. Their contribution in ascertaining nutritional security has been phenomenal. However, the productivity of small ruminants under the prevailing extensive system is substantially low.

It is, therefore, imperative to promote intensive andsemi-intensive systems of small ruminant production by adopting improved production technologies and practices for commercial production to harness their vast untapped potential that put forth considerable economic opportunities due to increasing demand for their meat and as well as other products.

I am sure that the ensuing seminar will analyse, identify and prescribe the strategies to address the constraints that limit the productivity of sheep and goats with objective to enhance the profitability and income of the sheep and goat farmers of the state.

I extend my heartiest greetings and best wishes to all who are associated with this seminar.

(N. Vijayalakshmi)

बिनोद सिंह गुंजियाल
भा.प्र.से.
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पशु एवं मत्स्य संसाधन विभाग
fcgkj ljdkj
Dept. of Animal & Fisheries Resources
Govt. of Bihar

fnukd% 05@02@2019

Message

I am extremely happy that Bihar Animal Sciences University, Patna and Indian Society for Sheep and Goat Production and Utilization are together organizing a National Seminar on "Current Scenario and Future Strategies for Augmenting Productivity of Small Ruminants" during 14th - 16th February, 2019 in Patna Bihar.

Small ruminants, especially goats occupy considerable importance in the household economy of many marginalized and weaker sections of the society in India. They are instant source of income and provide security in the situation of risk and uncertainties. It is, however, concerning that productivities of small ruminants are very low. A number of factors are responsible for low productivity. Low adoption of technology and numerous biotic and abiotic constraints including dominance of poor quality breeds, poor animal health and feed and fodder scarcity lead to poor performance in small ruminant production.

I appreciate the efforts of organizers who have meticulously chosen a very relevant topic and invited a number of eminent scientists, academicians, policy makers, entrepreneurs and farmers to deduce various issues that may guide and shape the future programs pertaining to small ruminant sector.

I wish this seminar a grand success.

(Vinod Singh Gunjiyal)

Message

Dr. Satish Kumar
Secretary, ISSGPU &
Principal Scientist ABTC, ICAR-NDRI Karnal

National Seminar
on
Current Scenario and Future
Strategies for Augmenting
Productivity of Small Ruminants

From the desk of Secretary

Dear Delegates,

I am glad to enlighten you that the Indian Society for sheep and Goat Production and Utilization (ISSGPU) is organizing a three days National Seminar on 'Current scenario and future strategies for augmenting productivity of small ruminants' in collaboration with Bihar Animal Sciences University, Patna, ICAR-Central Sheep and Wool Research Institute, ICAR-Central Institute for Research on Goats on November 14-16, 2019. The ISSGPU is a registered society of researchers and professionals, which is engaged in the research and development of sheep, goat and rabbit production and utilization in the country. The society supports the spread of latest research achievements, developments and innovative technologies for enhancing production of small ruminants through conducting national seminar, symposium and interactive meets in different parts of the country. This seminar on current aspect will provide better platform to the Scientists, researchers, students, livestock keepers, entrepreneurs, extension workers, policy makers, NGO, stakeholders, Bankers and related agencies to share their experiences on the different aspects associated with the production and utilization of the products of sheep, goat and rabbit in the country.

Sheep and goat is the most important source of income of the landless and poor peoples of India. These species can thrive in adverse climatic conditions and ability to convert poor feed resources into valuable products. Most of the peoples are solely depend on the sheep and goat production particularly in arid and semi-arid region of the country. The livestock keepers other states like Bihar, Jharkhand, and Orissa is also rearing sheep and goat, which is an important and vital sources of their livelihood. The major concern of the seminar is to discuss the various issues and strategies for improving the productivity and better utilization of the wool, meat, milk, fibre and manure of these species. There is an urgent need to use and disseminate the latest technologies in farm and field conditions through stakeholders and entrepreneurs. I sincerely hope that the recommendations emerged through this seminar will be helpful to the research organization and policy makers to initiate and formulate innovative research projects in coming years.

On the behalf of Secretary of National Seminar and all life members of the society, I am highly thankful to the ICAR and other agencies for providing funds for organizing this seminar. I extend warm welcome of all the delegates and sincere thanks to the organizer for conducting this seminar.

I convey my best wishes for grand success of the seminar.

(Satish Kumar)

ISSGPU 19 PATNA 14-16 Feb 2019

बिहार पशु विज्ञान विश्वविद्यालय
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निदेशक शोध
Dr. Ravindra Kumar
Director Research

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पत्रांक / D.O. No. .....

दिनांक / Date 09.02.2019

Message

It is a great privilege to be organizing secretary of the 27th Annual Convention and National Seminar on "Current Scenario and Future Strategies for Augmenting Productivity of Small Ruminants" organized at Bihar Animal Sciences University, Patna during February 14-16, 2019.I convey sincere thanks to Indian Society of Sheep and Goat Production and Utilization for choosing the Bihar, the intellectual land and promising land of second green revolution as a venue.

Bihar's livestock sector is crucial not only in terms of its contribution to rural income, but also for the section of the population to which this income goes. Bihar's livestock sector accounted for approximately one-quarter of the total value of agricultural output. Livestock activity is concentrated among landless households and those with marginal holdings of less than 1 hectare of land. Sheep and goats tend to be even more concentrated among landless and marginal rural households.

The demand for meat, milk and fiber is increasing progressively and expected to further rise in future in view of sizable increase in per capita income and health consciousness of people. Worldwide consumers are preferring products that are "clean, green and ethical". As such goat producers are shifting to husbandry practices that do not compromise the welfare of animals. Medicinal properties of goat milk increased the interest of society to use it as therapeutic health food.

I extend the most cordial welcome to the dignitaries and all the delegates who have come length and breadth of the country to attend this conference. Further, I also greatly acknowledge the tremendous efforts put forth by my colleagues, conveners and members of various committees to make this event memorable. I also express my sincere gratitude to the Hon'ble Vice Chancellor, Bihar Animal Sciences University, for all the support and guidance to make this event successful.

9/2/19

(Ravindra Kumar)

National Seminar
On
"Current Scenario and Future Strategies for Augmenting Productivity of Small Ruminants"
Bihar Animal Sciences University, Patna
February. 14-16, 2019

Organizing Committee

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	• **Dr. Ramesh Tiwary**(Surgery)

Indian Society for Sheep and Goat Production and Utilization

The ISSGPU is an active society with 1054 life members of professionals, researchers, Veterinarians and policy makers engaged in the research & development of sheep, goat and rabbit production and utilization in the country. The society supports the spread of the latest research achievements and developments for enhancing production from these species of livestock. Not only Indian citizens but also scientists from abroad are also members of this society. It is a non-pro? t making organization.

The idea of forming ISSGPUwas conceived in the year 1978. It was launched with the patronage of the research workers of the Central Sheep and Wool Research Institute (CSWRI), teachers of the college of veterinary science and the o? cers of Rajasthan state sheep and wool department. The ISSGPU was registered in January 1982 and its registration number is 474/81-82 dated 04.01.1982. The o? ce of the society is located at Central Sheep and Wool Research Institute, Avikanagar-304 501, Rajasthan. The ISSGPU was granted the approval under section 80 G (5) of the IT Act by the Commissioner of the Income Tax, Kota and registered the society under section 12AA of IT Act. The registration number of the society is IT /ITO (T) 12 AA/KTAS/2009-10 dated 12.06.2009.

The ISSGPU since 1995 is regularly publishing each year two issues of the "Indian Journal of Small Ruminants" in the month of April and October. The I.S.S.N. Number of Print Version is 0971-9857 and for Online Version is 0973-9718.

Aims and Objectives

1. The advancement of sheep, goat and rabbit production and utilization (SGPU) in all aspects by dissemination and application of knowledge gained from research activities.
2. The provision of opportunities for exchange of knowledge and ideas through discussions and other means and for collaboration between persons interested in di? erent ? elds of sheep and goat production and utilization.
3. To organise conference, symposia, seminars, workshops and other periodical meetings.
4. To participate in meetings and conferences which may be held in India /abroad for discussing ma ancement of sheep and goat production and utilization.
5. To publish scienti? c and technical journals, policy papers, memoirs, monographs, bulletins, pamphlets, newsle
production and utilization.

6. To strengthen ? nances by subscription/membership/donation/grants etc. and to make necessary investments in order to promote the technical, scienti? c and developmental activities of the society.
7. To acquire by gift, purchase, lease or otherwise lands, buildings or other immovable property together with all rights appearing thereto. The property acquired by the society on its dissolution shall be transferred to a similar institution failing which it will vest in the government of India/ ICAR without payment of any compensation whatsoever.
8. To provide ? nancial and other assistance for education and research or development activities in the ? eld of sheep and goat production and utilization.
9. To a? liate or associate with other national and international organizations for furthering the interest of the society.
10. To perform such activities as may be necessary deemed ? t for a objectives of the society.

Indian Society for Sheep and Goat Production and Utilization

Patrons

R.M. Acharya

N.K. Bhattacharyya

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Deepak Patidar, Goat Farmer

BIHAR ANIMAL SCIENCES UNIVERSITY- AN OVERVIEW

Animal Husbandry sector plays a very important role in the economy of the state. One third of the rural economy is dependent on this sector. The sector contributes aboutone-? fth of the total rural income and creates large scale employment to women and workersbelonging to the marginalised section of the society. Moreover, availability of protein for human need, su? cient andincessant economic gain for rural people and employment for unemployed youthsdepend upon the multifaceted programmes of Animal Husbandry.

Impediments to dairy development are also numerous. Scarcity of feed and fodder manifests in nutritional de? ciency in animals, particularly in indigenous breeds. Feeding is primarily based on crop residues and bye-products. Animal grazing is being restricted due to changing land use pa ern. Weak institutions and institutional linkages, inadequate veterinary services, poor supply chains, lack of cold chain, inadequate processing centres and facilities, and many more problems continue to retard the pace and potential of dairy sector in Bihar.

Thus, to provide an enabling platform to ? sh farmers, livestock owners, scientists, academicians, animal health professional and entrepreneurs to converge and to bring synergy among the stakeholders, a formal proposal for establishment of *Bihar Animal Sciences University (BASU)* was made in "Agricultural Roadmap- 2012-2017" and as an accomplishment towards implementation of Agricultural Road Map- 2012,*Bihar Animal Sciences University (BASU)* has been established with its headquarters at Patna through an act of Bihar State, BASU Act No. 15 of 2016, which has been carved out of the Bihar Agricultural University as two of its constituent colleges at Patna viz. Bihar Veterinary College and Sanjay Gandhi Institute of Dairy Technology have been transferred to the BASU.

PRESENT:

Bihar Animal Sciences University (BASU) has been established with its headquarters at Patna through an act of Bihar State (BASU Act No. 15 of 2016, noti? ed in the Bihar Gaze on 29 August 2016). The new University has been carved out of the Bihar Agricultural University as two of its constituent colleges at Patna viz. Bihar Veterinary College and Sanjay Gandhi Institute of Dairy Technology have been transferred to the BASU, whereas a new College of Fisheries is to be established. To further expand the horizon of the University and strengthen the research and outreach, following research institutes, stations and substations are being transferred to BASU viz. Institute of Animal Health and Production, Patna, Exotic Ca Breeding Farm, Patna, Central Poultry Farm, Patna, Government Goat Breeding Farm, Purnea, Government Ca a and Government Bu? alo Farm, Sipaya (Gopalganj).

Mandate:

The territorial jurisdiction and responsibility of this University shall extend to the whole of the State of Bihar.The University may establish, operate, maintain and develop Teaching Centres, Educational Centres, Research and Experimental Centres, and Extension Education Training Centres in the ? eld of Veterinary, Animal Husbandry, Fishery, Poultry, Dairy Technology and allied subjects as may be required in various parts of the State, and shall be responsible for its management, development and operations.The University may work having collaboration in teaching and research programmes, multi-disciplinary approach and academic programmes with other Universities, including foreign Universities or reputed and approved institutes.

Bihar Animal Sciences University: In The Services Of People Of Bihar

Since inception BASU has adopted proactive multipronged approach to accelerate the functioning of its di? erent units. To give impetus to research, training and other related activities BASU has signed MoU with several institute of repute in the country. To improve ties between scientists and students MoU has been signed with Indian Veterinary Research Institute (IVRI), Izatnagar, National Diary Research Institute (NDRI), Karnal, Central Institute for Fishery Education (CIFE), Mumbai, Regional Centre for Eastern Region- ICAR (RCER-ICAR), CIFA Bhubaneswar, CIFRI Barrackpore, CIRB Hisar, Agriculture Skill council of India (ASCI), Hester Biosciences, Ahmedabad.

Directorate of Extension Education has been encouragedto strengthen its extension services to livestock farmers though extension departments of its constituent colleges. Animal health care experts have also been called to give hands on training to the faculty members of clinical departments and ? eld veterinarians.

• Organization of Camp – Vaccination Camp, Animal Health Camp, KisanGoshti, Diagnosis and Treatment Camp are being organized with the collaboration of di? erent departments of Bihar Veterinary College, Patna.

• Veterinary Hospital, Danapur has been adopted by this institute for regular vaccination and treatment of animals of local villages.

• BASU adopted 2 villages in Muza? arpur district as Poultry Gram. Supplied 1000 chicks, established a farmer's club. BASU is regularly transferring the technology to the farmers. Promotion of Backyard Poultry Farming through PSP running under the University.

• On Campus Training: The Veterinary College has started *short duration on-campus training programme* for livestock farmers and Veterinary o? cials on livestock entrepreneurship, Integrated Animal Nutrition, Integrated Animal husbandry management, Advancement in disease diagnostic technique etc. The department of Extension, Bihar Veterinary College, has organized 175 trainings for the farmers and bene? ted 4180 livestock

Patna conducted a certi?cate course on *"Animal Disaster Management"* for students of Bihar Veterinary College, Patna from 03.05.2018 to 08.05.2018 in which 23 students participated.

- Bihar Animal Sciences University organized three days Young Authors' Workshop from 12th -14th May, 2018. The expert guests invited for the conducting the workshop were Shri Hasan Javed Khan, Chief Scientist CSIR and Editor of digni?ed Science Reporter magazine, Shri Pradeep Sharma former editor of popular magazine VigyanPragati and Dr.JagdeepSaxena, editor of Kheti Magazine.
- Bihar Animal Sciences University organized three days workshop on "Hands on Training on Imaging Techniques for Diagnosis in Pet and Large Animals" from 28th to 30th May, 2018 for ?eld veterinarians and clinicians at TVCC, BVC, PG students and Veterinarians from Patna Zoo. Invited resource person was Prof (Dr). JitenderMohindroo, department of Surgery and Radiology, GADVASU.
- Bihar Animal Sciences University organized four days training on *"Management of Animals in Emergencies"* from 4-7th June, 2018.
- Bihar Animal Sciences University, Patna organized a one-day workshop on *"Training needs assessment for ?shery farmers of Bihar"* on 10th July, 2018.
- Bihar Animal Sciences University organized a one-day Workshop on Utility of Laser Therapy in Animal Practice on 26th July, 2018. The resource person for workshop was Dr. S. Yathiraj, former Dean, Veterinary College, Bengaluru.

Vision:

The University is focused on the human resource development in veterinary and animal sciences, dairy sciences, ?sheries and other allied sciences through quality teaching to undergraduate and post graduate studentsand research. We also focus on interactive learning processes for be ledge, practical skills of the students to cater the need of farmers and industries.Training of youth in the ?eld of animal and allied sciences is one of the key areas for the University.Exposure of the students to the institutions of national and international standards in veterinary and allied animal sciences is the prime focus of the university to generate competitive human resources in the sector.

- Colleges of Fishery Sciences has already start his ?rst batch.
- Centre of Animal Biotechnology will be established.
- Institute of Poultry Sciences will be started.
- Centre for animal disease diagnosis-cum-epidemiology is planned.
- Centre for Mastitis Control will be established.
- Establishment of Institute of higher education in veterinary and allied sciences.
- Establishment of Experimental Animal House Facility and Post-mortem Centre

- Establishment of Analytical Feed testing laboratory
- PashuVigyanKendras, KukkutVigyanKendras and Fodder development centre will be established in di? erent agro climatic zones of Bihar.
- Strengthening of regional stations with well-equippeddisease diagnostic unit facility, demonstration centre and training centre for livestock farmers will be taken up.
- Diploma courses in canine and feline medicines will be started.
- Diploma courses in radio imaging techniques and diagnostics will be started.
- Diploma courses in wild life management will be started.
- Certi? cate course in ? sh breeding and managementwill be started.
- Complete automation of Library services with implementation of Koha and e-Granthalya.
- e-Governance implementation, to ensure paper free smart administrative work will be taken up.
- State of the art modern veterinary hospital with indoor facility will be established.
- Modernization and mechanization of livestock farm complex will be done for be exposure and understanding of management by faculty, students and farmers.
- Infrastructure for indoor and outdoor games and cultural activities will be developed in the campus to organize and host national and international events.
- Construction of new hostels for boys and girls in the university campus to accommodate UG/PG students, Trainees, Farmers and working ladies.
- Establishment of primary health centre in the campus for health services to students and sta? .
- Establishment of robust and reliable database encompassing resources, outputs and ? eld practices to support quality of planning and implementation.
- Construction of new building blocks for Dairy Engineering, Dairy Microbiology and Dairy Chemistry departments in future.
- Establishment of a small dairy processing plant of 10,000 litres milk processing capacity to impart training to the students and generate resources for meeting day to day operational expenditures of the plant. It is expected that the plant will be established and operationalized soon.
- Establishment of Central Instrumentation Lab and Engineering Workshop with latest dairy and engineering equipment and machinery to impart teaching, hands-on training and quality assurance to comply with the All India Council of Technical education (AICTE) norms for obtaining AICTE approval.
- UG Teaching through Interactive lectures, introducing case studies in teaching,

farmers 1179 veterinary o? cers/Subject Ma Specialists (SMS) /Project Coordinators (PCs) through training sponsored by DAHD, ATMA, BAMETI & ICAR Regional Complex.

- Certi? cate Course in Arti? cial Insemination: BASU Patna is organizing full time residential course Arti? cial Insemination certi? cate course (AI) of six months duration for unemployed youths.
- Bihar Animal Sciences University organized a one-day Workshop on *Role of Animal Feed Industry in Farmers Welfare* on 18th July, 2018.
- Bihar Animal Sciences University, Patna organized a Master Trainer's programmes collaborated by Agriculture Skill Council of India (ASCI). The master trainers are expected to carry out 'Training of Trainers' programme in collaboration with ASCI and Bihar Skill Development Mission, Government of Bihar.
- Bihar Animal Sciences University, Patna adopted two villages named ChakHelal and Mirzapur of Muza? arpur district under AdarshMurgi Gram Yojna.
- Bihar Animal Sciences University, Patna organized a “National Conference on Livelihood and Food Security” (LFS 27th-28th Jan 2018).
- Bihar Animal Sciences University, Patna organized a Dog Show –cum-competition on 25.02.2018 at Bihar Veterinary College Ground, Patna. In this Dog Show –cum-competition, 105 Pet owners registered their Dogs.
- Bihar Animal Sciences University, Patna organized a “National Conference of Agricultural Librarians and Users Community (NCALUC-2018) on Re-Engineering of Agricultural Libraries and Emerging Technologies: Challenges and Opportunities” (4th -5th September 2018).
- Bihar Animal Sciences University, Patna organized a “Biennial Conference of Animal Nutrition Association (ANACON-2018) on Reorienting Animal Nutrition Research in the perspective of Farmer's Welfare (19-21 Nov. 2018).
- Bihar Animal Sciences University, Patna organized a “Annual Convention cum conference of Indian Associationof Veterinary Microbiologists, Immunologists and Specialists in Infectious Diseases on Scienti? c and Technological Innovation In Animal Healthcare For Be Production and Trade (4-6 Feb. 2019).
- BASU conducted an ATMA sponsored training programme on Integrated Animal Husbandry from 09.03.2018 to 13.03.2018. A total of 30 progressive farmers participated in the training programme on integrated livestock farming.
- Bihar Animal Sciences University, Patna organized a Training Programme on *Basic Statistical Computing Procedures for Analysis of Experimental Data* from 15th–17th March, 2018 in collaboration with Indian Agricultural Statistics Research Institute, New Delhi.
- Veterinary Emergency Response Unit (VERU) of Bihar Animal Sciences University,

Student assignments and classroom presentation, in-plant and on-site training to enhance skill and understanding, Entrepreneurial a and Technocratic and managerial ability of students.

- Equipping of various undergraduate laboratories in the department of Dairy Technology, Engineering, Microbiology, Chemistry, Economics, Statistics and Management and Dairy Extension with necessary equipment and tools to undertake and strengthen research in dairy technology.
- Undertake inter-institutional and multi-disciplinary research in the ? eld of milk production and dairy technology like
  - study of value chain in dairy milk production
  - se priorities for dairy development in the state
  - new market arrangements like contract farming in milk production vis-a-vis dairy cooperative societies
  - development of new products, processes and methods pertaining to dairy technology
  - application of biotechnology in dairy sector
  - enhancing keeping quality and storage of milk and milk products, etc.

BIHAR VETERINARY COLLEGE, PATNA

Bihar Veterinary College, Patna, the 5th oldest Veterinary College in undivided India was founded on 2nd April, 1927 by Sir Henry Wheeler, the then Governor of Bihar & Orissa. The buildings were completed, laboratories were equipped and teaching & professional sta? joined the alma mater in 1930. However, the college started functioning *w.e.f.* 7th April, 1927. The College made tremendous progress under the guidance and supervision of Dr. R. T. Davis, the ? rst Principal of this historic College. During the post-independence period, Bihar Veterinary College developed to its full capacity and occupied a prestigious status associated

with strong academic base for teaching and research in the ? eld of Veterinary Science and Animal Husbandry as well as advanced Veterinary clinical services to the society. This institution acquired world-wide recognition for Human Resource Development through excellent teaching by quali? ed, experienced and commi faculty members; providing quality services to the farmers; strong clinical and para-clinical setup; well organized livestock farms as well as research stations and other ancillary facilities. One of the best Tharparkar herds, Central Poultry Farm and Livestock Research Station in its vicinity under one administrative and ? nancial control contributed signi? cantly in a the objectives of this institution. Bihar Veterinary College, Patna, for a long time, provided quality veterinary education and training not only to the candidates from Bihar and Orissa but also from several other states (U.P., Meghalaya, Mizoram, Tripura, Jammu & Kashmir, Assam, Himachal Pradesh etc.) of the country as well as from developing countries like Nepal, Bhutan, Afganistan, Iran, Malasiya etc. It can be mentioned with proud that Dr. C. M. Singh, Dr. B. S. Rajya, Dr. G. C. Mohanty, Dr. O.N. Singh, Prof. A. Ahmad, Dr. H. R. Mishra, Dr. R. B. Prasad, Dr. V. S. Pandey, Dr. D. V. Singh, Dr. G. Biswal, Dr. D. C. Nayak etc. are /were the gli alumni of this alma mater.

In the beginning (1930-1949), a three-year diploma course was started awarding G.B.V.C. (Graduate of Bihar Veterinary College) Diploma. Keeping pace with the advancement of Science & Technology, four-year degree course awarding the degree of B.V.Sc. & A.H. was started in 1949. An emergency Diploma-Shift-Degree course was introduced in the year 1954-55. The professional competency of diploma holders was also updated by subjecting them to “Condensed degree course” of two years and awarding B.V.Sc.& A.H. degree. The ? rst batch of regular degree holders, admi in 1949, came out in 1953 and became one of the stake holders of the Livestock & Poultry Resources of India in general and Bihar and its neighbouring states in particular. For the award of diploma or degree, the Bihar Veterinary College, had been a? liated to di? erent Universities of the state like Bihar University, Magadh University etc. The P.G. programme in di? erent subjects of Veterinary Science and Animal Husbandry was started in 1960.

Under the provisions made through enforcement of Bihar Agricultural University Act (1971), the Bihar Veterinary College, Patna became one of the pioneer constituent colleges of Rajendra Agricultural University, Pusa, Bihar in 1971 and altogether 14 departments of this college started functioning under Agricultural University System. With the development of Bihar Agricultural University at Sabour, Bhagalpur on 5th August, 2010, Bihar Veterinary College, Patna became its one of the constituent colleges. On 29th August 2016, Bihar Animal Sciences University, Patna was noti? ed by the Govt. of Bihar as per the provisions of Bihar Animal Sciences University Act, 2016 vide Gaze noti? cation no. 699 and the heritage status

of Bihar Veterinary College, Patna was restored. The College with its 17 well equipped departments along with a modern Veterinary Clinical Complex and the Composite Livestock Farm became a pioneer constituent College of the youngest and progressive Veterinary University of the Country.

SANJAY GANDHI INSTITUTE OF DAIRY TECHNOLOGY, PATNA

Sanjay Gandhi Institute of Dairy Technology, Patna is a constituent college of Bihar Animal Sciences University, Patna. The institute conducts teaching, research and extension in the area of dairy technology and runs a four - year degree program called Bachelor of Dairy Technology (B. Tech. D.T.). From the year 2017, post graduate program has also been started in the Department of Dairy Technology. The institute has adopted the course curricula as per the recommendation of the Deans' Commi constituted by the ICAR, New Delhi and presently the courses are o? ered as per the 5th Deans' Commi of ICAR.

Mandate:

- To train personnel in dairy technology and dairy husbandry in order to handle dairy development programs in the state of Bihar.
- To provide short term training to dairy farmers, dairy entrepreneurs and dairy technicians as and when required.
- To conduct under graduate and post graduate programs in the selected areas of dairy science as per the requirement of the state.
- To carry out research in collaboration with related disciplines on various aspects of dairy science and technology.
- To disseminate the scienti? c knowledge in relation to milk and milk products through extension education programs.

Departments of SGIDT, Patna

1. Department of Dairy Chemistry

2. Department of Dairy Economics and Business Management
3. Department of Dairy Engineering
4. Department of Dairy Microbiology
5. Department of Dairy Technology
6. Department of Dairy Extension
7. Department of Dairy Animal Husbandry

COLLEGE OF FISHERIES, KISHANGANJ

The College of Fisheries was incorporated in the Bihar Animal Sciences University Act as one of it's constituent college. It is located in the campus of Dr. Kalam College of Agriculture at Kishanganj. The State Government has approved creation of 270 new posts including 85 posts for Teaching faculty and 185 non-teaching positions. Hon'ble Chief Minister of Bihar Shri Nitish Kumar formally announced the start of ? rst academic session of this college on 29th August, 2018 at Patna.

The State of Bihar in particular has vast potential for ? sheries development. While working on Transformation of Agriculture through comprehensive scheme of Agriculture Road Maps in Bihar the Government made the provision for College of Fisheries in the 3rd Krishi Road Map to promote higher education, research and extension education in the ? sheries science. The College of Fisheries is located about 22Km away from the district town and 25Km away from Kishanganj Railway Station. The College is situated on the banks of river Mahananda.

Vision

A credible ? sheries education institution that nurtures the next-generation of professionals and entrepreneurs in the ? sheries sector and contributes to the state and nation by pursuing innovation and research that is relevant to local needs and directed towards maximizing outcomes for economic, social and environmental well-being.

Mission

The College of Fisheries has been established in the Integrated Agriculture College Campus shared by Dr. Kalam Agricultural College, the constituent College of Bihar Agriculture University, Sabour. Producing trained human resource in ? sheries having credible skills, capabilities and commitment of transform the sector through research and

innovation is the main mission of this College. More speci? cally the college will provide quality education in core and emerging disciplines of Fisheries Science and will conduct basic, strategic, applied and operational research in ? sheries, aquaculture and related science. The College will also take lead in the formulation and implementation of e? ective extension education and outreach programmes. The College of Fisheries is commi to become a centre of excellence in Fisheries education in the region.

Infrastructure Facilities

The college is unique with state-of-the-art infrastructure including centrally air-conditioned academic and administrative buildings with smart classrooms, modern laboratories, single-bedded hostel rooms for girls and boys, residential accommodation for faculty and sta? , playground, indoor game facilities, provision of stores, health clinic, well equipped auditorium, farm o? ces, wet laboratory and 90 acres of farm land for the construction of well-laid instructional and research farms with facilities for hatcheries and intensive aquaculture systems.

College of Fisheries

Single-bedded Hostel

Fisheries Farm Office

Fish Rearing Unit

Canteen

Residential Complex

Glimpes of Campus

Approved Faculty & Supportive Sta?

The approved faculty positions comprise of the Dean, 15 professors, 27 Associate Professors and 42 Assistant Professors, which is one of the largest ever faculty available with any Fisheries College in India.

There are 185 sanctioned posts of non-teaching sta? including technical, administrative, ?eld and supporting personnel to cater the need, of administration, laboratories, security and allied services and students to run the college e? ciently.

Procedure and continuances of Students

Bachelor of Fisheries Science (B.F. Sc.) is a 4-year degree course comprising of 8 semesters. Admission takes place purely on the basis of competitive entrance examination.

The state of Bihar conducts competitive entrance examination once in a year which is known as Bihar Combined Entrance Competitive Examination (BCECE). Depending on the results of competitive exam a merit list is prepared and students are called for counseling by Bihar Combined Entrance Competitive Examination Board (BCECEB) conducted at IAS Association building located beside the International Airport, Patna. Out of total intake capacity, 85% seats are reserved for the residents of the state of Bihar and rest 15% seats are ?lled up through All India Competitive Entrance Examination conducted by the Indian Council of Agricultural Research (ICAR), New Delhi.

A total of 40 seats have been approved for B.F. Sc. Programme, 85% (34) are reserved for stats quota and 15% (6) for ICAR quota. The ?rst Batch of BFSC, Programme have been started from 2018-19 session and a total of 35 students have been admi in ?rst batch.

Internship Programme (COFIP)

CoF has planned to provide unique opportunities for undergraduate students to intern at EU Certi?ed Processing Industries, Commercial Aquaculture Farms and Hatcheries, Trading and Export Houses, State sponsored or co-managed ?sheries resources, research organization and social impact groups (NGOs). This adds value to their professional quali?cations by embedding their education in the real-world context and helping them to gain ?rst-hand industry experience, on-the-ground practical training and develop leadership skills.

External Linkages

The college has entered into agreement with leading institutions of Education and Research organizations of India by signing MOUs. So far, MOUs have been signed with ICAR-CIFE (Deemed University), ICAR-CIFRI and ICAR-CIFA. Proposals are also in the pipeline for signing MOUs with foreign universities and with private-sector industries and farms within the country. Mutual agreements made under the MOUs would provide gainful opportunities for the faculty members and students through faculty and students exchange programmes, collaborative research projects and faculty development programmes.

Integrated Farming

The college is strategically positioned for the development and mainstreaming of aquaculture in family farming practices. The expertise of the two sister institutions, Bihar Veterinary College and Sanjay Gandhi Institute of Dairy Technology of BASU and Agriculture College of BAU will be available for developing viable integrated farming technologies.

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- Neurological conditions

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PLENARY LECTURE

Overall view of sheep production in India

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Introduction

Small ruminants are the key component among the livestock sector that plays a signi? cant role in sustainable livelihood of landless and small holder farmers in India. Rural human population constitutes 72.22 % out of which majority are dependent directly or indirectly on the agriculture and livestock related occupations. The total sheep in the country is 65.06 million that accounts for nearly 12.7% of total livestock population in India. Being the world's second most populous country, India has huge pressure on its food resources. The agricultural sector employs more than 50 per cent of the total workforce in India and contributes around 17-18 percent to the country's GDP (Economic Survey, 2018). The value of output from the livestock sector is 28.6% of total value of output from agricultural and allied sectors (DAHDF, 2018). Additionally, livestock provides employment to 19.4 million persons in India (MOSPI, 2017). The livestock and poultry (512.05 and 729 million numbers, respectively) sectors are proving to be key factors for India's food security. There are social stigmas associated with beef and pork among the majority Hindu community and the second-most populous Muslim community, respectively. The contribution of sheep in total meat consumption in India is only 7% (DAHD&F AR 2016-17). Sheep breeding programs of the past had the major objective of ? ne wool production, followed by carpet wool and meat. A number of crossbred strains were developed by crossbreeding of Indigenous stock with exotics. Since 1990, the Network Project on Sheep Improvement (NWPSI) focussed on improvement of indigenous breeds by intensive selection. Since 2009 Mega Sheep Seed Project (MSSP) also works for genetic improvement of the sheep in ? eld, using elite germplasm at the farm units. These projects are still running in the right direction. However, a major challenge towards pro? table and sustainable sheep rearing today is their market connectivity *i.e.* “linkage”, which has not received much emphasis in sheep improvement programmes.

Present status of sheep and its importance to Animal Husbandry

Sheep husbandry contributes signi? cantly not only for numbers but also for sustainable livelihood options in the country. The analytics on sheep population and drought prone zones in India conveys the picture that sheep population is more in the drought prone areas, thus acting as the bu? ering zone for human sustainable livelihood.It has been observed recently that the sheep population has increased in the areas of Andhra Pradesh/ Telangana where farmer's suicides due to crop failure were more. Sheep is the lifeline in areas where crop failure is a commonplace. According to the Livestock Census 2012, Andhra Pradesh (including Telangana) ranks ? rst in sheep population with nearly 40.57% sheep population followed by Karnataka (14.73%) and Rajasthan (13.95%). Sheep in true sense act as security option and remain always ready for cash option with the farmer. Hence, a jargon of ATM is also associated with sheep ? ock.

Leading states in sheep population (Livestock Census 2012)

State	Population ('000)	% share
Andhra Pradesh/Telangana	26060	40.57
Karnataka	9339	14.73
Rajasthan	9007	13.95
Tamil nadu	4470	7.36
J&K	3284	5.21
Maharashtra	2533	3.97
Gujarat	1641	2.62
INDIA	**65060**	**100**

Agriculture and allied sector contributes for 48.9% employment according to Economic survey (2013-14). Livestock contributed 16% to the income of small farm households that indicates importance of livestock sector as a whole. Agriculture sector contributed 17-18 percent to the country's GDP (Economic Survey, 2018). The value of output from the livestock sector is 28.6% of total value of output from agricultural and allied sectors (DAHDF, 2018), indicating a signi? cant contribution of the livestock. Presently, sheep is mainly reared for mu purpose due to the constraints of appropriate market for the wool and higher shearing cost. As far as meat production from sheep is concerned, Andhra Pradesh ranks ? rst with 28.68% contribution followed Telangana by (27.88%) andRajasthan (9.48%) and slaughter rate in sheep has been on rise consistently. During 2015-16 a total of 3,82,17,670 sheep were slaughtered that lead to per animal productivity estimates to be 12.70 kg during 2015-16.

Leading states in mu and wool production (BAH&FS 2016)

S. No	States	Mutton Production (million kg) 2015-16	States	Wool ('000 kg) 2015-16
1	Andhra Pradesh	139.26 (28.68%)	Rajasthan	13414.61 (30.8%)
2	Telangana	135.36 (27.88%)	Karnataka	8191.42(18.8%)
3	Rajasthan	46.03 (9.48%)	J & K	6865.65 (15.8%)
4	Tamil Nadu	36.48 (7.51%)	Telangana	4562.41 (10.5%)
5	Karnataka	28.55 (5.88%)	Gujarat	2282.65 (5.2%)
6	West Bengal	17.59 (3.62%)	Himachal Pradesh	1408.87 (3.2%)
7	Uttar Pradesh	15.77 (3.24%)	Maharashtra	1389.89 (3.2%)
INDIA		**485.53 (100%)**	**INDIA**	**43581.34 (100%)**

The meat production from sheep and goat in India as estimated (BAH&FS 2016) is 485.53 and 942.91 million kg, respectively, that constitutes 7% and 13% contribution to 7000 million kg of total

meat produced in country. Share of sheep meat towards total meat production of the country has been quite stagnant since last few years with 7.33% in 2007-08 to 7% in 2015-16.

Wool as a commodity from sheep is losing its value due to many reasons. First is its utility as an important by-product due to easy and cheap availability of the synthetic ? bres. Secondly, the income generated from wool is non-signi? cant as far as the primary producer is concerned. However, still the wool fetches a great value at market. During 2015-16 estimates of wool production was43.6 million kg that reduced from last year production of 48.1 million kg. It has remained almost stagnant from 43.9 million kg in 11th plan to 43.6 million kg in 2015-16 (BAH&FS, 2016). During last decade, more than 42 million kg of raw wool was produced annually in the country of which about 2.5 million kg was of ? ne quality. India's per capita/year consumption of meat is 5.11 kg (FAO, 2009), and it will increase in the coming future. As far as wool production is concerned, Rajasthan ranks ? rst with 30.8% contribution followed by Karnataka (18.32%) and Jammu & Kashmir (15.8%). Sheep husbandry is popular among many nomadic tribes In India, although it has been a key source in their sustainable livelihood but could not reach its true potential. This sector has been infected with the pests of poverty, illiteracy, absence of market, middlemen and absence of proper scienti? c management of the sheep ? ocks. In the near future, with advent of new technologies, streamlining of the market, access of market for sheep owners, formation of co-operatives by farmers, micro-credits, boom in the information technology, the future of sheep husbandry seems to be bright.

Diversity of Sheep Genetic Resources in India

There are 43 registered breeds of sheep found across the country well adapted to speci? c agro-climatic regions (www.nbagr.res.in). Details of the sheep breeds classi? ed on the basis of agro-ecological regions *viz*. a) North temperate region; b) North Western arid and semi-arid region; c) Southern peninsular region; and d) Eastern region are depicted below. In our country a sizable population of sheep are non-descript due to indiscriminate breeding and intermixing of breeds.

Breeds of sheep in di? erent agro-ecological regions in India and their major utility*

North Temperate	North-Western Arid and Semi-Arid	Southern Peninsular	Eastern
Bhakrwal (CW)	Chokla (CW)	Ballary (MCW)	Balangir (MCW)
Changthangi (CW)	Jaisalmeri (MCW)	Coimbatore (MCW)	Bonpala (MCW)
Gaddi (CW)	Jalauni (MCW)	Deccani (M)	Chottanagapuri (MCW)
Gurez (CW)	Kheri (MCW)	Hassan (M)	Ganjam (MCW)
Karnah (AW)	Magra (CW)	Kachakatti (M)	Garole (MP)
Kashmir Merino (AW)	Malpura (MCW)	Kenguri (M)	Tibetan (CW)
Poonchi (CW)	Marwari (MCW)	Kilakarsal (M)	Kendrapara (MP)
Rampur Bushair (CW)	Muzaffarnagari (MCW)	Madras Red (M)	
	Nail (CW)	Mandya (M)	
	Patanwadi (MCW)	Mecheri (M)	
	Pugal (MCW)	Nellore (M)	
	Sonadi (MCW)	Nilgiri (AW)	
	Munjal (M)	Rammand White (M)	
	Panchali (MCW)	Tiruchy Black (M)	
		Vembur (M)	
		Katchikatty Black (M)	
		Chevvadu (M)	

Within parenthesis is the major utility of the breed: (AW) Apparel wool; (CW) Carpet wool; (MCW) Mu and Carpet wool; (M) Mu (P) Proli?cacy Breeds in italics are not registered by NBAGR

Sheep Breeding Strategies in India: Lessons from past and a way ahead

The focus of sheep development in past was essentially on the improvement of quality and

quantity of wool by using di? erent types of exotic ? ne wool breeds. A number of strains were developed through crossbreeding of native breeds with exotics (Task Force 1996, Singh *et al* 2005). Developed genotypes demonstrated their production potential in terms of body weight, wool quantity and quality under experimental farm management conditions but these could not outdo the natives in ? eld conditions barring a few genotypes due to non-availability of required plane of nutrition and climatic conditions. Presently mu has almost outperformed the wool in terms of income to the farmers. In addition to the NWPSI and MSSP programmes of ICAR, the genetic improvement of indigenous breeds of sheep in their home tracts at present is being mostly done through state governments. State wise sheep breeding policy were ? rst proposed in 1970 by the Ad-hoc commi on sheep breeding policy set up by the Government of India.

Agriculture is a state subject hence; sheep breeding policies are to be enunciated by the State Government. Well de? ned sheep breeding policy in large number of states is still awaited.

Improving Wool Production

During the initial stages, e? orts for improving sheep were aimed at ? ne wool production through introducing exotic ? ne wool inheritance. The crossbreeding programmes have yielded encouraging results for improving the quality of wool, through developing several ? ne wool strains/ synthetics (mainly Bharat Merino, Kashmir Merino and Hisardale). Bharat Merino, a ? ne wool strain of sheep evolved at CSWRI with 75% exotic inheritance is now being exhaustively used in the southern region of the country especially Kodai and Nilgiri hills in Tamilnadu and Karnataka for improving the local sheep breed for wool and body growth. Kashmir Merino has succeeded in retaining its charm in the Kashmir valley and is being used for improving local breeds. Wool produced in the temperate region is suitable for apparel and ? ner carpets, therefore, apparel wool production may be intensi? ed only in northern temperate hilly region and Nilgiri and Kodai hills of southern region. In these areas 3/4th crosses of Rambouillet or Merino including Bharat Merino may be propagated and annual clips may be obtained to meet the requirements for apparel manufacture. In case of carpet wool, sheep breeds belonging to Rajasthan, Haryana, Gujrat, Madhya Pradesh and plains of U Pradesh produce good quality carpet wool except the wool of Malpura and Sonadi sheep. Presently about 60.76 m kg of raw wool is being imported *(www.texmin.nic.)* to meet the requirements of the industry. While it may not be possible to produce the apparel wool in required quantity there is every possibility of meeting the requirement of carpet wool if suitable and e? ective development programmes are undertaken. India can make a thrust in export trade by making hand-kno carpets, druggets, hosiery items, etc. Therefore, improving quantity and quality of carpet wool has to be given priority. As far as carpet quality wool production is concerned, CSWRI Avikanagar developed a strain Avikalin with 50% exotic inheritance that could achieve the de? ned targets with respect to carpet wool quality. However, at present, the native breeds with superior carpet quality traits such as Nali, Chokla, Patanwadi, Marwari, Magra, Jaisalmeri, Pugal, Bhakarwal, Gurez, Gaddi and Rampur Bushair are being favored for enhancing the carpet quality traits and production through selection programmes.

Enhancing Mu Production Potential of Sheep

In the past, e? orts towards enhancing body weight through selection within indigenous and crossbred population has been a The results of cross breeding on the whole, revealed

that percent improvement in body weight up to 6 months of age is conspicuous in di? erent crossbreds over contemporary natives but only marginal improvement is observed at 12 months of age. This is indicative of the fact that crossbreds/new synthetics require high plane of nutrition and if they are managed on the same feeding regimen as for natives, the di? erences which were conspicuous up to 6 month age became marginal at the age of one year. Due to non-availability of required plane of nutrition, mu type strains developed by crossing Su? olk and Dorset with the indigenous breeds could not outdo the natives under village management conditions despite the improvement in body size as well as in wool quality and quantity. Results on growth performance of native breeds reveals that Malpura and Muza? arnagri of North-Western breeds and Nellore and Mandya of Southern breeds have great potential for their use as improver breeds for mu production. Improvement of sheep through breeding strategy will also depend upon socio-economic and ecological considerations, existing genetic resources, their productivity, possibility of their improvement through selection within a breed, upgrading with indigenous improver breeds, or replacing an indigenous breed with an existing breed if it is arising from similar ecological region and thus will be adaptable, or cross-breeding for evolving new breed combining the adaptation and hardiness of local breed and higher productivity of the exotic breed.

Future plans for mitigating the e? ect of climate change on sheep production

Sheep husbandry has diverse stakeholders across the globe. Shepherds are the real breeders who have been developing and improving numerous sheep breeds over the millennia for utilization of sheep products in diverse forms. The dilemma with climate change is the uncertainty surrounding it and its timeframes. This may lead to a reluctant approach to the initiation of mitigating measures. Tropical regions like India and in particular the decerti? ed regions are expected to su? er more due to several factors. These regions have a huge dependency on livestock and related activities. Loss of biodiversity, decline in production, compromise on quality, disease threats has potential to break the backbone of rural industry and hence mitigating the impact of climate change is essential.

Breeding for climate change adaptation and mitigation in near future

Productivity and adaptability to heat tolerance is negatively correlated, there should be trade-o? between these two traits in breeding plan. Changing climate will demand many things from the animals to be included in the breeding program (Gowane et al. 2017b) such as:

- Fitness in the given environment
- Disease resistance or resilience
- Shock absorbance for water scarcity, heat stress, nutritional stress and combined stress
- High production
- Feed conversion ratio
- Methane emission

Preference to the indigenous sheep breeds evolved through the process of natural selection followed by man-made e? orts for survival and production under harsh climate needs to be given. High temperature and humidity provide a stressful climate for most of the closed ? eece sheep of cold climate, however, such stress can easily be managed without compromising much of the production by sheep in tropical climate where open ? eece is naturally grown. Selective breeding of such breeds can be a suitable option for managing the temperature combined humidity stress. The morphological characteristics preferred to the hot climate breeds should include a large skin area

to live weight ratio, shielded eyes, pigmented skin and eye lids and a light colored or white body cover. In addition, the ability of animals to walk long distances, to adjust to low water intake, to high intake of salts either in drinking water or in forages, to poor quality food, to harsh treatment and to resist ticks and other pests, should be involved. Import of breeds from one area to other area can be tried for utilizing the hardy germplasm in the changing climate regime. However, it is very essential to look for several parameters before doing it. The extent of climate change risk and associated factors such as health hazards, nutritional availability, water resources, accessibility to new vectors and parasites and adaptability of the imported germplasm to new area.

Enhancing the per animal productivity of the sheep

Average carcass yield from sheep is relatively low in India with national average of 12.7 kg, whereas the world average is 16 kg for carcass yield. In India, Assam has lowest average of 7 kg, and Himachal has highest average of 20 kg. Apart from this the increased slaughter rate is also a thing of concern, if population shows a declining trend. In the past, e? orts towards enhancing body weight through selection within indigenous and crossbred population has been a The results of cross breeding on the whole, revealed that percent improvement in body weight up to 6 months of age is conspicuous in di? erent crossbreds over contemporary natives but only marginal improvement was observed at 12 months of age. This is indicative of the fact that crossbreds/new synthetics require high plane of nutrition and if they are managed on the same feeding regimen as for natives, the di? erences which were conspicuous up to 6 month age became marginal at the age of one year. Due to non-availability of required plane of nutrition, mu type strains developed by crossing Su? olk and Dorset with the indigenous breeds could not outdo the natives under village management conditions despite the improvement in body size as well as in wool quality and quantity. Results on growth performance of native breeds reveals that Malpura and Muza? arnagri of North Western breeds and Nellore and Mandya of Southern breeds have great potential for their use as improver breeds for mu production. Improvement of sheep through breeding strategy will also depend upon socio-economic and ecological considerations, existing genetic resources, their productivity, possibility of their improvement through selection within a breed, upgrading with indigenous improver breeds, or replacing an indigenous breed with an existing breed if it is arising from similar ecological region and thus will be adaptable, or cross-breeding for evolving new breed combining the adaptation and hardiness of local breed and higher productivity of the exotic breed.

Per Sheep More Sheep

Considering the importance of multiple births in sheep breeding in special reference to mu production, Garole, an indigenous proli? c breed of sheep, was introduced at CSWRI, Avikanagar during 1997 for improving reproductive e? ciency of native sheep (Sharma et al. 2004). The results indicated that twining percent in Garole X Malpura (GM) half-breed ewes were 52.24 % and lamb born, as triplets were 7.46%. The average number of lambs born per ewe lambed was 1.64 in GM and 1.08 in Malpura sheep (Kumar et al. 2006, Mishra et al. 2007). It was observed that the body weight at di? erent ages of GM half-bred was on lower side compared to contemporary Malpura lambs. This was however the ? rst report that also signi? ed the importance of enhancing Malpura inheritance to 75% for be live weight gain and mothering ability in proli? c crosses. The overall percent gain in proli? cacy in GM was 52.38, which increased to 75.73 in third parity (Mishra et al. 2007). The FecB gene carrier GM were backcrossed with Malpura ewes to produce the GM x Malpura (GMM). The GMM crossbreds ewes were able to produce >50% twin lambings and higher body weight as compared to half-breds but problem of low milk yield of dam for feeding twins/triplets and to enhance the live weight gain during pre-weaning stage persisted. To address

this issue, Patanwadi sheep of Gujarat (a heavy sheep breed of Saurashtra, famous for higher body weight and milk) was introduced. By implementation of structured breeding plan, a high performing triple breed cross in terms of increased proli? cacy, more li eight, more milk per dam and adaptable to sub-tropical climate has been developed at CSWRI Avikanagar, which was named "Avishaan" on 04th January 2016. This newly developed proli? c sheep is a composite cross possessing 12.5% Garole, 37.5% Malpura, 50% Patanwadi inheritance in which *FecB* gene has been introgressed successfully. The average body weight of the lambs is 3.3 kg at birth, 16.8 kg at weaning and 25.9 kg at six month age(Sharma et al. 2016). More than 54% Avishaan females produced 2 lambs and 2% produced 3 lambs in a lambing leading to 57% proli? cacy with li size at birth 1.61. Avishaan ewe excelled the local Malpura sheep in terms of ewe productivity e? ciency at 3 month age by 32.5%. They also produced 50% twin lambings at farmer's door. Results obtained so far in case of newly developed proli? c sheep are encouraging and igniting a new way ahead for pro? table sheep husbandry. In times to come, proli? c sheep may prove a boon towards enhancing the economic returns per sheep for livelihood security of Indian sheep keepers.

Current challenges with the Indian sheep husbandry sector

1. Bo approach in sheep breeding policies: With so much of cultural, linguistic and biological diversity, India cannot a? ord to have one policy for all the sheep husbandry sector. In India, each state government has its own policy for livestock breeding as agriculture is a state subject. There are 42breeds of sheep in India and diversity between these breeds is very high that in? uenced by the agro-climatic condition of each region. Usually each state government has a well-crafted breeding policy considering locally available needs and germplasm. However, the execution of the policy fails due to the policy not being given priority, inadequacy of funds and infrastructure and no direct control over the wish and will of farmers to adopt the government policy. A bo approach is an essential requirement, whereby there is a need for the breeding programs to be chalked out at grass root level that will include Panchayati Raj structure. Given su? cient funds for operation, such a program will be able to deliver the best results.
2. Linkages between livestock producers and market:The genetic improvement programs for sheep have primarily been aimed at improvement of the live body weight and wool yield. However, in general farmers are not much bene? from having higher or lower weight animals, as their animals are seldom sold on a live weight basis. Thus having no incentive for producing animals of higher body weight, livestock keepers do not show much interest in adoption of the superior sheep germplasm. To address this problem, linkage with the market is essentially required. Study at ICAR-CSWRI Avikanagar on Malpura sheep breeders indicated that farmers sell their lambs at 3 to 4 months of age for the price ranging between Rs. 1200/- to 2500/- (Malpura Project AR 2012-13), and the average weight of lambs is more than 15 kg. The average price for live weight at the Delhi aba is Rs. 240/- per kg live weight. Market to producer linkages needs to be set up from government organization and or NGOs. Establishment of breeders' organizations, especially for small ruminants should be a priority.In this scenario, where weight of the animal carries less importance than the number of animals sold, the high genetic worth germplasm like *Avishaan*, can prove to be highly pro? table.

3. Coverageunder genetic improvement program:The number of breeds covered in the program and coverage of the population is not realistic looking in to the actual breeding population. Today MSSP and NWPSI covers only 10 breeds out of 42 enlisted. This is less than 25% coverage. Not only this, but the population covered under each program is very small, due to unavailability of the budget. Thus a strong support from government side in terms of with huge funding is essential for increasing the coverage of the sheep population so that gains can be predicted and realized in true sense.
4. Revival and conservation of grazing resources: Sheep being the animals of poor farmers are reared on zero input systems in India. The country's pastures have reduced from about 70 million ha in 1947 to about 38 million ha in 1997 (PCI 2011). The remaining grazing lands have either already degraded or are in the process of degradation. With shrinking grazing resources and extensive agriculture production, there is severe pressure on common grazing land. State policies in restricting the encroachment of the common property resources (CPRs) for grazing land needs to be strengthened. The grazing land should not be allo at all for human se or industrial purpose. The challenge is to revitalize the degrading common fodder and pasture resources in the country and improve their productivity. Stall feeding (with fodder and concentrate) to sheep is one option; however, this is unrealistic looking in to the poor economic condition of the shepherds. These days, entrepreneurs are entering in the sheep rearing business, where stall feeding is the only option left due to non-availability of the grazing land. Many entrepreneurs share their good experience with semi-intensive system of rearing. Shifting from extensive to semi-intensive and then to intensive system of rearing has the challenge of pro?t making due to the poor market infrastructure and supply chain in this sector.
5. Minimum support price for sheep produce:The sheep mainly produce the wool and meat as primary products, however the prices are not ?xed. Although meat receives be prices in market, but the wool from majority of the breeds is sold at very low cost. Many a times it was observed that the cost of shearing is also hardly recovered from the sale of wool. Again the problem is with linkage, where wool is not sold at the right platform. However, being a natural ?bre, wool is a prime product should receive a ?xed minimum support price (MSP). This will help sheep farmers to think over their produce and opportunities for marketing will increase.
6. Diversi?ed sheep produce and marketing: Sheep has been traditionally reared as a family business, without actually thinking about its economics in India. The pastoralist system was the only stakeholder of sheep in India. However, with shrinking grazing land, losinginterest of new generation in sheepraising and low returns as compared to the hard work requirement, now the time has come, when the sheep husbandry needs a boost. Sheep provides a multitude of produce about which farmers hardly think. Apart from meat and wool, the sheep manure can be a major source of income, if it is properly marketed. One such example is “AVIKHAD” prepared at ICAR-CSWRI Avikanagar, where sheep manure with wool waste is processed and packed for sell to the kitchen gardens, etc. Apart from this, the coarse wool that is not used for any production, can be best utilized for making toys, mats, etc., targeting the right customers. A

breeder's cooperative organization formulated for managing such business along with sell of live animals on a ? xed rate can prove worth.

7. Need of aba Sheep skin/hide can be utilized for making purse, and other leather products. Bone, blood obtained from the sheep also fetches good market value for making meals for poultry and ? sh, given right processing. However, all these things to happen require right processing of the sheep in the slaughter house, linked with marketing. Therefore, scienti? c aba with facility for processing of each produce of sheep needs to be constructed at every important city with su? cient two way linkages to farmers and market.

Conclusion and recommendations

Sheep husbandry is the backbone of India's rural economy. A few steps in the right direction with considerable economic investment are essentially required to rejuvenate this lifeline. There is a need to focus on sheep productivity in a sustainable manner with emphasis on pro? tability and institutional support.

- A sincere e? ort from government as well as other developmental agencies for addressing issues such as market viability of the sheep husbandry, linkages of sheep produce with the market, availability of feed and fodder, availability of superior males for breeding, management and healthcare are required.
- Scienti? c approach for management of breeding, lambing, nutrition, housing and healthcare must be followed for reducing the losses and fetching more returns from sheep rearing.
- Farmer participatory approach should be followed by working hand in hand with the farmers on their sheep ? ocks with scienti? c data recording and management. Genetic improvement of sheep for mu and wool using both farm and ? eld units should be strengthened.
- Proli? cacy may be incorporated in the breeds wherever possible using developed germplasm with high growth such as *Avishaan*, looking in to the fact that nutritional and environmental stress is avoided at best possible and availability of milk with nourished ewes.
- Co-operative approach in sheep husbandry may be tried at least at a village level and adopted for be breedin

References are available with the authors.

TECHNICAL SESSION - I
(GENETIC RESOUCES AND GENOMICS

LEAD:GRG-01

Genetics of adaptation in goats: Phenotyping to cellular regulation to heat stress

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Introduction

Adaptation to environmental stimuli will play signi?cant role in maintaining the livestock productivity in the face of climate change. Sustainable productivity can be achieved with best adaptable animal.Heat stress a?ects animal bioenergetics, and has a negative impact on animal performance and well-being. Goats are distributed in di?erent ecological conditions and are supposed to be more tolerant to extreme weather conditions because of their metabolic size and water conservation capacity (Silanikove 2000*a*). Short-term variations in weather pa a?ect the performance of goats and are exhibited by physiological and behavioural changes in goats (Appleman and Delouche 1958; Solanki 1989; Kannan *et al*. 2000; Hamzaoui *et al*. 2013; Silanikove and Koluman 2015).Goats are highly adaptable to heat stress due to speci?c anatomical and physiological characteristics. The morphological characteristics that result in be adaptation are large salivary glands, a higher surface area of absorptive mucosa and the capacity to increase the volume of the foregut with high?brous foods (Silanikove and Koluman 2015). The anatomical structure of goats favours be

Short hair, abundant sweat glands and minimal subcutaneous fat allow goats to regulate body temperature in an e? cient manner.Goats are more resilient and adjust to di?erent higher environment by expressing di?erent adaptive strategies (Silanikove and Koluman2015). Goats generally utilize its thermoregulatory mechanism to relieve from stress. It is necessary to select ruminants for heat stress tolerance; therefore we need to develop one or more measureable indices of heat tolerance (Bernabucci *et al*. 2010; Nardone 1998). Rectal temperature. Respiration and heart rates are commonly used to assess heat tolerance. Rectal temperature is considered as good index of thermoregulatory capacity (Yousef 1985). Due to speci?c anatomical and physiological adaptation goats e? ciently manage the heat in desert condition. The goats did not exhibit wide variation during heat stress period, however signi?cant variation was observed in RR and HR. Therefore an index based on RR and HR for phenotyping has been proposed for heat stress in goat in semi-arid tropic (Rout et al., 2017)

Exposure of goats to ambient temperatures above the upper critical limit results in heat stress (Yousef 1985; Lu 1989). The suggested upper limit of heat tolerance for goats was above 40°C (Appleman *et al*. 1958; Solanki 1989). Similarly, THI during heat stress period varied from 85 to 90 which were stressful to goats to maintain energy balance. THI is the most prevalent index to

evaluate heat stress which combines the e? ect of heat and humidity. This index has been developed as a weather safety index to monitor and reduce heat-stress-related losses. The sensitivities to ambient temperature vary between livestock species and usually classi? ed into di? erent ranges to indicate heat stress level. However, de? nitions of those levels vary between indices and authors. Armstrong (1994) identi? ed index below 71 as comfort zone, values ranging from 72 to 79 as mild stress, 80 to 89 moderate stress, and values above 90 as severe stress. Huhnke *et al*. (2001) divided THI7 into 2 categories: 79 $\leq$ THI7 $\leq$ 83 dangerous situations, and THI7 $\geq$ 84 emergency. Thom (1959) categorized THI as 70 $\leq$ THI3 $\leq$ 74 uncomfortable, 75 $\leq$ THI3 $\leq$ 79 very uncomfortable, and THI3 $\geq$ 80 serious discomfort. THI values for Indian goats in semi-arid region can be classi? ed as 74 or less comfortable; 80-85 stressful; 86-88 more stressful; more than 88 extreme distress. A similar weather heat stress risk class for dairy goats has been described by Silanikove and Koluman (2015).

Phenotyping to heat stress in goats in semi-arid tropic

The physiological response of goats such as rectal temperature (RT), respiration rate (RR) and heart rate (HR) was evaluated in di? erent environmental conditions. The range of variability in RR and HR was 24 to 108 and 80-160 during heat stress period in both the breed. The range of variability in response to heat stress was more in RR and HR during heat stress period; therefore, heart rate (HR) and respiration rate (RR) were considered to de? ne heat stress susceptibility and tolerance. There was signi? cant di? erence ($P<0.05$) observed in respiration rate and heart rate between heat stress and thermo-neutral (comfortable) period. During thermo-neutral condition, the HR and RR was in normal range and 3.19% of adult animal and 2.47% of kids were observed in higher range (>50 for RR and >130 for HR). In contrast to this, 21.57% of adult animals and 28.97% of kids were exhibiting higher RR and HR during heat stress period. There is direct shift of HR and RR (more than 25%) to higher side due to heat stress in both the breeds. The histogram distribution of HR and RR during heat stress and thermo neutral period showed the presence of two contrasting classes in the population .Basing on the distribution of RR and HR, It was also observed that respiration rate and heart rate could be used as stress indicator for identifying contrasting phenotypes. Phenotyping for heat stress susceptibility was proposed based on respiration rate (RR) and heart rate (HR). Basing on distribution of RR and HR over the breed in the population, it was observed that individuals having RR>= 50 and HR>= 130 are recognized as heat stress susceptible (HSS) phenotype and RR<= 30 and HR<= 100 are recognised as heat stress tolerant (HST) individual in adult goats. There is a slight deviation for kids. Kids having RR>=55 and HR>=145 are recognized as heat stress susceptible (HSS) individuals and RR<= 30 and HR<=100 are recognized as heat stress tolerant (HST) individual.

The variation in rectal temperature between HST and HSS was 0.709ºC resulting into variation in 15.728 breath/min in RR and 18.173 heartbeats /min in HR in Jamunapari goats. The rectal temperature variation of 0.361º C in Barbari goats resulted into variation of 24.051 breath/min (RR) and of 19.133 heartbeat/min (HR) between HSS and HST phenotypes. Moreover, the least squares analysis of variance indicated that the sire had signi? cant (P<0.01) e? ect on RR and HR in Jamunapari goats. Again sire had signi? cant (P<0.01) on RR in Barbari goats during heat stress period. Phenotype had signi? cant e? ect (P<0.01) on RR and HR in both the breed. Birth type and parity had no signi? cant e? ect on RR and HR in both the breed during heat stress and thermo neutral period.

The combination of RR and HR can be utilized to identify heat tolerant animal .In the present study, 21.57% of adult animal and 28.97% of kids were exhibiting higher RR and HR during stressful condition. There is a direct shift of HR and RR to higher side during heat stress period in the goats of semiarid region. It has been also reported that the change in environmental temperatures from 20°C to 40°C, the respiration rate increased from 30 to over 200 breaths/min in East African goats (Maloiy *et al*. 1971) and domestic Swedish goats (Olsson *et al*. 1995). Reference respiratory rate for adult goats ranges between 15 and 30 breaths/min according to Pugh *et al*. (2012). Increased respiration rate under heat stress conditions is a known mechanism for dissipating heat load by evaporation. Rectal temperature and respiration rate values peaked in heat stress (HS) goats during the ? rst week and then gradually decreased, which indicates a partial adaptation to the heat stress conditions. The general homeostatic responses in ruminant include reduction in feed intake, increase in RR, heart rate and sweating rate. Similarly the exposure of goats to heat stress condition depressed their milk yield (Lallo et al. 2012). Therefore physical, physiological, biochemical process play an important role to negate the e? ect of heat stress to maintain thermal balance.

Genetic parameter estimation

The heritability was estimated in combined data set with 75 sires and progeny within sire varied from 3 to 75. The heritability estimate of RT was 0.180 with precise standard error (0.058). The heritability of RR was low (0.077) with large standard error. Similarly the heritability of HR was moderate (0.307) with standard error of 0.074. Again the Heritability of RT, RR and HR was estimated separately for both hot and cold period and for kids and adults age group. The h^2 of RT, RR and HR was 0.363 ± 0.119, 0.201 ± 0.097 and 0.362 ± 0.119 with precise error, which was higher than combined period. HR and RR had moderate heritability during hot period. Similarly h^2 of RT, RR and HR was 0.137 ± 0.098, 0.362 ± 0.127 and 0.514 ± 0.144 during cold period, which was higher for RR and HR only. The h^2 estimate was signi? cant for both hot and cold period. Similarly

heritability was analysed separately for age group. The h^2 of RR and HR for kids was 0.073 ± 0.061 and 0.262 ± 0.093. The h^2 RR and HR in adult age group was 0.290 ± 0.107 and 0.221 ± 0.098, which was similar to combined data set.

The genetic correlation between RT and HR was high and positive. Similarly the genetic correlation between RR and HR was low and negative. The phenotypic correlation between RT and HR was low and positive. The phenotypic correlation between RR and HR was low and positive. Genetic correlation between RT and HR was high and ranged for 0.866 to 0.990 with low standard error in hot, cold and combined data set. The genetic correlation of RT with RR and RR with HR was low and positive during hot and cold period with high standard error. However the genetic correlation between RT with RR and RR with HR was low and negative with high standard error. The phenotypic correlation between RT and HR ranged from 0.132 to 0.190. Similarly phenotypic correlation between RT and RR was -0.005 to 0.062.

Regulation of heat stress at cellular level

Variation in heat stress tolerance at the cellular level in response to environmental stimuli is observed in individuals in the population. Cellular tolerance to heat stress is regulated by heat shock proteins (HSPs). Heat shock proteins (HSPs) are released in the cell in response to various environmental and oxidative stresses (Sonna et al. 2002; Hecker et al. 2008). The regulation of HSP production is critical to cell survival. HSPs activate various regulated proteins and block apoptosis (Chirico et al. 1998; Kregel et al. 2002). The HSP acts as a molecular chaperone by binding with other cellular proteins and facilitates intracellular transport. Among the HSPs, Hsp70 has a signi? cant role in cell thermo-tolerance (Barbe et al. 1998) and animal survival (Barbe et al. 1998; King et al. 2002). HSP transcription is increased by heat shock and other stress stimuli in bovine embryos and in di? erent tissues (Wrenzycki et al. 2001). Hsp70 concentration in blood is also a reliable indicator of chronic stress in feedlot ca (Gaughan et al. 2013). There is considerable evidence that the synthesis of Hsp70 is temperature-dependent (Zulki? et al. 2003) and thus Hsp70 responses could be considered as a cellular thermometer. HSPs are classi? ed into several families based on their molecular size and amino acid sequence similarity. The most highly conserved family of HSPs is the70 kDa family (Hsp70), which is controlled by 13 genes in human and four genes in bovine (Grosz etal. 1992; Gallagher et al. 1993; Kampinga et al. 2009). It has been established in mouse Hsp70 gene knock out models that the cytosolic Hsp70 family members regulate the cellular stress response, while other HSPs are involved in tissue-speci? c and housekeeping biological tasks (Daugaard et al. 2007). Heat stress is regulated in two stages: acute (short term) and chronic (long term) (Garret et al. 2009). The acute phase includes the heat shock response at the cellular level and

the chronic phase results in acclimation to the stressor and involves the reprogramming of gene expression and metabolism (Horowi 2002; Collier et al. 2006). In ruminants, there is a loss in productivity as animals pass through the acute phase and return to productivity as they undergo acclimation to the stress (Collier et al. 2006). The di? erential tissue-speci? c expression of Hsp70 proteins is not understood in ruminants. The cellular heat stress response has been analyzed in response to high temperatures in laboratory conditions; however, limited studies have been carried out in *in-vivo* conditions. Again, the adaptation to thermal stress should be analysed in di? erent physiological backgrounds to understand the interaction of several genes in di? erent pathways.

Genetic di? erences in thermo tolerance at the physiological and cellular levels are analysed in *Bos indicus* and *Bos taurus* (Paula-Lopes et al. 2003; Hansen et al. 2004; Lacetera et al. 2006). The polymorphic pa of the Hsp70 gene is associated with thermo tolerance in dairy ca (Basirico et al. 2011). The loss of productivity in livestock due to heat stress has been documented in ca (Bernabucci et al. 2010). Goats have broad ecological adaptability and are more productive in harsh environments than other ruminants, including sheep (Devendra 1990; King, 1983). However, the productivity of goats declines during thermal stress (Al-Tamimi et al. 2007). Information is available on the physiological changes that occur in goats during heat stress, but the regulation of heat stress at the cellular and genetic level is not understood properly. Understanding the regulation of heat stress at the cellular level and the expression pa of Hsp70 gene will throw light on the mechanism of heat stress adaptation in goats. Moreover, as individual animals respond di? erently to heat stress, it is interesting to observe gene expression in di? ering physiological response backgrounds. Characterization of the cellular heat stress response in terms of the expression of HSPs has been carried out in response to high temperatures in laboratory conditions, whereas only limited studies have been carried out to analyse mRNA levels in di? erent organs. Hsp70 gene expression has been positively correlated with variations in thermo tolerance in di? erent organisms. As Hsp70 plays a multifarious role at the cellular and tissue levels, heat shock protein 70 gene expression in di? erent tissues and in contrast phenotypes were evaluated in response to peak heat stress *in vivo* conditions. (Rout *etal.*,2016).

It is necessary to analyse heat stress regulation and thermal tolerance in di? erent environmental conditions at the cellular and tissue level. HSPs protect cells from the negative e? ects of heat stress by synthesizing HSP at the cellular level. In addition to their response to heat stress, HSPs are also synthesized by cells in response to a variety of stimuli, including oxidative, metabolic and chemical stress (Welch, 1992; Morimoto et al. 1994; Airaksinen et al. 2003). It has been suggested that the expression of Hsp70 was signi? cantly higher during the summer season as

compared to the winter season in tropical region goats, which might play an important role in thermal stress tolerance against harsh environmental conditions (Dangi et al. 2012).Thermal stress induces di? erential gene expression and biochemical response at the cellular level. Individuals exposed to stress elicit HSP response in the cells of various organs. Hsp70 concentration was higher in liver and kidney. Higher expression of HSP 70 at the tissue level provides protection to cells during chronic heat stress (Latchman, 2001). Similarly Zulki? i et al., (2010) also reported a higher expression of Hsp 70 in heart and kidney of goats during transportation stress. The protective e? ect of Hsp70 in di? erent organs such as heart and kidney tissue has been established (Latchman, 2001). Higher Hsp70expression at the cellular level is a contributing factor for be meat quality in goat as Hsp 70 provides protection to muscle glycogen content and thereby in? uences meat quality in ruminants (Zulki? i et al., 2008; 2010).

It has been observed that the mean Hsp expression at the protein level did not vary signi? cantly (P>0.01) among the breeds indicating a di? erential inducible response to heat stress within breeds. However the Hsp expression pa at the mRNA level di? ered signi? cantly (P<0.01) among the breeds. Heat shock (41°C) causes an increase in HSP synthesis and a decrease in protein synthesis. Collier et al. (2006) reported the direct e? ect of thermal stress on cellular growth and ductal branching of bovine mammary epithelial cells (BMECs) and showed a down regulation of genes associated with protein synthesis and cellular metabolism. Similarly the Sirohi breed exhibited a higher mRNA level of Hsp70 gene indicating that it was be at regulating heat stress compared to other three breeds.

High environmental temperature challenges the animal's ability to maintain energy, thermal, water, hormonal and mineral balance. Exposure of animals to heat stress activates the hypothalamo-pituitary-adrenal axis (Abilay *et al*. 1975) and secretion of di? erent hormones regulates stress of animals. In the chronic stress HSP70, HSP90 and leptin levels are higher in HSS individuals. C-reactive protein concentration was higher in HST phenotypes in plasma sample. Similarly HSP 90 was higher in liver tissues of HSS phenotypes. Leptin concentration and T3 concentration were higher in HSS phenotype, however there was no signi? cant di? erence in other blood biochemical parameter. The variability in concentration of biomarker in plasma occurs mainly during ? rst phase of heat stress period and subsequently individuals adapt to the environmental stimuli. Heat shock protein and leptin concentration indicated the adaptability of goats both at cellular level as well as to maintain energy balance. In ruminants, there is typically loss in productivity as animals pass through the acute phase and manages to restore the productivity as animals undergo acclimation to the stress.XThermal acclimation and thermal adaptation is associated with increased basal level of HSPs (Carper *et al*. 1987; Kregel 2002). It has

been observed that as skin surface temperature increases, then the skin epithelium releases heat shock protein to mobilize the thermal shock.Hsp70 and Hsp90 are generally synthesized in response to cellular stress and in response to heat stress. HSPs are proven to play key role in protecting stressed cell and thereby protecting the individuals from negative e? ect of environmental stress (Barbe *et al*. 1988; Hecker *et al*. 2011).The protein acts as a molecular chaperone by binding with other cellular proteins and assisting intracellular transport.There is a considerable evidence that the synthesis of HSP is temperature dependent (Zulki? i*et al*. 2003) and thus HSP response could be considered as cellular thermometer. Similarly, CRP, the acute phase protein, also expressed signi? cantly due to presence of environment stressor and indicating cellular damage due to stressful condition (Eckersal 2000).

Hsp70 protein concentrations in tissue extracts of di? erent organs were analysed. Hsp70 concentration was found to be signi? cantly higher (P<0.01) in liver, kidney and heart followed by brain, spleen, lungs and testis. Kidney, liver and heart had 1.5-2.0 fold higher Hsp 70concentrations than other organs. The di? erential mRNA level expression was analysed for the Hsp70 gene in goat. Gene expression pa of the Hsp70 gene in di? erent organs indicated that the liver, spleen, brain and kidney exhibited 5.94, 4.96, 5.29 and 2.63 fold higher mRNA level expressions than the control. Liver and brain tissues showed the highest gene expression levels as compared to kidney, spleen and heart. The Sirohi breed showed the highest level at 6.3 fold mRNA level as compared to the Jakhrana. In addition, the Sirohi showed a 4.2 fold and 1.97 fold higher mRNA level than the Jamunapari and Barbari goats, respectively. The distribution of HSS and HST over the population was 41.82% and 26.08%, respectively. The di? erential mRNA level expression between contrasting phenotypes indicated that heat stress-tolerant (HST) individuals showed higher Hsp expression than heat stress-susceptible (HSS) individuals.

References are available with the authors.

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Perspectives and challenges of genomic selection in sheep

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Summary

Sheep (*Ovies aries)* and goat (*Capra hircus)* were domesticated in Southwestern Asia about 12000 and 10000 years ago, respectively. Following human migrations and trade routes, sheep and goat rapidly spread over the rest of the world. Subsequently, arti? cial selection allowed the formation of a large variety of breeds with distinct morphology, coat colour and/or having specialized production potential (milk, meat, wool/hair, skin etc.). The improvement and conservation of these small ruminants require knowledge of available biodiversity. Genetic variation in the populations can be estimated using both, traditional pedigree-based methods andgenomic techniques. Generally, autosomal (microsatellite), mitochondrial and Y-chromosome markers were being used for diversity analysis. Now-a-days, SNP microarrays and whole genome sequencing (WGS) technologies are becoming the choice for analysis of thorough genomic diversity in populations of domestic and wild sheep and goat, investigation of population structure, reconstruction of demographic history and detection of recent and ancient admixture, identi? cation of selection sweeps and of marker–trait associations in genome-wide association studies (GWAS). Here, we review the recent progress in genomics and genome-wide markers for understanding genomic diversity and its use, selection sweeps in sheep and goat including pertinent issues, strategies and perspectives for livelihood security of small scale farmers.

Keywords: sheep; goat; diversity; genome; SNP chip; NGS; selection sweep, LD

Genomic diversity of sheep and goat-issues and strategies to use it

The major concern in animal breeding is to assess genetic variation within and among the breeds , and its use for genetic advancement of the breed(s) mainly through selection and mating systems. Genomics o? ers ample opportunities, not only for genetic improvement of animals but also for the assessment of thorough genome-wide diversity of livestock including local sheep and goat breeds. The availability of high throughput DNA methods and tools in recent years has opened up the use of genome-wide information for sheep and goat breeding.The advent of next-generation sequencing (NGS) technology has allowed *de novo* sequencing of sheep (Jiang *et al*.,2014) and goat genomes (Dong *et al*.,2013) and making possible the design of high-density assays (SNP chips) that include thousands to millions of SNPs distributed throughout the genome.These panels of

genome-wide SNPs are rapidly replacing microsatellites in paternity testing and genetic diversity studies, because of their robustness, low cost and automatic allele calling.

The Illumina OvineSNP50 BeadChip array features over 54,241 evenly spaced probes that target SNPs. It was developed as part of the International Sheep Genomics Consortium (ISGC; www.sheephapmap.org; Kijas *et al*.,2009). The OvineSNP50 BeadChip provides uniform genome-wide coverage with a mean gap of 50.9 kb.Recently, ovine HD BeadChip has been developed by ISGC that assays approximately 600K SNPs with an average genomic spacing of 5 kb. The array includes nearly all the content from the original OvineSNP50 array. This dense array will drastically increase the power of identifying key genes responsible for the desired measured traits.Similarly, International Goat Genome Consortium (IGGC; www.goatgenome.org) has developed GoatSNP50 chip by screening whole genome sequencing data of the following goat breeds: Alpine, Boer, Creole, Katjang, Saanen and Savanna (Tosser-Klopp *et al*.,2014). This chip is commercialized by Illumina (SNP50 BeadChip; www.illumina.com) and utilizes more than 52,000 SNP variants to provide uniform genomic coverage. A total of 10 breeds of goat were used to validate the 52k SNP content.

Both the SNP chips and whole-genome sequence data has been observed to provide much more accurate estimates of relationship between animals than pedigree information (Eynard *et al*., 2015) especially when pedigree records are incomplete or unavailable. In absence of accurate pedigree records, decisions about which animals to be conservedmay be biased leading to loss of genetic diversity. Genome-wide SNP genotyping/sequencing data has widespread implications in the process of *in vivo* and *in vitro* (genebank) conservation (Mucha and Windig, 2009) of FAnGR. Accurate estimation of co-ancestry not only permi have be mate assignment but also help in avoiding accidental inbreeding. The chips o? er su? cient SNP density for genome-wide association studies and other applications such as identi? cation of QTLs, genome-wide selection, determination of genetic merit, and comparative genetic studies, linkage disequilibrium and breed characterization for evaluating biodiversity.

Genomic selection

For centuries, arti? cial selection for economically important quantitative traits in domestic livestock species has been based on phenotypic records of the individual and its relativeswhere estimated breeding values (EBVs) are calculated by best linear unbiased prediction (BLUP).A novel approach was proposed by Meuwissen *et al* (2001) for estimating breeding value from DNA markers spanning the entire genome. Genomic selection refers to selection decisions based on genomic estimated breeding values (GEBV). The GEBV are calculated as the sum of the e? ects of all

genetic markers, or haplotypes of these markers, across the genome, thereby potentially capturing all the quantitative trait loci (QTL i.e. regions of the genome responsible for a portion of the genetic variance of a trait) that contribute to the variation in the trait of interest. With this approach, genetic e? ects of QTLs are estimated for each marker (haplotypes or SNP markers) and then summed up to predict the overall breeding value of any animal.Initially estimation of marker e? ects is carried out within a reference population, i.e. a large group of individuals with both phenotypes and marker genotypes information. In subsequent generations, only marker genotype information is required to calculate GEBV of candidates (Fig. 1).Genomic selection is thus a form of marker assisted selection in which densemarkers covering the whole genome are used so that all QTLprobably be in linkage disequilibrium (LD) with at least one or few markers.

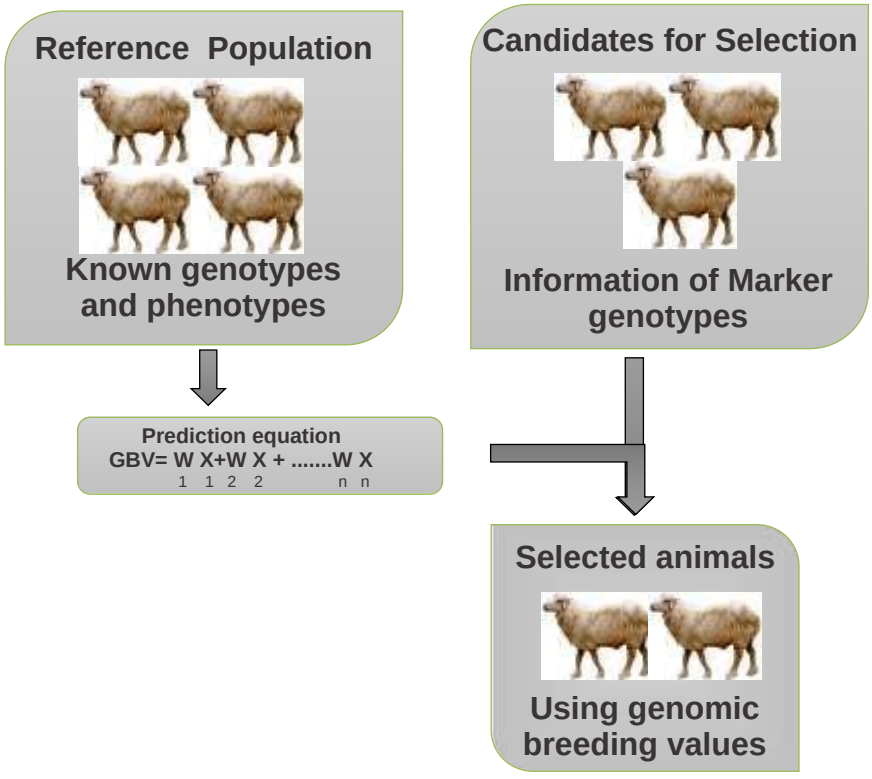

Figure 1: Schematic representation of Genomic Selection

Advantages of genomic selection

Under genomic selection, per year genetic gain depends on four parameters: genetic variability of the trait, intensity of selection, evaluation accuracy and generation interval. Last threefactors can be modi? ed by genomic selection. The main advantage of genomic selection is that candidates are evaluated and selected based on their marker genotypes information without phenotypic information either of their own or on their relatives/progeny. Therefore, selection can

be applied very early, just after birth or even on embryos which in turn reduces generation interval to a great extent (Meuwissen *et al*.,2001). Higher rates of genetic gain observed in genomic selection over traditional selection because GEBVs have higher reliabilities that BLUP EBVs. As the genotyping cost is going down day by day, a large number of candidates can be screenedand selection intensity can be increased. Moreover, large-scale screening also permits a be use of the available genetic resources. In addition to increasing selection accuracy, GS may reduce the rate of inbreeding per generation by providing additional information on Mendelian sampling e? ects of selection candidates more accurately,which reduces the co-selection of relatives (Daetwyler *et al*., 2007; Deckkers *et al*., 2007). The advantage of genomic selection may be appreciated highest in dairy ca breeding programs because generation interval in traditional progeny testing schemes is large and selection of young bulls for progeny testing is inaccurate (Schae? er, 2006); whereas genomic schemes found to be immediately pro? table. Furthermore, thousands of bulls that have been progeny tested in the last decades are available as reference population with reliable phenotypes, leading to GEBVs with high reliabilities (VanRadden *et al*.,2009). GS in ruminants are also useful for meat production breeds, for traits measured later in the life of reproductive females like reproductive ability, breeding seasonality and longevity. GS further be useful for traits (carcass composition and meat quality) which are recorded on relatives of selection candidates and require sacri? ce of animals.

Accuracy of Genomic selection in sheep and goat

Genomic selection in small ruminants has recently been evaluated in meat sheep of Australia (Daetwyler *et al*., 2012a, 2012b) and New Zealand (Auvray *et al*., 2014), dairy goats of France (Carillier *et al*., 2013, 2014) and UK (Mucha *et al*., 2015). Gains in GEBV accuracies were observed to be on average between 0.05 and 0.10 for carcass traits and meat quality traits in Australian sheep (Daetwyler *et al*., 2012a, 2012b) and between 0.05 and 0.27 (with a mean of 0.13) per breed for meat, ? eece, and li size traits in New Zealand Sheep (Auvray *et al*.,2014). A similar gain in accuracy between 0.10 and 0.20 was also observed by Baloche *et al*. (2014) across milk production traits in French Lacaune dairy sheep. The gain in GEBV accuracy in the French and UK dairy goat populations was 0.06 for milk yield and 0.14 for fat and protein content (Carillier *et al*., 2014). Except for New Zealand, which has 13,420 pure (mostly Romney) and crossbred sheep, the reference population sizes in all other GS studies mentioned above are still rather limited as compared with ca as reported to be well correlated with the reference population size and the genomic heritability of the trait(Daetwyler *et al*., 2012b), thus suggesting that accuracy and expected genetic gain can increase in the future if reference populations increase in size.

Status of linkage disequilibrium in sheep and goat

The extent of linkage disequilibrium (LD) between genetic loci has profound implications in QTL detection, accuracy of genomic prediction and genome-wide association studies. The extent of LD estimated by average r^2values between adjacent markers (50 kb) reported to be 0.15 and 0.13 in Spanish Churra sheep (Garcia-Gamez *et al*.,2012) and French Lacaune dairy sheep (Baloche *et al*., 2014), respectively. In Saanen and Alpine goat populations,LD was reported to be ranging from 0.10 to 0.18 (Carillier *et al*.,2013; Brito *et al*.,2015; Mucha *et al*.,2015a) and were mostly between 0.08 and 0.12 in sheep (Baloche *et al*., 2014; Kijas *et al*., 2014). Li higher LD (0.2) was reported in the population of Texel sheep (Mucha *et al*.,2015b). Soay sheep (Kijas *et al*.,2014) and boar goat (Brito *et al*., 2015) were an exception where higher LD ($0.28 < r^2 < 0.30$) was observed. This higher LD probably due to low primary e? ective population size. Extent of LD in di? erent breeds/populations of sheep and goat observed in di? erent reportsis lower than comparable estimates in dairy ca (0.20–0.23 at 40 kb; Khatkar *et al*., 2008; de Roos *et al*., 2008; Habier *et al*., 2010) or pigs (0.47–0.49 at 30 kb; Uimari and Tapio,2011). The level of LD estimated from most of the previous studies on sheep and goat populations indicated that the present Illumina Ovine SNP50 BeadChip and GoatSNP50 chip are not optimal and hence availability of a high-density SNP-array or the use of next-generation sequencing methods will improve the performance of QTL ? ne-mapping studies and accuracy of genomic selection.Recently, ovine HD BeadChip (600,000 SNPs) has been developed by the International Sheep Genomics Consortium (ISGC) with an average genomic spacing of 5 kb.

Potential of genomic selection in small ruminants

Genomic selection also has the potential to boos disease resistance potential in small ruminant such as facial eczema (Phua *et al*.,2014), parasite and ? y-strike resistance (Pickering *et al*., 2015). Genomic selection is also under way in large and small ruminantsfor e? cient selection of hard to measure traits such as feed e? ciency and methane emissions. Measurement of these traits involves considerable cost and facilities, making genomic selection an obvious alternative (Pickering *et al*.,2015).

Constraints of genomic selection in small ruminants

1. The higher cost of genotyping relative to the value of the animal is a strong economic barrier to undertake GS in sheep and goat.
2. In small ruminants, various important traits can be measured in both sexes before their reproductive maturity (growth, ultrasound carcass measures, and some disease resistance measurements).Hence, the potential of GS to accelerate genetic progress is less compelling.
3. In sheep and goat, small reference size, Low LD andlack of phenotypic records are the major impediments for its execution.
4. Genomic gain/year is less compared to large ruminants mainly due to lower selection

accuracy.

Status of QTL in sheep and goat

Economically important traits are mostly under control of quantitative trait loci (QTL). These QTLs need to be mapped and identi? ed so as to provide the information which can be used as a tool for genetic selection and genetic gain in the livestock species. The basic principle of QTL mapping is to ? nd the association of the genetic variation (V_g) with the phenotypic variation (V_p), which occurs within a family or pedigree of animals. QTL mapping depends on good experimental design, data storage and analyses (Bovenhuis *et al*., 1997; Sonstegard *et al*., 2001).As on December 30, 2016 with the *Release 31*, there are 1,412 sheep QTLs available for public access on the Sheep QTLdb. These data were curated from 123 publications and represent 218 di? erent sheep traits. The details of QTLs and traits (type or class) are given in tables 1-2.

Table1: Top 15 QTL/associations in sheep

.	Traits	Number of QTL
1	Average daily gain	74
2	Body weight	59
3	Milk protein percentage	46
4	Milk fat percentage	42
5	Milk Yield	41
6	Haemonchus contortus FEC	39
7	Fecal egg count	39
8	Bone density	30
9	Bone area	29
10	Maedi-Visna virus susceptibility	29
11	Immunoglobulin A level	26
12	Mean fiber diameter	23
13	Milk fat yield	22
14	Fat weight in carcass	22
15	Total lambs born	21

Table2: Number of QTL/associations by Trait Classes in sheep

S. No.	Trait Classs	Number of QTL
1	Meat and Carcass	368
2	Production	319
3	Milk	268
4	Health	242
5	Wool	98
6	Reproduction	61
7	Exterior	56

A Wordle representation of reported QTL/association traits in sheep is given in Fig. 2. This ? gure shows that the terms most frequently used in the QTL/association study related papers in sheep were milk and weight signifying the importance of growth and milk production in sheep.

Maximum numbers of QTLs were present on chromosome 2 (201) and 6 (185) as major genes for the body growth (myostatin, insulin like growth factor binding protein 5, gonadotropin releasing hormone 1 etc) and milk production (casein alpha s1, casein beta, casein kappa, toll like receptor 6, ? broblast growth factor 5) are located on these chromosomes.

Figure2. A Wordle representation of Reported QTL/Association Traits in sheep

Goats in general are poorly researched when compared to sheep and ca ery limited information is available about the goat QTL databases. Exploring the previous literature revealed only two known databases with su? cient information in case of goat viz Angora QTL database and GoSh database. QTL research in Angora goats has mostly been limited to certain growth traits and body measurements (Marrube *et al.*, 2004). Angoradb is a database for QTL research in Angora goats(Hefer *et al.*,2005).The GoSh db is a collection of 637Capra hircus and 58,353 Ovis aries EST sequences.

Selection signature in small ruminants

Selection brings speci? c changes in the pa of variation among selected loci and in neutral loci linked to them. These genomic footprints left by selection are known as selection signatures and can be used to ascertain loci subjected to selection (Kreitman, 2000). The recent advancement in sequencing technology, availability of vast genomic information on domestic animal species and improved statistical tools make the identi? cation of these footprints in a given species possible (International Chicken Genome Sequencing Consortium, 2004; The Bovine Genome Sequencing and Analysis Consortium, 2009; The International Sheep Genomics Consortium, 2010; Groenen *et al.*, 2012; Dong *et al.*, 2013). The identi? cation of selection signatures

provide valuable insights into the evolutionary processes that are shaping genomes as well as functional information about genes/genomic regions(Nielsen, 2001, 2005; Schlo 2003) which may or may not previously been identi? ed as contributing to any special trait in mapping populations. This approach couldalso lead to the identi? cation of genes related to ecologicaltraits (e.g., genes related to tropical adaptation) that are di? cul explore experimentally. The identi? cation of genes targeted by selection in livestock species may help to discover and validate the causal mutations (Nielsen, 2001; Schlo erer,2003; Hayes *et al*., 2008).The genes/gene networks,underlying a trait of interest, di? erentially expressed between breeds can also be identi? ed.

Strategiesfor identi? cation of selection signatures

The statistical tests used for selection signatures are mainly based on neutral genomic variation. They need di? erent kind of information like the haplotype structure of the population or the allele frequency distribution. Vi *et al*.(2013) classi? ed the di? erent methods of selection signature into two broad categories i.e. methods of macroevolution and microevolution. Macroevolution methods adopted the gene based approach like Ka/Ks or ω and McDonald-Kreitman test. In these tests synonymous substitutions are assumed to be selectively neutral. Thus, they tell us about the background rate of evolution. Signi? cant di? erence in the rate of non-synonymous substitution (ω >1) is the indication of selection signal. The microevolution methods (Vi *et al*; 2013) include (a) frequency based methods [Ewens-Wa test, Tajima's D and derivatives, Fay & Wu's H], (b) LD based methods [Long-range haplotype (LRH) test, Integrated haplotype score (iHS), Cross-population extended haplotype homozygosity (XP-EHH), Linkage disequilibrium decay (LDD), Identity-by-descent (IBD) Analyses], (c) population di? erentiation based methods [Lewontin-Krakauer test(LKT),

Locus-speci? c branch length (LSBL), hapFLK] and (d) composite methods [Composite likelihood ratio (CLR), Cross-population composite likelihood ratio (XP-CLR), DH test, Composite of multiple signals (CMS)]. Recently, a novel strategy, called de-correlated composite of multiple signals (DCMS) has been proposed by combining di? erent statistics to detect selection signatures (Ma *et al*., 2015) which was observed to have a higher power than most of the single statistics in the resolution of selection sweeps. Among the various statistics used for recognizing signals of positive selections from polymorphism data, the EHH, iHS and $_{ST}$F estimators are most commonly used.

Selection signature in sheep genome

The wide distribution of these species is a re? ection of their adaptability to di? erent environments and this has resulted in enormous morphological variation among populations (Kijas *et al*., 2009). Since their domestication, sheep have been selected for meat, wool and milk production. Kijas *et al*. (2012) performed a genome scan based on FST to detect selection signatures in a panel of 2819 individuals from 74 sheep breeds. Thirty-one regions showed selection signals and contained genes related to coat color, bone morphology, growth and reproduction traits. This analysis revealed a strong peak of di? erentiation surrounding the Growth Di? erentiation Factor 8 (GDF-8) gene when Texel individuals were compared with all other breeds (Kijas *et al*., 2012). Clop *et al*. (2006) showed a reduction in the variability of microsatellites surrounding this gene upon comparing hyper-muscled Texels with other sheep breeds. The region surrounding GDF-8 was associated with QTLs for carcass traits in the Texel breed, and a point mutation in the 3' UTR of this gene was suggested to be the causal mutation a? ecting extreme muscling in Texel individuals

(Clop *et al*., 2006).Moradi *et al*. (2012) performed a genome scan with approximately 50K SNPs to search for signatures of divergent selection in a comparison between fat and thin-tailed sheep breeds; their study identi? ed at least three regions (OAR5, OAR7 and OARX chromosomes) that have undergone selection. The regions identi? ed by Moradi *et al*. (2012) intersected with QTLs for carcass traits. Improvement in the sheep genome annotation will facilitate the search for and validation of candidate genes related to these traits.Sheep are reared mainly for meat, milk and wool production. Seven di? erent groups of sheep population (Africa, Asia, Central Europe, Italy, North America, South west Asia and South west Europe) were analyzed from the sheep HapMap data set to identify the selection signatures for coloration, morphology and traits of agro economic importance (Fariello *et al*; 2014). For coloration (hair, eye and skin colour), EDN3, KIT, KITLG, MC1R, MITF, SOX10, ASIP and BNC2 were found to be important candidate genes involved in the pigmentation. For body morphology, NPR2, HMGA2, BMP2, WNT5A, ALX4, HOXA, HOXC, ACAN were good candidate positions. HDAC9 was found to be the candidate positioned for muscling, ABCG2 for milk production, INSIG2 for milk fa acid composition and FGF5 for wool characteristics. However, identifying the casual variants under selection will require additional sequencing of these genes for individuals from several breeds with diverse background like color pa morphometry etc.

Selection signature in goat genome

There are more than 300 di? erent goat breeds worldwide. Guan *et al* (2016) detected selection signatures in candidate genes a? ecting the goat reproduction and production related traits such as neurohypophyseal hormone activity (PAIP2B, CCDC64, EPB41L5), photoreceptor activity and blue light receptor activity (BIRC6), meiosis and mitosis cell cycle (TAOK1, C6H4orf22,SGOL1,SLC33A1), pheromone activity (ZNF280D, CLEC16A, ARID1B, PAIP2), male gamete generation (FAT1, KDM4C, TPPP3, SBF1, PARD3B) adipocytokine signaling pathways (IKBKG,LOC102190823), ether lipid metabolism (PLD2, PLA2G1B), glycosphingolipid biosynthesis-ganglio series (SLC33A1) etc.

Perspective of genomic application in India and its impact on Livelihood security

India is a rich reservoir of small ruminant biodiversity with 42 sheep and 26 goat breeds spread across di? erent agro climatic conditions of tropical, sub-tropical, temperate type etc. The natural selection under diverse/harsh agro-climate resulted into unique genes/haplotypes and/or their combinations called loosely as breed. These unique genetic resources of sheep/goat do have desirable phenotypes for production, reproduction, disease resistance/resilience and ? tness. Deciphering the genetic basis of these phenotypes will help to augment their productivity under their own complete environment (climate, management, feeding resources, biotic/ abiotic stress etc). Genomic tools will reveal the complete genetic information at genome level to formulate suitable breeding strategies through balance between productivity and health, ? tness and adaptive traits to achieve set objectives (higher growth, more number of kids/animal, be quality of meat/milk, be health, etc). For achieving these set goals, the traditional selection of small ruminants based on recorded phenotype for higher productivity may be a di? cult proposition in view of poor economic status of small-scale farmers ($1.25/day earning) who may not be able to record the phenotypes. In absence of the pedigrees and phenotypes, genomic selection will be an alternate to conventional approach for their improvement. Therefore, there is a need to develop intuitional/cooperative mechanism to execute the screening/selection of these resources based on genomic information. The e? orts must be directed towards reducing the cost of genotyping of these animals. This can be done by making a low density customized array(s) of say1-2K SNPs for

speci?c objective through screening and selection of suitable markers. These markers may be picked up from existing arrays for small ruminants and then enriching them with SNPs speci?c to our indigenous breeds. Then, these novel SNPsmust be validated for their role in predicting genomic breeding value of the trait(s). With all these development in place, the farmers will feel encouraged to screen/select their kids at an early stage of their life for the traits of interest and thereby reducing the generation interval and hence, improved productivity and livelihood of these masses. Moreover, the choice of a species, breed or type that is well adapted to the total environment saves considerably on the resources that may otherwise be needed to o?set the choice of the wrong animal. For making a seasoned decision about the choice of animals for breeding will have desirable impact on productivity and livelihood of the farmers.

Conclusion

The use of genomic information will be resolve the genetic variation within and between the breeds. The genome wide markers will help to assess the genomic diversity and its use through genomic selection based on genomic estimated breeding value of an animal with/without phenotypic records and/or pedigree. The coe? cient of co-ancestry among the individuals can be estimated precisely and can be used to avoid inbreeding and preserve the diversity in the small ruminants. The loci under selection (signature) can also be exploited to choose the be animal and to improve the SNP arrays.

References are available with the authors.

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Prospects for Production of Transgenic and Genome edited Animals

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Genetically modi?ed small ruminants represent useful models for large-scale production of novel proteins or products for biomedicine and improving the economically important traits in these species. The ?rst transgenic animal was produced during 1980 by injecting gene construct into male pro-nucleus of zygote through microinjection, however this technique su?ers from several drawbacks such as uncontrolled and/or random integration of gene, unpredictable transgene expression and appearance of mosaicism. After the advancement of SCNT technique in late 1990s, this technique has become viable technique to introduce the gene of interest in donor cells and subsequently fusion of donor cells into enucleated oocytes to generate the genetically engineered animals. In the recent years, several modern tools like Zinc ?nger nucleases (ZFNs), transcription activator like e?ector nucleases (TALEN), and clustered regularly interspaced palindromic repeats (CRISPR)/CRISPR associated protein 9 (Cas9) molecules have been designed and being used to edit/insert/delete the function of the host DNA sequence or gene of interest very precisely. These tools have been used in the modi?cation of economically important traits in sheep

and goats worldwide. For instance, myostatin gene has been edited in sheep and goat by TALEN technique. Similarly, the goat primary ? broblast cells have been edited by CRISPR/Cas9 and these gene edited ? broblasts were used in SCNT to generate edited goats. Indeed, in merely 5-6 years, these molecular scissorshave produced more than 300 di? erently edited pigs, ca sheep and goats worldwide. Subsequently, transgenic goats were produced for human alpha lactalbumin protein in their milk through SCNT approach. TALEN basedhomologous recombination (HR) approach have been used to knockout the β-lactoglobulin gene from goat and knock of the human lactoferrin and alpha lactalbumin gene into goat genome. Such gene edited goats exhibited the expression of β-lactoglobulin protein and abundantly secreted the human a-lactalbumin in their milk. Such e? orts have not been a in sheep and goats of India. Therefore, the production of sheep and goat with improved economic traits or novel genes through transgenic and genome editing approach is challenging research in India. Hence, e? orts should be made to use such viable transgenic and genome editing techniques to enhance the animal production potential, to produce therapeutic proteins for bio-medicine and develop several genetic models for studying the human and animal diseases in India.

Introduction:

Transgenic animals are produced by transfer of foreign DNA or gene into the genome of host animal. The DNA that is introduced is called 'transgene'. The overall process is known as transgenic technology or transgenesis. The basic principle of transgenesis is that after transfer of the foreign gene into a genome of organism, the organism will exhibit a new property and transmit to its o? spring. Transgenic animals are able to express the foreign gene (s) because the genetic code is similar in all organisms. Therefore, speci? c DNA sequence will code the same protein in the organism. Presently, the possibilities for modifying the genome of animals are cheaper, easier, more e? ective, and less time consuming than several decades ago. Sheep and goats can be used as models for the application of transgenic and genome editing technology. After the generation of ? rst transgenic mice by pronuclear microinjection in 1981 (Gordon et al., 1981). Sheep were one of the ? rst farm animals subjected to genetic modi? cation in 1985 (Hammer et al., 1985). After production of Dolly (a clone sheep), the ? rst clonewas produced from an adult mammary gland epithelial cell, the ? rst transgenic sheep produced by nuclear transfer technique in 1997 (Schnieke et al., 1997). Some years later, goats were the ? rst species in which a pharmaceutical proteinwas produced from GE animals, which was approved for human use by the European Medical Agency in 2006 and by the US Food Drug Administration in 2009 (rhantithrombin III, ATryn). In the recent years, researchers have used the genome editors for alteration of the myostatin and beta lactoglobulin protein in sheep and goat (Cui et al., 2015; Proudfoot et al., 2015; Yu et al., 2016; Zhou et al. (2017).In addition of the above, transgenic animals have been produced for several purposes like improving the economic important traits of domestic animals. It can also be used as animal models for human diseases (Onco-mouse), delineating the function and regulation of newly discovered gene, screening of drugs and chemicals (toxicological study), gene pharming (because of easy puri? cation of the recombinant proteins from milk and production of large quantities of

protein from animals). The current review paper provides adetailed overview of the state of the art and new insights in the production of transgenic and genome edited sheep and goats.

Important milestones toward the production of transgenic sheep and goats

The world ? rst transgenic mouse was produced in 1974 by using SV40 DNA and their o? spring were developed leukemia (Jaenisch, 1974). The ? rst successful gene-transfer experiment was conducted in pro-nuclei of mouse using DNA microinjection(Gordon et al., 1981). The mouse was produced as the ? rst transgenic animal using micro-injection method (Gordon et al., 1981). Subsequently, super mouse was produced by incorporating human growth hormone gene (Palmiter et al., 1982). Further, mice were produced to synthesize the proteins in their milk that engineered to produce human tissue plasminogen activator (tPA) (Gordon et al., 1987).The sheep was the ? rst transgenic livestock animal produced by nuclear transfer (Schnieke et al. 1997). In the recent years, researchers have used the TALEN based homologous recombination (HR) approach to knockout the β-lactoglobulin gene from goat and 'knock in' the human lactoferrin gene in the goat genome (Cui et al., 2015). Sheep and goat have been produced after editing of themyostatin gene for enhancing the double muscling characters (Proudfoot et al., 2015; Yu et al., 2016). Zhu et al. (2016) have successfully knocked out the β-lactoglobulin gene using TALEN based HR approach and 'knock in' the human α-lactalbumin on the locus of β-lactoglobulin of goats. These transgenic goats exhibited down regulation of β-lactoglobulin protein and abundantly secreted human α-lactalbumin in their milk. Zhou et al. (2017) have used CRISPR/Cas9 approach to knock out the β-lactoglobulin gene in goat.Recently, transgenic goat has been produced by using testis mediated gene transfer technique (Pramodand Mitra, 2018).

Embryo production: a prerequisite for embryo manipulation

It is well known that advanced reproductive technologies play a critical rolein the generation and propagation of transgenic founderanimals. Hence, the starting point for the generation of founder animals is the acquisition of highquality oocytes and/or zygotes. Obtaining oocytes from aba ovaries sometimes represent a valid alternative for research projects. In small ruminants, *in vivo* produced zygotes were used for pronuclear microinjection(Ebert et al., 1993) and *in vivo* matured (ovulated) oocytes for nucleartransfer (Baguisi et al., 1999).Laparoscopic ovum pick-up (LOPU) and *in vitro*embryo production are currently well established methods of choice for the production of putative transgenicembryos for transfer into recipients (Baldassarre et al., 2002).In sheep and goats, the method of choice for productionof transgenic animals was the microinjectionof *in vivo* produced zygotes.Although this method results in zygotes of highdevelopmentalcapacity, the procedure is characterized bya great deal of variability in the number and stage ofdevelopment of ova recovered per donor. More recently, transgenic goats were e? cientlygenerated by microinjection of zygotes produced *in vitro*starting from immature oocytes sourced by laparoscopic ovum pick-up (LOPU)(Baldassarre et al., 2003). Thisprocedure has reported to be more e? cient as it yields ahigher average of pronuclear-staged zygotes for microinjection purposes.After LOPU, the oocytes are subjected to IVM (Baldassarre et al., 2002; Crispo et al., 2015). After IVM, the matured oocytes can be used in SCNT or they can be subjected to

IVF to generate zygotes. *In vitro*fertilization can be conducted in TALP medium (Parrish et al., 1986) in goats and in mSOF medium (Tervit et al., 1972) in sheep. Both medium is supplemented with 2% to 20% estrus goat and/or sheep serum, as per the protocol (Baldassarre et al., 2002; Crispo et al., 2015). Usually, in these conditions, the expected fertilization rate is about 70% to 90%.Subsequent to fusion and activation of the reconstructed embryos of SCNT, or after DNA/RNA microinjection into zygotes, or after sperm injection and activation when intracytoplasmic sperm injection (ICSI) is used for gene transfer, the embryos must be cultured *in vitro. In vitro* culture is conducted in mSOF medium following standard operating procedures previously described for goats (Baldassarre et al., 2002) and sheep (Crispo et al., 2015).It is believe that more o? spring are born when early embryos are transferred into the oviduct. There are several methods have been used for production of the transgenic and genome edited animals, which are given below:

1. Pronuclear microinjection:

Genome modi? cations can be classi? ed according to some intrinsic characteristics as the mechanism of insertion into the host genome (active or passive), speci? city of site of insertion (random or targeted), or the choice of gene modi? cation (gene insertion or gene deletion). The injection of multiple copies of a DNA construct into the pro-nuclei of zygote-staged embryos has been the method of choice for the establishment of transgenic founder animals for many years (Hammer et al., 1985; Ebert et al., 1993). This method represents an active and random procedure for gene insertion. Although the procedure is somewhat reliable, but usually less feasible than in mice and rather ine? cient (<10% transgenic o? spring, unpredictable transgene integration andexpression). It is much feasible in mice than in sheep and goat. The procedure is costly, time consuming and require highly skilled person.Moreover, transgenic animals show high percentage of mosaicism. Sometime transgene may disrupt the functional gene of host animal and may integrate thehigh copy number at one locus.Before microinjection, the ovine and/or caprine zygotes are typically centrifuged to stratify the cytoplasm and allow be visualization of pro-nuclei. Under 400x magni? cation, one by one, zygotes are hold in position using the micromanipulator's holding pipe and the DNA construct is injected into one of the two pro-nuclei of the zygotes using the microinjection pipe Successful injections are judged by observing the expansion of pro-nuclei to about50% increase of original diameter.

2. Somatic cell nuclear transfer based transgenesis:

An a was made in 1995 when scientists from Roslin Institute have produced Megan and Morag sheep (the ? rst mammals successfully cloned) by using embryonic stem cells derived from a nine-day-old sheep embryo (Campbell et al., 1996). After the birth of Dolly (Wilmut et al., 1997), SCNT was quickly pronouncedas method of choice for the generation of transgenic sheep (Schnieke et al., 1997), ca (Cibelli et al., 1998), goats (Keefer et al., 2001), and pigs (Park et al., 2001). By using this method, gene modi? cation is performed by incorporating the gene construct into the cell's genome during culture, allowing the transgenic cells to be fully characterized (site of integration, number of integrated copies, and integrity of the transgene) before use in the fusion of transgenic cells with enucleated oocytes for generation of transgenic embryos through SCNT

approach. As a result, although the developmental capacity of “reconstructed” NT embryos is lower, all the o? spring born should be transgenicmaking this technology much more e? cient than pronuclear microinjection. Several cell types have been used for the generation of transgenic animals using SCNT; however, the most popular cell types are the fetal ? broblasts followed by adult skin ? broblasts and cumulus-granulosa cells (Baldassarre et al., 2003). It has been found that the thedonor cells (G0 stage) or in a proliferating stage (G1) provides more cloning e? ciency. Serum starvation (low-serum conditions) can also be used to synchronize cells in G0 but can have detrimental consequences (Kues et al., 2000). Alternatively, cells can also be synchronizedby prolonged culture at con? uence (G0 arrest).

In small ruminants, initial work has been conducted using *in vivo* matured (ovulated) oocytes (Baguisi et al., 1999). This procedure is very invasive and results in variable numbers and stages of maturation of oocytes, so it was quickly replaced by the use of *in vitro* matured oocytes. Matured (MII staged) oocytes are stained with Hoechst 33342, enucleated under short exposure to UV light, and used as recipient cytoplasts. Alternatively, the oocytes can be cultured for 1 hour in media-containing demecolcine to visualize the position of the MII plate and remove the chromosomes by aspiration with a microinjection needle. Individual donor cells are transferred into the perivitelline space of the enucleated oocytes, followed by fusion of the oocyte-cell couplets using an electric pulse that can be repeated. Following fusion, the reconstructed embryos are activated using calcium ionomycin and cycloheximide. Finally, embryos are cultured until transferred to synchronized recipients (Baldassarre et al., 2003). The generation of a live genetically modi? ed animal resulting from SCNT embryos is extremely useful but has a relative low e? ciency and is susceptible to developmental anomalies. About 10% of transferred embryos resulting in live o? spring are usually obtained. Abnormal epigenetic programming have been detected in clones that fail during gestation or have development anomalies. Such issue should be resolved if SCNT e? ciency is intended to be improved (Long et al., 2014). Baldassarre et al. (2003) reported that the largest source of variation in the success was related to the donor cell line.

3. Lentivirus based transgenesis

Lentiviral vectors (LV) have been used in active transgenesis(Pfeifer, 2004; Lois et al., 2002). They have intrinsic ability to integrate into the host genome. Because they are able to e? ciently integrate into the genome of dividing and non-dividing cells with lower gene silencing than other strategies (Pfeifer et al., 2002). This technique was tested with success in several large species such as pig, ca and also sheep (Crispo et al., 2015; Ritchie et al., 2009). The main strengths ofthis technique are the easy injection of the LV into the perivitelline space with low embryo injury, and the high e? ciency to produce transgenic animals.Sheep model has been successfully produced usingLV transgenesis in sheep (Ritchie et al., 2009). The production oftransgenic sheep with this technology has been verye? cient elsewhere(Crispo et al., 2015), with 97.4% of embryos showinga strong GFP expression *in vitro*, 100% (9/9) of lambs bornbeing GFP positive, and 88.9% (8/9) showing a strong andevident GFP expression. In addition, transmission of the transgene to the progeny was observed in green ? uorescentembryos produced by IVF using semen from

thetransgenic founder lambs (Crispo et al., 2015).Safety of LV transgenesis has been addressed regardingtheir viral origin. It has been found that the LV doesnot cross the fetal-maternal barrier infecting the recipientewes. However, small size of the vectors (up to 8 kb), therandom integration of a single copy but in multiple sites,and the di? cult production of high titer virus free of contaminantsin the laboratory makes this technology notvalid to everyone (Remy et al., 2010). This technique requires less embryo micromanipulation skillsand is still much more e? cient than other techniques likepronuclear microinjection and present much lower embryoinjury than SCNT (Hofman et al., 2003; Whitelaw et al., 2008).

4. RNA interference (RNAi)

RNAi was used in the year 2000s as a promising tool to knock-down the proteins of interest in cultured cells culture and animals (Hammond et al., 2001; Lewis et al., 2002). This technique is based on the sequence-speci? c pos gene silencing mechanism. This technique has a good e? ciency using both small interfering RNA (siRNA) and small hairpin RNA (shRNA). In 2006, for the ? rst time RNAi was reported in small ruminants using LV technology to deliver a GFP transgene with a shRNA to suppress the expression of prion proteins in goat ? broblasts (Golding et al., 2006). Finally, a cloned goat fetus was produced by SCNT. Tissues from the cloned fetus expressed the GFP, and found a decrease of 90% in the expression of the prion protein in the brain by Western blot analysis. Further, transgenic sheep was produced for knock down of myostatinwithshRNA technology in ? broblast which was later fused with demi-oocytes tusingSCNT (Hu et al., 2013). Three live lambs expressing the shRNA targeting myostatin in muscle cells were produced, with a signi? cant reduction of the protein expression. The same group had reported the e? ciency of siRNA for downregulating the expression of the myostatin gene in *in vitro*produced adult sheep ? broblast (Tang et al., 2012).Using the combination of these three technologies (i.e., RNAi, LV and SCNT) could be a good option to produce knock-down animals.

5.Sperm-mediated gene transfer (SMGT)

For the ? rst time, Lavitrano et al. (1989) reported that mouse spermatozoa are able to “capture” foreign DNA molecules added to the sperm suspension. They reported 30% e? ciency for production of transgenic pups. Thus, this technology relies on the DNA bound of sperm cells before fertilizing oocytes *in vitro* or by ICSI. To validate this technology in *in vitro* produced goat embryos, Shadanloo et al. (2010) incubated buck sperm with di? erent pcDNA/his/Lac-Z plasmid concentrations and used it for IVF or ICSI in di? erent conditions (i.e., IVF, motile sperm-ICSI, live-immotile sperm-ICSI, dead sperm-ICSI, or sham). Blastocyst development rate ranged from 11.7% to 26.2% among groups, with no signi? cant di? erences with the development rate of control group (sham, 35.0%). Transgene expression was only observed in live-immotile and dead ICSI groups (9.5% best e? ciency rate). It was concluded that transgene transmission and expression are a? ected by the technique used and the sperm status. In 2010, Zhao et al. (2009) reported the birth of transgenic livegoats using sperm-mediated gene transfer (SMGT) witharti? cial insemination using di? erent doses of fresh orfrozen semen. Pereyra-Bonnet et al. (2008, 2011) reported animprovement in *in vitro* blastocysts development afterSMGT for ICSI by using haploid chemical

activation o? njected oocytes with ionomycin plus 6-dimethylaminopurine and obtained over 80% of EGFP expression in blastocystswith this approach.Another interesting approach called testis-mediatedgene transfer has been ? rstly reported in mice obtaining94% success rate (Dhup and Majumdar, 2008). This technology produces transgenic spermatozoa bytransfecting undi? erentiated spermatogonial stem cellswith gene construct. To validate testis-mediated gene transfer insheep and goats, some approaches have been reported withinteresting outcomes and acceptable e? ciency (He et al., 2012; Raina et al., 2015; Pramod et al., 2018).

6. Site-speci? c recombinases mediated transgenesis

Site-speci? c recombinases are originally found in bacteria, bacteriophage and yeast and these enzymes catalyze site-speci? c recombination between two speci? c DNA sequences and promotes integration, deletion, or inversion of DNA, depending on the orientation and direction of two recognition sites. The most common tool for *in vivo* genome engineering in rodents is the bidirectional tyrosine-type simple recombinase (Crerecombinases). Theenzymecatalyze reversible site-speci? c recombination events between two identical sequences (34-bp loxP sites for Cre). The Cre/loxP site-speci? c recombination system has been tested in goat ? broblast cells for SCNT (Xu et al., 2008). Two cloned goats were born using TAT-Cre recombinase system, showing that this system is functional to produce SCNT transgenic goats. PhiC31 integrase has been used in sheep and goat ? broblast cells, since it has some advantages over the Cresystem such as e? ciency, unidirectional integration, high levels of long-term transgene expression, and no size limitations (Calos, 2006).

7. Zink Finger Nucleases

Zinc ? nger nuclease (ZFN) can be recognized as a restriction endonuclease that can be directed against any target DNA sequence. Nevertheless, they remain a highly programmable, precise genome-editing technology for livestock (Lillico et al., 2013). Genome editors have two basic parts: the endonuclease which actually cuts the DNA and something that directs the endonuclease activity to a speci? c DNA sequence. For ZFNs, the restriction endonuclease is *Fok1*, whereas the targeting speci? city is mediated through the Cys2-His2 zinc ? ngers (Urnov et al., 2010). Zinc ? nger small peptides are one of the most common DNA binding domains in mammals and common to many transcription factors, with each ? nger speci? cally binding to a 3-base sequence. They are modular in nature and can be combined, usually as three or four adjacent ? ngers to target nine or 12 bases in a given DNA sequence. ZFNs are used as pairs which recognize target sequences in adjacent opposing DNA strands. When both partners in the pair bind to their respective target sequence, this brings together on the intervening sequence the *Fok1* which is an obligate dimeric enzyme. The result is a targeted double stand break (DSB). ZFNs have been successfully applied to many species, but as yet there are no reports of genome-edited sheep or goats. Because they have been successfully used in zygotes for pigs (Lillico et al., 2013) and are functional in ovine and caprine cells (Zhang et al., 2014; Song et al., 2015).

8. Transcription activator–like e? ector nuclease

Transcription activator–like e? ector nucleases (TALENs) are similar to ZFNs in that they are

based on the *Fok1* endonuclease with targeting speci? city through peptides. For TALENs, these peptides are thetranscription activator like-e? ector (TALE) domain existing in bacteria of plants, with each TALE domain recognizing a single DNA base. Each TALE consists of 34 amino acids with those at position 12 and 13 recognizing DNA and termed the repeat variable diresidue (RVD). TALENs have been used to produce genome-edited sheep (Proudfoot et al., 2015).They injected TALEN mRNA into the cytoplasm of aba oir-derived IVF oocytes and 24% blastocyst development rate was observed. A total of 26 blastocysts were transferred into nine recipient ewes with eight pregnancies going to term. Of the nine live lambs produced, one was shown to carry a heterozygous edit at the myostatin locus. In goats, gene targeting through TALEN-induced homologous recombination was recently reported for sequential gene knockout followed by gene knock-in by SCNT (Cui et al., 2015). The authors have produced β-Lactoglobulin-free milk in goats for the large-scale production of human lactoferrin in milk.

9. CRISPR/Cas system

The Clustered Regularly Interspaced Short Palindromic Repeat (CRISPR) and CRISPR associated gene 9 (Cas9), di? ers from the *Fok1*-based tools in that uses RNA to confer target speci? city. It is based on an ancient archaea- and eubacteria-adaptive immune defense system. It comprises several components; the CRISPR RNA (crRNA) array of exogenous DNA targets (protospacers) and direct repeat sequences, transactivating crRNA (tracrRNA), and Cas9 gene. The tracrRNA facilitatesprocessing of crRNA array into a 20-nt guide sequence and a partial direct repeat. The 20-base ribonucleotide guide sequences directs the Cas9 nuclease to the target site by Watson-Crick base pairing, which with a unique protospacer adjacent motif (PAM) directs cleavage of target site. The clever aspect in the development of this tool was the combining of crRNA and tracrRNA as a single guide RNA sequence (Doudna et al., 2014). The CRISPR/Cas9 system is extremely easy to set up in a general molecular biology laboratory. The reagents are not so expensive and quick to make. Since unlike both ZFN and TALEN the endonuclease is not physically tethered to the DNA recognition function, simultaneous delivery of multiple single guide RNA realistically o? ers multiplex-editing opportunities to be developed. CRISPR/Cas9 mRNA was injected into the cytoplasm of sheep zygotes. The cleavage rate and *in vitro*development of blastocyst comparable to that of control-injected zygotes, showing that the technique was innocuous for embryo survival. Genotyping of zygotes indicated a 50% editing frequency and from the 53 transferred blastocysts, 22 lambs were born of which eight bi-allelic and ? ve heterozygous-edited sheep for myostatin. The homozygous animals displayed the anticipated heavier body weight with double-muscled phenotype. This systemwas also recently ? rst reported in goats (Ni et al., 2014). The authors used CRISPR/Cas9-mediated approach to induce mono-allelic and bi-allelic gene knockout in goat primary ? broblasts. Four genes were disrupted simultaneously in caprine cells, which were successfully used for SCNT resulting in live-born goats harboring bi-allelic mutations.

10. Challenges and future direction of genome-editing

The genome-editing tools have a bright future with regards to sheep and goat and

compared to the traditional strategies (Fahrenkrug et al., 2010; Clark et al., 2003). To date, only non-homologous end joining (NHEJ) has been reported in sheep and goats. We still need to determine if o? -target truly represent a constraint, with recent mouse studies indicating that they are probably not of much concern (Iyer et al., 2015). Strategies to reduce o? -targets e? ects are continually being obstacle and can be overcome by use of nickase variant enzymes (Frock et al., 2015); however, they currently are much less e? cient than those which cause DSBs. The overall e? ciency of genome editor delivery is good; with some reports achieving 100% of live born animals carrying an edition at the target site (Bhanu Telugu, University of Maryland). The microinjection of Cas9 protein instead of mRNA has proven to be more e? cient to obtain HDR in mice and rats (Menoret et al., 2015) and is likely that it will also be the case with farm animals. Speci? cally, the issue of mosaicism in founder edited animals produced from injected zygotes needs to be tackled. Delivery of the editing reagents should be at the zygote level or the editing event can be produced in cells destined for SCNT, a route that may o? er multiplex editing strategies more easily than through zygote injection. The multiplex editing approaches, conditional strategies and o? -target free systems, are the challenges that are envisioned in the production of genetically engineered farm animals in the future.

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Milk production of Jakhrana goats under selective breeding

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Goats (Capra hircus) are one of the oldest domesticated species and have been used for their milk, meat, hair and skins. Goats are adapted from the wild version, “Capra aegargus”. It constitutes very important species of livestock, mainly on account of their short generation interval, good number of breeds and population.Goats are distributed over all types of ecology with more concentrated in the tropics, dry zones and developing countries. India with 135.17 million goats is one of the largest goats owning country in the world and playing a signi? cant role in livelihood and nutritional security.A small unit of Jakhrana goats is maintained at CIRG, Makhdoom as Jakhrana breeding nucleus ? ock. Animals were kept separately according to their reproductive and productive status.These animals were maintained under semi intensive system of feeding management.Data were collected from 58 does. 30 days (60.01±2.42 liter), 60 days (115.61±4.05), 90 days (154.05±10.59) and 120 days (203.05±11.85) milk production of Jakhrana does for the year 2017-18 were recorded in liter and this milk production of 2017-18 were compared with 2013-14, 2014-15, 2015-16 and 2016-17. Females are selected on the basis of 90 days milk production for selective breeding. Milk yield 2017-18 for 30, 60, 90 are increased than does kidded in 2013-14, 2014-15, 2015-16 and 2016-17. Year was highly signi? cant for all milk traits.

ABS (ORAL) : GRG-02

Estimation of growth performance in Sirohi goat under ? eld conditions

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The data on 6772 growth records of Sirohi goats maintained at All India Coordinated Research Projecton Sirohi goat at Livestock Research Station, Vallabhnagar, Udaipur, India**, and recorded between 2004 and 2016, were analysed to study the growth related traits and their genetic control. The overall least squares means of body weight at birth,** W3M, W6M, W9M, W12M, were 2.34±0.03, 12.44±0.19, 16.31±0.22, 20.08±0.47 and 25.09±0.40 kg, respectively while least-squares means for Pre- and Post-weaning average daily gains were 113.66±2.15 and 46.17±0.94 g/day, respectively. The various non-genetic factors exhibited variable e? ects on the growth traits at di? erent phases of age. Cluster and Period of birth had signi? cant e? ect on all growth traits. Season of birth had signi? cant e? ect except birth weight. Summer born kids heavier and higher body weight and pre- and post-weaning gains than winter and rainy season born kids. Males had a higher weight and higher daily gain than females at almost all stages of growth. Kids of Primi-parous dams had signi? cantly lower birth weight as compared to multiparous dams' kids. **Single born kids had a distinct advantagover those born in multiple births at all stages of growth. The regression on dam's weight at kidding were positive signi? cant for all stages of growth traits.**The heritability estimates of all body weights and weight gains at di? erent stages of growth were moderate (0.16-0.28), except for post-weaning average daily gain, which had low heritability (0.07±0.01). The phenotypic and genetic correlations among the di? erent growth traits were positive and high, except for phenotypic correlation between pre- and post-weaning gains which was negative. Four non-linear growth models, viz., Gomper Brody, Logistic and Von Bertalan? y were used to describe the growth pa in Sirohi kids based on the growth parameters. Brody model was superior with highest R^2(98.8%) and lowest MAE (0.766), MAPE (0.07) and AIC (2.36) values than the other models.

ABS (ORAL) : GRG-03

Improvement in growth performance of Chokla sheep:A promising breed of Rajasthan

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The All India coordinated Research project on sheep breeding was initiated in 1971. Since then Chokla sheep was the one of the native breed used for cross breeding with exotic animals. From 1991 AICRP on sheep breeding has been converted into Network Project on Sheep Improvement to undertake survey, evaluation & improvement of indigenous sheep breeds.In 2013, Chokla ? ock was shifted to ARC, Bikaner nearer to its breeding tract.The data on the body weights at di? erent stages over the period of 43 years (1974-2016) were analyzed to observe the overall performance of animals at di? erent stages and di? erent periods. Recordings of more than 6000 lambs have been recorded with pedigree information since 1974. The overall least squares means of birth, 3, 6, 9 and 12 month's weight of lambs were 2.78±.009 (6012),12.47±.05 (5051), 18.25±.08 (4396),20.53±.09 (3753) & 23.85±0.10 (3213) kg, respectively. The six month body weights varied between 12.55 and 24.20 Kg whereas 12 month body weight varied between 18.27 to 32.51 Kg. All the body weights at di? erent stages were signi? cantly a? ected by period and sex. The body weight at three month improved by 88.59 percent i.e. from 8.94 kg to 16.86 kg over the period after start.The body weight at six month improved by 92.82 percent i.e. from 12.55 kg to 24.20 kg over the period.Positive genetic trend, considerable amount of heritability and low level of inbreeding in the ? ock indicates scope of further improvement in the performance of Chokla sheep with scienti? c management. Signi? cant improvement in growth performance depicts a possibility of its use as a dual purpose sheep in future.

ABS (ORAL) : GRG-04

Genetic polymorphism of growth hormone gene and its association with body weight in local goat of Bihar

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Growth hormone (GH) is an anabolic hormone stored in preformed form in secretory granules of somatotroph cells of the anterior pituitary and is released by exocytosis in response to appropriate stimuli. Polymorphs of growth hormone gene are reported to be signi? cantly associated with milk production and growth performance traits in various species of livestock. Therefore, the present study was undertaken to detect polymorphism in the growth hormone gene at the genic level in local goat (crosses of Bengal with non descript goat) of Bihar. A total of 100 goats of same age, sex and season of birth were included under the present investigation. Genomic DNA was extracted from blood samples of the contributing animals and used to amplify a 472bp fragment (partial intron 2, exon 3 and intron 3 and partial exon 4) of growth hormone gene by polymerase chain reaction. Primer was designed on the basis of sequence available publicly at NCBI. PCR programme followed for ampli? cation of gene fragment was initial denaturation for 95-°c for 2 min than 30 cycles of denaturation at 95°c for 30 sec, annealing at 60°c for 45 sec, extension at 72°c for 45sec and then ? nal extension of 72°c at 5 min. Subsequently, the SSCP study was carried out to identify di? erent allelic pa and genotypes of the animal included in the study. 12% native PAGE gel was run for 12 hr at 4°c to identify various allelic pa of growth hormone gene. SSCP typing in Black Bengal goat revealed ? ve genotypes AA, AB, AC, BB and CC and three alleles

A, B and C of growth hormone gene. The genotype frequency of AA, AB, AC, BB and CC genotype was 0.28, 0.34, 0.19, 0.15 and 0.04, respectively. Consequently allelic frequency of A, B and C allele was 0.545, 0.320 and 0.135, respectively. Least squire analysis revealed that genotypes of 472 bp fragment have no signi? cant e? ect on body weight at 3 and 6 month of age. However it has signi? cant e? ect ($P \leq 0.05$) on body weight at 9 month of age in studied population of goat. Animals having AC genotype had highest body weight where as animals having CC genotype had lowest body weight.

ABS (ORAL) : GRG-05

Molecular characterization of Shahabadi sheep in hot and humid middle Gangetic plains of Bihar

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Sheep farming is one of the major occupations of rural India and plays an important role in the livelihood of small and marginal farmers and landless labourers. Basically, in Bihar, it is a traditional occupation of economically backward classes, however, educated and socially advanced people have also joined hands in sheep farming considering it a pro? table business and maintaining them scienti? cally.Among the registered breeds of India, Shahabadi, is the only one native to Bihar, is registered. A total of 50 unrelated Shahabadi sheep selected randomly from di? erent ? ocks were used for analysing genetic variability between individuals within the breed using 10 microsatellite markers. The estimates of mean genetic variability parameters revealed that the mean observed and e? ective numbers of alleles to be 6.5 and 5.35 respectively. The mean observed and expected heterozygosities were observed to be 0.8560 and 0.8075 respectively, and the mean polymorphic information content (PIC) was reported to be 0.7806. The high heterozygosity values obtained in the present study could be a to low level of inbreeding as a result of wider geographical distribution (in 8 districts of Bihar), low selection pressure, large number of alleles present in the population and the combination of these factors.The results of χ^2 test of goodness of ? t revealed that the Shahabadi sheep population was under Hardy-Weinberg Equilibrium for all the 10 loci subjected into microsatellite analysis. These results also re? ected the absence of systematic and dispersive processes and genetic substructure in the Shahabadi population.

ABS (ORAL) : GRG-06

Genetic Analysis of Body Weights of Sangamneri Goats under Field Conditions

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The body weights of Sangamneri goats were collected from the registered goat keepers of All India Coordinated Research Project on Goat Improvement (Sangamneri ? eld unit), M.P.K.V., Rahuri for the period from 2004 to 2016. To determine the e? ects ofvillage cluster, year and season of birth, type of birth and sex as non-genetic factors and sire as genetic factor on growth traits the data were analysed by least square technique. The overall least squares means for body weights at 1, 3, 6, 9 and 12 months of age in Sangamneri goats were 5.07 ± 0.01, 9.50 ± 0.02, 14.80 ± 0.03, 18.85 ± 0.06 and 22.78 ± 0.10 kg, respectively.The body weights at 1, 3 and 6 months in Sangamneri goat were signi? cantly in? uenced by village cluster, year of birth, sex, type of birth and sire except body length not a? ected by type of birth. However, body weight at 9 and 12 month of age signi? cantly a? ected by village cluster, year of birth, sex, type of birth and sire except season of birth. Genetic and phenotypic correlations among body weight were reported positive and signi? cant (P< 0.01) at all stages of age studied. The heritability for growth traits i.e. 1, 3, 6, 9 and 12 months body weight was 0.192±0.02, 0.402±0.02, 0.641±0.02, 0.756±0.02 and 0.512±0.02, respectively.

ABS (ORAL) : GRG-07

Exploring polymorphisms and e? ects of candidate genes on milk fat and protein quality in Munjal sheep breed

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Munjal, dual purpose (milk and meat) breed is popularamong the farmers of Punjab, Haryana and Rajasthanmaintained primarily for mu production due to its be e e? ciency. Animals of Munjal sheep are quite large in size, tall,rectangular and massive with long tail. Head is long withRoman nose and narrow forehead, both sexes are polled.Ears are large and leaf like hanging down with ? at cheeks.Fleece is white and coarse. Udder is well developed andmedium sized with medium teats. Rearing under organizedfarm conditions, Munjal sheep is very economical due toits earlier maturity, faster growth and shorter lambinginterval as compared to Magra, Malpura and Muza? arnagribreeds.Milk products manufactured fromsheep such as ice cream, ? avoured milk and milk powderare preferred as alternative food products for young andsick people due to its rich nutritional and antiallergenicproperties.

The coding region of the acetyl Co-A carboxylase alpha(ACACA) gene plays an important role in de novo fa acid synthesis, we have analysed SNPs in the promoterIII (PIII) region of

ACACA gene, with milk fat and proteinpercentage in the Indian native sheep breed Munjal. The180 pedigree sheep from LUVAS, Hisar (Haryana) wereanalysed for candidate gene association studies.The resultsrevealed three polymorphic pa at position 1330, 1338and 1480 in the PIII region, total nine genotypes weredetected in studied samples. Milk fat and protein yieldsobtained showed some relationship, but milk fat andprotein percentages were not statistically.

ABS (ORAL) : GRG-08

SSCP typing of serum lysozyme gene and its di? erential expression in Black Bengal goat

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Lysozyme is a ubiquitous bacteriolytic enzyme present in the body ? uid and tissues. It acts as an important antimicrobial component in serum and body ? uids. Polymorphs of serum lysozyme gene are reported to be signi? cantly associated with disease resistance traits. Therefore, the present study was undertaken to detect polymorphism in serum lysozyme at the genic level and study its association with mean serum lysozyme activity. 75 Black Bengal goat of same age, sex and season of birth were selected randomly and included under the present investigation. Genomic DNA was extracted from blood samples of the contributing animals and used to amplify 268bp fragment (partial promoter, exon 1 and partial intron1) of serum lysozyme gene by polymerase chain reaction. Subsequently, the SSCP study was carried out to identify various allelic pa and genotypes of the animal included in the study. Five genotypes AA, AB, AC, BB and CC and consequently, three alleles A, B and C were observed in the studied population. A allele was pre dominant in the studied population. The least square analysis was done to study the association of genotype with mean serum lysozyme activity. Genotypes showed signi? cant ($P \leq 0.05$) associations with mean serum lysozyme activity. Nucleotide sequencing of samples showing di? erent genotypic pa showed di? erence at nucleotide level between di? erent alleles. Di? erent alleles showed nucleotide variation at 4 places. Protein alignment study showed that there is no variation in amino acid sequences of all the alleles. Di? erential expression pro? ling of serum lysozyme gene in black Bengal goat revealed that the animal having AA genotype showed higher expression of serum lysozyme then the animal having AB, AC and BB genotypes.

ABS (POSTER) : GRG-09

Milk production, proli? cacy and their in? uence on kid growth in Black Bengal goats

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A study was conducted to investigate the milk production performance ofBlack Bengal doe and its e? ect on weight of kids on the basis of their type of birth reared in a semi-intensive system. Forty ? ve Black Bengal does were selected on the basis of their li sizes fromgoat Farm, ICAR Research Complex for Eastern Region, Patna, Bihar. Milk production of the goats was recorded from 2016 to 2018. Milk yield was recorded from oneweek after parturition to 12th week on weekly basis. Body weight was recorded every month from birth to 6 months of age. The average milk productionsupto 12 weeks of parturition of goats having 1,2,3,4 and 5 li ere 0.33±0.03, 0.45±0.03, 0.54±0.05, 0.70±0.06 and 0.79±0.03 Kg/day respectively. On an average, the initial yield (kg/d), peak yield (kg/d), and total milk yield (kg)were 0.35, 0.68 and 27.84; 0.53, 0.96and 37.84 kg; 0.64, 1.08and 45.49; 0.81, 1.21and 59.06 &0.84, 1.26 and 66.35 respectively for 1,2,3,4 & 5 li size. The milk production increased in the fourth week of lactation in all types of li size and then decreased afterwards.Total milk production was directly proportional to their li sizes. Single born kids was found to be heavier followed by twins, triplets, quadruplets and quintuplets in both the sexes. In conclusion, Black Bengal goats tend to have potential of milk production which may increase with the numbers of kids suckled.

ABSTRACT (POSTER PRESENTATION)

ABS (POSTER) : GRG-01

Evaluation of the Reproductive Characteristics of Sirohi Goats from Udaipur, India

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The data on reproductive performance of Sirohi goats maintained at AICRPon Sirohi goat at LRS, Udaipur, India**, and recorded between 2004-16, were analysed to study the reproductive traits and their genetic control. The overall least squares means of AFC, AFK, KI, SP, GP and DP** were 513.20±20.94,

657.20±20.48, 292.03±4.14, 142.17±4.18, 149.95±0.07 and 144.00±4.09 days, respectively while least-squares means for WFC and WFK were 27.84±0.42 and 30.57±0.40 kg, respectively. Sire and Cluster had signi? cant e? ect on all reproductive traits. Period and season of birth had highly signi? cant e? ect on AFK. Summer born kids had lowest kidding interval, service period and dry period as compared other season. The heritability estimates of all reproductive traits were moderate (0.13-0.38), except for gestation period, which had low heritability (0.002±0.027). The phenotypic and genetic correlations among the di? erent reproductive traits were positive and high, except for phenotypic correlations between gestation period with kidding interval, service period and dry period which were very low.

ABS (POSTER) : GRG-02

Genetic Studies on Average Daily Weight Gain in Sirohi Goat in Breeding Tract

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Data on 6054 Sirohi kids of 112 sires born during 2004 to 2016 in farmer's ? ocks under All India Co-ordinated Research Project on Goat Improvement (AICRP) project, Vallabhnagar, Udaipur were utilized to estimate the average daily gains (ADG) at di? erent growth stages. The overall least-squares mean of ADG for 0-3, 3-6, 6-9 and 9-12 months of ages were 113.66±2.15, 42.99±1.60, 41.44±2.32 and 53.55±2.08 g, respectively. Clusters and sex exhibited signi? cant ($P \leq 0.01$) e? ect on average daily gains at di? erent growth stages. Periods of birth had signi? cant ($P \leq 0.01$) e? ect on ADG1,ADG2 and ADG3 except ADG4. The males exhibited their superiority for average daily gains at all stages of life over female. Season had signi? cant ($P \leq 0.01$) e? ect at all stages of ADG except ADG2. Kids born in summer showed higher ($P \leq 0.01$) weight gain by 3.74% for ADG1 and 20.20% for ADG4 than those born in rainy season which might be due to adequate biomass availability in grazing area and extended grazing duration in summer. The kids born as multiple had signi? cantly ($P \leq 0.01$) lower weight gain than those born as single but had higher post weaning growth rate. The kids from heavier dams at kidding a higher ($P \leq 0.05$) pre-weaning weight gain and parity of doe showed non-signi? cant e? ect on all stages of ADG. The heritability estimates for these traits ranged from 0.06±002 (ADG4) to 0.27±02.03 (ADG1). The genetic correlation between ADG1 and ADG2 was negative which might be due to compensatory e? ect on growth. All estimates of phenotypic correlation were negative, which indicates highly variable environmental conditions involved in expression of these traits. The study indicates that improvement is required in growth rate during 3 to 6 months of age through managemental interventions.

ABS (POSTER) : GRG-03

Genetic Evaluation of Breeding E? ciency in Jamunapari Goats

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The present study was undertaken on performance records of 107 Jamunapari goats spread over a period of 8 years which were the progeny of 17 sires, maintained at Jamunapari farm, Central Institute for Research on Goats, Makhdoom, Farah, Mathura (U.P.). Only those goats which have completed minimum three lactations were considered for study on breeding e? ciency. The in? uence of year season of kidding and other genetic and non - genetic factors on the economic traits were studied by least squares analysis. After necessary correction for signi? cant e? ects, genetic and phenotypic parameters were obtained using paternal half – sib correlation method.

The breeding e? ciency was determined by using the methods of Wilcox et al. (1957) and Tomar (1965). The di? erence in average estimates by two methods indicated that there is great variability in the age at ? rst kidding. Breeding e? ciency as per method of Wilcox et al. (1957) and Tomar (1965) were 95.39 + - 04.25 and 88.29 + - 04.94 percent respectively. The year of kidding and regression of dam's weight at twelve months signi? cantly a? ected breeding e? ciency estimated as per the methods of Wilcox et al. (1957) and Tomar (1965). The breeding e? ciency values obtained using methods of Wilcox et al. (1957) were higher than that of method of Tomar (1965). The estimates in the present study by both the methods were high enough to indicate that the reproductive performance of goats was optimum. However, the di? erence in average estimates by two methods indicated that there is greater variability in the age at ? rst kidding. The breeding e? ciency computed as per method of Wilcox et al. (1957) were higher and indicated that the goats with lower kidding internals be retained is the ? ock to improve economic e? ciency. The jamunapari goats should be managed in such way that their service period may not extend 90 days and kidding internal may range between of 300 and 365 days. The optimum level of breeding e? ciency may be considered important criterion for selection to bring about improvement in the ? ock.

ABS (POSTER) : GRG-04

Genetic parameter of milk composition traits and association with allelic variation in CSN1S1 gene in Jamunapari goats

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Goat milk plays a signi? cant role in providing be health and ful? ll nutritional and protein requirement of children and women in disadvantage places in tropics. Milk composition traits are associated with milk protein polymorphism; therefore, genetic variation is used in selection programme for improving protein

content in milk. The present study characterizes CSN1S1 gene and e? ect of allelic combination on milk composition traits in 180 Jamunapari goats. Milk protein variability at protein and DNA level was carried out in 518 milk samples of Jamunapari goats. The milk composition traits (fat%, SNF% and protein%) were determined by infrared spectroscopy. The genotyping was carried out at both protein level (SDS-PAGE) and DNA level (PCR-RFLP), to correlate the expression with genetic variability with milk composition traits. Six variant groups of A, B and F alleles were observed in the analysed population and allelic frequencies were 0.4566, 0.503 and 0.041 respectively. The allelic variants obtained were con? rmed by cloning and sequencing of CSN1S1 gene variants. Genetic parameter estimates were obtained from 518 records from 48 sires and 131 dams with a pedigree covering over 3 generations. The mean protein%, fat%, SNF% and lactose% was 3.386, 3.368, 9.007 and 5.627, respectively. The protein content was highest in AB genotype followed by AA, BB, BF, AF and FF. The direct heritability for protein%, SNF% and lactose% was 0.441, 0.294 and 0.326, respectively. However the protein% was not a? ected by non-genetic factors. Therefore, variability at CSN1S1 locus can be used to develop conservation as well as genetic selection in Indian goat breeds targeting improved quality and quantity of milk production and also for protein research and dairy industry.

ABS (POSTER) : GRG-05

Dissemination of improved genetics and its e? ect on growth performance in di? erent goat breeds in their natural habitat

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The increase in production performance of goat in their natural habitat will provide be livelihood in enhancing income and employment. The growth performance of six breeds were analyzed in their production environment. Improved bucks were used for mating with does to disseminate be gene pool in the population. In Surti goat, the increase in body weight during 3, 6, 9 and 12 month were 14.11%, 7.68%, 9.36% and 13.01%, respectively. In Ganjam goat, the increase in body weight during 3, 6, 9 and 12 month were 11.79%, 5.07%, 4.23% and 3.36%, respectively. In Gaddi goat, the increase in body weight during 3, 6, 9 and 12 month were 15.31%, 19.67%, 24.71% and 27.85%, respectively. In Black Bengal goat the increase in body weight during 3, 6, 9 and 12 month were 22.33%, 11.79%, 18.57% and 20.03%, respectively.

In Assam local goat, the increase in body weight during 3, 6, 9 and 12 month were 3.72%, 2.94%, 3.37% and 9.33%, respectively. In Malabari goat the increase in body weight during 3, 6, 9 and 12 month were 3.51%, 8.63%, 14.66% and 3.77%, respectively.

The study shows signi? cant increase in body weight in their native tract due to intervention of improved buck in their productive environment.

ABS (POSTER) : GRG-06

Di? erential expression pa

semi-arid region

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The present study was carried out to evaluate the relative gene expression pa of Kisspeptin 1 gene in Barbari and Jamunapari goat breed by RT-qPCR. The ovaries were collected from 12 goats, 6 each from Barbari and Jamunapari goat breed. The RNA was isolated by Trizol method and the quality and integrity of the total RNA was checked by agarose gel (1.5%) electrophoresis and visualization under UV light. Synthesis of the complementary DNA (cDNA), that done by reverse transcription PCR (q-RT-PCR) technique. The ampli? ed product of Kisspeptin 1 gene in goat showed 110 base pair in length. The mRNA expression level was analyzed for the Kisspeptin 1 gene in Barbari and Jamunapari goats. Kisspeptin 1 gene was highly expressed in Barbari goatscompared to Jamunapari goats. The results showed breed expression pa of Kisspeptin 1 gene that the Barbari and Jamunapari had 2.275 and 0.00773(7.73E-03) fold higher gene expression when compared with caliberator. Barbari goat breed showed highest up regulation of Kisspeptin 1 gene in comparison to Jamunapri. Similarly Jamunapari showed down regulation of Kisspeptin 1 gene in comparison to Barbari. The Barbari breed showed the highest level at 2.94E+02 (294.307)-fold mRNA level as compared to the Jamunapari. Thus, the upregulation of this gene in Barbari breed which is more proli? c in nature than that of Jamunapari which is less proli? c as compared to Barbari breed may explain the important role of Kisspeptin 1 gene in the proli? cacy in goats.

ABS (POSTER) : GRG-07

Fecundity study in Shahabadi sheep of Bihar

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Shahabadi is one of the recognized breeds of sheep in India which is distributed in Shahabadi region of Bihar state. As the breed is being largely unexplored, the study was

undertaken to explore the reproductive performance of the Shahabadi sheep which acts as a bu? er economy in poverty stricken region of the country. The least squares analysis of data collected from Shahabadi sheep on age at 1st lambing and lambing interval showed that the overall means of these two traits were found to be 627.38±1.77 days and 417.26±1.40 days, respectively. Besides, there were signi? cant (P<0.01) di? erences in these traits due to various non-genetic factors. Data collected from 105 Shahabadi sheep ? ocks on lambing and twinning percentages were analysed using 't' test. The overall lambing and twinning percentages of Shahabadi sheep were observed to be 83.82±0.61 and 9.87±0.39 respectively. Remarkable twinning as found in the present study in Shahabadi sheep may be considered as one of the unique features of this breed. The e? ect of ? ock size and location on lambing and twinning percentages were found to be highly signi? cant (P<0.01). PCR-RFLP analysis of 140 bp region of BMPR-IB gene digested with *AvaII* enzyme from 72 Shahabadi sheep revealed single band at 140 bp suggesting that ampli? ed fragment did not contain *AvaII* cu site re? ecting no *FecB* mutation. Necessity to introgress the fecundity gene to further boost the proli? cacy in Shahabadi sheep may be one of the measures to improve the livelihood of sheep farmers in the region.

ABS (POSTER) : GRG-08

Genetic Analysis of Body Weights of Sangamneri Goats under Field Conditions

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The body weights of Sangamneri goats were collected from the registered goat keepers of All India Coordinated Research Project on Goat Improvement (Sangamneri ? eld unit), M.P.K.V., Rahuri for the period from 2004 to 2016. To determine the e? ects ofvillage cluster, year and season of birth, type of birth and sex as non-genetic factors and sire as genetic factor on growth traits the data were analysed by least square technique. The overall least squares means for body weights at 1, 3, 6, 9 and 12 months of age in Sangamneri goats were 5.07 ± 0.01, 9.50 ± 0.02, 14.80 ± 0.03, 18.85 ± 0.06 and 22.78 ± 0.10 kg, respectively.The body weights at 1, 3 and 6 months in Sangamneri goat were signi? cantly in? uenced by village cluster, year of birth, sex, type of birth and sire except body length not a? ected by type of birth. However, body weight at 9 and 12 month of age signi? cantly a? ected by village cluster, year of birth, sex, type of birth and sire except season of birth. Genetic and phenotypic correlations among body weight were reported positive and

signi? cant (P< 0.01) at all stages of age studied. The heritability for growth traits i.e. 1, 3, 6, 9 and 12 months body weight was 0.192±0.02, 0.402±0.02, 0.641±0.02, 0.756±0.02 and 0.512±0.02, respectively.

ABS (POSTER) : GRG-09

Morphological Characteristics of Bundelkhand Goats of Lalitpur District of U

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Goats are important species among the livestock in India. They contribute greatly to the agrarian economy, especially in areas where crop and dairy farming are not economical, and play an important role in the livelihood of a large proportion of small and marginal farmers and landless labourers. According to livestock census 2012 Govt. of India, total goat population of India is 135.17 million with decreased rate of -3.82% over the previous census 2007. U Pradesh possesses 15.58 million goats which is 11.538% of the total goat population of the country. The biometric measurements are used to assess several characteristic of animals. These measurements provide important evidences for the growth of the breed and the properties that change with environmental e? ects and feeding factors. There is scarcity in literature on Bundelkhand goats. The present investigation was undertaken to study the morpho-metric measurement and management practices of Bundelkhand goats in Lalitpur district of U Pradesh. Four villages namely Kakruwa, Dawni, Maheshpura and Jugpura were selected for the study. The body colors of goats were found to be black (86%), white patches on black (10%) and 4% tan. The body length, height at withers, chest girth, pouch girth, ear length and tail length of adults goats were estimated to be 72.43 ± 0.42, 74.52 ± 0.48, 73.77 ± 0.48, 92.44 ± 0.56, 16.22 ± 0.21 and 11.62 ± 0.08, respectively. The corresponding values for adult male were found to be 74.63 ± 0.44, 84.62 ± 0.52, 84.27 ± 0.46, 80.34 ± 0.46, 15.82 ± 0.21 and 13.62 ± 0.21, respectively. Most of the farmers maintained the breed on grazing in the district. Goats were grazed 5-6 hours in a day round the year. The study revealed that the breed should be characterized in the regions of Bundelkhand.

ABS (POSTER) : GRG-10

Conservation priorities for Indian goat breeds based on microsatellite and demographic data

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The demographic and microsatellite data on 25 markers along with non genetic information such as distribution, adaptation and utility pertaining to 24Indian goat breeds were used to assess their conservation priorities. The e? ective population size (Ne) of Gohilwadi, Jharkhand Black and Sangamneri was > 200 and that of Black Bengal, Kutchi, Mehsana, Sirohi, Malabari and Zalawadi ranged from 100 to 200 but it was below 100 for rest (60%) of the breeds with Ganjam having the least value of 17.5 based on microsatellite data. All goat breeds whose e? ective population size is >100 based on markers did have population size between 0.1 and 0.2 million except in few cases. The Ne based on microsatellite and demographic data revealed almost same order of ranking of goat populations. It was also revealed that A and Kutchi were at highest risk of extinction probability (0.63) and more than half of the Indian goat breeds were having < 50% extinction probability. Therefore, A and Kutchi should be given top priority for conservation.

ABS (POSTER) : GRG-11

E? ect of Non-Genetic and Genetic Factors on Reproductive Traits of Sangamneri Goats

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The performance of reproductive parameters of Sanganmeri goat maintained under ? eld conditions in the breeding tract of Sangamneri goat has been collected from the bene? ciaries of All India Coordinated Research Project on Goat Improvement (Sangamneri ? eld unit), M.P.K.V., Rahuri over a period of 13 years (2004-2017). The data were subjected to least squares analysis to estimate the e? ect of village cluster, year and season of birth/kidding and type of birth / kidding order as non-genetic factors and sire as genetic factor on reproduction traits were studied. Overall least-squares mean for age at maturity, age at ? rst conception, age at ? rst kidding, service period and kidding interval of Sangamneri doe were 260.73 ± 2.12, 307.20 ±3.92, 457.99±3.93, 121.79 ±5.27 and 272.74 ±5.31 days, respectively. The overall least-squares mean for number of kids per kidding of Sangamneri goat was 1.82 ±0.04. Twinning and sex ratio was of 62.05 per cent and 1:0.99 noticed in di? erent cluster and year of birth in Sangamneri goat. While all pre partum reproduction traits were signi? cantly in? uenced by village cluster, year of birth, season of birth and sire except type of birth while the post partum reproduction traits signi? cantly in? uenced by village cluster, year of

birth, season of birth and kidding order.

ABS (POSTER) : GRG12

DNA polymorphism of Fec B gene and its association with li Local Goats in Bihar

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The current study was consisting of analysing *Fec B gene* of Local goats of Bihar using PCR-RFLP techniques to detect the single nucleotide polymorphisms (SNP) of the Fec B gene and investigate its association with proli?cacy trait. The total 50 (Fifty) blood samples of goat of various li ere collected from Patna, Madhepura and Gaya districts of Bihar. The genomic DNA of 50 (Fifty) blood samples of goat of various li sizes was extracted using DNA isolation Kit. The quantity and quality of the isolated DNA samples were checked on running 2% Agarose Gel Electrophoresis. The ampli?cation was carried out using a pre-programmed Thermal cycler following conditions: initial denaturation of 4 min at 95^{oC} followed by 35 cycles of denaturation at 95^{oC}, annealing and extension at 65^{OC} and 72^{OC} each of 1 min respectively. PCR products quality and quantity will be checked using 2% gel electrophoresis. After quality and quantity checking, PCR products was digested using Ava II (G/GACC) restriction enzymes for RFLP at 37^{oC} for 4 hours. The Digested PCR products were electrophoresed on 3 % Agarose Gel Electrophoresis at 90 volt for 90 min.The RFLP band pa of Fec B gene of local goats yielded monomorphic band pa on 3 % Agarose Gel Electrophoresis.The band pa of Fec B in RFLP presented no cut with Ava II (G/GACC) restriction enzyme. The variation in the li size trait of local goats with respect to Fec B gene was not observed in present study of 50 goat blood samples using PCR – RFLP using Ava II enzyme method. The Fec B gene of local goats may not be related to the li size trait variation. The other candidate genes of local goats related to proli?cacy may be searched to explain variation and establish genetic marker. Further, sample size of local goats may be increased to explore Fec B gene to search variation in them and associate the li size trait.

TECHNICAL SESSION - II

(Physiology and Reproductive Biotechnology)

LEAD : PRB-01

Restoration of Fertility in Small Ruminants through Stem cellTechnology

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Fertility in domestic animals denotes the ability of an animal to conceive when served ata right time of ovulation, to carry out the pregnancy and to deliver normal healthy o? spring(s) at the end of completion of gestation period. It has more limited connotation than in general usage. There are various factors directly and indirectly associated with it andany aberration to any factor may lead to a condition termed as infertility or sterility. Infertility isused to express a degree of reduced fertility and sterilityto express complete inability to bear young ones.

As infertility is a heterogeneous condition, causedby various underlying pathologies, it is possible that someof the mechanisms leading to infertility also play a role in the etiology of this outcome. Various therapeutic approaches have been a empted to alleviate the condition, hormonal and nutritional aspect are two major areas to be very speci? c. In exclusion to that, cellular therapy which uses stem cells as a therapeutic agent to restore the fertility condition is the recent trend in global scenario. They play a very protagonist role in activating paracrine and autocrine functions in the cells/tissues concerned and also activate the progenitor stem cells to restore normal function of the cells. Due to their unlimited source and high di? erentiationpotential, stem cells are considered as potentially new therapeuticagents for the treatment of infertility. The source, their mechanism of actions, pro and cons and ? nally therapeutic applications garnered interest among researches throughout the world.

Stem cells: Source and Characteristics

Stem cells are the undi? erentiated cells of the body which have inherent capacity to di? erentiate and proliferate into any cell type under programmed command. These cells perpetuate themselves through self-renewal by programmed pathways to give rise to new adult cells. According to plasticity, the stem cells can be categorised into totipotent, pluripotent, multipotent and unipotent. Totipotent stem cells are those which can give rise to all types of cells along with placental membranes. They are most undi? erentiated cells andare found in early development.Pluripotent stem cells like embryonic stem cellscan be developed into all cell types except placental membranes. The multipotent set of stem cells can di? erentiate to more than one cell type and one of the most common examples is the mesenchymal stem cells. Unipotent ones can only give rise to one type of cells like skin cells.

Their presence can be traced fromtheembryonic andfetal stage to adult stages of life which subsequently give rise todi? erentiated cells forming tissues andorgans. In the postnatal and adult stages of life,stem cells can be found in various tissues and organs which are very pertinent to that organ or tissues and the play signi? cant role in the repairing of tissues in event of injury.The three major characteristics of stem cells irrespective of their origin are self-renewal,potency and clonality.

Stem cells as a potential candidate in cellular therapies:

Four main types of stem cells which are being used in cellular therapy and tissue

engineering are embryonic stem cells (ESC), induced pluripotent stem cells (iPSC), mesenchymal stem cells (MSC) and spermatogonial stem cells (SSC). However, due to ethical issues and teratoma formation, the ESCs and iPSCs use in therapeutic purpose have been lessened. Among various methods studied, transplantation of stem cells or theirderivatives into respective tissues or organs is consideredas one of the most promising remedies for many incurablediseases is the most promising one.

Embryonic stem cells (ESC)

ESCs are pluripotent stem cells derived from the innercell mass of the blastocyst. The essential characteristicsof ESCs include derivation fromthe preimplantation embryo,prolonged proliferation in their pluripotent state, and stabledevelopmental potential to form derivatives of all threeembryonic germ layers.They have been instrumentalin studying many genetic disorders, cell replacement therapies, drug discoveries etc. In reproduction they have been also studies in many areas. Di? erentiating embryonic stem cells (ESCs) can form ovarian follicle-like structures *in vitro*, consisting of an oocyte-like cellsurrounded by somatic cells capable of steroidogenesis (Woods et al., 2013). The ? rst demonstration that cells other than primordial germ cells (PGC) spontaneously form whatappear to be oocytes was reported in 2003 (Hübner*et al.* 2013) from an *in vitro* study of transgenic mouse embryonicstem cells (ESC) carrying a green ? uorescent protein (GFP) reporter gene under the control of amodi? ed Oct-3/4 promoter that conveys germline-speci? c expression. They showed the spontaneous generation of oocytes enclosed within structures thatresembled developing ovarian follicles, as determined by morphological characteristics, geneexpression pro? les, and estradiol synthesis. Few other works also relatethe ? ndings that ESC and skin stem cells spontaneously form small ovarian folliclelikestructures in vitro. These follicles possess the capacity for estradiol biosynthesis and, in the case ofskin stem cell-derived follicles, express FSH receptor (FSHR) and respond to FSH with increasedestradiol production. These ? ndings underline the fact that ESCs can be utilised in various reproductive disorders like regeneration of PGC. However, their use took a back seat due to ethical issues involved around it.The controversy is related to the moral status given to such early embryos, which would be destroyed in the process of removing the stem cells. Moreover, they can cause teratoma in transplanted animal.

Induced pluripotent stem cells (iPSC)

Induced pluripotent stem cells (iPSC) garnered much interest after a pioneering study by Shinya Yamanaka in 2006 who demonstrated that the introduction of four speci? c genes encoding transcription factors could convert adult cells into pluripotent stem cellsby reprogramming somatic cells.These cells are called induced pluripotent stem cells (iPSCs) and share similar characteristics with ESCs: exhibiting morphology of ESCs, expressing ESCs markers, having normal karyotype, expressing telomerase activity and maintaining the developmental potential to di? erentiate into derivatives of all three primary germ layers.Thus, iPSCs are adult cells that have been genetically reprogrammed to an embryonic stem cell-like state by forcing to express genes and factors important for maintaining the de? ning properties of embryonic stem cells. Various studies reported that oocytes and PGCs can be produces in vitro and transferred to live animals. Studies in rat and mouse demonstrated that their transplantation in testes induced into PGC like cells and contributed to spermatogenesis and upon injection into ovaries they play pivotal role in steroidogenesis. After injection, these cells expressed speci? c markers pertinent to either follicles or sperm cells.

Mesenchymal stem cells (MSCs)

Mesenchymal stem cells (MSCs), which fall under the multipotent stem cells category, have the multilineage potential to di? erentiate into many mesenchymal lineages like osteocytes, chondrocytes, adipocytes etc. Apart from the conventional mesenchymal origin, they also have the inherent potential to di? erentiate into cells of ectodermal and endodermal origin like hepatocytes and neurons. The MSCs, ? rst identi? ed by Friedensteinand co-workers in 1976, are subset of non-hematopoietic adult stem cells, which have their presence in all most all cell types. They can be easily isolated from the adipose tissues, bone marrows, muscles, liver, umbilical cords, lungs and bone marrow etc. Owing to their tremendous potential of regeneration capacity, MSCs have been used in regenerative medicine and tissue engineering. MSCs have also contributed signi? cantly towards the cell therapy, a sub-type of regeneration therapy, for the treatment of many diseases with or without the addition of gene therapy. The healing e? ects of MSCs can be utilised for a wide range of disorders like premature ovarian failure, chronic degenerative endometritis, vaginal tissue repair etc. MSCs have many advantages over the use of embryonic stem cells and induced pluripotent stem cells due to ethical issue and teratoma formation. Apart from that, MSCs also have properties like low immunogenicity, anti-in? ammatory, immunomodulatory, anti-apoptotic and neuroprotective e? ects which make it more suitable for the clinical utilisation.The must essential criteria that de? ne a cell as MSC are, they must adherence to plastic, express certain surface antigens and show multipotent di? erential potential. These standards have been laid down by International Society for Cellular therapy. The speci? c surface antigens which are expressed by MSCs during proliferation are CD73, CD90 and CD105. However, there have been di? erences of expression of CD90, CD105, and CD106 when it comes to bone marrow derived MSCs (BMMSC), umbilical cord derived MSCs (UBMSC) and adipose derived MSCs (ADMSC).Recently, MSCs were di? erentiated into neuronal tissuewhich is derived from the ectoderm. This is an example oftrans-di? erentiation, that is, when a cell from one germ layerdi? erentiates into another.

MSCs are the most used cells in current scenario as far as cell based therapy are concerned. Upon injection these cells secrete numbers of active biomolecules like integrins, TGF β, ILs, VEGF etc. which hastens paracrine and autocrine functions of the cells and their surrounding and also stimulates the progenitor stem cells to repair the organs. The site of MSC delivery may impact the route MSCs travel to reach the target organ. Systemic administration can be achieved by intravenous (IV) injection, intraperitoneal (IP) injection, intra-arterial (IA) injection, or intra-cardiac (IC) injection. IV delivery is the least invasive; however, IC and IA delivery have led to higher engraftment rates than IV delivery in certain models. A ? nal method of delivery is local infusion, which entails injecting MSCs directly into the tissue of interest.However, local infusion is likely not clinically feasible in many cases due to its potentially high degree of invasiveness and locally administered cells often die before signi? cantly contributing to the healing response due to di? usion limitations of nutrients and oxygen. However, in this context laparoscopic injection can be a method to reckon.

Spermatogonial stem cells (SSC)

Spermatogonial stem cells (SSC) reside in adult testis and play very crucial role in the event of spermatogenesisthereby maintaining a continual spermproduction throughout amale's lifespan. These are the diploid cells that originate from PGC and set out for their sojourn journey to the gonadalridges during embryogenesis. SSCsare found in theseminiferous tubule close to the basement membrane. After isolation they can be characterised by various SSC speci? c markers like Stra8, SSEA4, CD90, 1 and 6 integrins etc. (Gupta *et al*. 2018).

They have provided a potential candidate in dealing with male infertility conditions like testicular degenerations due to their ability to di? erentiateintomale gametes *in vitro* and capacity to restoremale fertility*in vivo*. SSC are adult stem cells, but SSC-derived cells,called multipotent adult germline stem cells (maGSC), havedi? erentiation potential similar to ESCs. *In vitro*, maGSCare able to spontaneously di? erentiate into derivatives of allembryonic germ layers and are able to generate teratomasafter transplantation in immune de? cient mice. The development of a spermatogonial transplantation techniquehas provided a new treatment strategy for male infertility. Following the transplantationof dissociated testis cells into a seminiferous tubulemicroenvironment, the spermatogonial stem cells colonize andinitiate spermatogenesis. Since spermatogonialstem cells self-renew and di? erentiate into proliferatingspermatogonia, they provide a limitless supply of maturespermatozoa. Thus,spermatogonial stem cell transplantationmay be useful for the treatment of di? erent types of male infertility (Chauhan and Kharche 2018).Animportant breakthrough for SSC-mediated spermatogenesiswasmade byHermann and co-workers in 2012 where they showed thatautologous and allogeneic SSC transplantations into the testesof adult and prepubertal recipient macaques, which wererendered infertile with alkylating chemotherapy, regeneratespermatogenesis resulting in production of functional sperm.These results strongly indicate SSC transplantation as a noveland successful therapeutic tool for male infertility causedby chemotherapy before puberty.

Conclusion

Although transplantation of stem cells helps in restoring fertility, both in males and females, there is a long way ahead as far as their detail mechanism of action, molecular events associated with it, best route and dose of application need to be sort out prior to establishment of regular treatment approach. A number of factors like challenges associated with protocols for their isolation,identi? cation, and culturing have to be addressed before theirclinical use.

References are available with the authors.

LEAD : PRB-02

Climate Change: Impact, adaptation, and ameliorative strategies for sustainable productivity in small ruminants

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Small ruminant is a multifunctional animal, providing meat, milk and wool. Small ruminant farming is aneconomic support to a large section of population in rural areas. It can be survival e? ciently on adverse harsh environment with poor quality available shrubs and trees where very few crop grown. They have developed di? erent signalling pathways or traits for

survival under di? erent extreme climatic conditions round the world. Rearing and management of small ruminants are economical and easy to handle because they can gather their requirement from grazing land. Due to the docile nature and small body size, the housing requirement and handling problem is very less. They achieve sexual maturity at the age of 10-12 months, short gestation period with proli? c breeders. Giving birth to two kids is very common in goat, but some breeds of goat like Assam hill and Black Bengal gives triplets even though they can give birth to four kids. Risk of small ruminants farming is very less as compare to other livestock farming because they can thrive well on wide variety of thorny bushes, crop residue weeds, agricultural by-products unsuitable for human consumption. Therefore, sheep and goat farming could be one of the alternative sources of economy for poor farmers. From nutritive point of view goat meat is low in cholesterol.Goat milk plays a signi? cant role in improving appetite and digestive e? ciency. The fat globules of goat milk are small in size compare to other dairy animals. It is easily digestible as compare to cow milk. Goat milk has antifungal and antibacterial and non-allergic propertiesso can be used for treating urogenital disease of fungal origin. Goat is also known as walking refrigerator, due to their ability to store milk and to be milked more than two times, even though number of times in a day. Therefore, sustainable development of small ruminants andstrategies to enhance its production is necessary for the marginal farmers under changing climatic conditions.

Impact of Climate on Small Ruminant

The Intergovernmental Panel on Climate Change forecasted that increased frequency of extreme climatic variables will have a negative impact on natural eco-systems of small ruminants round the world. Extreme climatic variables events like heat waves and extended drought periods can have a negative impact on genetically non-adapted breeds. Heat waves are recurring events in tropical climatic conditions and are projected to increase in numbers and intensity due to climate change (Gaughan et al., 2009). This must be addressed by changes in animal management systems and practices to enhance food and protein security. Heat stress a? ects animal performance and productivity of small ruminants in all phases of production. It causes decrease in growth, lactation, reproduction and increase in mortality. Economic losses are incurred by the livestock industries because farm animals are generally raised in locations and/or seasons where temperature conditions go beyond their thermal comfort zone (Amundson et al., 2006; Sproet al., 2001). The livelihood of marginal and landless farmers depends on natural resource based small ruminants rearing and production. As a result of negative impact of climate change the livelihood thesefarmers is endangered.

Adaptation of Small Ruminants to Climate Change

The strategies used to sustain small ruminant production depend upon adaptation of these livestock to changing climatic conditions. These strategies may includes developing tolerant breeds, improving water access, improved pasture species, mitigation/amelioration through nutritional interventions, manipulation of the rumen ecosystem, provision of shade, housing, fans, and sprinklers. Livestock producers adapted to climate change by shifting their practices from cropping to grazing, adopting mixed crop-livestock systems and decreasing herd sizes (Zhang et al.,2017). The adaptive responsesof livestockhave been evaluated and measured on the basis of ? eld observations under di? erent seasons, and laboratory experiments using only a given part of the complex climatic factors encountered in the natural environment.There are di? erent adapted breeds of small ruminantpossessing special characteristics, which make them to survive, reproduce and provide livelihood to many people living in rural areas.The present scenario of

climate change demands such livestock for the development and improvement in developing countries. Therefore, studies of unique traits and their propagation for upliftment of poor people as well as the sustainability of production under such conditions are necessary.

Morphological adaptation

Morphological adaptations characteristics short and thin hair, light hair colour, lightly pigmented skin, higher density of sweat glands, slender legs, and less subcutaneous fat makes the livestock well suited in extreme climatic conditions. The coat is theprimary protective layer against the direct e? ects of solar radiation. Sheep with light coat coloursre? ect more solar radiation than dark, dense and woolly hair coats. Sheep having longer, thicker, and darker coats exhibits higher rectal temperature and sweating rates than white-haired sheep under tropical climatic conditions (Sejian et al., 2018). Goats are highly proli? c desert dwelling animals. Their small body size, ? eece structure, and high digestive e? ciency help them to survive in harsh climatic conditions. Dwar of goats are be suited in arid regions than other breeds. Goats inhabiting arid zones possess short, erect and forwards pointed ears and their coat is a light color long-hair, coarse-? ber ? eeces to protect themselves from heatduring the day and cold at night. However, goats inhabiting temperateregions have a coat of long coarse ? bers and a seasonal coat of short, ? ne ? bers to protect against extreme cold.

Behavioural adaptation

Behavioural responses of livestock aid in the acclimatization process of extreme climatic conditions. These behavioural responses may consists of shade seeking, reduced feed intake, increased water intake and drinking frequency, increased standing time, decreased lying time, and reduced defecation and urination frequency of animals. Shade seeking is the most immediate response under heat-stress conditions. Reduced feed intake is an adaptive mechanism toreducethe metabolic heat production sheep, and goats during summer (Aleena et al., 2018). Also,increased water consumption and drinking frequency occur in these livestock during hot conditions. Desert sheep compensate the water loss by concentrating their urine during extreme heat stress conditions. Heat-stressed sheep tend to spend more time in standing position and also reorient themselves to avoid direct solarradiation and ground radiation.

Physiological adaptation

The physiological responses of animals to changing temperature may di? er between breeds, species and their adaptability. Therefore, the comfortable zone also varies among the species and breeds. The low body mass and low metabolism in small ruminant regarded as the vital asset for minimizing their maintenance and water requirement (Benerjee et al. 2014). Animals living in hot and desert environment have to face the water scarcity. The intake and distribution of water depends on the proper co-ordination of rumen, salivary gland and kidney. The ability to restrict the glomerular ? ltration rate (GFR) is found to be one of the adaptive mechanisms observed in hot and desert adapted breeds (Khan et al. 1978). Barmer goat of Rajasthan e? cient in water economy under water scarcity conditions, sharply decline the GFR upto third of its normal value under water restricted goats (Khan et al. 1978).They claimed that the reduction in GFR is one of the principal adaptation strategies to meet the body's requirement under water in-su? ciency conditions. Similarly, Marwari goat also found to have extraordinary ability to resist the ill e? ect of dehydration followed by Marwari sheep and donkey under water deprived condition for longer period (Khan and Ghosh, 1985).

The physiological response i.e., rectal temperature (RT), respiration rate (RR) and pulse rate (PR) are the indicator of extreme climatic conditions. The level of haemoglobin (Hb), packed cell volume (PCV) and total erythrocyte count (TEC) were signi? cantly higher in cold adapted breeds (Banerjee et al. 2015).The higher ambient temperature increases the PR and RR to maintain their homeostasis (Devendra, 1987). The cold adapted goats (Gaddi and Chegu) showed higher physiological response during summer as compared to hot environment goats (Sirohi and Barbari) which might be due to their adaptation to cold hilly climatic conditions, whereas, the lowered physiological response in hot environment breeds was due to their adaptability (Banerjee et al. 2015). Changes in physiological responses and their synchronization are essential for maintaining their survival in di? erent extreme climatic conditions (Marai and Habeeb, 2010). The higher pulse rate in the periphery indicates the higher blood circulation to the periphery to increase the heat exchange mechanism through conduction, convection and evaporation. Superior periphery circulation in hot environment adapted animals characterised by smooth and soft skin than cold adapted animals.Evaporation or heat exchange through respiratory system is the best way to unload heat from internal body to the environment when the environmental temperature reached the skin temperature. However, the higher haematological parameters as well as the physiological parameters in cold adapted breeds indicates the higher metabolism and other thermogenesis mechanisms superior in cold adapted breeds which are necessary for survival and maintaining the body at set point under such extreme conditions (Banerjee et al. 2015). The higher number of total erythrocytes and Hb in goats adapted to cold and hilly region is forful? lment of oxygen requirement of the body from less oxygen concentration. Therefore, seasonalvariations in physiological and haematological parameters in small ruminants are adaptive mechanisms.

Biochemical adaptation

The variation in di? erent biochemical and hormonal parameters were recorded between species, breeds, within breeds and also depending upon the agro-climatic condition of their habitat (Banerjee et al. 2015. The higher level of plasma thyroid hormones (Thyroxine and triiodothyronine) Aspartate Aminotransferase (AST) and Alanine Aminotransferase (ALT) were observed in cold adapted goats. Di? erent enzymes level in di? erent breedsmay vary as per their capacity to response to di? erent climatic conditions.The higher plasma AST activity was observed during summer than winter (Rasooli et al. 2004; Kataria et al. 1993). Similarly, Naqvi et al. (1991) also found higher AST in Avikalin sheep than in Malpura sheep which demonstrated the response of animals to heat stress. It is well known fact that the cold environment stimulates the non-shivering thermogenesis mechanism where the level of thyroid hormone (metabolic hormones) secretion increases. Therefore, the higher level of T_4 and T_3 were estimated followed by higher concentration of glucose during winter or cold stress (Eldon et al. 1994, 1998). The positive correlation was observed between thyroid hormone and glucoses concentration in cold and hot environment adapted goats (Banerjee et al. 2015). Interesting, higher blood glucose level was also reported during summer in cold adapted goats (Gaddi and Chegu) compared to heat tolerant breeds (Banerjee et al. 2015). This might be due to higher level of glucocorticoid (stress hormone) which stimulates the gluconeogenesis from muscle tissue, protein, lymphoid and connective tissue. After thermal exposure, goats showed signi? cantly higher plasma cortisol level (Sejian and Srivastava, 2010). Therefore, positive relation between blood cortisol and glucose can also be observed as an adaptive mechanism against heat stress, because higher level of cortisol acts as vasodilator helps in dissipation of heat load, while, higher glucose level provide compensated energy due to decrease in DMI during heat stress.

Electrolyte balance

The variations in electrolyte balance of small ruminants were found during extreme climatic conditions. The plasma electrolytes concentrations of Na and K content found to vary between cold and hot environment adapted goats (Banerjee et al. 2015). The increase urinary Na excretion and slightly lowered the plasma Na concentration was found might be due to decrease in secretion of aldosterone (Banerjee et al. 2015). El-Nouty et al. (1980) also found decreased concentration of Na in plasma during heat stress. The reduction in K concentration during summer a to loss in sweat. The reduction in secretion of aldosterone during heat stress is due to decrease in plasma K level (El-Nouty et al. 1980). These variations electrolyte concentration is an adaptive mechanism to conserve the water loss.

Oxidative and thermal stress

Heat stress caused increase production of free radicals which is neutralized by intracellular antioxidant enzymes. The overproduction of ROS re? ects increased level of thermal stress. Keller et al. (2004) observed that the exposure of animals to elevated temperatures accelerated mitochondrial respiration and increased mitochondrial ROS formation. ROS, being cellular toxicants (Davidson et al. 1996), can be induced through hyperthermia (Flanagan et al. 1998). Excess ROS production by intensively respiring mitochondria induces cellular damage (Abele et al. 2002). The breed/species di? erences observed in the levels of the ROS production, a to their di? erence in adaptability to di? erent environmental conditions. The major defences in detoxi? cation of superoxide anion and hydrogen peroxide resulted from oxidative stress, are Super oxide dismutase (SOD), catalase and glutathione peroxidase (McCord and Fridovich, 1969). The neutralization of ROS through enzymatic or non-enzymatic activities play signi? cant role under thermal stress conditions. They combat the adverse e? ect of ROS generated due to thermal stress. Catalase detoxi? es H_2O_2 which is produced during metabolic process, necessary to prevent the over accumulation of H_2O_2. The SOD, glutathione peroxidase (GPx) scavenges intracellular and extracellular superoxide radicals and prevents lipid peroxidation (Agarwal and Prabhakaran, 2005). Glutathione reduces the toxicity by preventing free radical formations. Other water soluble antioxidants like vitamin E and vitamin C mostly found in body ? uids and tissues prevent the cells from oxidants (Weiss et al. 2004). The higher antioxidant enzymes were estimated in heat stress goats (Kumar et al. 2011). However, the magnitude of antioxidant enzymes observed to be less in hot environment adapted breeds than cold adapted breeds under heat stress. The higher levels of antioxidant enzymes in small ruminants during heat stress conditions are a protective mechanism to protect the cell from oxidative stress.

Neuroendocrine adaptation

Interactions between the immune, the central nervous and the endocrine systems are crucial for the neuroendocrine adaptation during stress conditions. Activation of the stress axis is accomplished through the release of several neurotransmi and hormones. The stress axis or activation of hypothalamo-pituitary adrenal axis increases the cortisol level in plasma which is the most prominent response to stressful conditions. This increased level of cortisol stimulates physiological adjustments that enable the animal to tolerate the stress (Christison and Johnson, 1972). Plasma cortisol rises markedly when animals are acutely exposed to high environmental temperatures (Habeeb et al. 1992). The higher concentration of cortisol in plasma in heat stress animals is well established (Maibam et al. 2014; Chandrabhan et al. 2013; Francisco et al. 1992). The increase concentration of adrenal corticoids, mainly cortisol enables the animals to cope to the

stressful environment by eliciting the physiological adjustments. Hormones play a critical and important role in the thermoregulation of animal's body. The main hormones overcoming stressful situations are the glucocorticoids and catecholamines. The secretion of glucocorticoids is a classic endocrine response to stress.

Heat shock proteins (HSPs)

The physiological morphological, biochemical and molecular mechanisms make the livestock tolerant against thermal and cold stress. Heat shock proteins (HSPs) are one of the indicators of thermal stress in various livestock species. The basal level of HSPs is higher in hot environment adapted ca than crossbred breed under tropical climatic conditions (Maibam et al. 2014; Singh et al. 2014). This might be one of the reasons of lowerHSPs expression in hot environment adapted animals compared to non-adapted animals. Stressful conditions in animals elicit HSP synthesis especially the HSP 70. HSP 70 functions as molecular chaperones in restoring cellular homeostasis and promoting cell survival (Collier et al. 2008).Heat shock proteins (HSPs) involved in these responses are highly conserved and these molecular chaperones encompass several families, play important physiological roles and help cope with heat stress (Parsell and Lindquist, 1993). HSPs have been considered to play crucial roles in environmental stress tolerance and in thermal adaptation. Several studies in bovine, mice and human cells gave evidence that constitutive elevation of the inducible HSPs levels in gene and protein expression provides cyto-protection upon thermal stress (Collier et al. 2006). HSPA1A and HSPA2 under the family of HSP70i is found to be more sensitive to temperature and may also induced by various physiological and pathological stressors (Kumar et al. 2015; Beckham et al. 2004). HSPA1A and HSPA2 play a crucial role in guiding conformational status of the proteins during folding and translocation (Arya et al. 2007).The expression of HSP70 family genes increased signi? cantly in heat stress exposed goat blood mononuclear cells (PBMC) as compared to un-stress cells (Mohanarao et al. 2013). The expression of HSP72 also increased signi? cantly in heat stress animals under climatic chamber (Lallawmkimi et al. 2012). The level of HSP27 mRNA expression was found to be correlated with antioxidant enzyme concentration in heat stress animals (Lallawmkimi et al. 2012).Banerjee et al. (2014) studied the expression of pro? le of HSP70 in PBMCs of goat during di? erent season in cold and hot environment adapted breeds. It was observed the expression HSPA8, HSPA6 and HSPA1A were higher during summer whereas the expression of HSPA1A and HSPA8 were decreased. Microarray analysis revealed that a total 460 transcripts were di? erentially expressed with a fold change of P2 in peripheral blood leukocytes after heat exposure at 42 °C for 4 hourswhich indicateda signi? cant number of genes involve in thermo-tolerant (Kolli et al. 2014).

Ameliorative measure

Three basic managemental strategies may help in ameliorating impact of climate change on small ruminants' production. These are physical modi? cation of the environment, genetic modi? cations to improve thermo tolerance and improved nutritional management.

Physical modi? cation of the environment

The basic aim of physical modi? cation of the environment is to protect the livestock from the factors contributing to heat stress, and enhancing evaporative heat loss by animals.The modi? cations results in mitigation of heat gain byradiation. Other methods may include sprinkling or misting water, natural and arti? cial shade.

Genetic modi? cations to improve thermo tolerance:The local indigenous breeds of livestock which can perform well in adverse climatic condition can be use for development of genetically

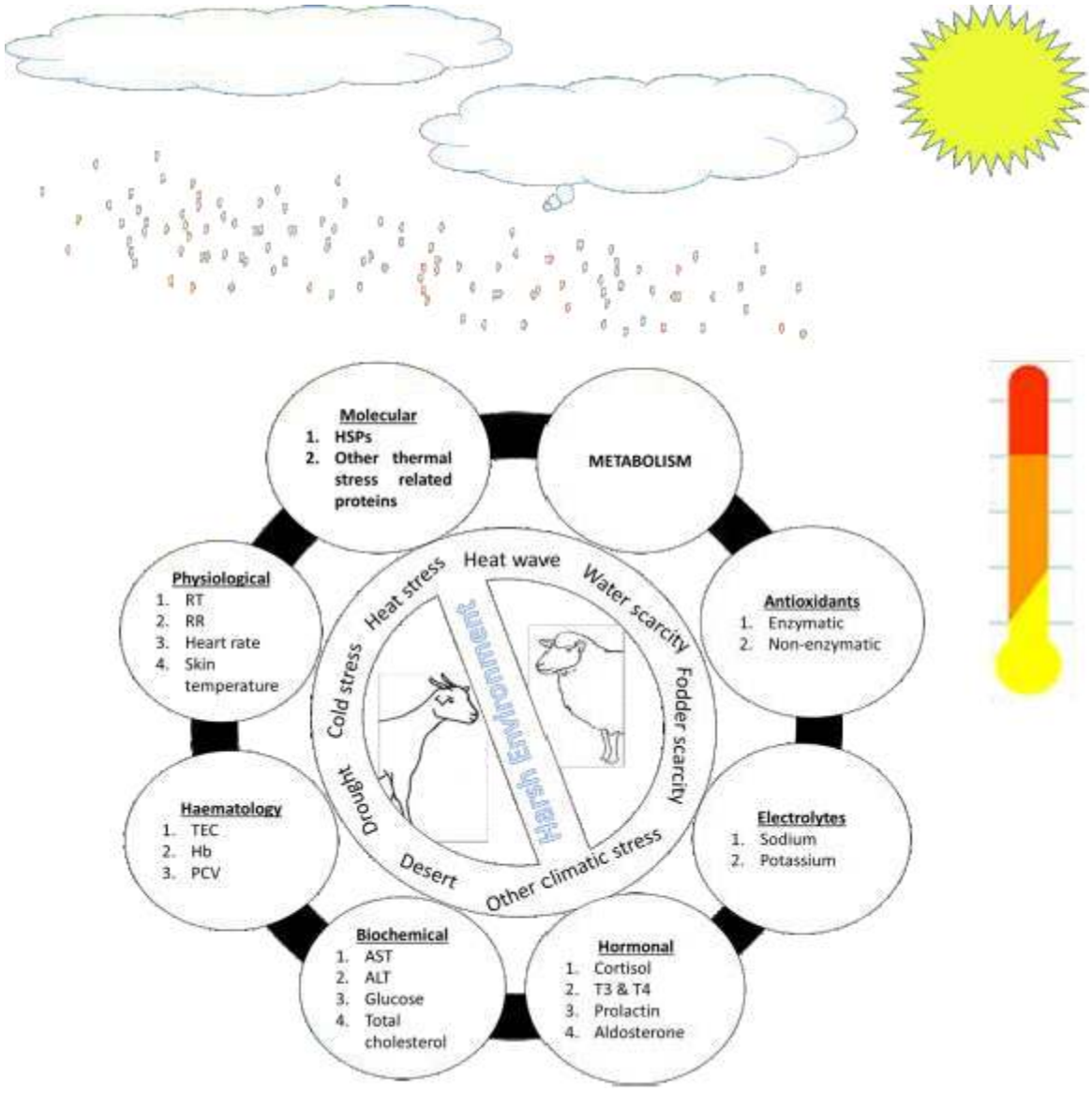

Figure: A schematic diagram showing the co-ordination of di? erent systems function together in a orchestrate manner for their adaptation in di? erent climatic conditions.

modi? ed thermotolerance breeds. In addition, there is a need to take up breeding programmes to develop climatic change ready breed which performs be under stress caused due to climatic variability by using available rich germplasm (Sejian et al., 2012). The recent advancement in global expression technologies (whole genome arrays, RNA sequencing) is poised to be e? ectively utilized to identify those genes that are involved in key regulatory/metabolic pathway for thermal resistance and thermal sensitivity (Moran et al., 2006). Gene knockout technology will also allow be delineation of cellular metabolic mechanism required for acclimatization to thermal stress in sheep and goats.

Improved nutritional management

During heat stress conditions dry ma intake decreases whichis responsible for reduced productivity. In these situations, thefrequent feeding, improved forage quality, use of palatable feeds, good nutrition balance and greater nutrient density may provide compensatory e? ects (Sejian and Naqvi, 2011). The most important feeding strategies during heat stress conditions include concept of cold diet, ? ber feeding, feeding fats and concentrates and balanced water availability which ameliorates the impact of heat load (Sejian et al., 2012).

Conclusion

Climate change can impact animal performance and pro? tability in small ruminants by lowering feed intake, nutrient utilization and production. The physiological responses and the metabolic hormones varied in di? erent breeds of goat according to di? erent agro-climatic conditions of India. These variations are due to their adaptation of that particular agro-climatic condition. Such as higher physiological response, haematological parameters and metabolic hormonal pro? le were seen in cold and hilly region goats. The higher RBCs in hilly goats are for the ful? lment of oxygen requirement in the bodyfrom less oxygen concentration. The higher level HSPs in hot environment adapted breeds and overexpression of HSP70 in cold adapted indicates their signi? cancein adaptation to thermal stress. The level of HSPs is also used as thermal stress biomarker. The conservation of native breeds and improvement of their production may bring great help in economic status of small, landless farmers. Goat production is a? ordable by the poor people as their livelihood due to their ability to survive in extreme climatic conditions.Goat is resistance to di? erent climatic extreme and can maintain theirproductive performance (milk yield) where, ca production tends to decline due to in-su? ciency of feed and fodders. Goat meat doesn't have religious taboos and its milk contain smaller fat globule which is easily digestible to old and young without any allergic a? ect. Strategies for improvement of goat breeds possessing special traits to tolerate stressful climatic conditions are necessary in our country for facing the future challenges of food security. Sustainable livestock production in a changing climate is one of the top priorities under tropical climatic conditions. Reducing the adverse impact of climate change on small ruminants requires multidisciplinary approaches. The integration of animal breeding, nutrition, housing, and health are one of the key strategies. Modi? cations of nutritional and environmental management strategies may leads to fruitful results. The integration of new technologies may potentially provide opportunities for further development of strategies to adapt to climate change.

References are available with the authors.

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Arti? cial Insemination as a tool to improve livelihood security of goat farmers

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Introduction:

Arti? cial Insemination (AI) has been considered one of the well known technologies for faster

multiplication of superior/genetically improved animals.In India, AI in goats is relatively less developed as compared to large animals due to number of social reseasons besides complex anatomy of cervix. The main reason is being lack of suitable protocol for this technology. There are approximately 71 million breedable does and 17 million breeding bucks available in India. One buck (male) by natural mating can cover maximum 50 does (female) in a year, but by frozen semen technique 3000 does can be covered in a year. Two million bucks are required to cover 71 million breed able does, whereas only 50,000 buck needed for Frozen Semen AI Technology. AI may play a pivotal role for the long-term ex-situ in vitro conservation of threatened breeds *viz*.Jamunapari, Jakhrana, Surti, Beetal, Sangamneri etc.The increase productivity and performance of large number of non-descript and low potential goats (>100 million) could be easily upgrade and improved only through AI.

Table 1: Trends in goat population

Census year	Goat Population (million)	Periods	Increase/Decrease%	CAGR (%)
1982	95	-	-	-
1987	110	1987-82	15.79	2.96
1992	115	1992-87	4.55	0.90
1997	123	1997-92	6.45	1.26
2003	124	2003-97	1.34	0.27
2007	140	2007-03	13.01	2.48
2012	135	2012-07	-3.82	-0.78

Source: Basic Animal Husbandry Statistics, 2015

Table 2: Distribution of goat breeds over different agro-climatic zones of India.

Zone	**States**	**Goat breeds**
.Northern Temperate	Jammu and Kashmir, Himachal Pradesh and Uttaranchal	Gaddi, Changthangi and Chegue
North-	Delhi, Punjab, Haryana, Rajasthan, Gujarat, Madhya	Beetal, Jamunapari Barbari, Sirohi, Marwari, Jakhrana, Surti,
Western	Pradesh, Chhattisgarh and Uttar Pradesh	Gohilwadi Kutchi, Zalawadi and Mehsana
Southern	Maharashtra, Andhra Pradesh, Karnataka and Tamil Nadu	Sangamneri, Osmanawadi, Konkan Kanyal, Berari, Kannai Adu, Kodi-Adu, Malabari, Black Attapady and Teresa
Eastern	Bihar, Jharkhand, Orissa, West Bengal, Meghalaya, Assam, Mizoram, Manipur, Nagaland, Sikkim and Tripura	Ganjam, Black Bengal

The goat population has increased at a faster growth rate in India and varied from 0.94 to 5.10% with an average of 3.05% during 1951-2013 in spite of about 41% slaughter and about 15% natural annual mortality. India produced 21.71% of the milk, 10.47% of the meat and 13.15% of the fresh skins of the world goat production worth of Rs. 1, 06,335 million per annum. The goat husbandry also generates about 4.2% rural employment over 500,000 remote villages. It contributes nearly 8.5% of the total GDP from livestock sector to Indian agriculture production system (12 th Livestock Census, India). Presently there is acute shortage of breeding males at farmer's ? eld to meet out breeding requirement. Farmers do not have high quality breeding bucks for breeding of estrous does. Simultaneously use of AI by liquid/frozen semen can further help to accelerate the production potential of 80% of goats which are of non-descript nature.

The goats play a vital role in the economy of the poor and marginal farmers of rural India. Notwithstanding the fact that the goat population has shown a steady growth over the year's very li e? ort has been taken for genetic improvement at farm level. AI using frozen semen is practiced to produce superior progeny and to accelerate the up gradation of stock.

Why Goat Farming?

The advantages of goat farming are as follows:

1. Goat farming need low initial investment.
2. Less housing requirement and management problems.
3. Small body size, docile nature, high proli? cacy, survives on low grade ration and relatively lower gestation period than large ruminant are some important a of goat production.
4. Less risk in goat farming compared to other livestock species.
5. No religious taboo against goat slaughter and meat consumption.
6. The goat meat is more lean (low cholesterol) and relatively good for health.
7. Goat milk is easy to digest because of small size of fat globules and non-allergic and more suitable for those having lactose intolerance.
8. Goat is more economical on free range grazing under semiarid conditions.
9. Goat is very good converter of poor roughages into high value output i.e. meat, milk & ? ber.
10. Goat is best suited animal to varied climatic conditions.

Semen Cryopreservation

Freezing of spermatozoa needs a concept of sperm-preservation from body temperature to freezingand-thawing, because these are phases which cryopreserved-sperm must successfully negotiate to retainfertility. If we measure e? ciency of freezing sperm of di? erent domestic animals by degree of fertility,then we must say that only in the bovine has freeze preservation reached fertility levels comparable to thatof liquid semen inseminations or natural service. In all-other species fertility results are not optimal or atleast-not comparable to natural service or AIwith fresh semen. Species di? erences are-seen considering the di? erent steps of freezing. There exists a large di? erence concerningcooling sensitivity-in the range between body temperature and refrigerator-temperature, boar sperm beingthe most sensitive to chilling. Most methods described are only e? ective when used in conjunction withgamete and embryo freezing methods. In addition cryopreservation plays a crucial role in conservationprogrammes aimed at maintaining genetic diversity.

The history of cryopreservation of gametes:

No meaningful introduction to history ofcryopreservation can be without the mention of Anton van Leeuwenhoek who discovered sperm in 1677using magnifying lens. Italian physiologist L. Spallanzani in 1780 discovered that the fertilizing power ofsperm resided in the sperm carried by the spermatic ? uid. When the semen was ? ltered, the liquid thatpassed through was sterile, but the residue on the ? lter was high in fertilizing power. He further observedthat freezing stallion semen in snow or winter cold did not necessarily kill the ? spermatic vermiculi? butheld them in a motionless state until exposed to heat, after which they continued to move for seven and ahalf hours. Philips and Lardy (1940) brought forth egg yolk as a semen dilutor to protect the spermcells against damage during cooling. Almquist et al. 1949 introduced the addition of the antibioticspenicillin and streptomycin to semen to control pathogenic microorganisms.

Characteristics of Extender:

A good extending medium is key to the successful process of cryopreservation of semen. The following characteristics are essentially required for a good extender.

1. It should provide nutrients as a source of energy.
2. It should protect the spermatozoa against the harmful e? ects of rapid cooling.
3. It should provide good bu? ering capacity to prevent harmful shifts in pH as lactic acid is formed.
4. It should maintain the proper Osmotic pressure and Electrolyte balance.
5. It should be able to inhibit bacterial growth

6. It should increase the volume of the semen so that it can be used for multiple inseminations.
7. The diluents should be easy to prepare, low in cost and give a clear picture of spermatozoa or embryosunder microscope and render no problem in the cleaning of glassware and other containers.
8. It should also ensure a long shelf life of spermatozoa /embryos on storage.

Principles of cryopreservation:

It is well known that low temperature storage of any material ensureslonger keeping quality of any material including foodstu? s. Refrigeration storage of food material is acommon knowledge. The storage at -40C or lower temperatures like deep freeze delays the harmfulbacterial growth which spoils the food or other material. This applies to preservation of gametes as well.Therefore, earlier a to extend diluted semen at refrigeration temperature extended the life span ofspermatozoa by few days. This period was su? cient for transport of semen up to a distance of fewhundred kilometers for insemination of ca at a distant place. However, the quality soon deteriorated.Freezing at below refrigeration temperature resulted in death of spermatozoa or embryos because o? ormation of ice crystals. Ice occupies more space than the water from which itis formed resulting in bursting of the vessel in which it is contained. Therefore, the availability ofcryoprotectants which prevent the formation of ice crystals during freezing and developments of suchprocedures which cause minimum damage to the cells during freezing became key to such long termpreservation of gametes.

The availability of cryoprotectants is very useful to prevent the damage from cold shock. Glycerol isthe most commonly used cryoprotectant although ethylene glycol and dimethy sulfoxide are alsoconsidered good. Egg yolk protects spermatozoa against cold shock. Most of the proceduresdeveloped for cryopreservation and insemination of ca le semen has been extrapolated for use with goatsemen. Freezing of caprine semen is technically challenging as itcontains the bulbourethral secretion capable of interacting with the cryoprotectants used and the freezingand thawing processes results in reduced viability, motility and velocity of sperm movement.

Arti? cial Insemination:

As the conception rate with AI is lower but it has great potential to multiply superior quality of goat with faster rate. This technique also spread elite genetic material throughout a population with increased rate of genetic improvement. This technique is also important for breed conservation process and has paved the way for other reproductive biotechnologies. The descript

goat population (33%) is very less compared to non-descript and non-productive goats (67%). So, to increase the productivity per goat, we need to improve the breed quality scienti? cally. The su? cient elite germplasm of male buck is not available throughout the country to cover breeding programme by natural mating. To cover 71 million breedable does, we need 1.5-2 million bucks for natural breeding as compared to only 50,000 buck needed for Frozen Semen AI Technology. AI is the only solution to improve the quality and productivity per goat. If by adding antioxidants, vitamin, membrane stabilizer, chelating agent, immuno-modulator, growth factor etcin goat semen dilutor may lead to enhance the fertility of sperm then low sperm concentration per semen straw will be su? cient for AI and successful conception. So, the production of semen straws will be more per goat and can cover entire population of goat in this country.

Unlike a cow or bu? alo, a few goats can be maintained easily and easily liquidated in times of distress. Presently commercial goat farming has emerged as important drivers of agriculture growth in India. Goat farming has huge opportunity in rural development as goat has potential for export of products, capital storage, household income, employment and nutrition. It is suitable for women and could be used for rural women empowerment. It could be the important means of doubling of goat owners' income by 2022 as desired by Honorable Prime Minister of India.

Identi? cation of superior bucks and maximum utilization of their semen for breeding doe have been the well-known method for promotion of goat production. Arti? cial insemination (AI) with freshly diluted buck semen has inherent limitations of rapid loss of sperm motility and consequent and freezing ability, particularly when stored at refrigerated temperature. Obviously large scale propagation of proven buck semen through AI with frozen semen is the only alternative means for increasing the goat productivity. Large scale propagation of buck semen on National as well as International plane is not possible unless a suitable technology for freezing buck semen is developed. The optimum freezing technique and an appropriate semen extender are yet to be successfully achieved. Therefore, the present project proposal is formulated to bridge the gap of non-availability of good quality frozen semen. It would be prudent to have production of quality frozen semen and made it available for its use at large scale. The post-thaw motility and the associated fertility of cryopreserved sperm are found to be reduced in goats due to inappropriate semen extender. The detail molecular mechanism and extent of cryopreservation-associated structural damages to sperm have not been explored systematically. The most potent contributing element identi? ed is the cryopreservation-associated oxidative membrane, protein and DNA damages of sperm.

Though the a of AI in goats have been undergoing on experimental basis at various organized farms and Research Institution of India, still serious and coordinated e? orts are lacking

for taking up the AI in goats on large scale like AI in ca and bu? aloes. Till date goat cryopreservation success rate has been considered around 50%. The post thaw motility of goat semen using best diluent (i.e. Tris and egg yolk) is 55% and subsequent conception rate is only around 38%. In order to have optimum success rate the diluent for freezing of goat semen need to be re? ned in term of post thaw progressive motility and membrane integrity. There are many additives which replaced the egg yolk has been established for production of quality semen after cryopreservation. These biochemicals (antioxidants, vitamin, membrane stabilizer, chelating agent, immuno-modulator, growth factor etc.) have been not tested in goat worldwide. Therefore in proposed research proposal we want to use these biochemicals (antioxidants, vitamin, membrane stabilizer, chelating agent, immuno-modulator, growth factor) to enhance the post thaw motility of goat semen and also to get maximum conception rate. The availability of improved quality buck in India is very low. The farmer generally keep poor quality buck for breeding purpose because of lack of awareness. The freezing of goat semen and AI is only one option for fast multiplication of superior goat. The mechanism by which sperm reach the oocyte and evade immune surveillance within the hostile environment of the female reproductive tract is not fully known. The male fertility problem (10%) in farm animals is due to poor immunological competence of spermatozoa and pregnancy losses (30%) by idiopathic and immunological origin.

International Status:

Molecules that neutralize lipopolysaccharide (LPS) activity, such as polymyxin B, betadefensin etc. rescue LPS-induced sperm motility loss and apoptosis via the reduction of LPS binding toTLRs (Okazaki, et al., 2010). LPS-induced epididymitis decreased the expression of epididymal betadefensins, disrupted SPAG11E expression and resulted in the impairment of sperm motility (Cao et al., 2010). β-defensin that possesses both LPS-binding and neutralizing activity *in vivo* and *in vitro*. There is an urgent need to develop a semen extender for goats based on its seminal plasma composition that can minimize the cryopreservation associated oxidative stress in sperm, which in turn may improve the post-thaw motility and associated fertility of cryopreserved goat semen.It is possible to maintain good fertility in goats after AI with semen stored for 24 hrs in TEMPOL (Mara *et al* 2007). Commercially available soy-based extender (Bioxcell®) was found superior to an egg yolk-based extender (Irvine TYB) in preserving motility of cryopreserved goat sperm using a two-step method (Roof *et al*., 2011). Jimenez-Rabadan et al. (2012) studied e? ect of di? erent extender on buck semen cryopreservation using Tris-based extender with moderate success. Dimethyl formamide was reported to be used as an alternative cryoprotectant for goat semen freezing by replacing glycerol at a 6% level (Bezerra*et al*., 2011).In recent years the main focus was on the various additives in the dilutor in order to obtain the higher

post thaw motility and fertility rates. Glutamine (2.5; 5mM) and hyaluronan (500µl/ml) treatment decreased ($P < 0.01$) the superoxide dismutase (SOD) activity (Bucak*et al.*, 2009). Supplementation with methionine (2.5mM), carnitine (7.5mM) and inositol (7.5mM) prior to the cryopreservation process protected the DNA integrity against the cryodamage (Bucak*et al.*, 2010). Supplementation of vitamin E (5 mM) signi? cantly improved the post-thaw motility and DNA integrity in normozoospermic and asthenozoospermic semen samples (Kalthur *et al*., 2011). Butylatedhydroxytoluene (BHT) a lipid soluble antioxidant has been reported to increase pre freeze and post thaws perm parameters like motility, viability, membrane and acrosomal integrity of Boer goat sperm (Memon *et al*., 2011) Rosato *et al*., 2012 reported that addition of lycopene diminished sperm lipidperoxidation during refrigeration and cryopreservation, prolonging the survival of rabbit sperm after liquid storage, but it had a limited e? ect on sperm cryosurvival. Padilha *et al.* (2012) reported supplementation of Tris extender with IGF-I improved subjective sperm motility and structural integrity of the plasma membrane without a signi? cant e? ect on pregnancy rates of ewes with frozen thawed semen.

National Status:Fertility of frozen-thawed semen

To date, the conception rate achieved at ICAR-CIRG, Mathura with frozen thawed goat semen was 37.57% on actual kidding basis. (Annual Report, 2016-17). ICAR-CSWRI, Avikanagar after transcervical AI (TCAI) with frozen-thawed ram semen was up to 36 % (Kumar and Naqvi 2014) and this results are very inconsistent which may vary from 0 – 40 %. However, much higher conception rate was achieved when frozen-thawed semen is deposited directly in to the uterus through laparoscopy (76 %, based on ultrasonography, unpublished data).

Motility and other sperm functions

The average post-thaw motility of cryo-preserved buck semen achieved at ICAR-CIRG, Mathura generally ranged between 45-55 % in Indian goat breeds (Ranjan et al. 2014, 2015)). The protocol involving programmable cryo-freezer and using ejaculates having high density (> 3 x 10^9 sperm mL^{-1}), rapid wave motion, >70 % initial motility and packaged in French mini straws resulted in the above motility consistently.

The pioneering work in goat carried out at Indian Veterinary Research Institute, Izatnagar and Veterinary College, Mathura (Roy *et al.*, 1957) revealed around 50% conceptions after ? rst insemination with washed spermatozoa diluted in EYC diluents. The pioneer work of Sahni and Roy (1972) on deep freezing of buck semen using original Cambridge method (-79°C) revealed 30-40 percent post thaw motility in citrate yolk and milk diluents containing 3-6 percent glycerol as cryo protectant. Later on in 1972 it 35-50 percent survival in buck semen frozen by straw method (-

196°C) was observed. Research work on freezability of buck semen with the use of citrate-yolk milk and tris-citrate acid yolk diluents was carried at veterinary college Anand, Guwahati, Tirupati, Ranchi, Bombay, Akola, NARI and Mathura including Central Institute for Research on Goat, irrespective of glycerol percentage (3-9%) and equilibration time (0-6 hrs), post-thaw motility varied between 42-66 percent. Bha a *et al* (2012) reported 71.43% pregnancy rate with kidding rate of 1.27 by pellet semen. Conception rate was poor (35-45%) due to deposition of frozen semen over the opening of cervix. Improvement in fertility (55-65%) was observed due to deep cervical insemination technique (Deka and Rao, 1989).

Further studies are required to obtain more repeatable results regarding the characterization of the enzymatic and non-enzymatic antioxidant systems in cryopreserved goat sperm. Similarly further research e? orts are required to develop be freezing protocols and diluents that minimize the ultra-structural and biochemical alterations in spermatozoa resulting from the freezing/thawing process, particularly if intended for transcervical AI (TCAI); because spermatozoa have to survive longer to traverse through cervical mucosa before reaching the site of fertilization.

Developed Goat Semen Freezing Protocol at ICAR-CIRG, Mathura, U.P.


Semen is collected using arti? cial vaginafrom elite and superior quality breeding bucks. Immediately after collection, volume, colour, consistency and mass activity of the ejaculates are assessed. Semen is extended in Tris –Egg yolk-citrate-Fructose (TCF) diluent having 10% (v/v) egg yolk and 6% glycerol (v/v). Sperm concentrations are adjusted to 100 million per semen straw and diluted semen quilibrated at 5°C for 4 hours. Horizontal vapour freezing should be done 2 cm above the level of LN_2 for 10 minutes and ? nally semen straws stored in LN_2 container (-196°C), storage of optimum quality frozen semen straws (PTM > 40%).

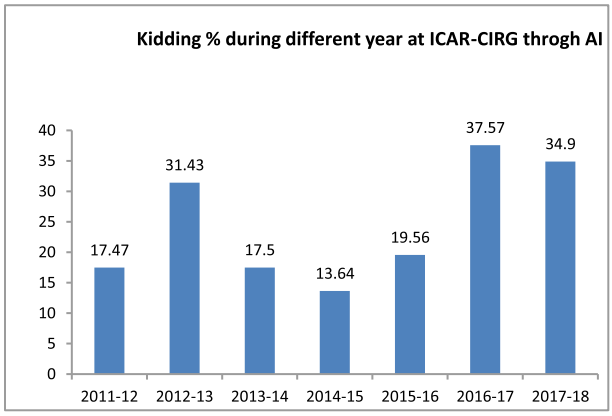
AI Procedure and Achievements

Intra-cervical AI is mainly used to get maximum bene? ts. For Intra cervical AI, the oestrous goat lifted from back for clear visualization of genitalia. A lubricated glass vaginal speculum is inserted through vagina for visualization of cervical opening under sunlight. Then frozen thawed semen straw inserted through vaginal speculum and go through cervical opening and semen was

deposited there and waits for two to three minute. AI should be done twice at 12 hours interval. AI should be performed after 10-12 hours of oestrous exhibition.Due to the complex cervical anatomy in goats it becomes very di? cult to pass the AI gun throughout the cervix. Therefore, the conception rate highly correlated with depth of penetration. This technique is more suited in our goats and easy to perform. The total time taken is 2-3 minutes.

The post thaw motility in Jamunapari, Barbari, Jakhrana and Sirohi were 52.83.54%, 54.42.84%, 48.83.12% and 46.22.32% respectively using our Institute protocol.More than 220 kids were born through AI last two years.The success rate (kidding) is 37 % till date.

Important application of AI:



- The technique helps to introduce a new or desirable genotype into the livestock population at a faster rate.
- The maintenance of a large number of males, which would otherwise, is economically viable.
- Al permits reproduction when suitable males are not available for natural mating.
- The technique provides accurate breeding records for good herd management.
- The technique helps to control disease transmission, since males used for insemination are under health control.
- Maintaining a buck in small herd be di? cult and may not be viable.
- This technology will check indiscriminate breeding and breed dilution.

Economic value

Economic value of AI in goat farming, especially by small and marginal farmers, has hardly

been realized. It is a cost e? ective technique and multiply high quality animals at the faster rate. The extra cost which mainly includes maintenance bucks, about Rs. 6000/- per annum, can be saved by using AI technique. This will help goat keepers of India to double their income in short period.

References are available with the authors.

ABS (ORAL) : PRB-01

Sexual Behaviour of Madras Red Ewes under Accelerated Lambing System

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The sexual behaviour of Madras Red ewes under accelerated lambing system as in? uenced by body condition score at mating was studied in forty eight Madras Red ewes of 2 to 4 years of age with an average initial body condition score of 2.74 ± 0.05 and with similar body weight (24.75 ± 0.4 kg). The study was conducted for three continuous breeding periods in two years and the ewes were managed under semi-intensive system of management at Postgraduate Research Institute in Animal Sciences, TANUAS, Ka Animals were randomly allo to two treatment groups; Animals in treatment - I were synchronised using exogenous hormones and animals in treatment – II were synchronised by Ram e? ect. The ewe's sexual behaviours viz. a eness, proceptivity and receptivity were recorded during mating for one breeding cycle after ram introduction. The results indicated that the there was no signi? cant di? erence between the treatment groups in the expression of ewe's sexual behaviour during mating. The body condition score of ewes at mating had highly signi? cant (P < 0.01) e? ect in the expression of solicit behaviour (BCS = 2.63 ± 0.04 vs 2.10 ± 0.07), ano-genital sni? ng (BCS = 2.65 ± 0.04 vs 2.13 ± 0.06) and tail fanning (BCS = 2.65 ± 0.04 vs 2.38 ± 0.07), whereas squa behaviour was signi? cantly (P < 0.05) in? uenced by ewe's BCS (2.51 ± 0.05 vs 2.67 ± 0.05). Head turning, non-? rm standing and ? rm standing behaviours were not in? uenced by the BCS of ewes during mating. It could be concluded that maintenance of moderate body condition score (2.5 to 3.0) would enable the ewes to express their sexual behaviour profoundly under accelerated lambing system for enhancing their lifetime productivity.

ABS (ORAL) : PRB-02

Circulating pro? le ofcaprine pregnancy-associated glycoprotein (caPAG) during

gestation and early postpartum period in Barbari goats

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Pregnancy-associated glycoproteins (PAGs) are produced by trophoblastic layer of placentaand released into maternal circulation during pregnancy. This study characterized caprine pregnancy-associated glycoprotein (caPAG) in peripheral plasma during entire gestation and early postpartum period in nulliparous and multiparous goats with singleton or twin fetuses, using an in-housedeveloped caPAG speci? c two-step sandwich ELISA system. The assays were conducted with polyclonal antisera against puri? ed preparations of caPAG (AS#707 and AS#708). Further, the earliest time points for pregnancy detection and number of fetus with appropriate cut-o? values of caPAG were identi? ed. Plasma samples Barbari goats (n=15) were collected during gestation and early postpartum period. In addition, plasma samples from six non-pregnant cyclic goats were collected during estrous cyclefor validation of the assay. The e? ects of fetal number and parity on plasmacaPAG level were analysed. Circulating PAG concentrations, in both single- or twin-bearing goats, were steadily increased throughout early gestation and reached to its peak on d45 of pregnancy. Thereafter, caPAG level remains unchanged up to d135 of pregnancy. Similarly, the caPAG level increased progressively in both nulliparous and multiparous goats, and reached to its maximum level at d45 of pregnancy. The caPAG levels in multiparous goatsweresigni? cantly (P<0.001) higher compared with nulliparous goats during the study. After parturition, maternal caPAG in does decline sharply and reaches to its basal level within 14 days postpartum. In conclusion, our results show thatplasma caPAG pro? leis a? ectedby type of kidding (single or twins) and parity in goats. The present caPAG ELISA system is a useful tool for early pregnancy detection and to discriminate singleton and twin pregnancies in goats.

ABS (ORAL) : PRB-03

Elucidating the chemokine signaling at maternal - foetal interface in goats

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Chemokines were ? rst discovered as mediators of migration of immune cells to sites of in? ammation but recently, they have been implicated in a number of reproductive events, such as ovulation, embryo implantation, parturition and endometriosis (Hannan *et al*., 2007). Recent studies have reported that expression of CCL8 (also known as MCP-2) and CXCL10 (also known as IP-10) mRNA was higher in the bovine endometrial on 15 and 18 days of pregnancy than in the non-pregnant stage. Therefore, in order to elucidate the chemokine signaling at maternal fetal interface during embryo implantation, present study was aimed at development of assay, for the

estimation of transcriptional abundance of two chemokines (CCL8 and CXCL10) in the peripheral blood leucocytes of Black Bengal does. The CCL8, CXCL10 and GAPDH genes were ampli?ed by conventional PCR. The ampli?ed PCR products were puri?ed for the preparation of tenfold six serial dilutions. Three standard curves were obtained using puri?ed amplicons of CCL8, CXCL10 and GAPDH genes. All the standard curves showed a linear relationship between the logarithm of the dilution factors and the Ct values for the serial template dilutions. The mean and SD of the slope from the two log linear regression plots, which represent the ampli?cation e? ciency, resulted to be similar.

ABS (ORAL) : PRB-04

Oestrus Induction and Synchronization in Anoestrus Ewes

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Sheep are seasonal breeders – in ewes oestrus begins as day light hours start to decrease in the autumn. From a marketing point of view it is important that lamb of a consistent quality is available all year round. To achieve this, a proportion of the national ?ock needs to lamb in the December /January period to provide ?nished lambs from Mid March onwards. While there are some breeds that will naturally commence oestrous cycles in July / early August bur for a few ewes showing anoestrus for two or more breeding season, oestrus can be induced by using progestagen impregnated sponges. The use of sponges allows for oestrus to be synchronised and thereby allows the use of PMSG to be used to increase ovulation rates and ultimately the li size of ewes successfully mated. A total of 24 anoestrus ewes were selected for the induction and synchronization of oestrus. These ewes were anoestrus from last one to 1.5 year. They were inserted intra-vaginal sponge in to the vagina for 10 days. On 9th day ewes were treated with 700IU of PMSG intramuscular. On 10 th day sponge were removed and injected 1ml Estrumate for regression of luteal tissue if any. The ewes were observed with aproned ram for onset of oestrus. Ewes in oestrus were mated with ram. The remaining ewes not showing oestrus were further treated with 1ml Estrumate and 2.5mg of estradiol on 12 th day of sponge withdrawal. The ewes were observed with aproned ram for onset of oestrus. Ewes in oestrus were mated with ram. Thus, out of 24 ewes 21 came in to oestrus. (87.5%) and out of 21 ewes 11 were lambed with a lambing % of 52.38%. Out of 11 ewes three lambed twins. A total of 14 lamb were born in which 7 were male and 7 were female

ABS (ORAL) : PRB-05

E? ect of varying concentrations of Glycerol in Cryopreservation of Gaddi Goat Semen

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Gaddigoats are important livestock species of Himachal Pradesh, India. The sensitivity/resistance to cryopreservation varies among di? erent species as also between animals of same species. A total of 180 ejaculates from eleven adult Gaddi bucks aged between 1.1 to 4.5 years (2.16±0.36 years), weighed 31-57 kg, (39.1±2.82 kg) were collected using arti? cial vagina and selected on basis of standard quality parameters. The ejaculates were extended in Tris citrate egg yolk extender containing 10% per cent Egg Yolk with varying concentrations of glycerol (6, 7 and 8%) to maintain a concentration of 150 X 10^6 sperms/straws. Filled and sealed straws were equilibrated at 5^0C for 4 hrs followed by vapour freezing of straws for 7 min at 4 cm above the liquid nitrogen and ? nally plunged into liquid nitrogen.The representative straws from each ejaculates were thawed at 37^0C for 30 sec, 24 hrs post incubation to compare the progressive motility, viability, morphological abnormalities and HOST reactive sperms in between di? erent glycerol concentrations along with per cent change due to the processing. The data was analyzed using package R version 3.4.3. Perusal of the results revealed a non-signi? cant variation in the average values of progressive motility, highest (35.18±0.87) being for 6 per cent and lowest (29.00±1.79) for 7 per cent glycerol. Similar, numerically high di? erence among varying glycerol concentration was obtained in viability of sperms, as the average (45.26±1.32) was highest in 6 per cent glycerol and lowest (34.81±2.78) in 7 per cent glycerol. The per cent change in morphological abnormalities was least (20.15) for 6 per cent followed by 7 per cent (21.75) and 8 per cent (30.26) glycerol, respectively. The average absolute values of HOST at di? erent glycerol concentrations were similar ranging from (52.48±1.4 to 53.90±1.47) as also the per cent change ranges from (26.26 to 30.01) in di? erent concentrations of glycerol.

In conclusions, extender containing 6 per cent glycerol was best with respect to least morphological abnormalities and be progressive motility, viability for Gaddi goat semen cryopreservation.

ABSTRACT (POSTER PRESENTATION)

Physiology and Reproductive Biotechnology

ABS (POSTER) : PRB-01

Scanning electron microscopic studieson sertoli cell of goat (*Capra hircus*)

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The structure of the Sertoli cell in the 10 goats was examined using scanning electron microscopy (SEM). In the basal portion of the seminiferous epithelium, spermatogonia and/or spermatocytes were located in compartments enclosed by adjacent Sertoli cells. From the basal aspect, they were situated in successive recesses. In the middle portion, early round spermatids halfway embedded in theSertoli cell were recognized. The exposed surfaces of these spermatids were wrapped with ramifying processes which were derived from the Sertoli cell. In the apical portion, only the heads of the maturing spermatids invaded the Sertoli cell. As the spermatid matured, the apical Sertoli process varied in range to ? nally release the spermatid head. It is probably that the maturing spermatids gradually leave the apical Sertoli process and ultimately segregate themselves from the seminiferous epithelium.

ABS (POSTER) : PRB-02

Heat Stress Amelioration in Small Ruminants through Astaxanthin Supplementation

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Small ruminants play major role in the economy of millions of rural people, and provide food security in terms of meat, milk, skin, wool and ? ber. Small ruminants especially goats are called poor man's cow. Animals undergo various types of stress i.e.nutritional, production, and heat stress etc. During changing climatic scenario heat stress is the most concerning. Heat stress results in decreased growth, reproduction and production.Thus, heat stress causes great economic losses.To combat the heat stress,nutritional intervention through antioxidant supplementation to the animals might be one of the best strategies. Therefore, for the present study, twelve goatsof 3-4 months age were selected from LRC, NDRI, Karnal and further divided equally in two groups i.e. control and treatment. All the animals were provided feed and fodder as per ICAR (2013) standard, whereas, animals of treatment group additionally supplemented with astaxanthin @ 0.25 mg/kg BW/Animals/day. Body weight, ADG,FCR and feed intake were recorded at fortnightly interval. Body weight, ADG and feed intake were found signi? cantly ($P \leq 0.05$) higher, while, FCR was lower ($P \leq 0.05$) in astaxanthin supplemented group compared to control. Based on the above ? nding, it can be concluded that supplementation of antioxidant (astaxanthin) ameliorated the adverse impact of heat stress and enhanced the growth rate of kids, and ultimately leads to increase in productive life of goats.

ABS (POSTER) : PRB-03

Physico-chemical parameters as indicator of semen quality of crossbred bucks under tropical climatic conditions

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In order to ? nd out the relationship among physical and biochemical parameters, six adult healthy crossbred (Alpine X Beetal) bucks were selected from NDRI, Karnal ? ock. These animals were maintained under standard conditions of feeding and management. Semen samples were collected at weekly interval from February to May month. Few ejaculates were discarded in the beginning of the experiment just to stabilize the semen quality. Just after collection of semen, each semen sample was evaluated for physical (colour, consistency, volume, mass motility, sperm concentration, live sperm percent) and biochemical (pH, MBRT, initial fructose, inorganic phosphorus and total cholesterol) parameters using standard methods. Signi? cant (P<0.01) positive correlation were found between live sperm (%) and sperm mass motility; volume and sperm concentration; initial fructose and MBRT; sperm concentration and total cholesterol. However, signi? cant (P<0.01) negative correlation was found between MBRT and various other semen a viz. mass motility, live sperm percent, sperm concentration and total cholesterol. Analysis of variance showed signi? cant individual variation in the volume, sperm concentration, MBRT, initial fructose and total cholesterol. Whereas, during di? erent months the variation was observed in volume, sperm concentration, MBRT, inorganic phosphorus and total cholesterol. Based on the results of the study, it can be stated that the some parameters of the buck semen ? uctuated during di? erent months and between the bucks but overall quality of semen was good. The biochemical parameters should also be given due weightage for testing the semen quality as there is high correlation between physical and biochemical parameters of buck semen.

ABS (POSTER) : PRB-04

Cryopreservation and fertility of frozen thawed Chegu goat semen

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Goats are important livestock species of India. Chegu is a pashmina producing goat native to the cold arid region of Himachal Pradesh (H.P.), India. Semen cryopreservation from six Chegu elite males (aged 2.05±0.40 years; weighed 29.16±2.02 kg) was practiced using Tris Citrate Egg Yolk extender containing 10% EY and 6% Glycerol. Gross semen parameters includes volume (0.80.85±0.07 ml), color (Creamy white to yellowish), concentration (2238.5±231.0 x10^{6} spermatozoa/ml) and mass motility (3.92±0.03).The signi? cant changes (P<0.01) in post thaw seminal parameters (75.48±0.69*v/s* 37.38±0.90; progressive motility), viability (75.79±0.95 *v/s* 48.25±1.78), morphological abnormalities (5.64±0.29 *v/s* 7.02±0.32) and HOST reactive spermatozoa (64.07±1.75 *v/s* 43.35±1.79) were observed in present study. Arti? cial insemination using frozen thawed semen having concentration (150 x10^{6} spermatozoa/straw) from three di? erent bucks was practiced in 40 synchronized goats with conception rate of 42.5 per cent. Non-signi? cant variations amongst di? erent bucks were observed with birth of 1.12 kids per doe and twinning rate of 11.8 per cent. It was concluded that semen cryopreservation along with arti? cial insemination can be practiced in Chegu goats to improve the population of this endangered species.

ABS (POSTER) : PRB-05

Mitigation of Heat Stress in Ruminants through Antioxidant Supplementation

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Small ruminants play major role in the economy of millions of rural people, and provide food security in terms of meat, milk, skin, wool and ? ber. Small ruminants especially goats are called poor man's cow. Animals undergo various types of stress i.e.nutritional, production, and heat stress etc. During changing climatic scenario heat stress is the most concerning. Heat stress results in decreased growth, reproduction and production.Thus, heat stress causes great economic losses.To combat the heat stress,nutritional intervention through antioxidant supplementation to the animals might be one of the best strategies. Therefore, for the present study, twelve ruminants (Sahiwal heifers) of 10-12 months age were selected from LRC, NDRI, Karnal and further divided equally in two groups i.e. control and treatment. All the animals were provided feed and fodder as per ICAR (2013) standard, whereas, animals of treatment group additionally supplemented with

astaxanthin @ 0.25 mg/kg BW/Animals/day. Body weight, ADG and FCR was recorded at monthly interval, while, feed intake was recorded at fortnightly interval. Body weight, ADG and feed intake were found signi? cantly ($P \leq 0.05$) higher, while, FCR was lower ($P \leq 0.05$) in astaxanthin supplemented group compared to control. Based on the above ? nding, it can be concluded that supplementation of antioxidant (astaxanthin) ameliorated the adverse impact of heat stress and enhanced the growth rate of heifers, and ultimately leads to increase in productive life of heifers and hence economy of farmers.

ABS (POSTER) : PRB-06

Serum antioxidants of physiological resistance against Reactive Oxygen Species during environmental stress in non-descript sheep from arid tracts

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An endeavor was carried out in non-descript sheep(*Ovisaries*) in order to ? nd out the resistance against reactive oxygen species (ROS) during environmental stress. Blood samples were yielded to harvest the serum of total 100 animals of di? erent age groups viz. 4-7,7-10 and 10-13 of either sex in moderate and extreme hot environmental temperature period (ETP). Serum levels of reactive oxygen species scavengers like vitamin E (μmol^{-1}), glutathione (μmol^{-1}), catalase (kUL^{-1}), monoamine oxidase (UL^{-1}), glutathione reductase(kUL^{-1}) were determined. The di? erence in mean values were 3.50±0.20 to 2.5±0.20, 6.40±0.10 to 3.60±0.20, 70.00±1.00 to 101.00±1.00 150.10±3.30 to 400±3.40 and 8.00±0.60 to 25.00±0.70 respectively. Environmental stress included extreme hot environmental temperature periods. These ? ndings were compared with those obtained during moderate environmental temperature period reckoned as control. Vitamin E and glutathione activity decreased signi? cantly during hot environmental temperature periods. Serum catalase, monoamine oxidase, glutathione reductase, activities increased signi? cantly during hot environmental temperature periods. Therefore, it can be concluded that environmental stress induced marked changes in the levels of reactive oxygen species scavengers in the serum of non-descript sheep from arid tracts. The stress facing animals can be managed by proper supplementation of balanced ration containing appropriate amount of antioxidants. This can defend the animals form the peril of oxidative stress.

ABS (POSTER) : PRB-07

E? ect of desert cooler on amelioration of heat stress in ewes under semi-arid region

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Arid and Semi-arid region is characterized by high ambient temperature with prolonged hot summer months. In hot arid and semi-aridregion, heat stress is a major constraint in sheep production. Desert cooler and evaporative cooling system is an e? ective method of amelioration of heat stress in dairy ca However, the e? ectiveness of desert cooler on sheep under hot semi-arid region during summer is yet to be established. Therefore, the present study was carried out to assess the e? ect of the desert cooler on amelioration of heat stress in ewes under hot arid and semi-arid region. For this purpose twenty adults,Malpura ewes of 2-3 year of age were selected from the experimental animal ? ock. The ewes were equally divided into two groups, viz. G1 (Control) and G2 (Desert cooler). Ewes of both groups were kept in an asbestos roofed,mud-? oored shed with four sides covered with chain linked fence. The ewes of G2 were provided with a desert cooler from morning 09:00h to evening 18:00h. Ewes of both the groups were provided with adlibitumdiet consists of 70% roughage (*Cenchruscillaris* hay) and 30% concentrate feed. The maximum temperature, relative humidity and temperature-humidity index at afternoon were signi? cantly ($P<0.01$) lower in G2 shed where the desert cooler was used as compared to G1 shed. The respiration rate and skin temperature at afternoon were signi? cantly ($P<0.05$) lower in G2 ewes as compared to G1. The plasma glucose and tri-ido-thyronine level were signi? cantly ($P<0.05$) higher in G1 as compared to G2. Other blood biochemical, endocrine and reproductive parameters did not vary between the groups. The present study clearly established that the provision of the desert cooler in sheep shed created a be microenvironment for sheep. However, the well-adopted native adult sheep of the hotsemi-arid region are well versed to combat heat stress in natural hot summer of hot semi-arid region.

TECHNICAL SESSION - II

(Nutritional and Feeding Manipulation)

LEAD : NFM-01

Bio-active Potential of Sheep Milk and its Therapeutic Utilization

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The ? rst animals to be domesticated were sheep and goats in middle East due to their size, ruggedness, adaptation, social nature and also cost e? ective management by humans. These animals were major source of meat and milk and clothing. The history of milk as food begins in the Neolithic period in the Middle East. Milk has become a desired and valuable source of nutrients so as herds were formed by selecting di? erent dairy breeds and cow milk is established as the most commonly consumed milk worldwide. where domesticating of animals was started with goats and sheeps during development phase of agricultural practices.Thus, 85% of the world milk production is derived from ca ed by milks from other species such as bu? alo (11%), goat (2.3%), sheep (1.4%),andcamel(0.2%). However, sheep farminghas lion share of the agrarian economies in many countries, especially those bordering the Mediterranean Sea and in the Middle East.

The China is leader in eves milk production in the world (12.2%) followed by Greece(8.7%),Romania(7.2%)andItaly (6.1%).Sheep milk is also important in the Near East and North Africa, with 7.5% production, and somewhat less important in sub-Saharan Africa (5.6%) and East and Southeast Asia (3.9%). Sheep are mostly reared for wool and meat. Sheep skins and manure constitute important sources of earning, the la
Milk from sheep is of limited importance and that too in very limited areas of Jammu and Kashmir, Rajasthan and Gujarat. Indian sheep are not regarded as dairy sheep.The quality of milk varies with stage of lactation, milking methods, environment, season, diet, feeding system, breed and species. Milk composition signi? cantly in? uences milk product processing and its quality. Sheep milk is rich source of proteins, fats, minerals, and vitamins as compared to the milks of other domestic species and being consumed by man since the beginning of sheep domestication. The unique physicochemical and biochemical properties of sheep milk can be advantageous for its promotion in category of functional foods containing prebiotics and probiotics which are part of a new market as increasing demand of healthy foods.

Health food may considered as bioactive substances, the bene? cial health e? ect of which relate to the prevention and treatment of speci? c diseases which normally require the use of pharmacologically active compounds. These bioactive food ingredients directly in? uence numerous biological processes evoking behavioral, gastrointestinal, hormonal, immunological, neurological, and nutritional responses. So, these may function as healthcare product or as functional, providing therapeutic value for either treatment of infection or prevention of diseases.

Today, milkproteins are considered themostimportant source of bioactive peptidesandan increasing number of bioactive peptides have beenidenti? ed in milk protein hydrolysates and fermented dairy products (Fi *et al*, 2004). Bioactive peptides have been de? ned as speci? c protein fragments that have a positive impact on body functions or conditions and may ultimately

in? uence health (Ki &Weiler, 2003). Upon oral administration, bioactive peptides, may a? ect the major body systems - namely, the cardiovascular, digestive, immune and nervous systems depending on their amino acid sequence. For this reason, the potential of distinct dietary peptide sequences to promote human health by reducing the risk of chronic diseases or boosting natural immune protection has aroused a lot ofscienti? cinterest over the past few years.

These bene? cial health e? ects may be a ributed tonumerous known peptidesequencesexhibiting,e.g.,antimicrobial,antioxidative, antithrombotic, antihypertensive and immunemodulatory activities (Fi *et al*, 2004Shimizu,2004).The activity is based on their inherentamino acidcomposition andsequence.The size of active sequences may vary from two to twenty aminoacid residues, andmanypeptidesare known to reveal multifunctional properties (Meisel&Fi). Angiotensin-converting enzyme (ACE)-inhibitorypeptides and calcium-bindingphosphopeptides (CPPs) aremostcommonly produced bytrypsin(Gobbe *et al*,2004). Other digestive enzymesand di? erent enzyme combinationsofproteinases including alcalase, chymotrypsin, pancreatin, pepsin and thermolysinas well as enzymes frombacterial andfungalsources have alsobeenutilized to generate bioactive peptides from various proteins (Kilara&Panyam, 2003). *Lactobacillus helveticus*iswidelyusedasa dairystarter inthe manufacture of traditional fermented milk products, such as Emmental cheese and highly proteolytic *Lb. helveticus*strains capable of releasing ACE-inhibitorypeptides, inparticular, have been demonstrated inseveralstudies. The bes tknown ACE-inhibitory peptides,Val-Pro-Pro(VPP) and Ile-Pro-Pro(IPP), have been identi? ed in milk fermented with *Lb.helveticus*strains(Sipola, et al,2002).

Sheep milk fat globules are smaller in size, providing be digestibility and confer greater consistency to these milks as compared to cow milk. In ruminants, sheep milk fat contains highest levels of conjugated linoleic acid (CLA), a large amount of its physiological precursor vaccenic acid and a lower ratio of $\omega 6/\omega 3$ fa acids. The CLA exhibits interesting activity from a physiological point of view, including antiobesity, anticarcinogenic, antidiabetic, antioxidant, and immunoregulatory e? ects. The most predominant fa acids in sheep milk yogurt are oleic acid (C18: 1n9), followed by palmitic acid (C16: 0) and myristic acid (C14: 0), and the polyunsaturated fa acids (PUFAs) mainly comprised of linoleic (*cis*-9, *cis*-12 C18:2) and α-linolenic (*cis-9, cis-12, cis-15* C18:3) acids. These unique milk properties contribute to the prevention of cardiovascular diseases.

Sheep milk is rich in casein amounts to around 80% of the total milk protein composed of four fractions viz. αS1-casein, αS2-casein, β-casein andκ-casein which are di? erent between the ruminant species. Sheep milk casein micelles have higher mineralization degrees and are less hydrated, multiphosphorylated forms and heat stable than cow milk which are technological advantage in cheese and curd preparations and also promotes lower allergic sensitization. Compared to cow milk, whey proteins from sheep milk are more sensitive to heating while whey protein concentrates having signi? cantly be foam stability and gel strength.The vitamin contents in sheep milk are mostly higher than those in cow milk Moreover, sheep milk fat is a good dietary source Sheep milk is rich source of proteins, fats, minerals, and vitamins as compared to the milks of other domestic species and being consumed by man since the beginning of sheep domestication. The vitamin contents in sheep milk are mostly higher than those in cow milk Moreover, sheep milk fat is a good dietary source of vitamin A and vitamin E.

Enzymatic hydrolysis of milk proteins can release fragments that are able to exert speci? c biological activities, such as antihypertensive, antimicrobial, opioid, antioxidant, immunomodulatory, or mineral-binding. sheep milk is more prone to a speci? c pa of proteolysis, generating more peptides that are capable of inhibiting the immune and ACE systems. The high fat levels in sheep milk replaced by the addition of the prebiotic inulin ? ber in the products formulation suggesting that there is great potential to be explored commercially.
Di? erent types of sheep milk cheese and yogurt have been described as sources of angiotensin-converting enzyme (ACE) inhibitory peptides, most derived from the *β*-subunit of casein. Higher immune and ACE-inhibitory activities reported in yogurt made from sheep milk compared with that made from cow milk. Sheep milk proved to be a suitable raw material for the production of fermented products using *L. acidophilus, Bi?dobacteriumbi?dus,* and *S. thermophilus*, which can potentially have bene? cial e? ects on human health. Functional foods containing prebiotics and probiotics are part of a new market niche that seeks consumer recognition, satisfaction, and acceptance; they have been a interest from the food industry for both economic reasons and due to scienti? c evidence related to their health bene? ts.

LEAD : NFM-02

Stall feeding in small ruminants: revisiting commercial production

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Abstract

Commercial sheep and goats farming and advent of small and large-scale entrepreneurship a stall feeding and strategic marketing aimed at increasing revenue and pro? tability. A shift form low-input to high-throughput production system could sustain a dynamic population with precisely low pressure on total livestock number as well as land disposition. This facilitated 'All-in All-out' system of rearing thereby meeting the progressive and market-driven demand for meat, milk and quality products. Therefore, for the sake of improving the farmer's income by eventually having a more productive asset and even otherwise to ful? l the growing and future meat/milk demand potential, there is need to improve as against increasing the population of animals with low yields so that the dual problem of adequate meat, milk and wool is addressed even while increasing the farmer's income from per unit holding of the sheep/goat and hence making it a more productive income generating asset. Unarguably, there is large scope to increase the small ruminants' role in the livelihood of small holder farmers not only to improve their economic and social status but also to explore job opportunity to rural youth. On the other hand, this will meet the growing demand for meat and meat products and enhance protein and nutritional security of Indian population by unleashing increasing production level through higher inputs.

Introduction

Small ruminants play an important role in the food and nutritional security of millions of rural people especially the landless, marginal and small farmers. The rural poor who cannot a? ord to maintain a cow or a bu? alo ? nd sheep and/or goat keeping as the best alternative source of supplementary income that essentially linked to socio-economic security and provides jobs to resource-poor population.They are most often termed 'ATM' (Any Time Money) for the rural people due to its ready marketing. However, the traditional rearing of sheep and goats is generally

based on low input-low output production system that may not be a long-term alternative due to increasing gap in demand and supply of meat to expanding non-vegetarian population of the country. This has adversely a? ected the population in? icting a decline by 9.07% in sheep and 3.82% in goats during 2007-12 (19th Livestock Census, DAHDF, 2014).The meat production in the country as per 2014-15 data was 6.6 MT with a per capita availability of 4.94 kg. Sheep contributes 529.03 TT and goats to 914.13 TT, which needs to be enhanced through commercial farming. Demand-driven high slaughter rate and depleting grazing resources are the major contributing factors. The major concern is the average carcass yields, which is lower than the world average of remained stagnant over this period. It could be due to the facts that most of the goats (65%) are kept on subsistence production system and are non-descript type with low yield of milk and meat. The production potential of sheep and goats is not being harvested due to a number of' interactive factors related to poor breeding, sub-optimal nutrition, improper health care, reproduction and poor access to these services and markets. Besides, the small ruminant rearing in India is widespread and is largely concentrated among resource-poor households which are landless or have tiny pieces of land. Households cultivating less than 2.0 ha land (marginal and small) are the custodian of more than 76 per cent of the total goats in the country (GOI, 2006-07). With large population base and untapped potential of both sheep and goats, there is a scope to harvest more bene? ts in short period of time through adoption of stall feeding practices aimed at commercial production.

Traditional feeding system

The small ruminant rearing practice is gradually transformed from transhumance and extensive production system to semi-intensive type based on post-grazing supplementation of both concentrates (mainly grain ? our, brans/chunnies, oil cakes etc.) and roughages (stored hay, vegetable crop waste, browses/tree forages etc.) with li or no supplementation of either salt or mineral mixture. Di? erent traditional feeding systems are depicted below.

a. Transhumane/migratory system: a vast population structure of sheep and goats are linked to this production system. The farmers may own the population or is just a keeper of a small herd ranging from 100 to 500 units (even larger), who migrate from one locality to other in search of feed resources, e.g. common property resources, post-harvested crop ? elds, forest lands, mountain pasture resources (alpine/sub-alpine pasture).

b. Extensive production systems: Animals raised under these systems satisfy their nutritional needs through grazing the available vegetation (village land and biomass reserve, CPR, post-harvested land/? eld, etc).

c. Mixed extensive systems: this system is largely grazing with some supplementation post-grazing at the paddock.

d. Mixed crop-livestock production systems:These production systems typically involve small herd sizes, with animals either con? ned in limited spaces or free-roaming. Animals under these systems are fed on di? erent feeds, largely available on-farm and primarily consisting of crops and crop residues produced and as they become available throughout the year.

e. Intensive production systems: Intensive production systems are, in general, professionalized, using high levels of resources available in plenty at the farm premishes or provided in the stall involving both concentrates and roughages

f. Semi-intensive system: This is more or less similar to 'Mixed crop-livestock production systems'.

Animals are being supplemented with adequate concentrates and roughages (cultivated, harvested or stored) to meet the intended production.

Stall feeding: scenario and possibility

There is considerable increase in slaughter rate, which draws more and more young-stock to meat marketing thereby incurring a huge loss of production output as well as the germplasm to cater the future demand. Use of promising germplasm with FecB genotype (e.g. Garole, Kendrapara, Edka and presently, Avishan) for introgression of proli?c gene in other less proli?c sheep breeds would de?nitely upturn the tide in favours of sheep husbandry. Similarly, reproductive manipulation aimed at three lamb/kid crops in two years and narrowing the gap in breeding age and empty days draws a while shifting to commercial production and the convenient and full-proof approach seems to be stall feeding based on intensive or semi-intensive system of rearing.

The pro?tability and sustainability in this sector stresses feeding and rearing plan targeted at net return to exceed that from other sectors. The category of animals that best ?t for stall feeding are 1) pre and post-weaned lambs/kids; 2) male lambs/kids reared for marketing and 3) lactating ewe/doe. The rest of the population can be reared under semi-intensive system, i.e. post-grazing supplementation while sheltering at night based on achieving multiple-targeted production during the maximum small ruminant productive life-cycle of 6-7 years.

While the population is expected to double in Asia and Africa by the year 2020, the demand for meat and meat products is expected to triple. To bridge the gap in demand and supply, there is need for augmenting the quantity and quality of meat production through scienti?c methods of organized livestock production by utilizing various locally available feed resources and by improving meat animal germplasm. Therefore, major goals for the meat industry to grow in India at par with many developed countries would be

- Switching to high-input high-output intensive feeding system from traditional low-input system
- Sustaining livestock population pressure by maintain a dynamic population through adoption of 'All-in and All-out' system focussing on country's animal protein demand Nutritional intervention, feed technology, processing and storage to deal with multitude problems of wastage, nutrient availability and scarcity/emergency feeding and specialized nutrition for augmenting nutritional health, combating stress and meeting consumer preferred quality traits in livestock produce will improve the overall small ruminant productivity (Sahoo and Karim, 2010).

Extensive system

Sheep and goat in India are generally reared under extensive system and play only a secondary role to crop as well as other livestock production. This system includes migratory, transhumance, free range, pasture and range grazing management of sheep and goats. It is the most common system in India and studies have shown that under the existing conditions, the rangelands and natural pastures fail to adequate energy throughout the year and adequate protein for more than half the year. A ?ock of 30 Malpura ewes and 30 local does along with one breeding male from each species was maintained at Institute (CSWRI) farm for three years on natural grazing/browsing without any supplementation. In another study, 15 Malpura and 15 Malpura × Rambouillet ewes and 15 Sirohi and 15 Sirohi × Beetal does were maintained on 23 ha protected

natural range land at the rate of one animal and followers per acre under free grazing management for two years. On similar line, the production performance of 50 native and 50 crossbred sheep and their followers maintained on 35 ha of natural rangeland under farmers' management was studied. The production performance of Avivastra and Avikalin strains of sheep on a developed pasture (*Cenchrusciliaris*) at the rate of 5 ewes under rotational grazing system without any supplementation except mineral-salt bricks was successfully demonstrated. A ? ock of 50 mu synthetic ewes was maintained on a *Cenchrusciliaris* pasture at the stocking rate of 3 adults and their followers per ha for 2 years. At birth, 3, 6 and 9 months, body weights during the three lambing seasons averaged 3.2, 13.9, 20.6 and 23.9 kg respectively. Thirty-two Avivastra sheep and 32 Marwari goats were maintained on 16 ha *Cenchrusciliaris* pasture for a period of 3 years averaging 2 sheep +2 goats and their followers per ha. The weaner lambs weighing 11.0 kg could a only 16.0 kg body weight at one year of age when maintained on a *Cenchrus* pasture alone, whereas lambs grazing on *Cenchrus* + *Dolichos* pasture reached 20.5 kg. It is to note that a marked improvement can be achieved in overall performance and productivity of sheep and goats by maintaining them on developed pastures.

Semi-Intensive system

This system is a combination of limited free range grazing and stall-feeding. Integrations of sheep rearing with arable cropping are also included where either the sheep/goats are tethered or cut or carry system of available fodder is employed. Animals belonging to several owners may be grouped for grazing which is mostly done in the morning and evening for 4 to 6 hours. As per availability, the animals are supplemented with kitchen wastes, concentrate mixtures, crop residues, green and dry fodders and tree leaves etc. The level of nutrition is found be than that under extensive system. A daily gain of 56 g on grazing on *Cenchrus* pasture, 92 g with low energy-low protein ration and 112 g with high energy and high protein concentrates fed at the rate of 300 g per day to Malpura lambs was recorded. A growth rate of 140 to 165 g per day was recorded when the mu synthetic male lambs maintained on *ad lib*. Supplementation of 400g concentrate mixture in addition to grazing to Malpura lambs increased the carcass yield by 30% whereas supplementation of 550 g concentrate mixture resulted in an increase of 55% in the dressed carcass yield as compared to the lambs maintained on grazing alone. It was observed that *ad lib* supplementation of concentrate, hay and green to kids between 91 to 180 days age, in addition to browsing resulted in an increase of 44.8% pre-slaughter weight, 65.1% carcass weight and 14.3% dressing weight over browsing alone. An experiment on kids showed an improvement of about 44.5% during 3 to 6 months and about 66.1% during 6 to 9 months on browsing + supplementation compared to browsing alone. In another experiment, the Sirohi, Marwari and Kutchi does produced 84.4, 89.1 and 94.3 kg milk with no supplementation, 98.6, 96.1 and 93.2 kg with 150 g concentrate, 100.9, 115.7 and 110.0 kg with 300 g concentrate supplementation in addition to 8 h grazing during 150 days lactation.

The advantage of grazing with supplementation based feeding system will have following advantages

- Economic: lamb rearing for mu production
- Quality mu designer meat with fa acids
- Possibility of manipulating mu quality with agronomic practices
- Possibility of producing Organic meat and meat products with be keeping quality

Intensive system

The intensive system of sheep and goat production includes grazing on developed pastures and/or completely stall-feeding on cultivated fresh or conserved fodders, crop residues and concentrates. Although goats prefer to browse as compared to grazing, they are quite capable of making e? cient use of cultivated pastures for meat and milk production similar to sheep. Between sheep and goats, ADG was higher in lambs than kids under intensive system. In this system, native Malpura lambs use to a 18-20 kg weight at three months and 30-32 kg at six months, but the system is practiced in less than 5% of the small ruminant production systems (Sahoo et al., 2015). This system of lamb rearing for mu production has been developed for harvesting maximum weights at an early age with higher feed e? ciency. The post-weaning gains of 150-200 g daily in native lambs have been achieved (Shinde et al., 2013). Similarly, the milk yield in goats during 150 d lactation becomes higher under intensive system than that under semi-intensive and extensive systems. Some of the proven and pro? table feeding systems are

- Maximizing preweaning performance with nutrient dense creep ration following up with post-weaning high-grain ? nisher diet
- Intensive feeding of lambs with supplemental arti? cial milk and subsequent high energy ? nisher ration
- Feeding high energy rations with rumen protected fat
- Feeding both energy-protein dense full-fat oil seeds (soyabean, linseed etc) based concentrates
- Intensive feeding for quality meat production
- Limited grazing followed by stall feeding with high energy high protein ? nisher ration

Options

There are four options in stall feeding protocol to rear either under 1) semi-intensive, 2) intensive, 3) complete stall feeding or 4) strategic feeding with an eye on whole farm productivity or market-demand.Sirohi goat kids found more suitable for quality and quantity chevon (goat meat) production slaughtered at 9 months of age under intensive system and 12 months of age under semi-intensive system (Rajkumar et al., 2010).

Concept of broiler lamb/kid production

Muza? arnagari sheep are more suitable for quantity and quality mu production at 6 months of age (Das et al., 2008). Similarly, a lot many feed formulations are evaluated in Malpura sheep to achieve ? nishing weight of 35 kgat 6 months of age with a promising FCR at around 4.0 (Bha et al., 2015;2018). In an ex-ante assessment on economic gains from technological and marketing interventions in goat production in India, Dixit et al. (2015) reported that the net economic gain through marketing of kids at commercial age has been estimated to be ? 11842 million, which is worked out after deducting cost of ? 13534 million for keeping animals for additional 4 months to a the commercial age. Similarly, male lambs in ? eld ? ocks are put to slaughter an early age of 3-4 month when they hardly a body weight of 12-14 kg. Provision of support from entrepreneur for procurement of these lambs and intensive feeding on stall up to slaughter stage will improve mu on production and quality and wholesome mu on for consumers.

There are numerous achievable possibilities which can a the educated and unemployed youth for small to large entrepreneurship:

- Maintaining a dynamic population without direct load on land and livestock population pressure
- All in-all out system and sustained supply of meat vis-à-vis demand
- Strategic rearing targeting demand in religious and cultural function
- Quality meat and milk production addressing human health
- Designer and functional animal produce, meat as well as milk and their products
- Cafeteria feeding practice targeting more meat per sheep/goat
- Stall feeding targeting 'Farm to Fork'Broiler lamb/kid production can be targeted during

pre- and post-weaning phase of life separately or consecutively. The advantage of additive approach involves maximizing pre-weaning weight gain through feeding of milk and/or milk replacer (Bha et al., 2017a; 2018; Bha and Sahoo, 2018) and additional creep feed for rapid adaptation to solid feed and early rumen development (Sahoo et al., 2005) and then harnessing post-weaning marketing live weight, preferably at 5 or 6 months of age in Malpura lambs (Bhaet al., 2017b,c; Bha et al., 2018). The concept of 'Cafeteria feeding' allows free access to the lambs to meet adequate energy and protein for this early growth phase in most e? cient manner. Chaudhary et al. (2015) assessed the in? uence of on-farm supplementary feeding of concentrate pellets to Sirohi goat kids (60 d old) maintained either on 6h sole grazing (control; n=5) or grazing with supplementation at 1.5% of live weight for 140 days and found ? nishing weight of 25.8 kg versus 12.08 kg. There was improvement in carcass yield with promising dressing percentage.

Therefore, the farmer/entrepreneur can focus on following three principal objectives:

- Targeting optimization of input, i.e. improvement in FCR (achieving FCR 1:4 to 1:5 with economic input: output ratio of 1:2.8 to 1:3.2)
- Maintaining a dynamic ? nished population for sustained supply to the market
- Expanding marketing avenues and enhancing pro? tability and revenue through demand-driven pricing of the produce and products.

Scope of commercial sheep and goat production

It is undoubtedly agreed upon augmenting commercial sheep and goat production to meet the progressively increasing demand for animal protein due probably to a change in feeding habit of the new generation besides the population growth reaching 132 crores. The factors are basically

- Demand of animal protein
- Preference of meat and meat products
- Increasing awareness for healthy food and designer meat

In commercial production, nutritional input-output ratio is considered one of the major determinants for assessing pro? tability in any livestock husbandry system due to lion-share (up to 70%) involved in cost of feeding and nutritional supplements. Therefore, net return and cost: bene? t ratio decides pro? t making and future expansion of this entrepreneurship. Availability of resources and judicious use of the same through feed banking is essential for year-round feed and nutrient supply without incurring any drop in production due to periodic scarcity or calamity. Nutritional immunization against production decline is invariably dependent on three following

approaches:

- Evolving a module simulating commercial sheep production involving two and three tier agro forestry production system.
- Fodder maximization and quality improvement adopting environment friendly agronomic practices and its e? ect on nutrient utilization in sheep.
- Exploring newer feed resources for sheep feeding and evolving farmers' friendly conservation techniques

Commercial sheep and goats farming involving challenge feeding of weaner lambs/kids to harvest maximum ? nishing weights will meet out the demand driven animal protein need of the increasing human population. In this line many commercial entrepreneurship have already been started in some parts of the southern India. Adoption of micro-climate environment in line with poultry enterprises will open up the scope for incorporating exotic sheep germplasm like Su? olk, Dorset, Awassi, fat-tail or fat-rump type sheep etc and goat germplasm like Spanish, Boer, Anglo-Nubian, Shami, Saanen, etc. for maximizing meat and milk production. Automation in feeding and rearing practices with micro-chip based disease diagnostics will aid in whole farm nutrient and health management system.

More lambs per lamb or more kids per kid

In most parts of India, lambs are sold at the age of 2.5 to 3.5 months of age. The reasons are more of socio-economic compulsion rather than any scienti? c or economic merit. The farmer is of the view that he has no bearing on lamb's preweaning growth so long milk is available from its dam. Because, native breeds of ewes except a few are poor milcher and their lactation hardly continues beyond 3-4 months, rearing lambs in the post-weaning period (3-6 months of age) involves accountable input cost. Moreover, small ruminant rearing is generally at the hands of rural poor and they have hardly any surplus money at hand to invest for a probable future return. In the hindsight, many farm and ? eld evaluation trials have come up with a feeding schedule to harness a promising cost: bene? t ratio of 1:2 to 1:2.5 during the post-weaning period (Sahoo et al., 2015). This not only enable the farmer to manifold the income but also saves a young one from early slaughter thereby doubling the meat output from the same lamb that would have yielded half of the carcass weight at pre-weaning compared to that at post-weaning. This will ultimately reduce the burden of accelerated slaughter percentage, a direct threat to existence of small ruminant population and dependent livelihood.

Di? erential approach in commercial rearing

Keeping in view that sheep and goats are mostly reared extensively, it will be interesting to know how they perform in a feedlot situation; i.e., to study the growth, carcass and meat quality of feedlot animals and to quantify the optimum time needed for them in a feedlot to achieve desirable growth and carcass quality. An economic assessment on goat production in India revealed that opportunity cost of technological interventions on health care, nutrition and marketing together are equivalent to about 1.24% of total value of output (at current prices) from livestock sector in 2010-11 and 14.74% of the value of output from goat sector for the year 2012 (Dixit et al., 2015).There is a need to determine suitable production systems using di? erent breeds suited to the di? erent environments which produce carcasses that cater to the needs for domestic and export markets and to study their performance in tropical and subtropical environments. Development of a carcass grading system and a suitable infrastructure in developing countries are some of the key

requirements needed to establish a sustainable meat industry in parallel with commercial sheep and goat farming. With an increase in demand by consumers for low-fat red meat alternatives, the future of the small ruminant meat industry looks promising.

It is a fact that economics of feeding was the vital factor for feeding forage to ruminants because of the unique capability of these animals to convert non edible ? bre by virtue of rumen fermentation to digestible nutrients like microbial biomass and volatile fa acids. Small ruminants are nothing di? erent and therefore, a healthy rumen and rumen ? ll cannot be ignored, which ultimately provides protein and energy to the animals, and is the bo line in any di? erential approach targeted at commercial rearing. The small ruminant production will be pro? table if it is looked from an industry perspectives that can provide job alternative to rural youth besides meeting the quantitative and qualitative demand of meat in the name of species having a 'Designer Tag' with desired functional properties bene? t to human health and improving keeping quality. Research and development strategies should focus on pros and cons of the following stall-feeding practices and to enumerate both quantitative and qualitative gain for pro? table marketing of animal produce, e.g. meat, milk, wool/? ber.

- High concentrate feeding
- Total mixed ration (TMR)
- Complete feed block/pellet
- Production of mixed silage and feeding
- Feed additives and supplements: inorganic and organic additives, phytochemicals, pre and probiotics, nutraceuticals, mineral and vitamin supplements

Rumen-bypass technology

The concept of bypassing the rumen and making the nutrients available post-ruminally for abomasal digestion is based on certain energy loss during microbial fermentation and recycling of costly feed nutrients. The word 'costly' refers to ruminal degradation of some of the essential amino acids (EAA; lysine, cysteine, methionine etc), carbohydrates (simple and compound sugars, starch, etc) and fats (essential fa acids; EFA), which otherwise would be more valuable post-ruminally. Explaining the theory on nutritional biochemistry perspective it could be like this; if 1 mole of amino acids was fermented it may yield only 1.5 moles of ATP which may produce 18 g of microbial biomass or 12 g protein out of 100 g. In case of starch, 1 mole may yield only 0.8 mole glucose whereas when bypassed may yield over 1.6 mole glucose. Similarly, ess fa acids when fed with less ? bre will yield more dietary energy.Thus, the advent of bypass nutrient technology, e.g. by-pass protein (RBP), by-pass EAA, rumen protected fat (RPF), etc. paved the way to evolve new feeding system. It was proved that the dietary nutrients saved from rumen fermentation will reduce the nutrient losses in animal system. If dietary protein is fermented in rumen the availability of protein through microbial route at the lower tract would be less than 20%. However, if it could be bypassed it may yield around 60%. It is true for glucose and fa acids. The above parameter was considered FCR and through practical trials it was found that broiler goat can achieve FCR 2.5 against 8 noticed in other breeds under conventional rearing system.

Restructuring carcass of cull animals

Under Indian condition about 40 % of sheep slaughtered are of spent category with low body score, low dressing yield with average carcass fat (Jacob et al., 2005). Meat from such aged

sheep is usually tough and ? brous in texture and is not preferred by the consumers (Mendira et al., 2008). Aged ewes constitute a considerable proportion of the animal sales and have usually poor body conditions and general appearance due to the burden of repeated pregnancies, lambing and poor nutrition, which reduce their market weights and values. Cull ewes are often sold and slaughtered in un? nished condition having lack of proper body condition and poor lean yield as owners mostly dispose of these ewes at lower value and do not regard them as valuable meat animals. Meat processing by comminution and producing emulsi? ed products has great advantage to augment utilization and add value to meat from cull animals.

Due to growing demand of meat in the country, more thrust is given for improving meat yield and quality of growing lambs by be feeding, however, there is ample scope of bridging the demand of meat by improving meat yield and quality of cull sheep by supplementary feeding, which have not been explored at present stage in the country. Signi? cant improvement in body condition and carcass characteristics was recorded in cull ewes reared under cafeteria system of stall feeding with nutrient-dense diet (Bha et al., 2012; 2013a,b; 2017e; Bha and Sahoo, 2017). Development and feeding of total mixed ration (TMR) or complete diet (pelleted or compact feed block; CFB) will be a useful approach to strategically achieve desired body condition score and improvement in carcass quality for fetching higher market price. Feeding of CFB with urea as a cheaper N source and RPF to enrich with energy supported the improved performance as evidenced from higher nutrient input, 'utilization and e? ciency with enhanced carcass traits' (Bha and Sahoo, 2017) for be marketability and returns from cull ewes.

Strategies for restructuring of carcass a and economization of protocol

Challenge feeding programme involving energy rich diet helps the animals to show recuperative changes in intake, metabolism and improvement in body condition. A short duration (45-90 d) feeding strategy with minimum feed input and maximum ouput in terms of live weight gain may fetch a higher price for the animals, which will compensate the feed and rearing cost and cancel out the recurring expenditure on these animals. Some of possible approaches to prepare energy-dense economic ration for such ewes are,

i) Substituting costly protein concentrate with cheaper NPN (urea)

ii) Substituting a portion of the costly energy concentrate with cheaper molasses or alternate grains (borken wheat/maize)

iii) Use of bypass fat supplements iv) use of yeast (Saccharomyces sp.) as probiotics to enhance feed utilization and animal performance

iv) Use of alkalizing agents and maintaining acid-base balance during high concentrate feeding

v) Use of succulent fodder to enhance voluntary feed intake

vi) Rumen manipulation with suitable additives (tannins, saponins) for reducing fermentable energy loss

vii) Optimizing nutrient input (energy: protein ratio) and maximizing microbial protein synthesis for reducing feed wastage and economizing feed input.

Designer milk/meat production

Nutritional and genetic interventions to alter the meat/milk composition for speci? c health and/or processing opportunities are gaining importance in meat, dairy and products

biotechnology. Altered fa acid (FA) and amino acid pro? les, more protein, less lactose and absence of -lactoglobulin are some challenges of 'designing' milk for human health bene? ts. Alteration of primary structure of casein and lipid pro? le, increased protein recovery, milk containing nutraceuticals and replacement for infant formula are some of the de? nite processing advantages, which needs to be harnessed for product formulation and development. However, the ? nal acceptability of the newly designed products will depend on animal welfare, safety and enhanced health properties of the products and increased pro? tability vis-à-vis conventional practices.The use of molecular biology to reduce the presence of pathogenic organisms in meat/milk is a potentially advantageous prospect. Innovative stall feeding or intensive system of rearing helps in manipulating the feeds and feeding of small ruminants in achieving quality a in animal produce and products thereby enhancing pro? tability. The pasture-diet presents some advantages over concentrate-diet in term of lipid oxidation and to a lesser extent on protein oxidation (Santé-Lhoutellier, 2007). Moreover, pasture feeding increases polyunsaturated fa y acids (especially ω3 FA) and conjugated linoleic acid (CLA) content of the meat, which are bene? cial for human health. The actual goal is ? rst to identify which foods are naturally rich in ω3 FA, and, second, to determine the true impact of the formulations (enriched in ω3 FA) in the ration of small ruminants on the nutritional value of the products and thus their e? ect on the health of consumers.

Central Sheep and Wool Research Institute (CSWRI), Avikanagar has already initiated research on this line and the results obtained so far are promising (Gadekar et al., 2015; Bha et al., 2016; 2017).Supplementation of 40 g/kg calcium soap (Ca-FA) prepared from industrial grade rice bran oil in growing lamb ration enhanced feed energy intake and nitrogen utilization, improved gain, feed conversion ratio, dressing yield and fa acid pro? le of adipose tissue (Bha et al., 2016). Enrichment of lambs' diet with vitamin E at a rate exceeding recommendations signi? cantly reduced lipid oxidation and tended to maintain be lipid pro? le for retaining its quality during storage. Incorporation of polyphenol-rich browses or tree forages in the diet laso modulate FA pro? le and enhances keeping quality of meat and meat products. Feeding of Ca-FA compared to full-fat soybean supplemented diet could preferentially modulate poly-unsaturated FA (PUFA), ω6 and ω3 FA in *Longissimus dorsi* muscle fat as well as adipose tissue for the bene? t of human consumption (Bha et al., 2017).Similarly, Central Institute for Research on Goats (CIRG), Makhdoom computed rations using coarse cereal grains and by-products of pulses and oil seeds and found that diet with 12% CP and 60% TDN was be for higher meat production from intact Barbari males (Du et al., 2009). Goat meat is a low-fat, nutritious red meat alternative for health conscious consumers owing to its low cholesterol content (Das and Rajkumar, 2010). Moreover, Barbari breed received higher overall acceptability scores than other breeds and goat producers can use this information to improve marketing of goat carcass or meat. Good quality meat balls could be prepared and safely stored for 4 months without signi? cant loss in eating quality except in general appearance (Agnihotri et al., 2006). The meat of intensively managed lambs had signi? cantly lower moisture and higher fat content but similar protein and ash contents compared to meat of semi-intensively managed Muza? arnagari lambs in both 6 and 9 months age groups (Das et al., 2008). The practicality of the intensive system for rearing sheep and goats and the corresponding improvement in yield and quality depend on ease of adoption as well as the production cost.It seems possible to substantially alter the FA composition of meat, and the extent of changes needs to be validated in economic terms vis-a`-vis addressing issues of human health concern through supply of designer meat and meat products.

Nutrition and feeding: Thinking di? erently

The importance of FCE to produce more food with lower emissions per unit feed needs to be recognized, with strategies incorporating new forage types and alternate feed resources. The importance of physical as well as chemical nutrition (to optimize rumen function) and improved and strategic feeding management has a profound e? ect on pro? tability and sustainability. Some of the useful approaches are:

- Improving e? ciency of feed to weight gain through manipulating rumen environment and feed formulation at cheaper price
- Nutritional intervention to lower saturated fa acids (SFAs) and raise monounsaturated fa acids (MUFAs) and polyunsaturated fa acids (PUFAs) in meat and meat products
- Use of high forage based diets or oil/oil seed supplements to enhance n-3 PUFA in meat and meat products so as to support human health and reduce risk of diseases
- Nutritional adequacy and modulation of basic nutritional physiology (reproduction, stress) of native breeds of animals
- Dietary manipulation during transition period and parturition to rebreeding interval
- Targeted nutrition to optimise reproduction and a more crops per ewe/doe in their life-span
- Nutritional programming, e.g. i) precisely-timed nutritional supplements to augment follicular dynamics and ovulation rate, ii) in-utero nutrition for increasing conception rate, embryo survival and maintenance of pregnancy, iii) pre-natal nutrition for foetal growth and higher weight and healthy o? spring

Whole farm nutritional model aimed at i) reducing age at puberty/sexual maturity/conception, ii) increasing rate of conception, iii) increasing li size, iv) reducing number of empty days, v) increasing productive year and per animal reproductive e? ciency will certainly help in a 'more sheep per sheep' and/or 'more goats per goat' thereby increasing input: output ratio and pro? tability. A theoretical calculation is depicted here for be understanding of the concept.

Possibility 1

Harnessing 3 crops in 2 year against 1 crop/year 3/2 time production

Possibility 2

Shifting to a proli? c ? ock (2/3rd twinning/triplets and 1/3rd singlet 2/3 × 2 + 1/3 × 1 = 5/3 times production

Possibility 3

Maximizing pre and post-weaning weight gain to prepare ? nishing lambs/kids for marketing (from 12-15 kg live weight in conventional rearing to 25-30 kg in stall feeding protocol) 2 times.

Final calculation: Expected output 3/2 × 5/3 × 2 = 5 times the present production

Conclusion

Revisiting commercial small ruminant production is thus focussed at augmenting sheep and goats production and products by increasing whole farm productivity through adoption of innovative and promising technologies likei) introgression of proli? c gene in non-proli? c sheep to

increase twins/triplets; ii) genetic improvement of native sheep by adopting inter-se-mating with heavier mu breeds; iii) accelerated lambing to achieve 3 lamb crops in 2 years or 9 lamb crops in its production life as against 6 lambs; iv) maximization of pre- and post-weaning weight gain with higher feed e? ciency; v) enhancing quality meat and meat products and their strategic marketing; and vi) widening the scope of sheep rearing by establishing it as a '5-STAR' animal (meat, milk, ? bre, manure and pelt/skin). The in? ow of commerce in to this livestock industry will open up establishment of small to large scale sheep and/or goat units at village or panchayat level thereby creating job opportunity to rural youth. Further, there is scope of collateral expansion aimed at strategic rearing and marketing practice through

- Harnessing quality and consumer trait-speci? c meat and value addition with technological manipulation for manufacturing ready-to-eat meat products
- Improving the current status of meat production, handling and marketing.
- Developing technologies for value addition to meat by processing into meat products.
- Providing research & development and marketing support to the export meat trade.
- Launching human resource development programmes in teaching, research, training and extension activities of meat science and technology.

Thus, there is a need for concerted e? orts on intensi? cation of transfer of technologies and delivery of extension services on improved sheep and goat production and management practices with a convenient access to resources, technologies and markets. Further, the problem-speci? c research and development programmes should be prioritized to improve income and nutrition of small ruminant farmers. The importance of developing sustainable small ruminant production through a conceptual framework that allows the integration of sound management practices based on the 3 Ps (Pro? ts, People and the Planet) is considered a prudent path for the future. Societal development through productivity augmentation in migratory and sedentary ? ocks cannot be ignored, which accounts for a major small ruminant population in our country.

References are available with the authors.

LEAD : NFM-03

Nutritional interventions to improve goat production at farmer's level

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Introduction

Livestock play a signi? cant role in rural livelihoods and the economies of developing countries, a contribution that goes beyond direct food production to employment generation as well as capital accumulation. In India, about 20.5 million people depend upon livestock for their livelihood. Livestock contribute 16% to the income of small farm households as against an average of 14% for all rural households. India is world's highest livestock owner with about 512.05 million livestock

heads, ranking second in the world for population of goats (135.2 million) and third for the population of sheep (65.0 millions). Livestock sector contributes 4.11% GDP and 25.6% of total Agriculture GDP (Anonymous, 2018).Our country stands ? rst in goat milk and is the second largest in goat meat in the world by sharing 29% and 12 % of production respectively. The goat sector contributes 8.4 % to the India's livestock GDP.

Sheep and goat rearing is the core activity of rural masses and plays a vital role in the economic upliftment of most of the under privileged communities and farmers. It is admitably a pro? table venture as the activity is capital oriented not labour intensive. In rural areas, small ruminants make an important economic contribution to farm households, and ensure the stability of the enterprise or farm. They have been called 'banks on hooves'.Goat husbandry generates about 42 % rural employment to the small, marginal and landless farmers.They are a crucial asset and safety net for the poor, especially for women and pastoralist groups, and they provide an important source of nourishment for billions of rural and urban households. Goats contribute to landless, rural farming, peri-urban and increasingly to urban households by providing food, heat, income, socio-cultural wealth and clothing.They also make important indirect contributions to households through the use of crop by-products, integration with other farming enterprises, use of household wastes and locally grown vegetation, soil fertility improvements and their roles in the social, cultural and religious aspects of everyday life. At the regional and national level, sheep and goats contribute to supplying markets with food and non-food products with export-earning and import-saving potential.

Rearing of goat is the major animal husbandry practice prevailing in the rural region of developing countries because of the high fertility and fecundity, low feed and management needs low investment, high feed conversion e? ciency, quick pay-o? and low risk involved. Their small size means they require less space than larger animals and they are less likely to damage and compact soils. They are easier to work with than large ruminants and are cheaper to buy and maintain. Moreover, under the right conditions, they can be quite proli? c. The range of products produced by small ruminants is easy to market because demand is high, yet largely unful? lled.

Goat rearing practices

Di? erent systems of goatproduction have developed in associationwith a variety of crop productionand farming systems. They are especiallydependent on the agro-ecologicalenvironment and as ruminants, mustalways depend on vegetation or cropsfor their feed base.

Goats are highly produced in pastoral and agro-pastoral systems. Relatively larger ? ocks are maintained in the lowland (agro) pastoralsystems. The major feed resources for sheep and goats include grazing on communal natural pasture, cropstubble, fallow grazing, road side grazing, crop residues, browses, and non-conventional feeds (household foodleftovers, weeds, crop tillers and ? llers). Production of improved forages, improvement of low quality feedsources such as crop residues and supplementary feeding (except fa is almost non-existent for migratory animals. Goats raised under these conditions are generally grazing on degraded rangelands and/or o? ered low quality ? brous feedstu? s like cereal straws and stubbles. Nutrient contents of these feed resources are so low and unbalanced that the provision of complements is necessary for livestock maintenance and production. Concentrate feed supplementations are

commonly used to tackle this objective. However, the impact of such supplementation strategy on livestock performances is often unsatisfactory and too expensive for smallholders. This leads to decline in the traditional way of pastoralism.

Constraints of Goat production

Against the huge demands for meat and wool at national as well as state level, goat does not meet the requirements of the humans despite huge population. Several constraints being responsible for the sector to be a non-vibrant economy. Lack of proper breeding policies coupled with poor nutrition, inadequate health cover, unhygienic housing, lack of value addition and proper marketing support remain the major constraints for improving productivity and production.

Lack of adequate feed resources is the main constraint to animal production, which is more pronounced in the mixedcrop-livestock systems, where most of the cultivated areas and high human population are located (Sisay, 2006).There is excessive supply of feed during the rainy season which is usuallyfollowed by a de? cit in grazing in the following dry season (Alemayahu, 1998). In hilly and mountain terrainous areas, agricultural farming is practiced on a limited scale due to scanty and uncertain rains and shortage of irrigation water leaving most of these regions to be used as rangeland grazing. Due to the increasing rate of rangeland degradation and economic instability at the international level, livestock feeding is facing serious di? culties related to quantitative and qualitative provision of nutrients and this is exacerbated by the continuous increase of feedstu? s' prices. Climate change leading to frequent and extended droughts, ? oods, cloudbursts, landslides, avalanches etc. are complicating the situation.

Non-availability of grazing during lean periods greatly a? ects the health, production and survivability. Typically, the vegetation is available from March to October followed by lean winter period. The winter season coincides with the gestation period of the animals as these are bred from September to November. Thus, the energy requirements of the animals increase so as to meet the requirements of the growing conceptus. Despite good nutrient composition of feeds and fodders available in the Jammu and Kashmir valley, the health status and production of the livestock is far from satisfactory due to scarcity of quality feeds and fodders during severe winter and unscienti? c feeding of livestock (Ganai*et al.*, 2006). It has been reported that sheep and goat reared in valley are not supplemented with salts and minerals and there is a great scope for improving the socio-economic status of the farmers if feed and feeding practices are improved. Improved wool production has been recorded with the farmers practicing scienti? c feeding practices (Ganai*et al.*, 2004). Lack of technological support or use of non-conventional feeds and development of alternative nutritional resources constitutes a limiting factor in addressing the problem.

Lack of adequate year-round feed resources is probably the most important factor contributing to low animal production in hill and mountainous regions in the world (Kawas et al., 2010). The recent leap in prices of concentrate feeds and the continuous increase of the price of petroleum at the international level is making machinery-based agriculture in serious di? culty and threatening livestock sector.

Crop residues, such as straw, that constitutes the bulk of the feed supply in tropical animal farming systems are characterized by a high percentage of cell wall components, low quantities of

protein and minerals. Low total digestibility, slow rate of breakdown of straw particles to a size that can leave the rumen, low propionate fermentation pa in the rumen and the negligible content of both fermentable nitrogen and by-pass protein are major associated limitations with straws. A feed containing less than 6% crude protein promotes negative N balance owing to protein malnutrition and therefore, require nitrogen supplementation to improve microbial protein synthesis in rumen. During draught, even these poor feed resources remain in short supply.

Nutritional strategies for augmenting goat production

Planning and implementing livestock development programmes are sensitive towards the needs, resources, production systems and perceptions of the families and therefore warrants holistic interventions in these areas for augmenting sustainable production and upliftment of socio-economic status of the stakeholders.A wide range of alternative strategies prove e? cient in improving sheep and goat performances and/ or reducing feeding cost.Therefore, there is an urgentneed to develop appropriate strategies for proper nutrition at low cost and be use o? ocal feed resources and to identify technologies optimizingthe potential use of these unconventional feedstu? s inlivestock feeding.

Rangeland management

Majority of the small ruminants in Indian conditions are ge nutrients from grazing alone. The high nutritive value of the pasture grasses and unconventional feed resources provides opportunities for their scienti? c exploitation. Many temperate, semiarid and arid regions are characterized by anerratic nature of rainfall. The strong rainfall seasonality isamong the main reasons of the high production variabilityof rangelands. These regions are facing other di? cultiessuch as the high demographic pressure, edaphic constraints,and land tenure. The scope of range management is toensure equilibrium between seasonal dietary requirements of animals and range production. Animal reproduction could be manipulated to line up maximum feed requirements with the annual peak of rangeproduction. The low fodder potential of temperate, arid and semi-aridareas coupled with degradation of natural rangelandsresulted in excessive use of supplementary feeding withinextensive system, which may have an important impact onthe range, either positive or negative. The generalized utilisation of subsidised feed supplements resulted to anincrease of stocking rates, which were far beyond the carryingcapacity, thus aggravating range degradation. Adjustment of the stocking rate, rotational and/or di? ered grazing could be emphasised to reach this objective. Manipulating vegetation consists in introducing other animal specieswhose positive or negative impact may in? uence its evolution over time. Options for be management ofprivate rangelands could be easily adopted by the herders. However, the application of theseoptions on collective rangelands is di? cult. Community systems, whereby range, land and water resources arepublic, invariably constitute an unfavorable circumstancefor a rational management since animals are privately ownedand their access to the resources cannot therefore becontrolled, hence managed. The organization of ethnic groups is a priority tangible solution for be management of collective rangelands.

Fodder shrubs and trees leaves feeding

The shrubs and trees form an integral part of feeding system of small ruminants in hilly and mountainous regions. In the wild, goats would primarily eat tree leaves, which tend to be higher in minerals than grass and carry a lower risk for spreading internal parasites. Tree leaves, which are

rich in nitrogen and widely used in the tropics (Baumer, 1992), o? er the opportunity for use as N supplements to livestock fed on crop residues (Tessema and Baars, 2004). Fodder shrubs and trees leaves could be used as feed supplements to increase animal intake of native resources and even can be used to replace a part of concentrate in the diet of small ruminants (Ganai and Beigh, 2014). They can be used also to defer grazing after the autumn/winter opening rains, so that more production could be obtained. With proper treatment and management, fodder shrubs and trees leaves could constitute a greater proportion of livestock diets, but good knowledge of their nutritive value and the responses of sheep and goats to nutrients and anti-nutrients factors present in the edible biomass of these fodder shrubs and trees leaves is required to ensure their be use in livestock feeding.

Supplementation of *Leucaenaleucocephala* and *Sesbaniasesban* to sheep provided higher concentrations of rumen metabolites, which naturally improved rumen function and feed digestibility, increased e? ciency of microbial N synthesis and N retention when supplemented to sheep fed te? straw. Inclusion of *Sesbania* leaves at 250 g/kg diet DM with hay grass-based feeding was recommended (Tessema and Baars, 2004). Similarly, supplementation of dried *Elaeisguineense* leaves at 25% or less was found to be suitable in hay-based diets for sheep (Osakwe *et al.*, 2004). Fallen tree leaves (FTL) are often responsible for forest ? re. However, this resource might be used as source of roughage especially during summer season (feed scarcity period) or during draught. Mishra *et al*. (2013) recommended an inclusion of fallen tree leaves upto 20% in complete feed block without any adverse e? ect on intake, digestibility, rumen fermentation pa and general health of the animals. Bakshi and Wadhwa (2007) evaluated *Azadirachtaindica*, *Melia azedarach*, *Morus alba* and *Leucaenaleucocephala* tree leaves in goats and reported that leaves of *M. azedarach*, *M. alba* or *L. leucocephala*, supplemented with mineral mixture and common salt, could serve as an excellent complete feed for small ruminants.

Development and use of climate resilient forages

Forage production in the hilly regions is low. Oftenforage species and cultivars adapted to humid conditionsare cultivated in these regions, thus they are exposed toheat and water stresses. Extension ofappropriate species and cultivars of various forages andlegumes for speci? c agro-climatic and ? eld situations isrequired to enhance livestock sector. More research isneeded on the screening of species and cultivars, agronomy,nutritional evaluation, utilization, and large-scalepropagation under commercial conditions. These e? ortsare the joint responsibility of crop and animal scientists.Because fertile land and water are limiting factors of fodderproduction in these regions, the strategy for increasingfodder production should explore the inclusion of selectedforages and legumes into prevailing cropping pa in thecontext of more intensive systems and land use. Althoughsome improved cultivars adapted to the conditions havebeen developed, most of them are not widelycultivated. Therefore, the establishment ofthe forage (legumes) – cereals rotation is di? cult and theunderstanding of forage legumes systems is complicatedfor farmers. This system requires good knowledge of thetechnical itinerary and of the physiology of forage species.Additionally, rotation between annual species and therotation between perennial forage species is also required.

Be use of agro-industrial by-products

Agro-industrial by-products are the by-productsderived in the industry due toprocessing of the main products. They are, in comparisonto crop residues, less ? brous and more concentrated,

andoften have a high nutrient content. Recycling, reprocessingand utilization of any agro-industrial by-products o? er the possibility ofalleviating the current limited feed resources and to reducefeeding cost.Li is known about the deleterious e? ects, in animals,of feeding agro-industrial by-products. Although, high quantities of some agro-industrial by-products areproduced in many countries the utilisation of these feedresources in livestock feeding is still limited. This situationis likely due to proximity of the agro-industrial by-products to livestock ? ock(transportation and storage needs), alternative uses andthe relative opportunity costs, the nutritive value of thenew feed, and the managerial capabilities of the farmer.Some technologies have been developed to overcome thissituation, thus to enhance the utilisation of theunconventional feed resources in ruminant feeding.

Strategic supplementation in growing kids and pregnant goats

The traditional goat production system in India is largely on grass based range production, which allowing the animals to graze on community pasture with li le tree foliage supplementation. Community grasslands/ pastures available for grazing either degraded due to over grazing or did not have su? cient biomass to meet the nutrient need of livestock. Goats generally maintained on zero or minimum input system (extensive/semi-intensive), which adversely a? ect the productivity due to low level of nutrients intake.Therefore, energy, protein and minerals were the most de? cient in goat diets, when compared with the nutrient requirement of NRC (1981). In addition to community grazing goats are supplemented with straw and stubbles to ful? ll their dry ma requirement during harsh environmental conditions, although strategic supplementation protocols have been developed, however goat farmers did not use concentrate supplements due to economic status and/or lack of awareness of the bene? ts of supplementation. It is well established that concentrate supplementation to young animals during active growth phase have promoted growth performance and provided the heavier carcass (Tripathi*et al*., 2007). There is an urgent need in the country to maintain stable grazing resources for sustainable small ruminant production in future by rehabilitating the community grazing land through establishment of perennial grasses and trees. However, supplementing concentrate in addition to traditional feeding and management can improve the meat production potential of the kids. Chaudhary*et al*. (2015) demonstrated that concentrated mixture supplementation during growing phase of kid's improved growth and meat production potential with high average daily gain, slaughter weight, dressing percentage. Concentrate supplementation did not change the meat composition and cholesterol levels. They recommended that under farmers feeding and management conditions supplementation of concentrate at 1.5 of live weight in diets of growing kids will provide optimum ? nishing live weight of 25 kg. The strategy can improve total goat meat production in the country.

Trace minerals feeding

Trace mineral de? ciencies have been reported in several parts of the world (Tripathi and Karim, 2008). Several strategies involving top dressing of minerals in the grazing land and ruminal implant of slow release soluble glass bolus (Kendall *et al.*, 2001) recommended for correct the trace minerals de? ciency in grazing ruminants. However, feeding of minerals in goat`s diet is a not common practice in India. Trace minerals are require in a very low quantity but in? uence animal metabolism and production at a greater levels because these are the component of several enzyme system or exerts catalytic function in animal body. However, mineral availability in animal system varies greatly depending on source, presence or absence of antagonism and interaction with other

trace minerals. The trace minerals use e? ciency can be improved by organic source of supplementation by minimizing excretion and this could also reduce pollutants on soil and environment and thus in human food chain, when present in feed and foods at balanced levels. The physiological advantage of organic trace minerals was o? ered by the unique chemistry of organic metal complex, which permits highly soluble, chemically stable product that resists interactions with antagonists in the gut. The trace minerals present in the animal body and their function occurs almost as organic complexes or chelates and not as free inorganic ions. Trace minerals complexes with organic molecules have been more bio-available than inorganic trace minerals (Brown and Zeringue, 1994). The metal complex or chelates can be absorbed as such or can be modi? ed to a chemical form of the mineral that can be absorbed (Spears, 1996). Since bio-availability of chelated minerals in animal system is higher in comparison to inorganic counter parts and the chelated Cu supplementation has been reported to reduce fecal excretion (Mondal*et al.*, 2007). The utilization of inorganic trace mineral depends on the ability of the animal to convert them to organically active form, which is governed by several biotic and abiotic factors. The animal feeds naturally contain trace minerals primarily as organic chelates or complexes. The higher bio-availability organic Cu be due to the formation of highly soluble and chemically stable products that did not a? ect bio-availability of Zn. Chelated Cu complexes are absorbed via a mechanism that di? ers from the one controlling absorption of inorganic Cu, and does not interfere with Zn and Fe absorption. The Zn, Cu, Co and Mn are the essential and most de? cient minerals in animal feeds and feeding. These are essential element for ruminants and their de? ciency may reduce appetite causing low growth rate and wool growth (Jia*et al.*, 2008). An interrelationship exits among these trace minerals (Haenlein and Anke, 2011). Supplementation of 50 % organic minerals to that of in-organic mineral requirements provided improved daily gain in kids. Supplementation of organic minerals in kids at 50 % of in-organic requirements have the higher bio-availability of Zn, Cu, Co and Mn that ful? lled daily requirement of kids for a 50-100g daily gains (Chaudhary*et al.*, 2013).

Feeding of pellets

Goats are predominantly being reared on community pastures with li supplementation during productive phase of life. But due to shrinkage of grazing land and pressure of urbanization the system of goat rearing is changing to intensive system. Intensive system of goat production recommended upon limited or lack of grazing resources and suitable under urban locations where higher returns from goats products expected. The goats receive a meal that satis? es the need in terms of quality and quantity. Complete pellet feed is a technique provided synchronized nutrient availability in the rumen of ruminant animals with higher nutrient use e? ciency for production functions. Technique discourage the selective ingestion habits of the goat, providing the ease in using unconventional feeds, fortifying several limiting dietary components facilitates balanced nutrient delivery for fermentation. Processing of complete feed mixtures in the form of pellet reduces the bulkiness of the feed resources by 3 times, reduces feed wastages 10-20%, improves storage, transportation and keeping quality by 2-3 times, and improves overall nutrient use and production e? ciency by 15-25 %. The intake of this pellet varies from 4-6% of body weight of goats depending upon physiological status. Tripathi*et al.* (2014) reported that *Tephrosiapurpurea*, *Cenchrusciliaris* and *Dactylotenniumaegypticum* monsoon herbages had the potential of feeding in the form of complete feed during post monsoon season to kids for optimum growth. The *Tephrosiapurpurea* being the leguminous forage had higher CP and be nutrients density, while *Cenchrusciliaris* and *Dactylotenniumaegypticum* had the higher palatability to cater the need for optimum growth. The kids on an average consumed feed DM 11.31 g, TDN 6.32 g and DCP 0.84 g for each g daily gain and had an average daily gain 66 g. Kumar *et al.* (2014) formulated complete

pellet feed having herbal formulation to check the coccidial infection in 3-6 months aged goats. They reported that production parameters a? ected due to coccidial infection get improved by feeding of these pellets.

Azolla feeding

Azollais a free-? oating aquatic fern which ? xes atmospheric nitrogen in association with nitrogen ? xing blue green alga *Anabaena azollae*, making it an excellent source of protein for livestock. It belongs to the family *Azollaceae*and order Pteridophyta. The plant is highly productive with the ability to double its weight in seven days. It can produce 9 tonnes of protein per hectare of pond per year. This can be used as a part of feed or as a supplemental source of protein and minerals in the ration of goats. Azolla in the complete feed, which can reduce the cost of feed of goat there by increasing the pro? ts from goat rearing to the farmers. Azolla was contains 78-80 % organic ma 17-22 % crude protein, 2-3 % crude fat and 12-15% crude ? bre on dry ma basis. The per cent NDF and ADF of azollais 45-47 and 30-33, respectively. Sodium, potassium, calcium (%) was 0.60, 0.73, 0.11 while copper and zinc (ppm) is 16.12 and 71.47 respectively indicating azolla as a good source of macro as well as micro minerals (Kumar *et al.*, 2015a). Fresh azolla can be fed to growing and adult goats. Fresh azolla harvested can be mixed with straw and fed to the goats. The rate of incorporation of azolla should be 50-100 gm/day in growing animals and 100-200 gm/day in the adult animals. Azolla can be harvested and sundried for storage and feeding to goats. Sundried azolla can be mixed in the concentrate mixture as a replacement of concentrate mixture in the goat ration. This will economize the feeding cost of goats because the ingredient cost of concentrate mixture is quite high. Complete pellet feed for goats can be formulated by incorporation of sundried azolla. 15-25% of concentrate mixture in complete pellet feed (Roughage concentrate ratio 60:40) can be replaced with sundried azolla (Kumar *et al.*, 2015b). This complete feed is quite economic and farmers can fetch more bene? ts from goat rearing.

Feed blocks (FBs) technology

Feed blocks manufactured bythe cold process are made from a mixture of one or more agro-industrial by-products, binder, water and common salt, aswell as urea with or without molasses. They should be airdrieduntil hardness and compactness criteria are met,and then o? ered to stall-fed or grazing ruminants on lowquality diets. The technique of FB making is well describedin the literature (Ben Salem &Nefzaoui, 2003). Medicated blocks containing anthelmintic agents andtannins to control internal parasites have been used inAustralia and Ethiopia. Mineral enriched FBs (e.g.phosphorus, copper, etc.) were distributed to animals tomitigate their de? ciency and improve reproduction inruminants. Depending on the formula,FBs can replace partially or totally concentrate feeds,thus alleviates feeding costs without detrimentale? ects on livestock performances. These advantagesmay explain the increasing adoption of FB technologyby farmers in about 60 countries (Makkar, 2007).

CONCLUSION

Lack of adequate quality feed is the major constraints of goat farming. Therefore, feeding strategies like supplementary feeding, use of shrubs, pelleting, and pasture management will improve the production potential goat and resource poor farmers can fetch more pro? t from goat farming.

References are available with the authors.

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Nutritional characteristics and health a

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INTRODUCTION

Goat is universally accepted as the poor man's cow. Dairy goat and dairy sheep farming are aprominent contribution in the national economy in many countries, especially in the Mediterranean and Middle-East region and are particularly well organized in France, Italy, Spain and Greece (Chiofalo *et al.*, 2004, Kumar *et. al*,2012).Now, Goat milk is become popular all over world.It contains many health bene? ts and rich in nutrients. Even people who are lactose intolerant can consume this milk easily and digest it without any issue. The goat is a one of the main contributor of dairy and meat products for rural people, more than any other mammalian farm animal,particularly in developing country. One of the prominent aspects of demand of goat milk is its home consumption. This demand is increasing because of the growing populations of people. The second important aspect of demand for goat milk is the connoisseur interest in goat milk products especially, cheeses and yoghurt in several developed and developing countries. This demand is growing because of the increasing levels of per capita incomes. Further, another important aspect of demand for goat milk derives from the a? iction of persons with cow milk allergies and other gastro-intestinal ailments. This demand is also growing because of a greater awareness of problems with traditional medical treatments to such a? ictions among the people.The chemical characteristics of goat milk can be used to manufacture a wide variety of products, including ? uid beverage products (low fat, forti? ed, or ? avored) and UHT (ultra high temperature) milk, fermented products such as cheese, bu or yogurt, frozen products such as icecream or frozen yogurt, bu condensed/dried products, sweets and candies (Ribeiro *et al.*, 2010).Non bovine dairy products including goat milk are considered as excellent carriers, and there is increasing demand for such products (Ranadheera *et al.*, 2018).The probiotic bene? ts present in goat milk yoghurt help support healthy digestion, lower your risk of diabetes, support weight, prevent fat loss and reduce blood pressure.Goat milk is wanted or even needed by people of all income groups. Despite the much larger volume available of cowmilk, it's much cheaper production usually and therefore, lower market price, the production and marketing of goat milk and its products is therefore, an essential niche in the total dairy industry sector.

Goat milk has also been known for its bene? cial and therapeutic e? ects on the people who have cow milk allergy.Goat milk is considered to have similar properties to human milk. It has a higher amount of small fat globules,which important in human nutrition.However, goat milks produce a softer curd during fermentation process (Clark and Garcia 2017).

The speci? c gravity of cow and goat milk is almost similar and generally found in the range of 1.023 to 1.030. Titrable acidity (expressed aspercentage of lactic acid) is also nearer to that of cow's milk and generally observed from 0.11 to 0.18. Viscosity at 27°C ismarginally lower than that of cow's

milk. In addition to that, the refractive index of goat milk is also almost close to cow milk. The electrical conductivity of goat milk is found in the range of 0.0101 to 0.0188 $ohm^{-1}cm^{-1}$, whereas, pH value of goat milk found in the ranges of 6.5 to6.9 as against 6.6 to 6.8 in case of cow milk. However, curdtension is below thanthe cow milk, which isresponsible for be digestibility in goat milk ascompared to cow milk. Goat milk has more Ca, P and Kin comparison to cow and human milk(Bihaqi and Jalal, 2010). Goat milk also has simple lipids (diacylglycerols, monoacylgycerols, cholesterol esters), complex lipids (phospholipids) and liposoluble compounds (sterols, cholesterol esters, hydrocarbons). Non-protein nitrogen (NPN) contents of goat and human milks are higher than in cow milk (Jooyandeh and Aberoumand, 2010).Especially,one of the important aspects of demand for goat milk ismainly due to itsmedicinal value. Still, more research for its nutritional and medicinal value is essential for utilization of goat milk in human consumption as well as in medicinal use in developing as well as in developed countries.

NUTRITIONAL VALUE OF GOAT MILK

The basic nutrient composition of goat milk resembles that of cow milk (Table 1). Both milks contain substantially higher amounts of proteins and minerals, but lower lactose content than human milk (Hatmi *et al*., 2015). Nonetheless, goat milk has high concentrations of fat globules,which are smaller than those present in cow milk; these globule diameters average are approximately3.6 and 3.0 µm against 4.0 µm, respectively (Balthazar *et al* 2017). The smaller size of fatglobules provides a smoother texture in goat's derived products. Furthermore, goatmilk contains lower amounts of α1-casein conferring it a higher water-holding capacity and a lower viscosity (Gomes *et al*., 2013). Cow milk allergy is considered a common disease with a prevalence of 2.5% in children during the ? rst 3 years of life (Businco and Bellanti, 1993), occurring in 12–30% of infants less than 3 months old (Lothe *et al.*, 1982), with an overall frequency in Scandinavia of 7–8% (Host *et al.*, 1988), even as high as 20% in some areas (Nestle, 1987), and reported in Italy in 3% of children under 2 years of age (Bevilacqua *et al.*, 2000). Treatment with goat milk resolved between 30 and 40% of the problem cases, and in one particular study 49 of 55 treated children bene? ted from treatment with goat milk. There are wide varieties of genetic polymorphisms (Grosclaude, 1995) of the di? erent caseins and whey proteins adds to the complexity of the cow milk allergy situation and di? culty to determine which protein is mainly responsible for an allergic reaction. However, it has now been noticed that this genetic protein diversity may actually help identify which protein is the allergen, if genetic polymorphisms of milk proteins are speci? cally used for clinical tests (Bevilacqua *et al*., 2000). Goat milk with the genetic trait of low orno αs_1-casein, but instead with αs-$c_2$asein, hasless curd yield, longer rennet coagulation time, moreheat lability, and weaker curd ? rmness, which alsomay explain the bene? ts in digestibility in the humandigestive tract (Ambrosoli *et al*., 1988).The children on goat milk surpassed those oncow milk in weight gain, height, skeletal mineralization,and blood serum contents of Vitamin A, calcium,thiamin, ribo? avin, niacin and hemoglobin. Similar? ndings were obtained in studies with rats (Park *et al.*,1986). In other extensive clinical studies with children allergic to cowmilk, the treatment with goat milk produced positiveresults in 93% of the children and was recommendedas a valuable aid in child nutrition because of less allergenicityand be digestibility than cow milk (Reinertand Fabre, 1997; Fabre, 1997; Grzesiak, 1997).It is evident from the studies with rats, which had 50% of theirdistal small intestine removed by resection, simulatingthe pathological condition of malabsorption syndrome,the feeding of goat milk instead of cow milk as partof the diet resulted in signi? cantly higher digestibilityand absorption of iron and copper, thus preventinganemia (Barrionuevo *et al*., 2002). Also in these further studies,the utilization of fat and weight gain was improvedwith goat milk in the diet, compared to cow milk, andlevels of cholesterol were reduced,

while triglyceride,HDL values remained normal (Alferez*et al.*, 2001). It was concluded that the consumption ofgoat milk reduces total cholesterol levels and the LDLfraction because of the higher presence of mediumchain triglycerides (MCT) (36% in goat milk versus 21% in cow milk), which decreases the synthesis ofendogenous cholesterol. Thus goat milk is recommended as a "usefulalternative to cow milk for all age groups especially to children."

Table 1: Basic composition of di? erent milks (mean values per 100g)

Species	Energy(Kcal)	Water (%)	Protein (%)	Fat (%)	Lactose (%)	Ash(g)	Total Solids(g)
Goat	70	87.5	3.2	4.0-4.5	4.6	0.8	12.2
Cow	69	87.7	3.3	3.8	4.7	0.7	12.3
Human	68	86.7	1.3	4.1	7.2	0.2	12.3

Source: Yadav *et al.*, 2016

PROTEINPROFILE OF GOAT MILK

The total protein content in goat milk varies from 2.6 to 4.1 g/l. Casein is composed of four fractions: αS1-casein, αS2-casein, β-casein, and κ-casein (Selvaggi *et al.*, 2014). The comparative composition of proteinsand their components in the milk of goats and cowshave been reviewed by Jenness (1980) and Haenlein(2001), identifying many unique di? erencesbetween the two species, and showing a wide diversitydue to genetics of di? erent breeds within eachspecies, in? uences of stage of lactation, feeding, climate,and subclinical mastitis. It has been found that goat milk has a signi? cantlyhigher dye-binding capacity per unit protein(1% more than cow milk) and a lower infra-redabsorption (4% less than cow milk) (Grappin *et al.*,1979), making it necessary to use di? erent calibrationcurves for each species to measure milk proteincontent. These studies has been supported byZeng (1996), when testing with cow milk standards resultedin 0.04% less fat and 0.27% less protein in goatmilk.Goat milk proteins are their structural conformations and the amountsand subtypes of micelles, which are smaller (180 nm) than those of cow milk (260 nm) (Park *et al.*, 2007)and similar to those of sheep milk (193 nm).Goat milk proteins are similar to the major cowmilk proteins in their general classi? cations of α-, β-, κ-caseins, β-lactoglobulin, α-lactalbumin, but they di? er widely in genetic polymorphisms and their frequencies in goat populations (Grosclaude, 1995). It has been reported that beta casein comprises the largest fraction of total goat milk casein. Although αS2-casein is relatively higher in goat milk, the αS1 fraction of cow milk alone is higher than both the αS1 and αS2-casein fractions present in goat milk. These di? erences might help explain the soft curd-forming properties of goat milk, as well as its be digestibility and the lower frequency of allergic reactions in children(yadav *et al.*, 2016). The presence of the αs_1-casein trait has been studied much in recent years, when it was discovered that it has six di? erent types, A, B, C,E, F and "null" in goat milk. In cow milk, α_{s1}-casein is the major α_s-casein. The "null" type or absence in some goat milk means that in di? erent goats the major (α-$_s$

casein is the α_{s2}-casein variant, but which has di? erent digestibility and cheese making properties (Remeuf, 1993). The di? erences in genetic types are because of amino acid substitutions in the protein chains, which are responsible for the di? erences in digestibility, cheese making properties and ? avors of goat milk products (Rystad *et al.*, 1990), but the amino acid substitutions also enable the detection of even small amounts of adulteration with cow milk (Ascha? enburg and Dance, 1968; Amigo *et al.*,1989). Peptides formed from goat milk casein by proteases tasted much less bi than those from cow milk casein (Pelissier and Manchon, 1976). Casein micelles, the form of casein molecule suspended in goat milk, also di? er markedly from cow milk in less complete sedimentation rate, greater β-casein solubilization, smaller size of micelle, more calcium and phosphorus, less solvation, and low heat stability (Jenness, 1980). When compared to cow milk, goat milk has higher levels of essential amino acids: threonine,leucine, lysine, cystine, tyrosine, phenylalanine, valine, and nonessential proline and glutamic acid(Table 2).Their comparative metabolic e? ects have not been studied muchin goat milk, but this could assist in the interpretation of some of the empirical bene? cial e? ects of goat milk inhuman nutrition. In studies with rats, which had malabsorption syndromes, it was found that goat milk improvedthe intestinal absorption of copper, which was a to the higher contents of cysteine (derived from cystine) in goat milk (83 mg/100 g) than in cow milk (28 mg/100 g) (Barrionuevo *et al.*, 2002). Overall, the adult daily dietary nutrient recommendations for essential amino acids would be met equally or exceeded by a 0.5 litre goat milk consumption compared to cow milk (NRC, 1968).

Table 2: Average amino acid composition (mg/l00 g milk) in proteins of goat and cow milk

Species	Energy(Kcal)	Water (%)	Protein (%)	Fat (%)	Lactose (%)	Ash(g)	Total Solids(g)
Goat	70	87.5	3.2	4.0-4.5	4.6	0.8	12.2
Cow	69	87.7	3.3	3.8	4.7	0.7	12.3
Human	68	86.7	1.3	4.1	7.2	0.2	12.3

	Goat milk	Cow milk
Essential amino acids		
Threonine	138.67	115.81
Isoleucine	160.54	128.04
Leucine	341.01	115.81
Lysine	342.86	252.59
Methionine	77.95	71.15
Cystine	30.62	23.20
Phenylalaine	175.45	133.51
Tyrosine	162.51	159.99
valine	210.23	147.34
Non-essential amino acids		
Arginine	135.65	114.44
Histidine	122.73	93.06
Alanine	250.15	214.22
Aspartic acid	117.95	96.0
Glutamic acid	694.58	554.30
Glycine	55.83	49.24
Proline	310.61	253.38
Serine	152.65	147

Source: Ceballos *et al.*,2009

FATPROFILE OF GOAT MILK

An important component in goat milk is its fat or lipid content. The size of fat globules in milk range from 1-10 micron in both cow and goat. But in goat milk the globule size less than 5 microns is 83% as compared to62% in cow's milk (Bihaqi and Jalal, 2010).Average goat milk fat di? ers in contents of its fa acids pro? le signi? cantly from average cow milk fat (Jenness, 1980), being much higher in butyric (C4:0), caproic (C6:0), caprylic (C8:0), capric (C10:0), lauric (C12:0), myristic (C14:0), palmitic (C16:0), linoleic (C18:2), but lower in stearic (C18:0), and oleic acid (C18:1) (Table 3). Capric, caprylic acids and medium chain triglycerides (MCT) have become established medical treatments for an array of clinical disorders, including malabsorption syndromes, chyluria, steatorrhea, hyperlipoproteinemia, intestinal resection, premature infant feeding, non-thriftiness of children, infant malnutrition, epilepsy, cystic ? brosis, coronary by-pass, and gallstones, because of their unique metabolic ability to provide direct energy instead of being deposited in adipose tissues, and because of their actions of lowering serum cholesterol, inhibiting and limiting cholesterol deposition (Alferez *et al.*, 2001). Goat milk has higher content of monounsaturated (MUFA), polyunsaturated fa A), and medium chain triglycerides (MCT) than cow milk, which all are proven to bebene? cial for human health, especially for cardiovascular conditions (Table 3). This biomedical superiority has not been promoted much in marketing goat milk, goat yoghurt and goat cheeses, but has great potential in justifying the uniqueness of goat milk in human nutrition and medicine (Haenlein, 1992) for treating the various gastro-intestinal disorders and diseases, besides its value in alleviating cow milk allergies.Fa acid composition of goat milk fat also can be changed towards even more of the bene? cial fa acids by di? erent regimes of feed supplementation to goats including changes of forage: concentrate ratios (LeDoux *et al*., 2002; Sanz Sampelayo *et al*., 2002).

Manipulations of goat feeding towards higher contents o unsaturated fa acids in goat milk fat byfeeding special feed supplements like protected fatscan be used to “tailor make” “functional foods” andeven further improve the nutritional value of goat milk(Sanz Sampelayo *et al.*, 2002). Recentlymore “bene? cial fat”, conjugated linoleic acid(CLA), has been identi? ed as a potent anticarcinogenand is primarily provided to the human diet bydairy products (Pfeu? er,2000). Monoethyl-branched substitutions on C4 andC6 fa acids are present only in goat milk and notin cow milk. A comparatively high number of minorbranched-chain fa acids is found in goat milk andthe content of *trans*-C18:l fa acids is signi? cantlylower in goat milk than in cow milk, also a bene? t for coronary heartdisease risks.

Goat bu ghee and related products with theireven higher contents of MCT, unsaturated fa acidsand CLA than the original milk has not been studiedmuch nor produced commercially. Here is the potential to provide a goat milk productwith specially bene? cial and proven properties forhuman nutrition and health, besides its general foodvalue to starving people and to connoisseurs. This supports theidea that goat bu would have new and not yet promotedfor human health bene? ts so far. So, there is a need to further studies the bene? cial health aspects of goat milk and milk products.

There are a number of unique physiological and anatomical di? erences between goats and cows which translate into di? erences in composition of goat milk and its products (Haenlein, 1992, 1996, 2001). This was already recognized by the Goat Milk Task Force of the National Conference on Interstate Milk Shipments (NCIMS, USA) (Atherton, 1983).US dairy industry had set up

separate standards for goat milk from cow milk for bu fat content minimum, solids-not-fat content, somatic cell count maximum, method for only nucleated cells in milk, lower freezing point level, di? erent natural inhibitor test, di? erent milk pasteurization test, validity of brucellosis ring test, detection of cow milk in goat milk, all of which had to insure fair market quality control regulations and practices for goat milk producers.

Table 3: Average fatty acid composition (g/100 g milk) in lipids of goat and cow milk

	Goat milk	Cow milk	Difference (%) for goat milk
C4:0 butyric	0.13	0.11	
C6:0 caproic	0.09	0.06	
C8:0 caprylic	0.10	0.04	
C10:0 capric	0.26	0.08	
C12:0 lauric	0.12	0.09	
C14:0 myristic	0.32	0.34	
C16:0 palmitic	0.91	0.88	
C18:0 stearic	0.44	0.40	
C6-14 total MCT	**0.89**	**0.61**	**+46**
C4-18 total SAFA	**2.67**	**2.08**	**+28**
C16:1 palmitoleic	0.08	0.08	
C18:1 oleic	0.98	0.84	
C16:1-22:1 total MUFA	**1.11**	**0.96**	**+16**
C18:2 linoleic	0.11	0.08	
C18:3 linolenic	0.04	0.05	
C18:2-18:3 total PUFA	**0.15**	**0.12**	**+25**

(Source: Kumar. S. *et al*,2012)

MCT: medium chain triglycerides; SAF
A: saturated fatty acids; MUFA: monounsaturatedfatty acids; PUFA: polyunsaturated fatty acids.

Lipid profile	Goat milk	Cow milk
MUFA	1342.67	874.27
PUFA	213.25	109.32
PUFA n-6	146.97	86.41
PUFA n-3	26.81	8.55
PUFA n-6/n-3	5.49	10.49

SFA:saturated fatty acid; MUFA : monounsaturates fatty acid; PUFA: polyunsaturated fatty acid

source: ceballos et al. 2009

MINERALS PROFILE OF GOAT MILK

Mineral contents of goat milk are muchhigher than cow and human milk. Goat milk containsabout 134 mg Ca and 121 mg P/100 g (Table 4), whilehuman milk has only one-fourth to one-sixth of these twomajor minerals. The concentrations of macro-mineralsmay not ? uctuate much, but they vary depending on thebreed, diet, individual animal, stage of lactation, andstatus of udder health (Park *et al*,2007). Overall, goat milk has moreCa, P, K, Mg and Cl, and less Na and S contents than cowmilk (Park andChukwu, 1988; Chandan *et al.*, 1992).Among trace minerals, Zn was in greater amounts, butgoat and cow milk had more Zn than human milk (Parkand Chukwu, 1989). Levels of Fe in goat and cow milkare signi? cantly lower than in human milk (Table 4),whereas goat and cow milk contain signi? cantly greateriodine contents than human milk, whichwould be importantfor human nutrition, since iodine and thyroid hormonesare involved in the metabolic rate of physiologicalbody functions (Underwood, 1977).Goat and human milk contain higher levels of Se thancow milk (Table 4). Small amounts of Se (<3%) areassociated with the lipid fraction of milk. Glutathioneperoxidase is higher in goat than in human and cowmilk.Total peroxidase activity (associated with glutathioneperoxidase) was 65% in goat milk as opposed to 29%for human and 27% for cow milk (Debski *et al.*, 1987).In this document, authors complicated data available concerning the main mineralcomposition of goat and sheep milks (Table 4.1). Goat milk is distinguished by its high chloride and potassium content.

Table 4: Mineral contents (amount in 100 g) of goat and cow milk as compared with human milk

Mineral	Goat	Cow	Human
Ca (mg)	134	122	33
P (mg)	121	119	43
Mg (mg)	16	12	4
K (mg)	181	152	55
Na (mg)	41	58	15
Cl (mg)	150	100	60
S (mg)	28	32	14
Fe (mg)	0.07	0.08	0.20
Cu (mg)	0.05	0.06	0.06
Mn (mg)	0.032	0.02	0.07
Zn (mg	0.56	0.53	0.38
I (mg)	0.022	0.021	0.007
Se (µg)	1.33	0.96	1.52

Source: Park *et al.,* 2007

Mineral composition of goat and sheep milk:

	Goat (per L)	Sheep (per kg)
Calcium(mg)	1260	1950-2000
Phosphorous(mg)	970	1240-1580
Potassium(mg)	1900	1360-1400
Sodium(mg)	380	440-580
Chloride(mg)	1600	1100-1120
Magnesium(mg)	130	180-210
Ca/p(mg)	1.3	1.4
Zinc(µg)	3400	5200-7470
Iron(µg)	550	720-1222
Copper(µg)	300	400-680
Iodine(µg)	80	53-90
Selenium(µg)	20	31

Source: Balthazar *et al.* 2017

VITAMINS PROFILE OF GOAT MILK

Goat milk has higher amounts of VitaminA than cow milk (Table 5). Because goats convert allβ-carotene into Vitamin A in the milk, caprine milk iswhiter than bovine milk. Goat milk supplies adequateamounts ofVitamin A and niacin, and excesses of thiamin,ribo? avin and pantothenate for a human infant(Ford *et al*., 1972; Parkash and Jenness, 1968).If a human infant fed solely on goat milk, the infant isoversupplied with protein, Ca, P, Vitamin A, thiamin,ribo? avin, niacin and pantothenate in relation to theFAO-WHO requirements (Jenness, 1980). Compared to cowmilk, goat milk has signi? cant de? cienciesin folic acid andVitaminB12, which cause "goatmilk anemia" (Jenness, 1980). Levels of folateand Vitamin B12 in cow milk are ? ve times higherthan those of goat milk, and folate is necessary for thesynthesis of hemoglobin (Davidson andTownley, 1977). Goat and cow milk are bothde? cient in pyridoxine (B6), Vitamins C and D, and allthese de? cient vitamins must be supplemented to babynutrition from other sources (McClenathan and Walker,1982).In heat treatment of goat milk, Lavigne *et al*. (1989)reported that high temperature short time pasteurization(HTST) of goat milk was the best processing method topreserve vitamins as well as to extend shelf-life of themilk, although some losses of thiamine, ribo? avin andVitamin C occurred.

Table 5:Vitamin contents (amount in 100 g) of goat and cow milk as compared with human milk

Vitamin	Goat	Cow	Human
Vitamin A (IU)	185	126	190
Vitamin D (IU)	2.3	2.0	1.4
Thiamine (mg)	0.068	0.045	0.017
Riboflavin (mg)	0.21	0.16	0.02
Niacin (mg)	0.27	0.08	0.17

CONCLUSION:

It is evident that goat milk is superior with respect to cow milk in terms of nutritional and health aspects of milk. The advantage of consumption of goat milk should be popularized by creating awareness among the people so that production and utilization of goat milk could be enhanced. Stillemphasis is required to research and proper utilization of goat milk to exploit the use of liquid goat milk as well as its application in manufacture of varius milk products, probiotic milk products especially various types of cheese and fermented milk food throughout the world.

References are available with the authors.

ABS (ORAL) :NFM-01

E? ect of replacing groundnut cake with corn-based Distiller's Dried Grainwith Solubles (DDGS) on growth performance and cost economics in Nellore Brown ram lambs

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This research study was conducted to investigate the e? ect of replacing groundnut cake with corn-based distiller's dried grain with solubles (DDGS) on growth performance and cost economics in growing Nellore ram lambs.Twenty four young ram lambswere divided into four groups (n=6; mean b. wt. 14.6± 2.35 kg). Control group (T_1) wasfed sorghum stover as basal diet and supplemented with groundnut cake at 1.5% of their body weight. Groundnut cake was replaced with corn based DDGS at 50 (0.75% b.wt.), 75 (1.125% b. wt.) and 100% (1.5% b.wt) in T_2, T_3 and T_4 groups while continuing sorghum stover as basal diet. Daily feed o? ered, refusals and body weights at fortnightly were recorded during the experimental period of 120 days. Experimental data was analyzed by using Completely Randomized Design (CRD).Although no di? erence were noticed in roughage, concentrate, or total dry ma intake, DDGS replacements resulted in signi? cantly (P<0.01) higher growth rates and average daily gain with a quadratic maxima at 100% replacement levels.The average weight gain (kg) in T_1, T_2, T_3 and T_4 were 11.8, 13.2, 13.6, and 14.8, respectively.A signi? cant day × treatment interactionswere found among the roughage, concentrate, and total DM intake.The ram lambs supplemented with DDGS showed a linear increase (P<0.05) in feed conversion ratio compared to those supplemented with GNC to sorghum stover based diet.Regarding cost economics perspective, the replacement of GNC with DDGS showed be income (17-37%) over feed cost because of the low price of DDGS (Rs. 18/kg) compared to GNC (Rs. 38/kg).The overall income per kg mu production was Rs. 281, 314, 338, and 348 in T_1, T_2, T_3 and T_4 groups, respectively.

ABS (ORAL) : NFM-02

E? ect of Dietary Supplementation of Active Dried Yeast on Nutrient Utilization in Surti Goat Kids

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Small ruminant farming is still the major chunk of livelihood among the small and marginal farmers in India. Availability of nutrients from the high ? brous feed recourses is the main constraint for these small ruminants. In recent years, probiotic has been used to manipulate the rumen microbial ecosystem to enhance the nutritive value and utilization e? ciency of low-quality

roughages. Among the di? erent microbial feed additives, Yeast Culture (YC) supplementation in ruminant diets can increase dry ma intake, production performance, cellulose degradation, and nutrient digestibility. However, the e? ects of Yeast culture on animal productivity are strain-dependant. Therefore, the present study was undertaken to assess the e? ect of live YC (*Saccharomyces cerevisiae* CNCM I-1077) supplementation on utilization of various Nutrients in Surti goat kids. A total of 16 male Surti goat kids of 4-6 months old with average body weight of 7.53±0.13 Kg were randomly divided into two groups. Active dried yeast (CNCM I-1077) was supplemented in one experimental group at the rate of 2 % of DMI, and the second group without any supplementation were treated as control. The feed intake was measured daily for 80 days and a digestibility trial was conducted for seven days from day-74 to day-80, with adaptation period of 3 days. A signi? cant (P< 0.05) improvement in the digestibility of dry ma (62.3 vs. 63.8), organic ma (63.9 vs. 65.6), crude protein (70.2 vs. 71.6),total carbohydrates (61.7 vs. 63.8),ADF (34.6 vs. 37.2), NDF (49.0 Vs 51.0), and hemicelluloses (55.4 vs. 58.6), wereobserved. It was concluded that supplementation of active dried yeast (*S. cerevisiae* CNCM I-1077) at 2% of dry ma intake would improve digestibility of various nutrients in Surti goat kids.

ABS (ORAL) : NFM-03

Growth performance of Salem black kids supplemented with wet brewer's spent grain

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Wet brewer's spent grain (WBSG) is the extracted residue remaining after grains have been fermented during beer making process with a crude protein content of 25 - 34 per cent and 7 - 10 per cent crude fat.Eighteen 3 month old weaned Salem Black kids were divided into three treatment groups of six animals each (born to the does of respective treatment groups). The T1 group fed with concentrate feed (control), the T2 group fed with WBSG by replacing concentrate at 50 per cent and the T3 group replacing concentrate at 100 per cent with isonitrogenous and isocaloric level. Weekly feed consumption and body weight of kidswere recorded and monthly blood samples were collected for growth hormone and IGF I analysis.The dry ma intake of kids born to T3 does are signi? cantly (p<0.05) lower than control group. The body weight was signi? cantly (p<0.05) higher in T3 group. Similarly, the average daily body weight gain was higher (p<0.05) and feed to weight

gain ratio was lower ($p<0.05$) in these kids compared to control. All the above parameters were similar in T1 and T2 groups. The growth hormone and IGF - I levels in T3 group kids showed a signi? cant ($p<0.05$) increase as compared to the T1 group kids. Supplementing WBSG at 100 per cent in the diet of kids increase growth hormone and IGF-I and resulted in signi? cant increase in the bodyweight and reduced feed to body weight gain ratio.

ABS (ORAL) : NFM-04

E? ect of Di? erent Levels of Azolla (*Azolla Pinnata*)Feedingon Growth Performance of Goat Kids

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The present study was conducted to ? nd out the e? ect of di? erent levels of dry Azolla feeding on growth performance, structural growth, plasma growth hormonelevels and economics of feeding in crossbred female goat kids. A total of 30 crossbred female kids of 4-5 months age were selected and divided into three groups of 10 each. These were maintained in a semi-opened house with brick ? oor. The treatments groups were; control group (T_1) animals fed with green maize and concentrate mixture as per ICAR (2013) standard, while in Group II (T_2) and group III (T_3) the concentrate mixture was replaced by dried Azolla @ 25 and 50%, respectively.Body weight, growth rate and blood samples were collected at fortnightly intervals. DM intake was signi? cantly ($P<0.05$) higher in T_2group as compared to T_3(577.74 vs.526.66 g/d), however, no signi? cant di? erence was observed in T_1(577.74g/d) and T_2 group (565.34g/d7), respectively. Average total gain in weight during experimental period was 6.43, 6.95 and 5.79 kg with average daily gain of 71.33, 77.22 and 64.33 g/d, respectively, in T_1, $T_2$and T_3groups. The growth rate was 9% higher in T_2 group, however treatment di? erences were non-signi? cant. Similarly, the average gain in height at withers, body length, abdominal girth and heart girth among the groups were non-signi? cant. Mean plasma GH concentration (ng/ml) ranged from 1.05±0.036 (T_3) to 1.12±0.034 ng/ml (T_1) and was non-signi? cant between the groups. The cost on per kg live weight gain was Rs 121.41, 97.33 and 99.88 for T_1, T_2 and T_3group, respectively. The feed cost per kg gain was reduced by 25% in T_2 group as compared to T_1 group which indicated that Azolla can be replaced upto 25 percent of concentrate mixture without in? uencing growth performance of growing kids.

ABS - NFM –05 (ORAL)

E? ect of di? erent level of Azolla Meal on Nutrient Utilization and Growth Performance in Goat kids

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An a was made to assess nutritional potential of Azoll in a total mixed ration (TMR) at di? erent dietary level on nutrient utilization and metabolic status of goats under hot humid agro climatic condition in Bihar. Eighteen growing male kids of 3-4 months age with average body weight of 5.72± 0.88 kg were distributed into three groups of six animals each on the basis of body weight in a randomized block design. The animals were fed graded level of Azolla meal (0, 20 and 40 %) mixed in concentrate mixture and green fodder berseem. In this study di? erent parameter like feed intake, body weight gain, feed conversion ratio, digestibility of nutrient of Black Bengal goats (cross) were observed, respectively. This experiment was conducted for 90 days on 18 male kids. The average body weight of the goats of T1 (control), T2 (20%, azolla meal) and T3 (40%, azolla meal) group were 10.68,11.93 and 10.20kg, respectively. The total DMI (g/d) of T1, T2 and T3 group were 458.12, 449.54 and 494.66 respectively. The intake of DM in each group was comparable and so is the R:C ratio.However CP,DCP and TDN obtained is quite signi? cant in T2 group than T1 and T3 group. The digestibility of other nutrients such as OM, NDF, ADF, CP, EE, CF, TA and NFE were numerically higher in T2 group, lowest in T3group, due to more inclusion of azolla i.e 40% azolla in concentrate mixture. From here it can be concluded that though azolla is protein rich but its inclusion in concentrate mixture is helpful only in moderate level to animals,as higher amount hampers digestibility of nutrients. The ? nal body weight was higher in T2 and lowest in T3 group as compared to control group. The body weight (kg) and average daily gain (g/d) was signi? cantly higher ($P \leq 0.05$) in T2 as compared to T1and T3 group. The ADG obtained was highest in T2 group (60.33 g/d) and lowest in T3 group (45.66 g/d). The total DMI by the animals of T2 group was higher than T3 and T1groups, respectively. The FCR in T2 (20% azolla meal) supplemented group was lower than T3(40% azolla) and T1 group. The body weight changes observed at sixth fortnight was signi? cant in T2 group (20% azolla meal). The weight gained after sixth fortnight was signi? cantly higher in T2 group, i.e(5.73 to 11.16 kg) in T2 group, (5.76 to 10.29 kg) in T1 group and (5.66 to 9.77 kg) in T3 group. This study has been done for more information about the e? ective utilization of alternative feed resources in developing feeding strategies for be utilization of nutrient from protein rich feeds by goats under Bihar condition.

ABS (ORAL) : NFM-06

Study on feeding wild vetch (*Viciasativa*)seed on the growth performance and digestibility of Black Bengal kids

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An experiment was conducted for 90 days to evaluate the growth performance and economics of growing male kids fed diet containing wild vetch (*Vica sativa*) seed replaced by soyabean meal as protein source in the diet. Wild vetch is a leguminous weed of wheat and lentil. It is available in plenty in Bihar and has high yield. Seed of wild vetch has good nutritional potential and contains 92.61% dry ma 28.4% crude protein, 4.7% crude ? bre, 1.65% ether extract, 4.0% ash, 61.25% nitrogen free extract, 0.26% calcium, 0.57% phosphorus and 0.28% magnesium.Eighteen male (Black Bengal) goats (3-4 months of age; average body weight: 5.98±0.61 kg) were assigned to three treatment groups. Three isonitrogenous concentrate mixtures were prepared such that soyabean meal @20% (T_1) in concentrate mixture was replaced by wild vetch seed at 50.0% (T_2) and 100% (T_3) levels. A feeding trial was conducted for 90 days followed by a metabolic trial for 5 days. Body weight gain and average daily gain didn`t di? er signi? cantly among di? erent treatment groups. However, body weight gain was maximum in T_1 group (3.88 ± 0.17 kg) kg and minimum in T_3 group (3.69 ± 0.24) daily. Total feed cost/kg wt. gain was maximum and minimum in T_3 group (117.93/kg) and T_2 group (116.40/kg), respectively. Nitrogen intake due to inclusion of wild vetch seed in the diet did not a? ect signi? cantly. As the level of *Vicia sativa* increased the digestibility of dry ma decreased signi? cantly ($P<0.05$) in comparison to control group. Digestible crude protein (DCP) and total digestible nutrients (TDN) intake (g/kg $W^{0.75}$) was not a? ected by dietary treatments. Total feed cost (Rs./kg wt. gain) was maximum in T_3 group (117.93/kg) and minimum in T_2 group (116.40/kg). It was concluded that wild vetch (*Viciasativa*), a locally available feed ingredients can be included upto 10 % replacing 50% of soyabean in the concentrate mixture of growing kids without any harmful e? ect.

ABS (ORAL) : NFM-07

Growth Traits of Muza? arnagari Sheep reared under Semi-Intensive Feeding Management

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Muza? arnagari, the heaviest mu breed among 42 sheep breeds of the country, is mainly distributed in Muza? arnagar and its adjoining districts of Western U ar Pradesh viz. Meerut, Bulandshahar, Saharanpur and Bijnor. At present, the animals of this breed are also found in and around Mathura & Agra districts of U Pradesh and in some parts of Rajasthan, Haryana and Delhi states. For

evaluating growth traits viz. body weights at various age and average daily gains (ADGs) in di? erent age intervals, the data on 2845 Muza? arnagari lambs born during 2001-2015 at ICAR-Central Institute for Research on Goats, Makhdoom, Farah, Mathura were recorded. The breeding rams were selected based on their six month body weights and animals were maintained under semi intensive feeding management where these grazed 6-7 hours daily and supplemented with concentrate, dry & green fodder at farm. The overall least squares means for body weights at birth, 3, 6, 9 and 12 months age were 3.46±0.06, 16.11±0.37, 24.13±0.32, 28.49±0.28 and 32.68±0.27 kg and average daily gains (ADGs) during 0–3, 3-6, 6-9, 9-12 and 3-12 months age groups were 137.59±4.14, 88.49±3.57, 56.47±3.07, 55.57±2.93 and 65.12±1.68 g, respectively. Sex, season and period of lambing had highly signi? cant (P<0.01) in? uence on all the body weights and average daily weight gains while parity of dam showed highly signi? cant in? uence on birth weight, 3 month weight, ADG during 0-3 & 3-12 months and type of birth of lamb had similar e? ect on birth, 3 and 6 month weights and ADG during 0-3 and 3-6 month age intervals. Male lambs gained higher weights and ADGs than female lambs at all the growth stages while, period of lambing did not show any de? nite trend. Comparison of body weights and ADGs of single and twin lambs indicated that lambs born as single had higher birth and 3 month weights and ADG (0-3M) and thereafter twins showed higher body weights as well as ADGs at subsequent age stages. Dams' weight at lambing showed highly signi? cant in? uence on birth and 3 month body weight and preceding weights had highly signi? cant e? ect on their subsequent body weights. Maximum growth of lambs was recorded during 0-3 month (pre-weaning) age followed by 3-6, 6-9 and 9-12 age groups. This period of growth may be considered very crucial and should be ensured with proper management, feeding and health care for be productivity and outcome.

ABS (ORAL) : NFM-08

Characterization of Black BengalDoes in Jharkhand

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Characterization of Black Bengal Does was conducted in this study, under four centers of All India Coordinated Research Project on Goat Improvement, Black Bengal Field unit B.A.U., Ranchi namely Palojori(Deoghar), Barabanki(East Singhbhum),Chamguru (Ranchi) and Tiko (Lohardaga). A total of 1203 goats of di? erent age were studied. The experiment was performed on growthand reproduction parameters in black Bengal does at ? rst day and 3,6,9 & 12 months of age for measuring parameter as body weight, age at ? rst ma body weight at ? rst ma age at ? rst kidding, weight of ? rst kidding, service period, kidding interval and gestation period were found to be 1.50 ±0.12,6.30±0.02 , 8.91 ±0.18, 11.30 ±0.14, 13.90±0.49 kg, respectively, and 268.90 ± 0.08 days, 11.80 ± 0.29 kg, 416.79 ± 0.79 days, 12.00 ± 1.01 kg, 68.00 ± 0.62 days, 215.89 ± 0.76 days and 147.28 ± 0.12 days, respectively,whereas all the ? nding were gradually increased for all parameters according to their speci? c age period.

ABS (ORAL) : NFM-09

Methane emission, nutrient utilization, microbial protein synthesis and growth performance in ? nisher lambs fed complete feed block with tree leaves available in semi -arid region

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Tree leaves of *Ailanthus excelsa*, *Ziziphusnummularia*and *Prosopis cineraria* were fed to 36 ? nisher lambs in three groups and methane emission, nutrient utilization and animal growth was recorded. The feed block in T_1 consisted forty percent *Ailanthus excelsa* leaves and in T_2 and T_3 groups twenty percent of the were replaced by *Ziziphusnummularia*and *Prosopis cineraria* respectively. Plant bioactive compounds were higher (P<0.05) in T_3 and T_2 compared to T_1 feed blocks. Digestible organic ma metabolizable energy and digestible crude protein intake increased (P<0.05) in T_2 and T_1 compared to T_3 group. Digestibility of DM, OM and ADF lowered (P<0.05) in T_3 that of CP and EE in T_3 and T_2 group and resulted lower (P<0.05) nitrogen balance. Loss of energy through methane was low (P<0.05) in T_3 followed by T_2 groups compared to control and similar trend was observed when these values were expressed as percent of ME, DE and GE intake. Methane emission per kg digestible OMI lowered by 15.5 and 10.7 percent in T_3 and T_2 resulting lesser (P<0.05) loss of energy compared to T. Signi? cant (P<0.05) di? erences were observed in protozoa population and population of holotrichs, spirotrichs and total protozoa was reduced (P<0.05) in test groups (T_3 and T_2) with lowest population in T_3 group followed by T_2 and highest population of it was recorded in control group.. Microbial crude protein (MCP) synthesized per 100 g digestible organic ma intake was 25.2 g in T_3, 23.7 g in T_2 and 22.0 g in T_1 which was signi? cantly (P<0.05) higher in T_3 compared to other groups. Low weight gain and poor feed conversion was recorded in T_3 and T_2 compared to T_1 groups. It is inferred that adding *Prosopis cineraria* and *Ziziphusnummularia*at 20 percent level reduced methane, however concomitant reduced nutrient digestibility and poor N balance outweigh the energy conservation and led to poor gain and FCR in these groups. Therefore these two forage resources may be tried at lower levels for methane mitigation and be performance.

ABS (ORAL) : NFM-10

E? ect of age and sex on growth rate of pure bred Salem Black kids

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The present study was carried out in Mecheri Sheep Research Station, Po The period of study was taken from 2002 to 2018, in which data on 765 Salem Black kids were included in the

study. The average birth weight of kids was 2.20±0.03 kg (765). The kids were weaned at 90 days. The average weaning weight of kids was 8.75±0.14 kg (700). The average body weight of kids at 12th month of age was 17.84±0.33 kg (241). The pre-weaning growth rate of male kids and female kids were 72.23±3.20 g/day (320) and 64.84±1.85 g/ day (309) respectively. The overall pre-weaning growth rate was found to be 68.79±1.85 g/day (629). The post-weaning growth rate of male kids and female kids were 39.87±2.18 g/day (179) and 30.97±1.63 g/day (187) respectively. The overall post-weaning growth rate was found to be 35.12±1.34 g/day (366) respectively. The study revealed that pre-weaning growth rate was higher than post-weaning growth rate and the growth rate of male kids was higher than the growth rate of female kids.

ABS (ORAL) : NFM-11

Pre-weaning and post-weaning growth rate of Mecheri lambs

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The present study was carried out in Mecheri Sheep Research Station, Po The period of study was from 1979 to 2018, in which data on body weight of3483 lambs were included in the study. The average birth weight of lambs was 2.27±0.01 kg (3483). The lambs were weaned at 90 days. The average weaning weight of lambs was 9.00 ±0.06 kg (2893). The average body weight of lambs at 12th month of age was 18.41±0.15 kg (1379). The pre-weaning growth rate of ram lambs and ewe lambs were 75.30±0.90 g/day (1554) and 68.42±0.93 g/ day(1534) respectively. The overall pre-weaning growth rate was found to be 71.86±0.65 g/day (3088). The post-weaning growth rate of ram lambs and ewe lambs were 40.22±1.21 g/day (724) and 30.85±0.910 g/day (1133) respectively. The overall post-weaning growth rate was found to be 35.28±0.75 g/day (1857) respectively. The study revealed that pre-weaning growth rate was signi?cantly higher than post-weaning growth rate and the growth rate of ram lambs was higher than the growth rate of ewe lambs.

ABS (ORAL) : NFM-12

E?ect of sex and season on birth weight of pure bred Mecheri lambs in organized farm

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The present study was carried out in pure bred Mecheri lambs at Mecheri Sheep Research

Station, Po Data on lambs born from the year 1979 to 2018 were taken for the study.During thisperiod 3483 lambs were born, out of that 1765 were ram lambs and 1718 were ewe lambs.The birth weight of ram lambs ranged from 1.1 to 3.9 kg and ewe lambs ranged from1.3 to 3.6 kg. The average birth weight of ram lamb was 2.33±0.01kg(1765) and ewe lamb was 2.20±0.01kg (1718). The overall average birth weight of lambs was 2.27±0.01 kg (3483). In the ? rst season (January to June) the average lambs birth weight was 2.39±0.01 (2465). In the second season (June to December) the average lambs birth weight was 2.15±0.01(1018).The study showed that the average birth weight of ram lamb was higher than the ewe lamband the lambs born on ? rst season had higher birth weight than lambs born on second season.

ABS (ORAL) : NFM-13

Feeding management with supplementation of live yeast culture (*saccharomyces cerevisiae*) on performance of local female goats of Bihar

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The experiment was conducted on twenty female kids of age 3 to 4 months of local area of Patna goats, which were divided into two groups of ten kids each based on their average body weight (6.42±0.28 kg). The experiment was lasted for 120 days (November to March). Two di? erent diets o? ered in the ratio of 50:50 concentrate: roughage supplemented with Live Yeast Culture incorporated @ 0%, & 5% in concentrate mixture. Group I (T_1) = 0% Live Yeast Culture + Concentrate mixture + Roughage and Group II (T_2) =5% Live Yeast Culture + Concentrate mixture + Roughage. The traits Feed intake, Body weight, Feed conversion ratio (FCR), Performance index (PI), recording of pH of Colony Forming Units (cfu) of Yeast and total volatile fa acids (TVFA), Ammonia nitrogen, Total-Nitrogenweremeasured in the experiment.One of the groups was supplemented with *"Saccharomyces cerevisiae"* NCDC-49 and the second groups without any supplementation, which served as control.

The body weights of kids were signi? cantly in? uenced by treatments. The total body weight gain at the end of experiment was higher in the treatment groups (4.9±0.04 kg) as compared to control group (3.9±0.04 kg) and the di? erence was statistically signi? cant (P<0.01). The average daily live weight gain for the entire growth period was signi? cantly higher (43.81±0.41 g) in live yeast culture fed groups as to control groups (35.05±0.40 g). Body length of live yeast fed group was marginally higher in comparison to control group, but the di? erence was not signi? cant. The ? nal height at withers for control and live yeast fed group was 50.12±0.55 and 53.1±0.34 cm respectively. The ? nal heart girth for control and live yeast fed group was 52.17±0.38 and 55.2±0.32 cm, respectively. Fortnight average dry ma intake for control was 311.30±9.49 and for live yeast fed group was 330.44±7.36 g/day/kid respectively which was Non signi? cant.

The overall FCR for control group was 8.89 and for treated group was 7.65 resulting in signi? cant (P<0.01) di? erence between the two groups. Rumen fermentation showed no signi? cant

di? erence in pH and total nitrogen concentration. However, supplementation of concentrate with live yeast culture showed signi? cant e? ect on TVFA, NH-Ñ and cfu concentration in strained rumen liquor of kids. The incidence of diarrhoea outbreak (40%) was more in control group with less severity as compared to live yeast fed group (10%). Net pro? t per kids was relatively higher (Rs. 1,122.85) in supplemented groups in comparison to control group (Rs. 828.15). It could be concluded that *Saccharomyces cerevisiae* NCDC-49 supplementation along with concentrate mixture showed the best performance with respect to growth, feed conversion e? ciency and economic e? ciency.

ABSTRACT (POSTER PRESENTATION)

ABS (POSTER) : NFM-01

Nutritional evaluation and dietary inclusion of *Acacia nilotica*pod meal on performance of growing goats

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Livestock production is one of the major components of Indian agriculture and contributes signi? cantly in the farmer's economy.Goat farming plays important role in rural economy of developing societies by employment generation and house hold income. However, animal production cost is increasing day-by-day so, an experiment was design to improve the production of goatswith the application of unconventional feed resources for sustainable growth at minimum cost. This study will give more information about the e? ective utilization unconventional feed resources, which will help in developing feeding strategies for be utilization of nutrient by goats under Bihar condition.The animals were supplemented graded level of *Acacia nilotica* pod meal (0, 10, 20 and 30%) respectively, for ninety days feeding trial. The ? nal body weight after 90 days of experiment was also statistically (P>0.05) similar among the groups. However, ? nal body weight was 2.75 and 9.83% higher in T2 and T3 group as compared to control group. The ADG was 11.21 and 25.48% higher in T2 and T3 group as compared to control, whereas reduction in BW and ADG was noted in T4 group. The total DMI by the animals of T3 group was 2.06 and 2.95% higher than T2 and T1groups, respectively. The increase in total DMI in treatment groups may be due to higher body weight gain during the experiment. The feed conversion e? ciency was signi? cantly (P=0.071) be in T3 than control group and T4 group. The FCR in 20% babul pod meal supplemented group was 22.60% lower than control group. So, based on above ? nding we can conclude that the feeding of *Acacia nilotica* pod meal improved growth performance and FCR without a? ecting the nutrient metabolism of goats.

ABS (POSTER) : NFM-02

E? ect of rearing ? nisher Malpura lambs under intensive and intensive along with strategic grazing system on carcass traits

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The study was conducted on twenty four weaner Malpura lambs aging 90 days reared in two types of rearing system. Twelve lambs were reared in indoor feeding system and o? ered *ad-libitum* ? nisher ration and dry ardu (*Ailanthus excelsa*) leaves and free choice access to water (group-I). Lambs were let loose in open shed for two hours in the morning and evening. Another twelve lambs were reared in the system where lambs were grazed for two hours in the pasture and all the inputs as mentioned in group 1 were also given (group-II). All the lambs were fed up to 6 months of age and representative (5) lambs from each group were slaughtered to assess the carcass and meat quality traits. The body length (60.4 vs 62.6cms) and paunch girth (83.8 vs 91.2cms) was signi? cantly higher (P<0.05) in the group-II. The pre-slaughter weight (30.26 vs 36.56 kg), empty body weight (26.97vs 31.76 kg) and hot carcass weights (14.88 vs17.61 kg) were was signi? cantly higher in group-II. Similarly, forequarter (8.02 vs 9.39 kg) and hind quarter weights (6.43 vs 7.78 kg) di? ered among the groups. Among o? als, head, fore canon and hooves, and liver weights di? ered (P<0.05) signi? cantly. The cut-up parts of the carcasses indicated that, leg cut (2.18vs2.68 kg) and half carcass weight (7.23 vs 8.51 kg) was signi? cantly heavier in group-II. The chilling losses (3.66 vs 3.78 %) were comparable. The lean yield was similar in both groups expect for rack cut. The subcutaneous fat (10.15 vs 7.56 %) was signi? cantly higher in group-I. Dissected bone (%) was comparable. Meat: bone ratio (2.18 vs 2.41) was signi? cantly higher in group-II while muscle pH 45 minutes after slaughter was signi? cantly higher (6.62 vs 6.33) in group-I. The ? ndings of the study indicated that, intensive rearing system along with strategic grazing has bene? cial e? ect on carcass traits in ? nisher Malpura lambs.

ABS (POSTER) : NFM-03

Lactation performance of Salem black goats supplemented with wet brewer's spent grain

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Wet Brewer's spent grain (WBSG) as a feed ingredient for small ruminants can be used to

replace the concentrate feeds. The present study was conducted to evaluate the milk yield, composition and fa acid pro?le by supplementing WBSG. Eighteen Salem Black does aged between 8 and 10 months were randomly divided into three equal treatment groups. The T1 group was fed with concentrate feed, the T2 group replaced 50 per cent concentrate with WBSG and the T3 group replacing concentrate at 100 per cent with isonitrogenous and isocaloric level. Milk yield and composition (fat, lactose, proteins and total solids) were evaluated at 15, 30, 45, 60 and 90th day of lactation. Milk fa acids pro?les were determined by gas chromatography. The mean total milk yield of T3 group was signi?cantly ($p< 0.05$) higher compared to T1 and T2 groups. WBSG supplementation (T2 and T3) increasedmilk fat, milk lactose and total solids percent upto 90 days and solids not fat percent upto 45 days of lactation in comparison to control. Similarly, 100 per cent supplementation with WBSG signi?cantly decreased the milk $C_{10:0}$ (capric acid) and $C_{16:0}$ (palmitic acid) fa acids and milk short chain fa acids level but increased the $C_{18:0}$ (stearic acid), $C_{18:1}$ (oleic acid), LCFA and decreased the SFA: LCFA ratio as compared to the control. Replacing WBSG at 50 and 100 per cent in the diet of goats revealed signi?cant increase in the milk yield, milk composition and long chain fa acid and fa acid pro?le and showed signi?cant decrease in short chain fa acid.

ABS (POSTER) : NFM-04

Evaluation of Proximate analysis, Minerals and Vitamins of Moringa Fodder (*Moringaoleifera)* and its Evaluation as Goat Feed

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Moringaoleiferais a plant that is in high demand for its nutritional and medicinal values. This study was aimed at assessing the nutritional value of the leaf of *Moringaoleifera*and its evaluation as goat feed. Samples of leaf of PKM-1 variety of Moringa were obtained from fodder ?eld of Animal Production Research Institute (APRI) of RPCAU, Pusa. The proximate analysis of dried leaf of *M. oleifera*showed that it is highly rich in protein (27.50±0.33%) with appreciable levels of fat (5.70%), ash (9.25%), crude ?bre (11.77%) and carbohydrate (37.21%). Sand and silica content was 0.41%. The leaf was found to be rich in minerals and vitamins. It contained high concentrations of Zn, Mg, Ca and K. The rich array of results obtained displays that *M. oleifera*is suitable plant that could contribute immensely towards meeting feed and fodder requirement of goats. For dietary treatment thirty Black Bengal goat kids of goat unit, APRI, RPCAU, Pusa were selected. They are randomly divided into ?ve treatment groups of six kids in each group. The ?ve dietary treatments were having Moringa fodder and green Oat of varying proportion; T1 (100% Moringa fodder); T2 (75% Moringa fodder and 25% green Oat); T3 (50% Moringa fodder and 50% green Oat); T4 (25% Moringa fodder and 75% green Oat) and T5 (100 % green Oat) as control group. The experiment

was arranged in CRD to evaluate feed intake, nutrients digestibility and body weight gain. The dry ma intake was signi?cantly higher (p?0.01) in Moringa diet group in comparison to Moringa-green Oat diet group and green Oat diet group. Crude protein intake was found to increase with increase in Moringa fodder in the diet. The CP digestibility was increased in similar trend with increasing level of Moringa fodder. The mean average body weight gain was higher in T1 than other groups, which is probably due to higher nitrogen retention.

ABS (POSTER) : NFM-05

Characterization of Black BengalDoes in Jharkhand

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Characterization of Black Bengal Does was conducted in this study, under four centers of All India Coordinated Research Project on Goat Improvement, Black Bengal Field unit B.A.U., Ranchi namely Palojori(Deoghar), Barabanki(East Singhbhum),Chamguru (Ranchi) and Tiko (Lohardaga). A total of 1203 goats of di?erent age were studied. The experiment was performed on growthand reproduction parameters in black Bengal does at ?rst day and 3,6,9 & 12 months of age for measuring parameter as body weight, age at ?rst ma body weight at ?rst ma age at ?rst kidding, weight of ?rst kidding, service period, kidding interval and gestation period were found to be 1.50 ±0.12,6.30±0.02 , 8.91 ±0.18, 11.30 ±0.14, 13.90±0.49 kg, respectively, and 268.90 ± 0.08 days, 11.80 ± 0.29 kg, 416.79 ± 0.79 days, 12.00 ± 1.01 kg, 68.00 ± 0.62 days, 215.89 ± 0.76 days and 147.28 ± 0.12 days, respectively,whereas all the ?nding were gradually increased for all parameters according to their speci?c age period.

ABS (POSTER) : NFM-06

E?ect of concentrate supplementation on body weight of Bengal goats

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Goats are preferred livestock for rearing especially by the small marginal farmers due to its unique ability to adopt and maintain them in harsh environment. The well established market coupled with low capital investment and recurring cost, quick return, small size, less risk make

goat farming a pro? table and sustainable endeavour for rural households. Most of the goat owner (more than 50%) reared goat only by grazing system and li supplementation of tree leaves and local grasses. Goat rearing would be more bene? when they reared in semi- intensive system by supplementing additional concentrates besides normal grazing and feeding practice. The productivity of goat may be increased through nutritional manipulation of the concentrate feeding. The three di? erent treatmentsof feeding were tried in thirty Bengal goats,ten in each group. One group of animals were not provided any concentrate feed, feeding only by grazing(Treat I).Theanimals of treatment II group were given broken wheat and rice bran besides grazing.Treatments III group of animals were provided homemade balanced concentrate, composed of broken maize (40%), wheat bran (45%), oil cake (12%), salt(1.5%) and minerals(1.5%) along with grazing.The overall growth performance of the Bengal goats were found to be higher in concentrate supplementation feeding plan as compare to feeding only by grazing(Treat I). The weight gain at 6months of age in treat III andtreat II groups of animals was higher than Treat I. The maximum weight was observed in feeding o balanced concentrate along with grazing.Goatrearing with improved feeding and be management practices could lead to be growth performance of Bengal Goats which would be bene? cial for small, marginal andlandless farmers to establish their own livelihood at rural areas.

ABS (POSTER) : NFM-07

E? ect of rearing Lambs on Milk Replacer and Weaning at sixty and Ninety days of age

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This experiment was conducted to perform early weaning in lambs and rear them on milk replacer during subsequent period and study its e? ect on production performance. Sixty six number lambs of one week age were divided into three groups of twenty two lambs each (11 male and 11 female). In control group (Gr-I), lambs were maintained on suckling up to 90 days of age. In Gr-II, they were o? ered milk replacer @ 50 ml daily for one week, then gradually increased (100 ml to 250 ml) from 20 to 60 days of age. In the modi? ed management, ewes were stripped once a day in the evening up to 60 days of lactation and afterward two times in a day up to 90 days of lactation. In Gr-III, lambs were supplemented milk replacer as in Gr-II, but for 90 days of age. The ewes were stripped once a day in the evening up to 90 days of lactation. Lambs in all the group were o? ered *ad lib* concentrate, pala leaves, cowpea hay and fresh ardu leaves every day in cafeteria system and properly recorded.DCP and ME intakes were 73.1g/d and 2.78MJ/d in Gr-I, 72.4g/d and 2.45MJ/d in Gr-II and 75.4g/d and 2.89MJ/d in Gr-III respectively. Compared to control (Gr-I), higher concentration of TVFA (acetic, propionic and butyric acid) in Gr-II and Gr-III was observed. The protozoa population was lower in Gr-II and Gr-III compared to Gr-I. Growth performance of lambs

revealed similar body weight at 60 and 90 day in all the groups however, the body weight in Gr-III were higher than other two groups. The gain in weight and average daily gain (ADG) between 60-90 days was dipped (P<0.05) in Gr-II group. The overall gain in weight and ADG in Gr-III was higher. The study indicated that lambs weaned at 60 days need additional milk replacer for higher growth. The lamb rearing system of suckling in the morning and milk replacer supplementation in the evening provided a pro? t of Rs 300-400 per lamb compared to conventional system. Further the economic return from lamb rearing in Gr-III (90 days weaning) was 10% more over control (Gr-I) and 18% over Gr-II (60 days weaning).

ABS (POSTER) : NFM-08

E? ect of dietary incorporation of Co *Gossypum sp.*) on feed intake, nutrient digestibility and rumen fermentation metabolites in growing Barbari goats

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Eighteen male growing Barbari goats (Age approx. 5 months and mean body weight 10.37 ± 0.19) were divided into three groups (Gr I, Gr II and Gr III) of six each as per completely randomized design. Three di? erent type of iso-nitrogenous concentrate pellet was formulated having di? erent proportion of co seed cake (CSC). The animals were fed with concentrate pellet and Bengal gram straw in 40:60 ratio to meet their nutrient requirement. A metabolism trial of ? ve days duration was conducted after 130 days of experimental feeding. The dry ma intake (g/d) was 674.92, 692.72 and 728.08 in Gr I, Gr II and Gr III respectively. DMI (%BW) was also 3.96, 4.10 and 3.90 Gr I, Gr II and Gr III respectively. There was no signi? cant di? erence in DCP and TDN intake in di? erent group of goats. The digestibility of di? erent nutrients was statistically similar in all groups of goats. However nitrogen balance was higher in Gr III as compared to Gr I and Gr II. Rumen liquor was collected by stomach tube method to study di? erent rumen metabolites at 4 hr post feeding from each goat of all three groups. No di? erence was reported in rumen pH, total volatile fa

Present study concluded no adverse e? ect of CSC inclusion in the diet of growing Barbari goats on intake and digestibility of nutrients.

ABS (POSTER) : NFM-09

Evaluation of Urea Molasses Mineral Blocksin Black Bengal goat in Dumka district

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Goats have di? erent and very speci? c nutritional requirements. If these requirements are not met, the animal will not perform to its full potential, and worse still will be subject to a higher level of disease or insu? cient body weight gain. The urea can be mixed with molasses and minerals to form the Urea Molasses Mineral Blocks (UMMB). Twenty Black Bengal kid of Dumka Jharkhand subjected to this present study were randomly divided in to four groups with following feeding schedule from at the age 1 month; Group I-FP (Farmers practice) open grazing without any additional minerals/UMMB, Group II- FP with 1/2 teaspoon salt daily; Group III - F.P + licking of UMMB (Mol.40%, Wheat bran 30%, urea 10%, Salt 5%, MM 5%, cement 5%& lime 5%) and Group IV - F.P + licking of UMMB-2(Mol.30%, Wheat bran 35%, urea 5%, Salt 5%, MM 10%, cement 10 % & lime 5%) additional vitamin E and Se added @1%. A signi? cant increase in body wt. were observed in group II, III and IV up to 6 months of age as compare to group I. The mean body weight at 9 th month of age in the entire four groups was 8.32±0.24, 8.9±0.17 ^{ab}, 9.22±0.22 ^{bc} and 9.7±0.10 ^{c} respectively. This shows that a highly signi? cant increase in body weight was observed in group IV as compare to rest three groups. No any health/ disease problem like diarrhea and anorexia etc. were observed in any group rather slight increase in feed intake e? ciency in Gr II, III and IV.

ABS (POSTER) : NFM-10

Evaluation of Shaktimix GS a novel small ruminant feed supplement in goats in Bihar

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The study was conducted to evaluate the e? ects of a novel feed supplement for goat and sheep (Shaktimix –GS) on growth performance of semi intensively grown goats in Bihar.Shaktimix-GS has been formulated based on the mineral and vitamin requirements of small ruminants de? ned by ICAR and NRC. Total 12 growing goat kids BW 10-15 kg were randomly divided into 2 groups of 6 animals each i.e Control (fed Basal diet without Shaktimix GS) and Treatment (Basal diet + Shaktimix GS @10g/animal/day). Body weight change, skin coat, hoof and

horn condition and disease incidences were closely monitored for 30days trial period.After the experiment, higher ? nal Body weight (P>0.05) was observed for treatment group T2 (21.10 ±.73 kg) as compared to T1 (20.28±.73) the initial BW being similar i.e. 18.18±.43 kg and 18.20 ±.43 kg for T1 and T2 respectively.A growth of 5.9% in total body weight has been recorded in treatment group in comparision to 3% growth in control group animals. Average daily weight gain in Treatment group was 196.67 gm in comparision to 100.5 gm in control group. Skin, hoof and horn condition were improved in treatment group in comparision to control group animals. A supplementation of Shaktimix GS at dose of 10 gm/day resulted in higher body weight gain in the animals with overall improvement in general body conditions.

TECHNICAL SESSION - IV

(Animal Health Management)

LEAD : AHM-01

Some thoughts on epidemiology and management of gastrointestinal nematodes in small ruminants of India

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India is characterized by high ecological diversity as evident by variable climatic conditions from hot-humid to hot-dry, arid to semi-arid and plain to hills. Livestock rearing in India has so far been subsidiary to the agriculture, however small ruminants has provided sustenance to rural economy and play an important role in the livelihood of a large proportion of small and marginal farmers and landless labourers. Though, India has the distinction of possessing world's richest small ruminant base comprising of 65.0 million sheep and 135.2 million goats (19 th Livestock Census) with 3rd and 2nd ranking, respectively (Anon 2012), their productivity is not up to the mark. The reason behind this are many, like large animal population with rapidly diminishing grazing lands and consequent overstocking, poor nutrition, traditional husbandry practices accompanied by clinical or sub-clinical mixed infections and poor exploitation of genetic potential. The productive potential of small ruminants is limited by several factors with parasitism as major one. An exhaustive review commissioned to prioritize animal health research for poverty reduction in the developing World, by an international donor consortium consisting of the WHO, OIE and FAO concluded that gastrointestinal parasitism had the highest global index as an animal health constraint to the poor. Chronic nature of gastrointestinal nematode (GIN) infections resulted in high morbidity and huge production losses in economic sense. In many instances, these costs exceed the costs of losses due to the major “killer” diseases due to viruses and bacteria (Anon 1991). The total annual cost of parasitism in sheep was estimated to $ 222.0 million in the Australia (McLeod 1995), > $ 3.0 billion in USA (Smith 2002), US$ 41.8 million in Uruguay (Nari et al. 1997), $ 2.0 billion in sub-Saharan Africa (de Haan and Bekure 1991), US$ 400 million in Ethiopia (Gazehegan 1992), $ 5.6 million in Indonesia and $ 103.0 million in India (McLeod 2004). With the approach of partial farm budgeting Singh et al. (2011) estimated that under natural challenge of infection in sheep, the components of losses were reduced mu production (59.56%), increased susceptibility for mortality (16.57%), premature culling (11.25%), reduced fertility (7.97%) and decreased wool yield (4.65%).The presence of gastrointestinal parasites in an animal however, does not mean that they are necessarily the cause of any overt disease in that animal, thus it become essential to assess the type and level of parasitism in a ? ock to determine the signi? cance of parasitic infection and to recommend a cost-e? ective feasible management programme. Since long for small ruminants the standard parasite control measures in practice are:

- Anthelmintic drench when faecal sample found positive without considering its intensity, climatic conditions and grazing management i.e. frequent use of anthelmintics at short intervals
- Deworming all the animals at the same time re? ecting ignorance about role of *refugia* in preservation of susceptibility to anthelmintics in worm population

- Advocating and adopting dose and move strategy thus increasing proportion of anthelmintic resistant worms in population
- Periodical anthelmintic intervention without considering the bionomics of economically pathogenic worms in particular area
- Frequent rotation of anthelmintic type favouring emergence of multiple anthelmintic resistance

In early 1960's, the availability of e? cacious, safe and broad-spectrum anthelmintics made parasite control simple and e? ective. Frequent regularly scheduled treatments with anthelmintics kept animals healthy and productive and had a great cost-bene? t return. However, this strategy has turned out to be short-lived and unsustainable. Moreover, psychological addiction of the farmers to over-use / misuse the anthelmintics to be on safer side has done more harm than bene? t. Unfortunately, these practices and other factors have contributed to the development of parasite resistance to anthelmintics. The rising emergence of anthelmintics resistance strains of parasites is challenging the ability of the animals to produce and maintain high level of productivity. Though, anthelmintics have a de? nite role to play in worm management programme but their use need to be minimised to the extent possible by exploiting the knowledge of parasite epidemiology, both in the host and on the pasture. Keeping in mind above scenario, the present communiqué highlights the pa of epidemiology of GINs and feasible options for their managements.

Issues in Epidemiology and Management of Parasites

The epidemiological studies showing considerable regional, between and within ? ock variations in faecal egg counts (FEC) are worthy to note when devising an e? ective management programme. Since long in worm control practice, *en-mass* drenching with anthelmintic has been recommended however, this strategy has turned out to be unsustainable and researchers now favour a selective approach where animals in need of anthelmintic intervention actually receive medication as worm burdens are highly aggregated in hosts with about 20-30% of animals harbouring about 80% of all the worms (Hoste et al. 2002; Singh et al. 2015). Majority of parasitologists now considered levels of *refugia* as the single most important factor w.r.t. anthelmintic resistance in parasites. Treating animals with low worm burdens particularly during climatic extremes does li to control parasites, but removes an important source of *refugia*, thereby accelerating the level of drug resistance (van Wyk 2001). There is a paradigm shift in the way to deal with parasites – away from ? ock control and the chemical 'big hit' approach to something more akin to parasite management i.e. “living with worms”. The insight into extent and severity of worms, rampant emergence of anthelmintic resistance in them and un-sustainability of chemotherapeutic based worm control programme, rose following issues before us:

- Reset / set objective for epidemiology of parasites
- Need to consider double-edged problem in worms and their management
- Identify and harvest bene? ts of soft targets available in epidemiology

Epidemiology of Gastrointestinal Nematodes (GINs)

On reviewing the epidemiological ? ndings across the di? erent states of India, it was realized that comprehensive studies on di? erent aspects of epidemiology are limited and su? er with lacunae like lack of objective of study, reporting point prevalence, limited to incidence only using small sample size, failure to quantify the magnitude of intensity, poor correlation with climatic conditions and management / rearing practices of livestock, status of pasture infectivity and drug-use pa etc. While formulating the worm management strategies it is essential to give due emphasis on bionomics of both pre-parasitic and parasitic stages of parasite on pasture and in host, respectively.

A. Regulation of pre-parasitic stages of gastrointestinal nematodes:

Since last seven decades time-to-time introduction of e? cacious chemotherapeutics put the interest on role of biology of pre-parasitic (exogenous) stages of parasites in corner but development of anthelmintic resistance now forces us to resurrect this discipline and give full a on it while devising a worm management strategy. The major epidemiological factor in? uencing worm burden in grazing animals is the number of infective (L_3) larvae ingested with pasture. Both temperature and rainfall (moisture) in? uence the infectivity of pastures. Rain (moisture / relative humidity) tends to increase the infectivity of pasture by assisting in the movement of L_3 out of faeces and by providing the ? lm of moisture necessary for L_3 to migrate on to herbage. A low humidity accompanied by either low or high temperature inhibits vertical migration and the maximum numbers of infective larvae are found during rainy season (O'Connor et al. 2006). Regardless of the timing of or even the existence of a clinical disease, the timing of peak larval availability on pasture is of crucial importance. Development of L_3 and their availability for ingestion by host was optimum at about 25°C when adequate moisture is present. The optimum conditions for translation of *H. contortus* includes total monthly rainfall of more than 50 mm and a mean monthly maximum temperature over 18.3°C. *Trichostrongylus* spp. requires a total monthly rainfall of over 50 mm and mean monthly temperature of 12.8 to 18.3°C for their translation on pasture (Gordon 1953). As the climatic conditions vary from place to place, studies on the bionomics of the larvae under local conditions are of immense help in formulating the worm management strategies. The construction of bioclimatograph was the ? rst rational a to explain the epidemiological pro? le in accordance with climatic conditions of an area. In India, the region-wise favourable periods for translation of major GI nematodes are as under (Swarnkar and Singh 2013):

In temperate and sub-temperate climate eggs deposited over prolong period in winter, spring or early summer may result in large number of larvae being available to grazing animals in spring, summer, autumn, respectively depending on their temperature-rainfall relationship. Typical seasonal rise in nematode worm burden in host and on pasture was observed following monsoon accompanied with moderate temperature during July makes the environment favourable for the development, survival and dissemination of exogenous stages leading to high rise of GINs in host and infective larvae on pasture during the period from July to September.

Region	State	*H. contortus*	*Trichostrongylus* spp
Sub-Temperate Himalayan	J&K Himachal Pradesh Uttarakhand	Jan - Apr, Jun - Late Sep Jan - Oct Mid Feb - Oct	Feb-Late Apr, Mid Sep-Late Nov Mid Feb - Late Nov Mid Mar - Mid Oct
North Eastern Hill	Sikkim Assam	Late Feb - Nov Feb - Mid Oct	Whole year except Jul - Aug Early Oct - Apr
Eastern	Odisha Jharkhand Bihar West Bengal	Early Apr - Nov Late Apr - Mid Oct Late Mar - Mid Sep Jun - Mid Oct	Nov - Feb Mid Jan - May, Sep - Dec Mid Oct - Late Mar Early Oct - Mid Mar
North-Central	Uttar Pradesh Haryana Punjab MP Chattishgarh	Jun - Late Sep Mid Jun - Mid Oct Mid May - Late Sep Jun - Oct Jun - Oct	Late Sep - Mid Mar Feb - Mid Apr, Mid Sep- Mid Nov Feb - Mid Apr, Mid Sep- Mid Nov Oct - Apr Mid Oct - Mid Mar
Western	Arid Rajasthan Semi-arid Rajasthan Gujarat Maharashtra	Jul - Late Aug Jun - Early Sep Late May - Late Sep Mid May - Mid Oct	Oct - Early Mar / Apr in all states The period was marginally longer in Gujarat state
Southern	Kerala	Mid Mar - Mid Nov	NIL
	Andhra Pradesh Karnataka Tamil Nadu	May - Mid Oct Early Apr - Late Oct Mid Mar-Mid May, Mid Aug–Dec	Nov - Feb Sep - Mar Dec - Late Feb

The favourable conditions prevail from February to November in Sikkim. In Himachal Pradesh, monsoon rains triggers by mid-June with moderate temperature and makes the environment favourable for development and survival of free-living stages on pasture (Jithendran 1998). In U pasture larval burden (PLB) was higher during September-October. Higher PLB was observed during May to October in Meghalaya and from July to October in Sikkim. In Northern plains the climatic conditions suitable for development, survival and dissemination of infective stages are during monsoon (June-October) causing high incidence of GIN with peak intensity during monsoon and post-monsoon period. In Rohilkhand region of UP, the pasture

infectivity was higher during the period from September to January.In Madhya Pradesh, PLB was higher from May to October. Period from June to August were most favourable for translation of nematodes in Cha (Dey et al. 2008).The bioclimatographs for *H. contortus* showed suitable climatic conditions for translation of exogenous stages of parasites were from June to September and July to August in semi-arid and arid Rajasthan, respectively (Swarnkar and Singh 2011). From southern region, there was bi-modal parasitic activity on pasture in western (April-May, August-September), high rainfall, Cauvery delta and southern zones (April-June, August-December) while in northern zone favourable conditions prevails from March to November.

B. Regulation of parasitic stages of gastrointestinal nematodes in host:

Following biological phenomenon are essential to be considered for e? ective management of GINs in small ruminants.

a. Peri-parturient rise (PPR)in faecal egg counts: It refers to an increase in the number of nematode eggs in the faeces of animals around parturition and during lactation (from 2 weeks prior to lambing to 8 weeks post-lambing) due to a temporary relaxation in immunity (O'Sullivan and Donald 1970) and associated with changes in the circulating levels of the prolactin. The occurrence of PPR phenomenon has been reported from Kashmir (Dhar et al. 1982), Haryana (Gupta et al. 1987) and Tamil Nadu (Sanyal 1988). However, In Rajasthan, the agroclimatic conditions do not favour the development of strongyle larvae (Swarnkar et al. 1997; Swarnkar and Singh 2010) during December-June resulting in non-availability of source of infection for ewes and absence of typical PPR (Singh et al. 1997; Swarnkar et al. 1998). Based on this observation, anthelmintic drench as practiced by farmers in the month of February-March was withdrawn without hampering the ? ock productivity (Swarnkar et al. 2008a). The avoidance of deworming during this period enables survival of susceptible parasites within the host (as hypobiotic) which in turn leads to help in reducing selection pressure for anthelmintic resistance and maintaining the e? cacy of anthelmintics by increasing the size of *refugia* (Singh and Swarnkar 2008a).

b. Hypobiosis: It is a temporary cessation in development of a nematode parasite at a precise point in its parasitic phase of development. The abomasal nematodes like *H. contortus* and *T. axei* and small intestinal worms such as *Trichostrongylus,Cooperia and Nematodirus* spp are capable of interrupting or arresting their development at L_4 stage. On return of favourable conditions they resume their development and become normal egg laying adults. Hypobiosis is considered as an evolutionary adoption which delays egg production and death of worms until the following monsoon when eggs deposited on pasture have a higher chance of continuing the worm life cycle (Fakae 1990). From India, this phenomenon has been reported from Tamil Nadu (Sanyal 1988, 1989) and Rajasthan (Singh and Swarnkar 2013).In Madhya Pradesh, a decline in intensity from November to June indicates possible occurrence of hypobiosis (Singh and Swarnkar 2011). Absence of hypobiosis was reported from Haryana (Gupta et al. 1987). In Tamil Nadu, the exposure of larvae in cold climate on pasture might be the factor inducing hypobiosis and Sanyal (1989) hypothesized that these hypobiotic larvae in turn, may become the potential source of pasture contamination in spring coinciding with the lambing. In Rajasthan, investigations on hypobiosis showed lower proportion of abomasi harbouring only adult worms from December to April compared to other months with maximum number of L_4 in abomasal mucosa in January. The factors responsible (probably cool and dry conditions) for induction of hypobiosis were probably

dominant during October/November. During the period from August to October lower level of cortisol in sheep inspite of higher THI (Thermal – humidity index) suggested that climatic stress during the period was compensated by good plane of nutrition to sheep due to increased biomass in grazing area and reduced walking distance/stress. In-spite of lower THI (non-stressful) in the month of March, the occurrence of higher level of cortisol in sheep might be due to reproductive stress (Swarnkar and Singh 2018). Resumption of development occurs in response to yet unidenti? ed stimulus in June but is thought to be related with nutritional and walking stress along with suitable climatic conditions with pre-monsoon showers (Swarnkar and Singh 2015).

C. Self-cure phenomenon

It means expulsion of *H. contortus* when there was a fresh growth of pasture, along with an increased *H. contortus* larval intake and it was of short duration (Stewart 1950; Gupta et al. 1986). In sheep ? ocks of Rajasthan, the initial rising trends in FECs in June is probably due to resumption of development of hypobiotic worms within the host, giving peak of infection in July and provide the source of pasture contamination during monsoon. The decline in FEC in the following months may be due self-cure phenomenon (Allonby and Urquhart 1973) following acquisition of fresh wave of infection from pasture and expulsion of old worms (Swarnkar et al. 2008a). Thus, it is not necessary to drench the ? ock on ? rst rise in FECs at the end of summer season. Further adoption of this practice will be useful in increasing the size of *refugia* and maintenance of anthelmintic e? cacy for longer period.

D. Nutritional status vis-a-vis submandibular oedema

In ? eld ? ocks, the occurrence of submandibular oedema without anaemia in 20-30% of sheep during November to February is a constant feature and assigned to worm infection. To mitigate the problem, anthelmintic intervention is common practice. However, investigation showed that sheep ? ocks remained under low plane of nutrition during summer (as maintained on tree leaves only). With the onset of monsoon, though there is enough grazing material on surface but higher water content in fodder kept the situation of low plane of nutrition as such. In succeeding months, majority of sheep became pregnant and in late gestation/early lactation (November) failed to meet required amount of protein (lactation stress, prolonged lower plane of nutrition) resulting in hypoproteinemia and occurrence of bo jaw. The role of nutritional stress is further supported by parasitological observations that during this period the FECs were quite low (<200 epg) with almost nil pasture infectivity (Swarnkar et al. 2008a). Thus to mitigate the problem of submandibular oedema during winter in sheep, e? orts must be diverted from anthelmintic intervention to nutritional (high protein) intervention.

E. Over dispersion in faecal egg counts

Assumption like that each host is infected with the same number of worms should not be a criterion for *en-mass* anthelmintic intervention as GINs in small ruminants are highly over-dispersed, with around 80% of the worms found in only 20-30% of the host (Hoste et al. 2002). Studies in sheep ? ocks of Rajasthan showed that during favorable season (July-September) around 20-30% and 50% of sheep in ? eld and farm conditions, respectively had FECs to the tune of >1000 epg(Singh and Swarnkar 2014; Singh et al. 2018). In recent times, it has been recognized that the phenomenon of parasite over-dispersion could be put to good use if those animals su? ering from level of infection su? cient to cause considerable production loss or health e? ects, can be identi? ed

and treated individually (Singh and Swarnkar 2012a). The available information on alternate approaches of worm management suggested that existence of this phenomenon can be used in form of targeted selective treatment and for breeding for resistance / resilience to parasites (Singh and Swarnkar 2007, 2008) ultimately with the aim to increase the size of *refugia*, maintain anthelmintic e? cacy and cost-e? ective worm management.

F. Lambing pa and source of infection

It was noticed that whenever farmer implements anthelmintic intervention in ? ock, all the animals (including 30% lambs below 3 month of age) were given anthelmintics, thus unnecessary using 30% of anthelmintic. In ? eld ? ocks majority of sheep (80%) are lambing between September to December and lambs are sent for grazing at the age of 2.0-2.5 months. Similarly in farm ? ocks, where lambing is concentrated during late December to February, the lambs are allowed to graze on pasture from May onward. In Rajasthan, higher PLB was usually observed during monsoon. Thus, spring-born lambs had the opportunity to pick up infection during late June – July depending on onset of monsoon (Swarnkar et al. 2008a). Hence it can be advocated that in Rajasthan young sheep (born during spring season) of marketable age (3-6 months old) could be raised without anthelmintics till July. Further for remaining young ones in ? ocks, the GINs infection under such situation could be e? ectively managed by a single anthelmintic intervention during mid monsoon (Singh et al 2015).

Pro? le of GINs:

In the epidemiology of GINs, incidence (study on the dynamic changes which occurs both with in host and environment) pa has li signi? cance as it may remain continuously higher throughout the year without noticeable ill-e? ect on host. On the other hand, the intensity of infection indicates the pathological level of GI parasitism in a ? ock. It is directly related with the animal factors (age, nutrition, immunity etc), management practices (reproductive, grazing, rearing etc), herbage larval burden and agro climatic conditions. Analysis and correlation of intensity of GIN infection with managemental practices provide a solid base for formulating an e? cient worm management programme.

In temperate and sub-temperate Himalayan region, the common GI parasites encountered were *Haemonchus contortus, Trichpstrongylusaxei, T. colulobriformis, Bunostomumtrigonocephalum, Skrjebimaovis, Cooperiapunctata, Oesophagostomum, Chabertia, Trichuris, Nematodirus, Marshallagia*and *Strongyloides*sp. (Dhar and Das 1982; Jithendran 1994, 1998; Mi et al. 1998; Katoch et al. 1998; Bhat et al. 2007).North-Eastern Himalayan region has high rainfall with super humid climate and ideal optimum temperature for faster propagation of the parasites and is known endemic zone for the metazoan parasites (Sharma and Godara 2010). From Assam, the nematode recorded on autopsy from goats were *H. contortus, Trichuris ovis, T. globulosaBunostomumtrigonocephalum, Trichostrongyluscolubriformis, T. axei, Oesophagostomumcolumbianum, O. venulosum, Ostertagiacircumcincta, Gongylonemapulchurum, Gaigeriapachyscelis, Strongyloides papillosus* and *Skerjabinemaovis* (Talukdar 1996). The GI nematodes

recorded in West Bengal were *HaemonchusBunostomum*, *Trichuris* and *Strongyloides* sp. (Bandyopadhya 1999).In Northern plains, the predominant nematode was *Haemonchus contortus* followed by *Trichostrongylus*,*Osophagostomum* and*Bunostomum* sp. (Thaper 1956; Nadakal 1961; Patnaik et al. 1973; Bali and Singh 1977)The common nematode species recorded in Rajasthan were *H. contortus*, *T. axei*, *T. columbriformis*, *O. columbianum*, *S. papillosus* and *Trichuris* spp (Singh et al. 1997). The prevalent parasites in Southern Humid region were *H. contortus*, *T. colubriformis*, *O. venulosum*and *Strongyloides* sp. (Raman et al. 2010).

State / Region	Prevalence (%)	Intensity (EPG)	Remarks / References
J & K	Annual: 59.83 - 94.30 Seasonal: K: 84.60 (S) – 60.00 (A), J: 88.54	1418 (W) - 2302 (M)	Low intensity in 68.22% of stock
	(M) - 76.01 (W) Altitude: 20.51 (High, 4000-6000' above MSL) 70.84 (Middle, 1500-4000' above MSL) 74.88 (Plain, 1000-1500' above MSL) 17.85 in Chegu goats (Lahaul and Spiti)		High intensity in 1.96% of stock (Nasreen et al. 2005; Yadav et al. 2006; Sharma et al. 2007; Khajuria et al. 2006; 2010; Agnihotri et al. 2010; Wani et al. 2011)
HP	Annual: 94% (Migratory flocks) Minimum in winter – Maximum in monsoon	722 (W) – 1324 (M)	Outbreaks in rainy and winter season in migratory flocks (Jithendran 1998; Sharma et al. 2007)
Uttarakhand	Annual: 60.7 (Sheep), 63.4 – 87.0 (Goat) 42.1-47.8 (H), 52.1-60.0 (P), 70.7-75.4 (T) Altitude: 33.31 (Hill region) - 66.89 (Tarai region) Higher incidence: Jul-Oct / Jan -Mar in Plains, Apr-Nov in Tarai and Jun-Dec in Hills	775 (W) – 1717 (M) 1047 (H) – 8023 (T)	(Banerjee et al. 2004; Yadav et al. 2007; Ram et al. 2007; Pant et al. 2009)
Sikkim	Annual: 77.13 (Goat) Seasonal: 30.8 (W) – 79.4 (S) Altitude: 18.36 (Alpine dry zone) 27.27 (Sub-alpine low humid zone) 58.52 (Temperate humid zone) 70.54 (Sub tropical high humid zone)	Annual 1167 epg with peak (2320.4 epg) in September	EPG profile suggests occurrence of hypobiosis and spring-rise phenomenon (Pal and Bandyopadhyay 2004)
Arunachal Pradesh	Sheep: 43.66 (Annual)		Sarvananan et al. (2006)

Assam	Seasonal: 92.06 (M), 75.00 (W), 32.14 (S)	3525 (M) - 1225 (S)	Barua et al. (2015)
Meghalaya	Goat: 52.00 – 67.37 (Annual) 34.48 (W) - 57.14 (S)	125 (Dec) - 2250 (Jun)	Higher pasture larval burden (May to Oct) Laha et al. (2010)
Odisha	83.98 to 87.00 Higher incidence during monsoon season		(Mishra et al. 1974; Subudhi et al. 2006)
Bihar	89.00 (Sheep), 79.33 (Goat)		Kumari et al. (2010)
Jharkhand	Annual: 62.37 in goats Seasonal: 84.19 (M), 66.45 (W), 36.45 (S)		
West Bengal	Sheep: 66.85 – 69.73, Goat: 65.21 – 73.49 Higher incidence during monsoon season	Sheep: 453 (May) to 944 (Sep)	Bandyopadhya (1999), Anon (2011), Brahma et al. (2015)
	Existence of regional variation Sheep: 54.1% in Red letarite zone to 66.5% (Coastal zone) Goat: 53.7% (Old Alluvial zone) to 65.6% (Hill zone)	Goat: 453 (May) to 937 (Sep)	
Haryana	Minimum: Mar - Jun Maximum: Jul - Oct		Gupta et al. (1987)
Uttar Pradesh	Annual: Field: 68.89 (Sheep), 60.70 (Goat) Farm: 44.32 in goats Seasonal:16.22 (W), 34.67 (S), 42.95 (M)	596 (Winter), 624 (Summer), 1050 (Monsoon)	Two peaks (Jul-Oct and Dec-Jan) for intensity of infection in sheep compared to single peak (Oct) in goats (Arora et al. 2006; Shankar et al. 2010, Anon 2011)
Rajasthan	Annual: 55.0 (Field) to 65.0 (Farm) >65% incidence:May-Nov (Farm flocks of semi-arid region) Jul- Nov (Farm flocks of arid region) Jun- Oct (Field flocks of both regions)	Semi-arid farm: 128 (Feb) to 1753 (Jul) Semi-arid field: 88 (Mar) to 1013 (Sep) Arid farm: 194 (Mar) to 2315 (Oct Arid field: 59 (Apr) to 1429 (Aug)	Peak infection during July to September (Swarnkar et al. 2008a, 2010; Godara and Sharma 2010; Singh et al. 2018)

MP	Annual: 65.0 – 78.6 in goats		Higher incidence/intensity from Jul to Dec 43 (Bundelkhand area) to 75% (Vindhya plateau) (Anon 2011)
Chattishgarh	Annual: 85.2 in goats Seasonal: 63.15 (W), 85.50 (S), 94.60 (M)		Pathak and Pal (2008)
Maharashtra	Annual: 29.66 – 65.85 (goat), 33.59 – 52.32 (sheep) Maximum incidence during monsoon followed by winter and minimum in summer	Maximum intensity during monsoon followed by winter and	Deshpande and Deshpande 2005; Chavan et al. 2008; Palampalle et al. 2009; Sutar and Khan 2011
		minimum in summer	
Tamil Nadu	Annual: 57.7 - 64.6 (goats), 66.3 - 72.6 (sheep) Seasonal: 55.3 (Summer) - 68.4 (South-West monsoon)	Maximum intensity: South-West monsoon (Jun-Aug) Minimum intensity: summer (Mar-May)	Higher infection rate in high rainfall region followed by North-Eastern region, Cauvery Delta zone and minimum in high altitude zone (Soundarajan and Iyne2003; Raman et al. 2010)
Pudducherry	Annual: 56.0 in goats		Das et al. (2006)
Andhra Pradesh	Annual: 94.1 (goats), 85.9 (sheep) Seasonal: 96.8 – 97.6 (W) to 77.0 – 90.0 (S)		Shivajothi and Reddy (2018)

K- Kashmir valley, J- Jammu, S- Summer, A- Autumn, M- Monsoon, W- Winter, H- Hills, T- Tarai, P- Plains, SA- Semi-arid

Worm management strategies

Given the wide regional variation that exists between sheep management systems and the di? erent parasites that inhabit them, it is hardly surprising that there are no universally applicable "blueprint" approaches for management of GINs.Worm management strategies should be based on a sound understanding of the epidemiology of parasite in both host and environment. Majority of parasitologists now considered levels of *refugia* as the single most important factor contributing to selection for anthelmintic resistance in parasites (van Wyk 2001; Soulsby 2007; Leathwick et al. 2009). Treating animals with low worm burdens does li to control parasites, but removes an important source of *refugia*, thereby accelerating the evaluation of resistance. Thus, consideration

of double-edged problem in worms and their management is need of hour. There is a paradigm shift in the way to deal with parasites – away from ? ock control and the chemical 'big hit' approach to something more akin to parasite management i.e. “living with worms”. The di? erent worm management strategies are as under:

a. Refugia based strategies: *Refugia* can simply be de? ned as a population that is either unexposed to or, in certain circumstances, una? ected by an anthelmintic (van Wyk 2001; Fleming et al. 2006). All the three components of host-parasite-environment triod plays crucial role in maintaining the quantum of *refugia*. The concept of *refugia* can be applied to slow the development of anthelmintic resistance through the use of approaches such as dilution of resistant with susceptible parasites when the proportion of resistance alleles is high and targeted and selectively targeted treatments when resistant alleles are less common. The host based approach includes reducing the numbers of treatments by targeting them e? ectively and/or selectively. Whenever anthelmintics are used it is important to consider not only the impact on the infra-population but also what is happening at that time to the free living stages. For example anthelmintic treatments that are administered when the supra-population size is drastically reduced (during dry periods, grazing on reseeded pastures), pose a considerable risk with regard to the selection of resistance (Besier and Love 2003). Other important factors are the classes of animal to be treated, the type of the anthelmintics used, the biotic potential of the nematode species exposed to treatment and the treatment regimes being employed. Sharing of common grazing by groups of animals with di? erent pa of treatment may provide *refugia* and has been exploited in the management of resistance (Sissay et al. 2006). Resilient animals continue to perform whilst under parasite challenge and therefore require less anthelmintic treatments than non-resilient animals (Silvestre et al. 2002; Bisset et al. 2001). The incorporation of resilient animals into ? ocks could also be used to manage *refugia* by provide untreated populations.

The parasite basedapproaches are based on the frequency of the resistant alleles in the parasite population, the biotic potential of the parasite and the longevity of both the supra- and infra-populations. The frequency of resistant genes in? uences the rate at which homozygous resistant parasites appear in the population. If the proportion of resistance genes is high, then there is an increased probability that heterozygotes will have the opportunity to mate and produce homozygous resistant o? spring. The degree of biotic potential of a parasite species determines the numbers of individuals of that species required to provide a given level of *refugia*. For example, species with high biotic potential, e.g. *H. contortus*, can provide a high degree of pasture contamination from relatively few individuals and therefore, e? ective *refugia* can, assuming successful completion of the lifecycle, be maintained by leaving a relatively small proportion of the host population unexposed to treatment. In other species with lower biotic potential, e.g. *Trichostrongylus* spp., a greater proportion of the host population would need to be left unexposed to treatment to provide the same level of *refugia*. A study conducted at ICAR-CSWRI, Avikanagar on the seasonal variation in di? erent genotypes of *H. contortus* exhibited that sheep harbour more number of BZ-susceptible worms during monsoon and winter compared to summer. The relatively higher proportion of rr genotype in supra-population during the period from March to July indicates existence of unsuitable climate for larval dissemination as well as meager chances of re-infection from pasture(Swarnkar et al. 2006). The deworming in later half of monsoon is helpful in increasing the e? cacy of anthelmintics by increasing the size of *refugia*.

b. Conventional treatment (CT): It is most commonly practiced and consists of en-mass treatment with anthelmintics 2-4 times a year. The timings of treatment were either usually based on information in literatures / books i.e. without considering actual epidemiological pro? le in particular set of environment and management (Swarnkar and Singh 2010, 2012). This approach leads to increased selection pressure in nematode populations and rampant rise in incidence of anthelmintic resistance.

c. Smart drenching: The term "Smart Drenching" was coined to describe selective treatment of certain animals with the goal to maintain animal health and production while decreasing the rate of development of parasite resistance to anthelmintics (Sanyal 2014). It encourages producers to use anthelmintics selectively, judiciously and e? ectively. It involves:

- Identi? cation of e? ective anthelmintic type in an area through faecal egg count reduction test
- Proper dose calculation (based on maximum body weight in similar age-group of animals)
- Ensure administration of correct amount of over the animal's tongue and to the back of its throat
- Use dewormers from two di? erent classes if resistance is suspected on the farm
- Keep animals to be wormed o? feed for 12-24 hours before treating with benzimidazoles or ivermectin, doramectrin and moxidectin
- Only deworm animals that require treatment.

The bene? ts of smart drenching are 3-fold, (i) reduced cost of worm management as fewer animals (maximum of 20-30% during wormy season) are dewormed, (ii) reduced selection pressure on parasites to develop resistance and (iii) preservation of anthelmintic e? cacy for prolonged period due to increased quantum of *refugia*.

d. Targeted treatment (TT):It means *en mass* treatment given at the most appropriate times bearing in mind the need to maintain *refugia*. These treatments are generally given on the basis of epidemiology in a given area (Besier and Love 2003; Cringoli et al. 2008). To determine the most suitable time for anthelmintic intervention a thought needs to given on bioclimatograph and rearing / grazing practices. It serves to reduce the numbers of anthelmintic treatments and thus minimise pasture contamination with resistant genotypes.In Rajasthan, the experience gained after over the years by application of anthelmintic drench during mid to late monsoon showed increase in *refugia* with high e? cacy of anthelmintics for prolonged period. The comparative evaluation of two schemes showed reduction in drench frequency in farm ? ocks had not hampered the ? ock productivity. Like-wise in ? eld ? ocks, annual lambing, purchase, sale and morbidity rates were remained almost similar in both the categories of ? ocks (Singh et al. 2018).

e. Targeted selective treatment (TST):TST is a method of identifying individual sheep and goats that are heavily parasitized, based on physical evidence of anaemia caused by *H. contortus* (Jackson and Coop 2000; van Wyk and Bath 2002). This system may help in identifying the heavily parasitized individuals so producers can make appropriate management decisions w.r.t.

treatment or culling (Sanyal 2009; van Wyk et al. 2006) .A color chart based on ocular mucous membrane, microhaematocrit and intensity of infection in sheep was developed and tested at CSWRI, Avikanagar(Singh and Swarnkar 2012b). With TST application it was observed that frequency of anthelmintic treatment/year ranged from 8.65% to 29.31% an average of 16.80% compared to >100% drenching in CT/TT approach. The application of TST is feasible and e? ective not only in managing the haemonchosis but also help in increasing the size of *refugia* which may ultimately resulted into both maintenance of drug e? cacy against parasites and sizeable reduction in the cost of worm management in sheep ? ocks(Cabaret2008). The main disadvantages are the di? culty and time spent on selecting animals in need of treatment and the possibility of lower production. The comparative evaluation of TT and TST showed that in monetary terms the net annual income / 100 sheep remained higher in ? ock managed for worms with TST approach with use of anthelmintic at a frequency of 0.13 drench / head / annum compared to ? ocks where GIN infection was managed with TT approach with use of anthelmintics at the frequency of 1.61 drench / head / annum (Anon 2016).

e.Non-chemical measures: These will become even more important as resistance to anthelmintics grows. The possible practices that can reduce the dependency on anthelmintics in ? ock are as under:

i. Breeding for increasing resistance / resilience to GINs: The largest source of genetic variation in resistance is between sheep within a ? ock, rather than between di? erent ? ocks (Gray 1997; Kumar et al. 2006). In most studies, FEC was the main phenotypic measurement used for selection of the responding animals (Hunt et al. 2008). The heritability of resistance to GIN infection in sheep, as measured by FEC varied from 0.01 to 0.50. Using FEC as phenotypic marker for within breed selection of resistant and / or susceptible animals at ICAR-CSWRI, Avikanagar, it was observed that this trait is low to moderately heritable (Singh et al. 1999, 2009; Swarnkar et al. 2009; Prince et al. 2010; Gowane et al. 2019). The pro? le of intensity of strongyle infection in divergent lines (resistant "R" and susceptible "S") over the years exhibited that animals of R-line had lower monthly FECs compared to their counterparts in S-line. The animals of S-line required strategic as well as tactical anthelmintic intervention while animals of R-line were maintained without any anthelmintic intervention (De et al. 2017; Swarnkar and Singh 2017; Swarnkar et al. 2017).

ii. Community dilution strategy: The correlated response between genotypic frequency of homozygous BZ-resistant larvae and BZ-e? cacy exhibited that a marginal rise in the proportion of BZ-susceptible alleles during September to November resulted in increased e? cacy of BZ anthelmintics as well as reduces the proportion of ? ocks harbouring BZ-resistant *H. contortus*. An introduction of animals infected with BZ susceptible strains of *H. contortus* for grazing on pasture area of farm resulted in dilution of resistant population in *refugia* with resultant increase in anthelmintic e? cacy at farm (Sissay et al. 2006; Singh ad Swarnkar 2017).

iii.Grazing practices: It is stated that "Drenching is not a substitute for good feeding" and "There is no be anthelmintic than good quality green grass". The role of grazing management in worm control programme is simply to provide "low risk" pastures for the most susceptible sheep with the aim to provide be nutrition at the same time. It is most successful if applied when larval numbers are at low levels. If PLB is high during winter then be to target the summer for

reducing larvae on the pasture (in trichostrongylosis) while, in haemonchosis prone areas where high PLB occurred during spring and monsoon, e? orts must be made to limit contamination of pasture during autumn and spring.

iv.Interactions between nematode infections and host nutrition: Recent studies have brought evidence showing that manipulation of the host nutrition could represent an option to improve the host resistance and or resilience to parasites. Several studies, performed in small ruminants, have underlined the possible antiparasitic e? ects of plant secondary compounds on nematodes. Amongst these secondary metabolites, tannins, present in some legume forages or in woody plants composing the vegetation of rangelands have been investigated. Results from both *in vivo* and *in vitro* studies suggest an action of tannins on the biology of the most prevalent worm species in small ruminants (Athanasiadou et al. 2003; Paolini and Hoste 2003; Swarnkar and Singh 2005; Swarnkar et al. 2008b; Sahoo et al. 2011).

In addition, other non-chemical practices are (i) allow to graze sheep ? ock on pasture >3” in height due to abundance of infective strongyle larvae in water droplets on grass blades in the lower 3” of forage, (ii) follow the Gumboot rule – avoid grazing on pasture with height shorter than the toe of gumboot, (iii) avoid grazing of ? ock on wet pastures, (iv) rotate pastures and allow as much rest time as possible between re-grazing (at least 6-9 weeks), (v) encourage practice of multi-species grazing and (vi) do not overstock animals on grazing area.

Conclusion

The ability to predict the timing and magnitude of infection level in host and on pasture to plan grazing and worm management strategies are important requirement of preventing losses caused by GINs in sheep. Increasing rate of emergence of anthelmintic resistance has threatened the e? cacy of valuable non-renewable anthelmintics, making chemical based worm management programme an un-sustainable option. Climatic consideration in combination with grazing pa and practices can be taken into account in evaluating expected levels of *refugia* and thus treatments can be avoided at times when *refugia* are likely to be small. Anthelmintic intervention in ? ocks should be restricted to the active parasite transmission season. Thus, we need to look at anthelmintics, not as a tool in our tool box, but as a band aid to ? x a management problem. In ever-changing scenario of dynamics of parasite epidemiology more a and research is needed for a thorough quantitative discipline of strongyle larval bionomics and a be understanding of their epidemiology on regional basis. The alternate approaches in worm management need to be researched which require basic data to convince the policy planner for research fund aid to show the bene? t to the farmers in adopting the technologies evolved with minimal use of chemotherapeutics. The single anthelmintic drench during mid to late monsoon was found more bene? cial and cost e? ective compared to conventional (2-3 drench/annum) worm management programme for sheep ? ocks of Rajasthan. Similarly, TST approach reduced the number of drenches and thereby decreased drenching cost without a? ecting the ? ock performance.

References are available with the authors.

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Sustainable control of helminth parasites in small ruminants of North Western Himalyan Region

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India, a developing country is a land of villages and more than 60 % of the human population still depends upon agriculture and livestock sector for their livelihood.The livestock sector of India contributes approximately rupees 2,00,000 million per year to gross national production. Livestock contributed 10% to the income of small farm households as against on an average of 14%. For all rural households, livestock provides livelihood to 2/3 rd rural community. There are various factors related with low production and among them parasitic diseases rank very high. In the region, the animals generally follow open grazing system and pastoral system which are major contributing factors to predispose them to helminthic diseases. The animals generally su? er from sub-clinical infections without showing apparent clinical symptoms. In comparison to bacterial or viral diseases, they cause less mortality but high morbidity resulting into huge economic losses to the farmers in the form of low milk, wool and meat production, retarded growth, emaciation, lowered draught capabilities and reduced absorption of food nutrients (Soulsby, 1982; Chaudhri and Singh, 2003). The major helminthic diseasesof the ruminants reported from the region are amphistomosis, fasciolosis andgastrointestinal nematodosis (Yadav *et al*., 2005; Khajuria, 2010; Nazeer, 2011; Khajuria *et al*., 2013).

Sustainable control of helminths

Worms means “Wisely thinking in opportunities and Resources available with us and their integration into formulation of Programme for parasite Management with the aim of Sustainability in production” (Singh and Swarnkar, 2012). Under extensive conditions follows in

the region, only anthelmintic treatment will not provide su? cient control and there is a risk due to widespread occurrence of resistance to these chemicals. In addition, due to decrease in pasture land and increasing stringency of maximum permissible residue levels for meat and wool in export market has compelled to enhance search for other means of control (Newton, 1995). Under evasive strategies, following steps should be taken into consideration.

Knowledge of epidemiology

The prevalence of helminths depends upon agro-climatic conditions, animal husbandry

practices and pasture management in a particular area. For example, *Paramphistomum* species are more prevalent in the low-lying canal irrigated areas of Jammu region (Yadav *et al*., 2005; Khajuria *et al*., 2013), whereas *Fasciola* species are mainly restricted to middle and high altitudes (Khajuria, 2010). However, gastrointestinal nematodes are found throughout the Jammu region. For be and appropriate control strategies, it is important to identify the epidemiological and ecological aspects of helminths and the associated risk factors that are unique to a particular area and farming system. Once the epidemiology is established, a control strategy can be implemented.

It is often considered that necessary epidemiological work has already been done and that work conducted in one climatic region can be extrapolated to another region. It is a misconception and in most of the cases our knowledge on the epidemiology is rather incomplete and needs use of high technology methods.

Improve nutritional status of the host

The work on the role of nutrition in the management of parasitic diseases is yet to be initiated in the Indian scenario. The most of the animals are under nourished and under low state of productivity. Under such circumstances the e? ect of pathophysiology of parasitic diseases increases many folds. The presence of helminths, particularly in the digestive system causes decrease in food consumption, malabsorption and changes in host metabolism (Swarnkar and Singh, 2005). It has been reported that parasites have special a? nity to vitamins and minerals such as the infection of *Diphyllobothrium latum* in man causes de? ciency of vitamin-B12, leading to pernicious anaemia (Soulsby, 1982). Haemonchosis in small ruminants has a direct relationship with cobalt de? ciency, as cobalt is used to synthesize vitamin B-12 and its de? ciency further leads to internal parasitism (Katoch, 2005). Moreover, haemonchosis in small ruminants and hookworm infections in canines cause de? ciency of iron and thus lead to anaemia (Lapage, 1959; Miller, 1971; Soulsby, 1982).Manipulation of the host nutrition could represent an option to improve the host resistance. Vitamins A, D and B-complex are the important component of the diet to develop resistance against gastrointestinal helminths (Lapage, 1959). The increased protein supply in the diet increases the resistance of the host against helminths which resulted into reduced worm burden and suppression of growth and fecundity of worms (Molan *et al*., 2000). Introduction of molasses/mineral feed blocks and use of dewormer plus mineral mixture in the diet is recommended to improve the general nutrition of the animals as well-nourished animals are less susceptible to infections.

Many studies have established the antiparasitic e? ects of some plant secondary compounds amongst which tannins, present in some legume forages or in woody plants are most important (Paolini and Hoste, 2003; Swarnkar *et al*., 2009). Condensed tannins are polyphenolic secondary

plant metabolites, well recognized for their ability to form complex with soluble protein at normal ruminal pH (when fed at concentration less than 10% of diet). This restrict the normal break down of protein to ammonia in the rumen and allow more dietary protein to pass unchanged to the small intestine, acting as by-pass protein. The increased protein supply to animals leads to increased resistance to infection, as evidenced by suppression of growth and fecundity of worms, reduced worm burden and faecal egg count and improved status of protein and phosphorus (Molan *et al*., 2000; Athanasiadou *et al*., 2001). Therefore, the feeding of traditional tree fodder in hills is recommended. However, the consumption of condensed tannins may not result in economic gain because of the negative e? ect of excessive condensed tannins consumption on the performance of host in term of reduced feed intake and digestibility, impairment of rumen metabolism and mucosal toxicity. The improved performance observed in animals grazing such forages is a consequence of improved resilience rather than the consequence of improved resistance (Singh and Swarnkar, 2007).

Strategic deworming

Reducing the use of dewormers and decreasing the resistance development to these dewormers is the need of hour. Anthelmintic treatment should be provided at the end of rains as the infective larvae on pastures are in abundant after rains. The use of anthelmintics during late winter months will kill the hypobiotic larvae and reduce the levels of infective larvae of strongyles on pastures during early summer months. Another treatment during early summer (March-April)will kill the overwintered larvae plus peri-parturient rise. The use of e? ective ? ukicides (triclabendazole or oxyclozanide) in autumn (September-October) and mid-summer (May-June) can reduce incidences of fasciolosis (in middle and high altitudes) and paramphistomosis (in low-lying areas) in Jammu region. Do not move animals to pasture immediately after deworming as all the dead worms with viable egg in them will contaminate the pasture. Again, changing the class of anthelmintic after some period will further reduces the risk of resistance development.

Judicious use of anthelmintics

Generally farmers like quick and easy solutionand they think thatcontrolling worms by management is more complicated than a standard treatment programme and therefore, a “treat and forget” approach seems to be preferable and there is a widespread use and misuse of anthelmintics. These frequent dosing results in development of anthelmintic resistance.Only those animals should be treated that get most bene? t from the treatment, leaving the rest of the ? ock untreated.

Application of part-? ock treatment (Targeted Selective Treatment)

Considering *Haemonchus contortus* as major nematode species, a technique has been standardized for the identi? cation of those animals in the ? ock which harbour higher intensity of infection, su? er with clinical form of the disease and are actually in need of chemotherapeutic intervention (Singh and Swarnkar, 2012). TST is directed towards those animals that are susceptible or that most contaminate pasture (Jackson and Coop, 2000). For the application of TST, sheep and goat ? ocks should be screened for anaemia by visual appearance of gradation in conjunctiva using colour chart and treat only those animals which are anaemic, particularly during wormy season. The application of TST is feasible and e? ective not only in managing the haemonchosis but also help in increasing the size of *refugia* which may ultimately resulted into both maintenance of drug e? cacy against parasites and sizeable reduction in the cost of worm management in sheep ? ocks.

Biological control

Biological control agents rarely eliminate the target organism, but reduce the numbers to acceptable levels and maintain a balance between the pathogen and the antagonist (Singh and Swarnkar, 2007). It is mainly focuses on the free-living stages of nematodes on the pastures. Di? erent species of fungi include nematode trapping (predacious) fungi, endoparasitic fungi, fungi that invade nematode eggs and fungi that produce metabolites that are toxic to nematodes (Barron, 1977). Among various biological agents used to reduce the number of infective larvae on the pastures,only *Duddingtonia?agrans*has shown success and the most promising candidate for biological success which utilizes nematodes as their main sources of nutrients. This fungi ingested by grazing livestock, pass safely through the gut to the faeces and then quickly colonize fresh faeces after excretion. Another fungus which has been exploited belong to the genus *Arthrobotrys* did not survive gut passage (Prasad *et al*., 2009). These fungal spores may be delivered to animals through on farm addition to grain supplements, incorporation into lick blocks or in a controlled release device. The spores should be kept dry prior to ingestion, as spores that already germinated have diminished survival through the gastrointestinal tracts. Although these predacious fungi have shown promising results, further work is needed to optimize the delivery of these agents to the ruminants and establish su? cient number in the faeces.

Dung beetles are capable of rapid and often complete dung removal. However, such dung dispersal activity is very dependent on ideal weather conditions. Thus, these dung beetles are indirectly responsible for the signi? cant reductions in the number of free-living stages of parasites (Singh and Swarnkar, 2007). When the climate is cool and moist, then earthworms take over the role of dung beetles. Both of them break up the dung pats and expose the nematode eggs and larvae to dehydration.

Switching to herbal dewormers

The herbal dewormers or phyto-chemicals have long been used as traditional healers to treat parasitism and improve performance of livestock. Now-a-days many herbs have been evaluated for their antiparasitic activities and new opportunities are being created to develop anthelmintic therapies using natural molecules (small peptides, enzymes etc.) to interfere with natural processes in worm (metabolism, egg production, larval development etc.). Plants like garlic and *Sericea lespedeza*possess low to high level of antiparasitic activity against di? erent stages of gastrointestinal nematodes (Annon, 2003). Sudden drop in fecal egg count due to tannin component of plants has been reported (Min, 2004). Scienti? c validation of the antiparasitic activities and possible side e? ects of phyto-products in ruminants by *in-vitro* and *in-vivo* experiments is necessary prior to their adoption as an alternate mean of worm control. However, it has been reported that considerable physiological di? erences are present between the *in-vitro* conditions and in the predilection site of worm within their animal hosts including factors that a? ect bioavailability of the active compounds.

Pasture management

Due to commercialization in last few decades, the pasture land is decreased while there is an increase in the animal population resulted into over stocking rate.Increased number of animals on the pastures will increase contamination of the pastures as well as the mass of herbage is reduced and infective larvae will be accessible more easily. The height of the pasture should be maintained greater than 2 inch and providing browsing area can reduce the parasitic load as larvae climbs up to one inch of height of grass blades. Beside the animals should be grazed in late morning hours, as it is well proven that after increasing in temperature the larvae move downwards and are not available on the upper parts of the grass blades.

During rainy and post rainy months, the contamination of pastures increased many folds (Katoch *et al*., 1998; Sharma *et al*., 2004; Yadav *et al*., 2004), hence during this period the animals should be stall fed with the leaves of fodder tree or straw feeding should be provided. During summer months, the larvae remain at the lowest part, thus the animals are not allowed to graze very close to the ground. In addition, the pastures followed by crops should be preferred instead the pastures grown continuously. Further, avoiding grazing in wet patches of pasture and fencing o? naturally wet areas reduces the infection rate. Furthermore, rotational grazing of sheep and goat with ca and horse and providing tannin rich forage decrease the worm burden of animals.

Selecting resistance animals

Breeding of selectively resistant animals is also helpful in decreasing the worm burden of ruminants. Selection at breed level and even individual level can contribute. These resistant

animals also remain productive in parasitic contaminated environment.

Immunity

With the advancement of age, the animals usually develop some immunity against parasites. The animals that are poorly nourished, immunocompromised and young animals in which immune system has still not been developed are more prone to parasitic infections. So another way to reduce the production losses is to boost up the immunity level of animals. This can be done with vaccination, high plan of nutrition and using some compounds like copper oxide particles which has direct e? ect on internal parasites and also increases immunity (Singh and Swarnkar, 2012).

Interruption of life cycle

The life cycle of strongyle worms, especially *Haemonchus contortus* which have a short life span and majority of infective larvae disappearing from pasture within 4-6 weeks, can be broken either by adopting stall feeding (commercial ? ocks) for at least two months (implementation of cut and carry practice for fodder) or by adopting pasture resting strategy or rotational grazing.

Manure management

It is an e? ective method but cannot practice in our country and the animal faeces during grazing are the only manure they get (Katoch, 2005). Part of this is also collected by the poor people and used as fuel (dry pats).

References are available with the authors.

LEAD : AHM-03

Biological Control of Ovine *Haemonchus contortus* using Nematophagous Fungi at Organized Farms

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1. Introduction

Gastroenteritis caused by parasitism is an important cause of production losses in sheep. The most prevalent and pathogenic parasite that a? ects sheep in the tropic and subtropical regions is the barber- pole worm, *Haemonchus contortus*. Adult worms live in the abomasum (true stomach) of sheep, where they feed on blood and lay eggs that pass into the faeces. The parasite can be found in both adult and growing sheep. However, growing lambs su? er more severely than mature sheep. It causes the disease haemonchosis (Preston and Allonby, 1979) which is responsible for serious production losses in sheep being maintained at sheep breeding farms. The symptom most commonly associated is anaemia, characterized by pale mucous

membranes, especially in the lower eye lid; and "bo jaw," an accumulation (or swelling) of ? uid under the jaw. The parasite is di? cult to control because it has a short, direct life cycle and is a proli? c egg producer. A female barber pole worm can produce 5,000 to 10,000 eggs per day.

Bo Anaemic animal

The life cycle of *H. contortus* involv on, free-living, infective and parasitic. The contamination phase begins with eggs that are passed out in the faeces. The eggs hatch and develop through three larval stages (L_1, L_2 and L_3) and these stages constitute the free-living phase. L_1 and L_2 larvae feed on bacteria and other organic material within the faeces. L_3 larvae retain the L_2 cuticle and this ensheathed larval form is relatively resistant to adverse microclimate conditions in the faecal material and climatic conditions after leaving the faeces onto the pasture herbage. Climate conditions that in? uence the level of L_3 on pasture are relative humidity, illumination and temperature (Krecek *et al.*, 1992). Under ideal conditions development from the egg to L_3 can happen in as li as a week. The L_3 can not feed and migrate out of the faeces which require a moisture medium such as rain or heavy dew, thus becoming the infective phase of the cycle ready to be ingested by a new host. The parasitic phase begins with the ingestion of the L_3. After ingestion, exsheathment of the L_3 occurs in the rumen and the larvae migrate to the abomasum where they penetrate into the mucosa. In the mucosa, another moult occurs to the fourth stage (L_4) larvae. The L_4 emerges back into the lumen where they moult to the adult stage. Adults mate and eggs are passed out in the faeces, thus completing the life cycle. Grazing on infective pastures provide the connection between the free-living and parasitic stages of nematode parasites (Waller, 1997a).

2. Control of *Haemonchus contortus*

Over the last 5 decades a number of very e? ective anthelmintic drug treatments have been discovered and made available to farmers to successfully control these parasites. However,

resistance to these anthelmintics is becoming increasingly prevalent in sheep and there is li prospect of new drugs coming into the market in the near future.

In Rajasthan seasonal prevalence of gastrointestinal nematodes has been observed, being highest during the monsoon (Singh *et al.*, 1997). Veterinarians and animal health workers are well aware of this fact and accordingly treat the animals with commonly available anthelmintics such as albendazole and tetramisole. Treatment when clinical parasitism is apparent to prevent mortalities and not to control parasites is the frequently used method in sheep raised by farmers in the ? eld conditions. On many occasions especially when farmers treat the animals on their own chances are there that these drugs are not given at appropriate dose rates. In many instances, lengthy periods of high rainfall require regular and frequent treatment. Moreover, salvage treatment is of common practice and animals after treatment return to the communal contaminated grazing areas.

3. Why there is need to evolve alternate methods of control

There are issues such as increasing incidence of anthelmintic resistance in GI nematodes, increasing awareness of issues involving environmental contamination with chemicals, consumer pressure to reduce drug residues in meat and meat products. As a result there is need to reconsider the issue of e? ective worm control within context of sustainability. In this context an alternative or adjunct to anthelmintics may be the management of free living stages of GIN through BC using predatory fungi.

4. Biological control of GI nematodes using nematophagous fungi

An exciting development in parasite control over recent years has centred on biological control (BC) using nematophagous fungi. BC of nematodes is no longer a novelty and is fast becoming an area of applied research with the possibility of becoming an important integrated element in developing new sustainable control strategies (Larsen, 1999). It is directed at the free-living stages and will not have an e? ect on the parasitic phase within the host (Waller, 1997b), therefore, the objective of BC is to reduce the availability of L3 on pasture and thus reduce parasite establishment (Fernandez *et* al., 1997). In this way the sheep would be able to avoid both clinical and subclinical e? ects due to parasitic nematodes in general and *H. contortus* in particular. The infective larvae will not be eliminated completely from the pasture and the sheep will constantly receive a small amount of larvae which will result into development of a natural immune response.

4.1 Nematode trapping fungi

These fungi belong to a heterogenous group of micro fungi that utilize nematodes either as the main source of nutrients, or supplementary to a saprophytic existence. These fungi are found world wide in many di? erent habitats, but are especially frequent in organically rich environments such as compost and faeces. Fungi are naturally picked up by grazing ruminants and subsequently excreted in the voided faeces (Hashmi and Connan, 1989; Larsen *et al.*, 1994; Manueli *et al.*, 1999; Saumell *et al.*, 1999; Chandrawathani *et al.*, 2002; Khan *et al.*, 2001).

4.2 Steps involved in biological control

The Division of Animal Health, CSWRI, Avikanagar has been involved in BC of *H. contortus*, over the past few years with emphasis on developing simple and practical device to deliver nematophagous fungi to sheep. A number of experiments were designed and conducted to arrive

at logical conclusions. Research done demonstrated that the whole method involves following steps:

- Isolation and identi? cation of nematophagous fungi
- Screening of isolated fungi
  - *In vitro* experiments
  - *In vivo* experiments
- Formulation and implementation of suitable fungus

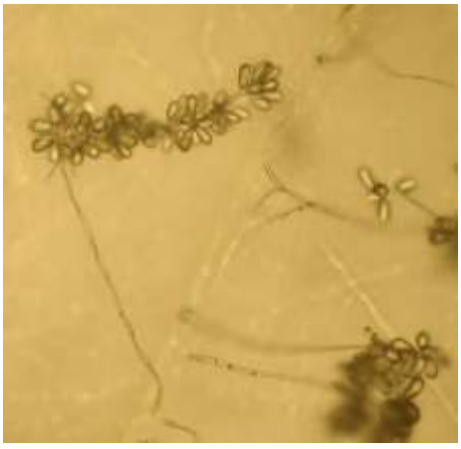
Isolation and identi? cation of nematophagous fungi

Nematophagous fungi may be isolated from soil, grass, old faecal pellets/ pats and fresh faeces. However, fungus obtained from fresh faeces has already established their gut survival ability. Therefore, it is anticipated that such fungi will have a greater potential as BC agents compared with the isolates obtained from other sources. It is very important to isolate the fungus locally because of the reasons that laboratory maintained stocks may loose their nematode trapping ability and importation of such fungi from other countries has become very di? cult these days. In order to isolate nematophagous fungi from fresh faeces following methodology is used: thoroughly homogenized freshly collected faeces (about 8-10 grams) were spread in cross con? guration on 2% agar plates containing 0.02% tetracycline to suppress bacterial growth. Each plate was baited with infective larvae of GIN (predominantly *H. contortus*). These plates were maintained at 28 ± 2 0 C in a B.O.D. incubator and observed under a stereomicroscope weekly during a two week period for the presence of nematophagous fungi. From the plates that had fungal growth characteristic of nematophagous fungi, a were made to make pure isolate of the fungal species, by transferring conidia to Petri dishes containing 2% corn meal agar (CMA).

In India Sanyal (2000) ? rst of all isolated 4 and 2 isolates of *A. oligospora* and *D. ?agrans*, respectively at National Dairy Development Board (NDDB), Anand (Gujarat). Subsequently Khan *et al* (2001) obtained one isolate each of both the fungi from two di? erent animals at CSWRI, Avikanagar. Later on a detailed survey of Rajasthan state having predominantly arid and semi arid climates, has been conducted under All India Network Project on Gastrointestinal Parasitism funded by Indian Council of Agricultural Research, New Delhi. The survey resulted into isolation of one isolate of *D. ?agrans* from CSWRI farm and many isolates of *A. oligospora*from both the zones. These isolates have the advantage of evolving under local razing conditions.

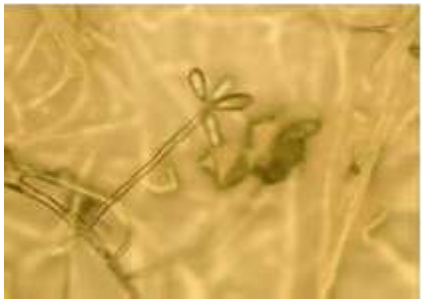
The next very important step is the correct identi? cation of the isolated fungus. The characteristic appearance of conidia, chlamydospores and trapping structures are very helpful in identi? cation by using the keys provided by Rubner (1996).

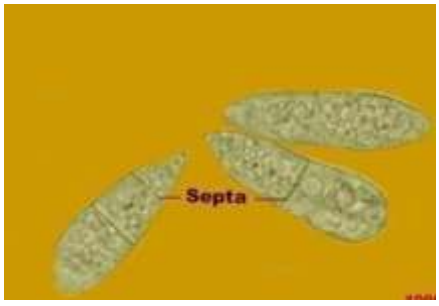
Two types of spore are produced by both the fungi: thin walled conidia on erected conidiophore and thick walled resistant spores, chlamydospores. Morphologically *A. oligospora* has long, erect and septateconidiophore. Numerous conidia are borne in clusters on the swollen conidiogenous heads along the length of conidiophore. Conidia are broad, obovoidal, mostly one septate (rarely 2-septate), tapering to the base and septate below the middle. The fungus produces very few chlamydospores. *D. ?agrans* is distinct from *A. oligospora* because of the conidiogenesis i.e. conidia are formed at the conidiophore apex and slightly below without being borne on pronounced denticles. Conidia are ellipsoidal, truncate and 1-2 septate. There is enormous production of chlamydospores, which are thick walled and red brown. Mature chlamydospores have warty protuberances on their surfaces.



Conidiophore of *A. oligospora* (200X)

Conidia of *A. oligospora* (1000X)





Conidiophore of *D. ?agrans* (200X) Conididia of *D. ?agrans* (1000X)

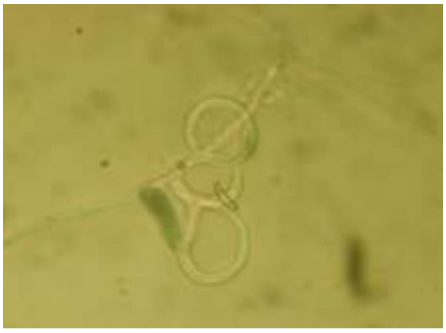
Chlamydospore of *D. ?agrans* (1000X)

Screening of nematophagous fungi

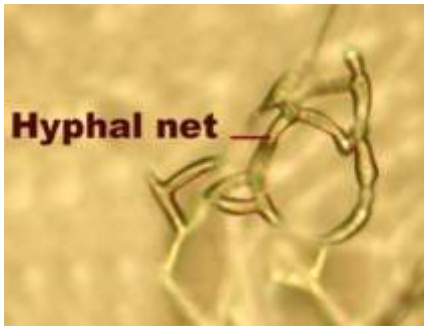
In order to be sure of potential of isolated nematophagous fungi a number of laboratory and in- doors tests (passage tests through housed animals) is required. The types of experiments conducted for the purpose can be divided into two categories:
(i) *In vitro* experiments observing the predacious capacity of pure fungal cultures on agar medium or in faecal culture assays.
(ii) In vivo experiments where fungal material is given per os to the sheep and the subsequent e? ect on the developing larval stages of the parasite in faecal environment is monitored.

In vitro experiments
(a) Interaction between fungi and nematode larvae on agar medium

For the purpose infective larvae of GI nematodes are added to petri-dishes containing fungal growth on agar medium. The results of experiments conducted with *D. ?agrans* on corn meal agar (CMA) medium revealed formation of extensive mycelial network consisting of many loops after addition of larvae (Fig). On the other hand *A. oligospora* could not produce such networks on this medium. However, when simple agar medium was used it displayed excellent net formation (Khan *et al*., 2004).



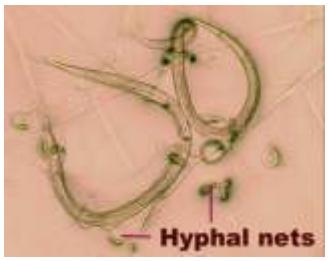
3 dimensional hyphal loop produced by *A. oligospora* on agar medium



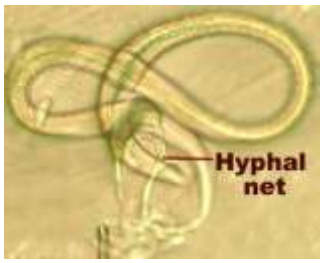
3 dimensional hyphal loop produced by *D. ?agrans* on corn agar medium

All *H. contortus* larvae were e? ectively trapped by *D. ?agrans* within 2-3 days of addition of

larvae (Khan *et al*., 2001). On the other hand *A. oligospora* was less e? cient as only 67% larvae were trapped and that too after 6 days of baiting.



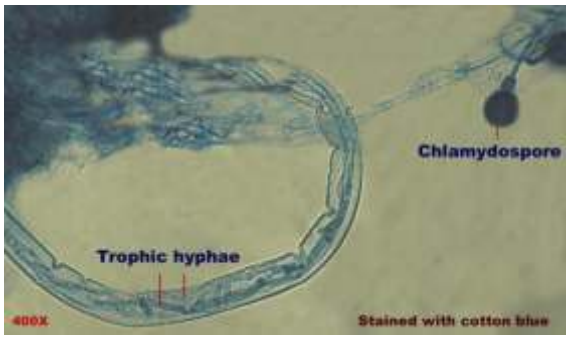
Infective larvae trapped by *A. oligospora*



Infective larvae trapped by *D. ?agrans* on on agar medium (400X) corn meal agar

After penetration of larval cuticle both the fungi form infection bulb from which the assimilative (trophic) hyphae grow into the body of larvae.

Trophic hyphae of *A. oligospora* seen inside the infective larva (400X)



Trophic hyphae of *D. ?agrans* seen inside the infective larva (400X)

(b) Interaction between fungus and parasite in faecal cultures

Faecal culture assay is conducted to determine the e? ect of fungal spores on the development of infective GI nematodelarvae in sheep faeces. Here fungal spores are added in the faecal cultures set up from sheep infected with GI nematodes. Spores (conidia and chlamydospores) are obtained from about 2 weeks old fungal colonies by gently washing the culture plates with water containing 0.01% Tween 80. The number of spores is estimated using a haemocytometer and diluted to the required numbers for adding in the faecal cultures set up from sheep infected with GI nematodes. Varying concentrations such as 20, 200, 2000 per g of faeces are used. Faecal samples are properly mixed with spores and kept for 10 days to culture infective larvae. Larvae are then harvested by Baermann procedure and recovered larvae counted.Result of the assay with local isolates of *D. ?agrans* and *A. oligospora* obtained in 2000 revealed more than 80% reduction in the number of infective larvae (Khan *et al*., 2001, 2004). The larval development was almost nil when the faecal cultures were admixed with spores @ 2000 spores/ g of faeces. Cultures were found full of fungal growth at this concentration.

However, conclusions drawn from these experiments are only indicative of potential of the investigated fungi as BC agents against GIN larvae and further studies such as ability to survive the passage through the gastrointestinal tract of sheep are required to answer the question of how to implement biological control in practice.

In vivo experiments

In order to introduce nematophagous fungi into practical animal management system fungi

must be capable of growing and trapping pre parasitic stages of nematodes in faeces following passage through the gastrointestinal tract of animals. Therefore, oral dosing trials are required, where spores of fungi growing on CMA medium are collected in water and fed to sheep infected with GI nematodes (predominantly *H. contortus*). Fresh rectal faecal samples are collected at di? erent time intervals. For each faecal collection, nematode egg counts are determined and faecal cultures are set up for estimating larval development in faecal cultures.

Among the local isolates of nematophagous fungi tested in our laboratory the isolate of *D. ?agrans* was found much more e? cient in surviving the gut passage than isolates of *A. oligospora.* Due to its ability to survive passage through the GI tract, to grow and to trap the developing larvae in deposited faeces (Larsen *et al.*, 1992; Sanyal, 2001; Khan *et al.*, 2002) *D. ?agrans* has been selected for BC of GI nematodes in ruminants. Research on *D. ?agrans* in sheep has been carried out throughout the world (Peloille, 1991; Larsen *et al.*, 1998; Faedo *et al.*, 2000; Chandrawathani *et al.*, 2003, 2004; Fontenot *et al.*, 2003; Khan *et al.*, 2001, 2002; Sanyal, 2000 a, b and c; Waghorn *et al.*, 2003; Waller *et al.*, 2004).

Formulation and implementation of suitable fungus

An important consideration in the implementation of BC through *D. ?agrans* is the development of a suitable device to deliver the fungus to the animals in such a way that they pass in the faeces along with the eggs of GI nematodes, where they germinate in close association with the free-living stages. Therefore, mass production of chlamydospores becomes necessary. Various cereal grains, viz., maize, wheat, sorghum, lupins and unmilled rice, could be used for the production of chlamydospores of *D. ?agrans* (Waller *et al.*, 2001 a). In India barley grains have been found suitable for the purpose (Sanyal and Mukhopadhyaya, 2003;Khan *et al.*, 2002) . Overnight soaked and sterilized barley grains were used.

D. ?agrans grown on sterilized barley grains

The easiest method of delivery is to o? er the grains supporting the growth of fungus. Feeding small quantities of grains supporting the growth of fungus resulted in the presence of fungus in faeces and subsequent reduction in the number of infective larvae recovered from faecal cultures (Larsen *et al.*, 1992; Gronvold *et al.*, 1993; Githigia *et al.*, 1997). However, feeding grains to sheep is not a regular practice in India and daily supplementary feeding for a long period of time may be expensive, di? cult and impractical.

In India supplementary feeding of concentrate feed is a routine ruminant husbandry practice, so deployment of fungal spores through supplementary feed may be ideal. Therefore, dried chlamydospores obtained from barley grain culture, were incorporated into the feed ingredients and pelleted in a pilot-scale pelletizer at NDDB, Anand (Anon., 2001). However, feeding trials with these feed pellets led to no reduction in larval recovery. Further desiccated chlamydospores were used as daily top dressing on feed given to sheep experimentally infected with *H. contortus* resulting into virtual elimination of larvae from both the faecal cultures and pasture (Sanyal and Mukhopadhyaya, 2003).

Barley grains supporting the growth of fungus had been incorporated into straw based complete feed block (CFB) at CSWRI, Avikanagar. These blocks had forage: concentrate ratio of 60: 40. Di? erent ingredients are thoroughly mixed using a horizontal mixer and then barley grains supporting the fungal growth are thoroughly mixed manually. The quantity of barley grains was adjusted in a manner that required dose of chlamydospores (about 6.0 million) was delivered in 400 g of CFB. Finally blocks of 20 x 20 cm size and 1.6 kg weight were made by applying a pressure of 5000 pounds / cm^2 using a horizontal complete feed block machine. Prepared blocks were kept in polythene bags and stored at room temperature.

In order to have continued e? ect of fungus, fresh batch of blocks were prepared after every 3 to 4 weeks keeping in view the shelf life of chlamydospores. A feeding and grazing demonstrated no signi? cant di? erence in FEC between the groups, but a concurrent declining trend during 3 to 7 weeks was observed in fungus treated animals than the control. It was observed that mean larval development was signi? cantly lower compared to control from day 1 to the end of the feeding. These observations showed that chlamydospores incorporated into CFB having very meager moisture content (11.7%), survived well when stored at room temperature.

Complete feed block incorporated with chlamydospores of *D. ?agrans*

The study demonstrated that block feeding might prove a potential means of delivery of *D. ?agrans* to sheep for successful biological control of GIN (predominantly *H. contortus*) at organized sheep farms.Another form of delivery device (fungal capsule) was developed and evaluated. Fungus was produced in bulk on soaked and sterilized barley grains. Chlamydospore suspension after washing from barley grains was lyophilized to get in powder form. About 5.42 g powder was obtained from one ? ask culture. The chlamydospore concentration was 10,000/ mg of powder. Each capsule was ? lled with about 400 mg powder having 4 million chlamydosores. Two sheep (about 5-6 month old), arti? cially infected with pure *H. contortus* were maintained indoors and used in the experiments. Animals were fed once a day for 3 consecutive days with 2 capsules delivering about 8 million chlamydospores. About 60% reduction was observed in larval development 1 day post inoculation (PI). Reduction in larval development increased to about 90% on day 2 and 3 PI. This was only an initial study demonstrating the practical feasibility of administering fungal chlamydospores to livestock when they are likely to be excreting nematode eggs. The results provided considerable encouragement but di? culty was felt in feeding capsules.

Chlamydospores of fungus *D. ?agrans*

Gelatine capsules containing sporesin powder form

The basic objective of an alternate, non-therapeutic method for controlling GI nematodes, such as BC, is to reduce the seasonal peaks in the larval availability on pasture rather than to eliminate the larvae. Therefore, certain points should be kept in mind while deploying *D. ?agrans.* The most important one is the timing of deployment. The fungus should be fed at the time when there is maximum availability of infective larvae on pasture. Hence to know the detailed epidemiology of GI Nematodes in the area becomes very important. In order to get best results timing of treatment is also very important and it should start just before an expected increase in

herbage larval number appears. The treatment period should be long enough to cover most of the anticipated average life expectancy (months) of adult parasites. By using right dose and time it should be possible to signi? cantly reduce the number of infective larvae on pasture resulting into the safe environment for young stock from heavy infection and disease. The treatment should be given daily otherwise it will result in an uneven shedding of fungal spores in the faeces of animals which will allow some eggs to develop to infective larvae in a faecal environment with sub optimal concentration of *D. ?agrans*.

References are available with the authors.

LEAD : AHM-04

Status of *Haemonchus contortus*infection in small ruminants

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Haemonchus contortus is probably the most relevant GIN nematode and represents about15% of all gastrointestinal diseases of small ruminants (FAO).*Haemonchus* spp. infection has been described widely as the most common and economically important strongyle nematode infection in sheep and goats (Swarnkar and Singh; 2012: Sharma et al. 2009; Okoye et al. 2013; Kandasami et al. 2013; Farooq et al. 2012; Brahma et al. 2015; Singh et al. 2015). The disease is more rampant and has been reported from all over the world where sheep and goats are reared a (Kandasami et al. 2013; Almalaik et al. 2008; Pathak and Pal 2008; Sutar et al. 2010; Singh et al. 2013; Swarankar and Singh 2012; Sharma et al 2009; Saiful Islam and Taimur 2008; Hossain et al. 2015; Odeniran, et. al. 2016; Futagbiet al. 2015). Haemonchosis is cause of serious production losses in small ruminantsin the form of lowered meat, milk and wool production. The prevalence of the disease is so serious that we cannot imagine the ideal management conditions where one can think of keeping the problem at way and losses free. The cost incurred on health management practices for Haemonchosis is quite high which includes regular pre and post monsoon deworming, pasture management along with labour.

Prevalence of *Haemonchus*spp. infection described varied in di? erent places and species. In goats and sheep the prevalence may be as high as 100 per cent over a period of time in monsoon season though it mayrange 24-70.0 percent as reported from various part of the world (Sutar et al. 2010; Pathak and Pal 2008; Singh et al.2013; Sharma et al. 2009; Okoye et al. 2013; Tefera et al. 2009;Badaso and Addis, 2015;Futagbi et al. 2015). Though *Haemonchus* spp. leads to abomasal infection but interestingly Bandhyopadhyaya et al. (2010) reported *Haemonchus contortus* prevalence in 76.8 percent cases from reticulum rather than in abomasum. The two livestock species have been reported to be signi? cantly di? erent in susceptibility (Badaso and Addis, 2015). Futagbi et al. (2015) described higher prevalence of *Haemonchus* infection in imported than in local goats in Ghana.

Further the prevalence of *Haemonchus*spp. infection in small ruminant is determined by various factors, both non genetic and genetic in nature. Haemonchosis, in sheep and goats, is reported more in monsoon season as compared to extreme hot or cold season (Pathak and Pal 2008; Katoch et al. 2000). The high humidity, in microclimate of faeces and the herbage, being essential for larval development and survival, was described to be the cause of frequent and severe outbreaks of GI nematode infection in rainfall season (Urquhart et al. 1996). Physiological states like pregnancy, age and lactation in animals were found to a? ect the faecal egg counts in *H. contortus* infected animals and thus the susceptibility their of (Yadav et al. 2008; Agrawal et al. 2010). Raza et al. (2014) a the higher prevalence of *Haemonchus* infection to short generation interval of this nematode along with high fecundity. Genetically, there are reports, there exists resistance within and between di? erent breeds of sheep and goats against *Haemonchus* contortus(Bishop and Morris 2007, Babar et al. 2013, Babar et al. 2015) which was regulated by immunological response against the infection. Chiejina et al. (2015) described West African Dwarf goat as haemonchotolerant.

Clinically acute haemonchosis in sheep and goats has been described with dark colouredfaeces with blood and sudden death of a? ected animals (Bhatia et al. 2010, Kandasami et al. 2013). Also there is report that *Haemonchus* spp. infection leads immunosuppression which predisposes the animals towards secondary infections (Kandasami et al. 2013).

Control of the gastro-intestinal nematodes particularly *Haemonchus contortus* and Trichostrongylus species is a prerequisite for pro? table small ruminant production (FAO). However, control of*Haemonchus* infection in small ruminant is still a challenge and it continues to cause serious production losses in small ruminant production system. Presently only e? ective way to control this infection is chemotherapy. But,it has been used so rampantly and indiscriminately in many goats and sheep rearing countries and there are various reports describing anthelmintics resistance from di? erent parts of the world.The situation is so grave that resistance in parasite has been described against all the available anthelmintics groups. This emphasizes the judicious use of these chemicals and in inevitable conditions only as no new drug for last more than three decade has been invented.Further, people awareness towards organic and chemical free animal products discourages the frequent use of such chemical anthelmintics and prompts scientists to work on non chemical approach for control of Haemonchosis and other gastrointestinalnematodes (GIN).

Non Chemical Approaches

Among non-chemical approaches, vaccination is considered the most potent and e? ective way to control Haemonchosis. However, we have yet to get breakthrough in developing a vaccine against *Haemonchus* infection and our approach so far has been based on hidden antigens (usually derived from the gastrointestinal tract of the adult parasite) or natural antigens (those exposed to the immune system of the host during the course of infection, usually derived from the infective larval stage). Though promising success has been observed with use of hidden antigens like H11 and H110D and more recently by using H-gal-P, another hidden antigen yet the natural antigen based vaccines are being considered be as natural challenge infection would act as booster in this case. A native antigen of *H. contortus* has been marketed (Barbervax®) and is widely used in Australia as vaccine. A Recent a with a recombinant form of a somatic antigen (rHc23) has been e? ective in resulting signi? cant reduction in faecal egg count (above 80%) and abomasal burden (above 70%) (Gonzalez-Sanchez et al. 2018). However, we have to go long way before a e? ective usable vaccine is available against this parasite.

Nutritional approach is also a potent, promising and most acceptable non-chemical wayto control the Haemonchosis in small ruminant specially in immuno-compromising states like pregnancy, lactation and growth. There are reports describing that supplementation with proteins, during these states, improves the serum immunoglobulin level and boost immune status of susceptible animals. Further, supplementation of goats in pregnancy has been found to a? ect peri-parturient rise of faecal egg count so that deposition of larvae on pasture is lowered and so also the establishment of infective larvae in GIT.

Genetic resistance of hosts

Genetic resistance is the ultimate in sustainable parasite control. It is a low-cost, permanentsolution requiring no extra resources and incurring no additional costs. However, for mostspecies of ruminant livestock, animals that have evolved to be highly resistant to parasiteinfection are not generously endowed with desirable productivity traits for wool or meatproduction. These innately resistant breeds are found in the tropics, where the formidablecombination of malnutrition, environmental stress, long-term and often massive larvalchallenge and limited relief by way of e? ective anthelmintic treatment have imposed theharshest conditions for selection, resulting in survival of the ? However, a arebeing made to identify those genes that encode parasite resistance in laboratory animalmodels. With the aid of comparative genomic maps, the aim then is to identify the locationsof similar genes in ruminants and to develop transgenic animals in which genes for resist-ance are inserted into economically productive breeds. Even with the more productive, butmore-parasite- susceptible, sheep breeds that have evolved in the temperate regions of theworld, within-breed selection for nematode resistance has made good progress. This applieseven to Merino sheep, which are generally considered to be the most susceptible of all breedsto nematode parasite infection. Irrespective of the bene? ts that have come from the use o genetics to control nematode infections, progress is likely to be slow (the generationinterval of livestock is long), controversial (if transgenic animals are used) and uncertain(there might be side-by-side evolution of parasites to changes in host genotype and/or aninverse relationship between resistance and performance). Predictive modelling will be avaluable tool in this endeavour.

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breeds.Investigations to detect quantitative trait loci (QTL) for nematode resistance or detect associations with candidates have been promoted in many countries

A new nonconventional approach in the form of predacious fungi is being seen as potential biological way to control GIN and specially the *H. contortus.* Some natural gut inhabiting fungi, *Duddingtonia, Arthrobotrys, Dactyleria, Verticillium*etc produce spores the chlamydospores having the capacity to pass through ruminant's gut unharmed and while growing in faeces on pasture they trap and kill the infective larvae of GIN. The method has been e? ective used in Danish conditions to reduce the infective larvae burden on pasture as well worm load in animals grazed on such pastures when such spores were fed to the animals. It has been con? rmed in France, United States, Australia and Mexico and e? ective delivery system in process of development which may be in the form of slow release bolus or molasses blocks.

Also some plants derivatives are being considered for control of *Haemonchus* infection. These plants are not used as animal food as such but if given as feed supplement the secondary metabolites in them reduce the establishment of infective larvae along with reduction in faecal egg count. In this case, the tannin is considered important. Initial studies in sheep showed that grazing leguminous crops rich in condensed tannin resulted in reduced levels of GI nematode infections. The main e? ect of dietary condensed tannins in both sheep and goats seems to be a reduction in fecal egg counts, often in the order of 50–60%, based on a combination of reduced worm fecundity and elimination of adult worms. The variable outcome of many studies using Neutraceuticals is probably related to many factors a? ecting the production (quantity and composition) of secondary metabolites in the crops: soil type, climate, season, cultivar, cu grazing, and so on. However, the approach is still under scanner and need to to be intensively investigated.

As *Haemonchus* spp. infection in sheep and goats has its origin from pasture, the management of pasture is considered a very e? ective way for controlling its infection. Ploughing the pasture, leaving it as fallow land and without grazing, pasture treatment with copper sulphate, rotational grazing on pasture etc are some e? ective ways to control the density of infective larvae and also restricting their availability to animals thus controlling the disease. Rotation of animal species on pasture grazing, specially with monogastric animals like horses and mules, cut short the load of infective larval load. However, in present Indian conditions where availability of pasture is limited and waste lands are dwindling, this approach has a limited scope and frequent visits of animals on limited available pasture is likely to expose animals to reinfection. However, the approach is cost e? cient and highly e? ective, particularly when combined with anthelmintic treatment.

A large and diverse range of herbal de-wormers is used throughout the world, particularly in Asian and African countries. However, there is lack scienti? c validation of the purported anthelmintic e? ects of these products. The considerable expanding interest is being seen worldwide in traditional health practices in both industrialized and developing countries of the world. Many plants such as *Ocimumgratissimum* (Pessoa et al., 2002), *Spigeliaanthelmia* (Assis et al., 2003), *Carica papaya* (Hounzangbe-Adote et al., 2005), *Azadirachtaindica, Caesalpinia crista, Vernoniaanthelmintica, Embeliaribes,* and *Ananascomosus* (HÖrdegen et al., 2006), *Melia azedarach* (Maciel et al., 2006), *Coriandrumsativum* (Eguale et al., 2007), *Ananascomosus, Annona reticulata, Cynodondactylon, Momordicacharantia, Nicotinatabacum* (Sujon et al., 2008), *Cucurbita moschate* (Marie-Magdeleine et al., 2009), *Butea frondosa, Allium sativum, Zingibero? cinale, Curcurbitamexicana* and *Ficusreligiosa* (Qadir et al., 2010), *Annona squamosa, Ecliptaprostrata,*

Solanumtorvum, Terminalia chebula, and *Catharanthusroseus* (Kamaraj and Rahuman 2011), *Calliandracalotyrsus; Gliricidiasepium*, and *Leucaenadiversifolia* (Wabo et al., 2011), *Euphorbia helioscopia* (Lone et al., 2012), *Annona muricata* L. (Ferreira et al., 2013), and *Eucalyptus staigeriana* (Ribeiro et al., 2013) have been tried as dewormer against *Haemonchus* and other GIN. But marketing of these products with a high level of e? cacy will inevitably be accompanied by regulatory requirements on residue levels and human safety. However, for resource poor farmers in developing countries, traditional herbal remedies based on local plants o? er an alternative to the expensive and often inaccessible commercial anthelmintics. Studies are now underway to evaluate some of the 'best candidates' used as livestock de-worming preparations by resource-poor communities in East Africa or Asia.

Sanitation and hygiene at animal farms as well as in their vicinity isimportant to limit the piling up the infection on one hand and restricting it availability to the animals on the other hand. Timely removal of excreta, soil bedding and disposing of to a distant and protected place, use of raised feeding and watering trough, raised and slated ? ooring with limited stocking rate etc are good management practices to control the haemonchosis. This approach is, is considered as best and most acceptable way to control GIN infections.

Chemical Approach

In spite of various e? ective and practical non-chemical approaches available we cannot rule out the *Haemonchus* or GIN infection in sheep and goats. In that case, use of chemotherapy becomes inevitable. This is more truefor control of parasitic stages present inside the body animals. However, resistance of *Haemonchus* and other GINs to the three groups of anthelmintics (benzimidazoles, nicotinic agonists, and macrolytic lactones) has become prevalent all over the world. Further, anthelmintic resistance (AR)is an expanding problem and is of major concern in many countries (Kaplan 2004; Sutherland and Leathwick 2011; Kaplan and Vidyashankar 2012; Torres-Acosta et al., 2012a; Geurden et al., 2014). This, however, enforces us to use these anthelmintics judiciously and in rare case so that they are usefulness and e? cacy could be maintained for longer period without resistance in parasites.

Treatment strategies that are employed to control *Haemonchus* and other GINs involve tactical, salvage and selective ways to use anthelmintics aprogram that involves treating the herd excessively are very much discouraged. Tactical treatment involves treating the herd based on environmental conditionssuch as weather (i.e. rain) which is likely to make the environment advantageous for the rise of parasite numbers. Tactical treatments might also be based on an increase in fecal egg counts or treating animals at the start of the grazing season, in the summer when parasite numbers are high, in the fall or winter after the ? rst frost, and when moving the animals to a “clean” pasture. The entire herd is usually treated to prevent disease. Salvage treatment involves treating the animals that are seriously a? ected by disease and usually show many of the symptoms of infestation including wasting away, rough coat, anemia, bo jaw and diarrhea. This treatment is usually done to save the life of the animal. Selective treatment involves treating only animals that are susceptible to parasite infection. Animals like females that are about to kid (2-4 weeks before kidding), young growing animals, and that are showing symptoms of infection based on visual observation or the FAMACHA© system are treated. Selective treatment probably the best program out of the three in the long-run because uses the least amount of anthelmintics by leaving some animals untreated while still maintaining a healthy herd. It is the best approach especially to slow the rise of anthelmintics resistance. A management plan that incorporates aspects of all three treatment strategies is recommended. One aspect of tactical

treatment that may be bene? cial is to closely observed the herd both visually and evaluate them using fecal egg counts or the FAMACHA© system when environmental or seasonal conditions are favorable to parasite development. Selective treatment involves making smart decisions based on a method of selecting individuals either by the FAMACHA© system, individual fecal egg counts, or another factor that may show symptoms of a parasite infection.

It is however necessary to monitor the anthelmintic resistance (AR)and look for slowing down its progress. The regular faecal egg count is necessary both pre and post treatment. A comparisonwould state the likely occurrence of AR. If a reduction of 90% or more in the egg count is not observed, resistance should be suspected. So also, the production performance of ? ock after deworming must improve in normal case, however, if ? ock shows no improvement in its production after deworming then AR can be suspected. There are also some laboratory based tests to detect the AR.Management practices to slow down the development of resistance should be incorporated at farm. Under dosing is one practice that may contribute the most to the development of resistance. It is extremely important that animals not be under-dosed. Dosage should be set according to the weight of the heaviest animal instead of the average weight of the herd. A veterinarian should be consulted to determine the proper dosage for goats since many anthelmintics are not approved for use in goats and goats usually require a higher dosage rate than sheep or cows. Rotation of the type of anthelmintic is another technique that should be employed as routine. Anthelmintics rotation slows the development of resistance by not allowing a population to build up a signi? cant tolerance or resistance to a particular anthelmintic and ensures that sensitivity remains high. It is important to not rotate anthelmintics less than on a yearly basis because a rotation scheme that is less than yearly may result in parasites that are resistant to multiple anthelmintics. New animals should be quarantine in a separate area for at least 4 weeks before they are introduced to the general herd to check entry of resistant parasites in herd. This allows the animals to shed the parasites that they might have picked up from their previous location. The animals should also be treated with anthelmintics from two separate classes of drugs while they are quarantined.

Conclusion

It is away from any controversy that control of *Haemonchus* in small is di? cult and almost impossible. However, our sincere and well planned e? orts can de? nitely overcome the losses caused by this parasite. Further, a strategic use of the available anthelmintics along with non-chemical approaches would be more appropriate to address the problem in holistic manner. Use of herbal dewormers can be e? ectively used to cut losses as well as pasture contamination at low level. Scienti? c developments in near future may, however, be looked to bring more e? ective ways to ? ght this devastating nematode in be and fruitful manner.

References are available with the authors.

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Goat Plague (PPR): A Threat to Small Ruminants

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Peste des petits ruminants (PPR) is a highly contagious and infectious viral disease of domestic and wild small ruminants. It is an economically signi? cant disease of small ruminants such as sheep and goats. It was ? rst described in Cote d'Ivoire in West Africa where it used to be identi? ed as kata, pseudorinderpest, pneumoenteritis complex and stomatitis-pneumoenteritis syndrome (Gargadennec and Lalanne,1942; Braide,1981). For many years it was thought that it was restricted to West Africa until a disease of goats in Sudan, which was originally diagnosed as rinderpest in 1972, was con? rmed to be PPR. The realization that many of the cases diagnosed as rinderpest among small ruminants in India may, instead, have involved the PPR virus, together with the emergence of the disease in other parts of Western and Southern Asia, signi? ed its ever-increasing importance(Lefevre and Diallo, 1990). The disease threatens food security and the livelihoods of smallholders and prevents animal husbandry sectors from achieving their economic potential.

Etiology

PPR is caused by the PPR virus that was assumed for a long time to be a variant of rinderpest virus adapted to small ruminants. However, studies based on virus cross neutralization and electron microscopy showed that it was a morbillivirus that had the physicochemical characteristic of a distinct virus though biologically and antigenically related to RPV. The development of speci? c nucleic acid probes for hybridisation studies and nucleic acid sequencing have proved that PPR virus is quite distinct from rinderpest virus(Diallo et al., 1989). PPRV is in the Morbillivirus genus of the Paramyxoviridae family(Gibbs et al., 1979). The virus has low resistance in the environment and it is highly sensitive to lipid solvents.Morbilliviruses are linear, non-segmented, single stranded, negative sense RNA, enveloped viruses with genomes approximately 15-16 kb in size and 200 nm in diameter (Norrby and Oxman, 1990).

Geographical Distribution

PPR is known to be present in a broad belt of sub-Saharan Africa, Arabia, the Middle East and Southern Asia(Shaila et al., 1996) .Major outbreaks in various countries including India in recent years have indicated a marked rise in the global incidence of PPR. Genetic relationship between PPR viruses isolated from di? erent geographical regions has been studied by sequence comparison of the F-protein geneFour lineages were revealed(Shaila et al., 1996;Dhar et al., 2002). Lineage 1 is represented by viruses isolated in Africa in 1970s. Lineage 2 which includes viruses isolated in the late 1980s in West Africa is the only African lineage that did not cross the Red Sea to the Asian countries. Lineage 3 is a combination of isolates from Sudan and Ethiopia. Lineage 4 of PPR virus isolates are the Asian isolates; Israel/1994, Iran/1994, Nepal/1995, Bangladesh/1993 and India(Shaila et al., 1996)and is con? ned to Asia. Recently, it was reported in Turkey (Ozkul et al., 2002). The presence of the two African lineages in Asia beside a distinct Asian lineage may be taken as indication of the trade route of spread of the disease.

Disease Transmission

Transmission requires close contact between infected animals in the febrile stage and susceptible animals because of the lability of the virus outside the living host(Braide, 1981).Introduction of PPR into a ? ock may be associated with any of the following: (a) history of recent movement or gathering together of sheep and/or goats of di? erent ages with or without associated changes in housing and feeding, (b) introduction of recently purchased animals; contact in a closed/village ? ock with sheep and/or goats that had been sent to market but returned unsold, (c) change in weather such as the onset of the rainy season (hot and humid) or dry, cold periods, (d) contact with trade or nomadic animals through shared grazing, water and/or housing, (e) a change in husbandry (e.g. towards increased intensi? cation) and trading practices(Roederand Obi,1999). Discharges from eyes, nose and mouth, as well as the loose faeces, contain large amounts of the virus. Fine infective droplets are released into the air from these secretions and excretions, particularly when a? ected animals cough and sneeze(Bundza el al., 1988; Taylor, 1984).It is suspected that infectious materials can also contaminate water and feed troughs and bedding, turning them into additional sources of infection (Lefevre and Diallo, 1990).

Host Range and Susceptibility

PPR is mainly a disease of goats and sheep. Goats are severely a? ected while sheep generally undergo a mild form (Lefevre and Diallo, 1990). Breed may a? ect the outcome of PPR virus infection and its epidemiology. The Guinean goat breeds (West African dwarf, Iogoon, kindi and Djallonke) are known to be highly susceptible(Lefevre and Diallo, 1990). Seroneutralization test for the presence of PPR antibodies detected 4.2% in 142 camels. PPR a? ect wildlife: American white deer was found to be susceptible(Hamdy et al., 1976), along with Dorcas Gazelles, Nubian Ibex, Laristan sheep and gemsbok. Antelope and other small wild ruminant species can also be severely a? ected(Abu Elzein et al., 2004).

Disease Occurrence

In general, morbidity is common, particularly in fully susceptible goat populations. Milder forms of the disease may occur in sheep and partially immune goat populations(Lefevre and Diallo, 1990). There are considerable di? erences in the epidemiological pa of the disease in the di? erent ecological systems and geographical areas. The susceptibility of young animals aged 3 to 18 months was proved to be very high, being more severely a? ected than adults or unweaned animals (Taylor et al., 1990).

Clinical Signs

PPR has a 2-6 day incubation period during which the virus replicates in the draining lymph nodes of the oro-pharynx before spreading via the blood and lymph to other tissues and organs including the lungs causing a primary viral pneumonia(Hamdyet al., 1976). The salient clinical signs start with sudden rise in body temperature to 39.5 - 41°C (Roeder et al., 1994). A clear watery discharge starts to issue from the eyes, nose and mouth, later becoming thick and yellow as a result of secondary bacterial infection (Hamdyet al., 1976). The serous to mucopurulent nasal discharge may crust over and occlude the nostrils and may lead to sneezing while the ocular discharges result in ma of the eyelids(Obi, 1984). One to two days after fever has set in, the mucous membranes of the mouth and eyes become much reddenedresulting in small pin-point greyish areas on the gums, dental pad, palate, lips, inner aspects of the cheeks and upper surface of the tongue (Hamdy et al., 1976;Lefevre, 1987; Taylor, 1984 and Roeder et al., 1994). A? ected animals breathe fast, sometimes so fast that they exhibit rocking movements with both the chest and abdominal walls (Roeder et al., 1994).Diarrhoea commonly appears about two to three days after the onset of fever.

The faeces are initially soft and then watery, foul-smelling and may contain blood streaks and pieces of dead gut tissue (Roeder and Obi, 1999). Due to diarrhoea, a? ected animals eventually become dehydrated with sunken eyeballs and death often follows within seven to ten days from onset of the clinical reaction (Hamdy et al., 1976). Body temperature usually remains high for about 5-8 days, and then slowly returns to normal prior to recovery or drops below normal before death. Some animals will recover after a protracted convalescence(Roeder and Obi., 1999).

Post mortem ? ndings

The carcass of an a? ected animal is usually emaciated, the hindquarters soiled with soft/watery faeces and the eyeballs sunken. The eyes and nose contain dried-up discharges. Lips may be swollen; erosions and possibly scabs or nodules in late cases.(Sco 1981). The nasal cavity is congested (reddened) lined with clear or creamy yellow exudates and erosions (Bundza et al., 1988). There are erosions on the gums, soft and hard palates, tongue and cheeks and into the oesophagus(Roeder and Obi, 1999).The lung is dark red or purple with areas ? rm to the touch, mainly in the anterior and cardiac lobes (evidence of pneumonia) .Lymph nodes (associated with the lungs and the intestines) are soft and swollen.Erosion in the oral cavity is a constant feature. Occasionally, there may be erosions on the pillars of the rumen. The omasum is a common site of regularly outlined erosions often with oozing blood (Roeder et al., 1994). . Abomasum is congested with lining haemorrhages (Bundza et al., 1988).Lesions in the small intestine are generally moderate, being limited to small streaks of haemorrhages and, occasionally, erosions in the ? rst portions of the duodenum and the terminal ileum. The large intestine is usually more severely a? ected, with congestion around the ileo-cecal valve, at the ceco-colic junction and in the rectum. In the posterior part of the colon and the rectum, discontinuous streaks of congestion termed “zebra stripes” form on the crests of the mucosal folds (Roeder et al., 1994).In the respiratory system, small erosions and petechiae may be visible on the nasal mucosa, turbinates, larynx and trachea. Bronchopneumonia may be present, usually con? ned to the anteroventral areas, and is characterized by consolidation and atelectasis (Hamdy et al., 1976).

Immunity

The surface glycoproteins hemagglutinin (H) and fusion protein (F) of morbilliviruses are highly immunogenic and confer protective immunity. Recovered sheep and goats develop solid immunity and are unlikely to be infected more than once in their economic life (Taylor, 1984). Lambs or kids receiving colostrum from previously exposed dams or those vaccinated were found to acquire a high level of maternal antibodies that persist for 3-4 months. (Libeau et al., 1992).The shedding of PPR antigens by recovered goats may explain how the disease is maintained between seasons of low incidence and periods of high incidence. It may also help to explain the phenomenon that introduction of new sheep or goats into healthy PPR recovered ? ocks often leads to fresh outbreaks of PPR (Obi, 1980).

Diagnosis

History and clinical signs enable a presumptive diagnosis to be made in endemic regions.Tentative clinical diagnosis may have to be con? rmed by laboratory analysis. Diagnosis of PPR may be performed by virus isolation, detection of viral antigens, nucleic acid sequencing and detection of speci? c antibody in serum.

Virus isolation

Samples for virus isolation include heparinized blood, eye and nasal swabs (from live animals), tonsil, mesenteric lymph nodes, spleen, section of colon and lung. For successful isolation, samples must be collected during the hyperthermic phase (Hamdy et al., 1976) and

submi to the testing laboratory in cold ice. The most widely used cell culture systems are primary lamb kidney and ovine skin(Gilbert andMonnier, 1962; Laurent, 1968, Taylor and Abegune, 1979) and Vero cells(Hamdy et al., 1976).Vero cells are however widely used for their continuity and low liability of contamination. Appearance of cytopathic e? ects (CPE) may require at least 8-10 days or several blind passages. In Vero cells, the cytopathic e? ects (CPE) produced by PPRV consist of cell rounding, clumping into typical grape-like clusters, formation of small syncytia and appearance of long ? ne often anastomosing "spindle cells". (Hamdy et al., 1976) Like other morbilliviruses, PPRV produces eosinophilic intracytoplasmic and intranuclear inclusion bodies both in primary cells (Laurent, 1968) and continuous cell lines(Hamdy et al., 1976). .Once isolated in cell culture, a candidate PPRV may be identi? ed by one of the three procedures: (a) animal inoculation: PPR causes clinical disease in goats and sheep but not in ca (Gibbs et al., 1979); (b) reciprocal cross neutralization (di? erential neutralization): PPRV is neutralized by both PPR and RPV reference sera, but is neutralized at greater titre with the homologous serum and(Taylor and Abegunde, 1979; Taylor, 1979); (c) molecular techniques: cDNA probe(Diallo et al., 1989a; Pandey et al., 1992), electrophoretic pro? le in polyacrylamide gel (PAGE) (Diallo et al., 1987)and PCR. (Barret et al., 1993; Forsyth and Barret, 1995; Couacy-Hymann et al., 2002).

Antigen detecting methods

*Agar Gel Immunodi?usion Test:*Agar gel immunodi? usion test (AGID) is widely used and can detect antemortem and necropsy specimens (Obi, 1984; Abraham and Berhan, 2001). It can be used to test the presence of both antigen and antibodies (Obi, 1984). One of the important advantages of this test is that it is highly speci? c, simple to conduct and easy to interpret.

*Counter immunoelectrophoresis:*Counter immunoelectrophoresis (CIEP) uses the same principle as the AGID except that the gel is electrically charged to improve the sensitivity of the test (Abraham and Berhan, 2001).*ELISA for antigen detection:*A monoclonal antibody-based sandwich ELISA was found to be highly sensitive in detection of antigen in tissues and secretions of infected goats. (Saliki et al., 1994).*Reverse transcription polymerase chain reaction (RT-PCR):*Other than the conventional serological techniques and virus isolation normally used to diagnose morbillivirus infection in samples submi for laboratory diagnosis, the polymerase chain reaction (PCR) has proved invaluable for analysis of ? eld samples. Since the genome of all morbilliviruses consists of a single strand of RNA, it must be ? rst copied into DNA, using reverse transcriptase, in a reaction known as reverse transcription polymerase chain reaction (RT-PCR). Currently a quantitative PCR (qPCR) also termed real time PCR is available (Light Cycler Probes). Quantitative PCR or real time PCR allows detection of the accumulation of PCR products during the ampli? cation process in real time. This enables quanti? cation of the number of templates present in the original sample before the PCR reaction has been started. This has the advantage of monitoring the PCR reaction process in real time, precisely measuring the amount of PCR products per cycle, combining ampli? cation and detection and elimination of post-PCR interferences (Light Cycler Probes).

Serology

Many tests have been used for the demonstration of PPR antibodies in serum: virus neutralization test, agar gel di? usion test, immunoelectrophoresis and recently blocking and competitive ELISA.

Virus neutralisation test:

The virus neutralisation test (VNT) is sensitive and speci? c, but time-consuming and expensive. The standard neutralisation test is carried out in roller-tube cultures of primary lamb kidney cells or Vero cells when primary cells are not available. VNT is the most reliable test for

detection of morbillivirus antibodies.

cELISA:

Competitive and blocking ELISA based on monoclonal antibodies speci?c for N-protein(Libeau et al., 1995) and H-protein (Anderson and Mckay, 1994; Saliki et al., 1994; Singh et al., 2004) were developed for detection of antibodies in animal sera. The cELISA test can be useful for the screening of animals either naturally infected or vaccinated with a PPRV vaccine. It could also be used to di?erentiate infected animals from those vaccinated with F- and/or H-recombinant marker vaccines in areas where the virus is endemic. (Kang-Seuk Choi et al., 2005).

Control and prophylaxis

There is no speci?c treatment against PPR. Control of PPR in non-infected countries may be achieved using classical measures such as restriction of importation of sheep and goats from a?ected areas, quarantine, slaughter and proper disposal of carcasses and contact fomites and decontamination of a?ected premises in case of introduction.Control of PPR outbreaks can also rely on movement control (quarantine) combined with the use of focused ("ring") vaccination and prophylactic immunization in high-risk populations(Roeder and Obi, 1999).Homologous a PPR vaccine produces a solid immunity for 3 years. The PPRV homologous vaccine was found to be safe under ?eld conditions and it induced immunity in 98% of the vaccinated animals (Diallo et al., 1995). The availability of a homologous vaccine for PPR is fortunate since the use of rinderpest vaccine in all animal species has now been discontinued worldwide. The a homologous PPRV vaccine is now the only vaccine permi for use in sheep and goats to protect them against PPRV infections (Diallo et al., 2007).

Economic Importance of PPR

The PPR epidemics can cause mortality rates of 50-80% in naive sheep and goats populations (Kitching, 1988). Due to the confusion with other diseases, the economic impacts of PPR are probably underestimated, but it is believed that PPR is one of the major constraints of small ruminant farming in the tropics (Taylor, 1984). The economic losses due to PPR alone in India have been estimated annually to 1,800 million Indian Rupees (39 million US$) (Bandyopadhyay, 2002). The impact of peste des petits ruminants on livestock rearing communities is very huge and pushes many of them into poverty. In a particular ?ock, the risk of outbreak is greatly increased when a new stock is introduced or when animals are returned unsold from livestock market. If all countries can embark on comprehensive vaccination targeting over 50% of their small ruminant population, then the disease can be wiped out following the recommendations of OIE/FAO by the year 2030.

Eradication Programme

It is expected that the control and eradication of PPR will improve incomes from small ruminant husbandry systems and lead to their improved pro?tability and productivity. In 2013, the OIE and FAO jointly decided to embark upon the control of PPR on a global scale and develop a 'PPR Global Control and Eradication Strategy', with a strong willingness to address the animal health problems in a systematic way through approaching horizontal as well as more disease-speci?c issues. The strategy recognizes that situations and contexts can be very di?erent between and even within countries. Consequently, the proposal is to begin by controlling the disease in areas where it is highly endemic and then to consolidate these control e?orts by concentrating on areas where a low endemic level has been reached and where eradication is a feasible objective or is already underway. For countries already free of PPR, the Global Strategy is designed to maintain this status. The duration of each stage is variable and will depend on the context. (PPR Eradication

strategy, 2015).

References are available with the authors.

ABS (ORAL) : AHM-01

Implications of *Pest DesPetits Ruminants* on Small Goat Farms in Gangetic Plains

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Pest des Petits Ruminants (PPR) commonly called as *goat plague* is a viral disease caused by Morbillivirus in the family of Paramyxoviruses, which is related to rinderpest (RP), measles and canine distemper (CD). In Bihar many outbreaks of PPR are reported in goats from time to time from di? erent districts mostly presented by farmers associated with mixing of new stocks, transportation and other stress factors. PPR having great potential to cause heavy economic losses to farmers due to very high mortality and associated production limitation post outbreak among survivors. The goats are mostly reared by weaker section of the society, except few organised goat farms. A study of three years was undertaken to explore and record the sero-prevalence of PPR and incidence of clinical disease outbreak in goats of all the four agro-climatic zones of Bihar. Later a pre-tested questionnaire were taken up to record socio-economic aspect of the disease in eight villages of four district of Bihar covering all the four agro-climatic zones. The overall average prevalence of PPR in Bihar was 34.39% with range of 27.08% to 48.84% in di? erent districts. Sero-surveillance of PPR antibody indicated very low prevalence in kids of age group <5 months. Highest circulating PPR antibody was recorded in non-pregnant goats. There was non-signi? cant di? erence between male and female goats. Further analysis based on group discussion, primary data recorded from farmers and secondary data retrieved, indicates heavy economic losses due to *Pest des petits ruminants* infection. An average loss of Rs.1283.00 per a? ected goats has been estimated due to this disease infection. The major loss 37.35% found out in PPR is due to mortality of the animal. Higher economic loss and mortality suggests the signi? cance of this disease among weaker section, needs preventive measures in Bihar.

ABS (ORAL) : AHM-02

Exploration of acaricide resistance status in *Hyalomma* ticks from an unorganized ? ock of Sheep

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*Hyalommaanatolicum*is an ectoparasite a? ecting sheep,mostly found in ear and vulval region and considered as the most important obstacle insheepmanagement. In integratedtick management program, the controlmeasures varied from manual removing of ticks from the sheep to application of chemical acaricides. Acaricide resistance is a major problem that hinders the control of the ticks in Gujarat. In view of the increasing reports of acaricidal resistance in di? erent ticks, a study was designed to evaluate the e? cacy of Deltamethrin and Cypermethrin using larval packet test (LPT) against *H.anatolicum*collected from sheep ? ock.Results of LPT revealed that deltamethrinat 25 ppm induced 100 percent mortality of tick larvae, whereas cypermethrin induced 100 percent mortality at 300ppm. The results of the current study state that deltamethrin and cypermethrin were e? ective on larval stages of *H. anatolicum*from sheep at its recommended dosage.This could be probably due to slower development of acaricide resistance in multi host ticks due to the longer generation interval and less exposure to these chemicals.

ABS (ORAL) : AHM-03

Prevalence of ? uke infestations in sheep ? ocks of Rajasthan

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Small ruminants are infectedwith several gastrointestinal helminths such as nematodes, trematodes and cestodes. Among trematodes, ? ukes (rumen, liver and blood) are found both in tropical and sub-tropical climates causing a deleterious impact on livestock production. A long-term study (2004-2018) was conducted to establish prevalence pa of ? ukes in sheep ? ocks reared in two di? erent agro-climatic regions of Rajasthan with the purpose to chalk-out suitable strategy for their management. A total of 89112faecal samples (32261 from arid and 56851 from semi-arid region) were collected *per rectum* from adult sheep and examined for ? ukes by sedimentation technique. The same ? ocks were monitored for at least three years at monthly interval.

Among three types of ? ukes an overall prevalence was maximum (6.08%) for *Paramphistomum* spp. followed by 0.19% for *Schistosomaindicum* and minimum (0.03%) for *Fasciolagigantica.* A signi? cant in? uence of agro-climatic region was seen for *Paramphistomum* spp. and *S. indicum* with higher incidence in semi-arid region (8.66 and 0.22%) compared to arid region (1.51 and 0.12%). Irrespective of regions, the annual prevalence rates for all the three types of ? ukes exhibited signi? cant variations and varied from 1.69 to 9.70% for *Paramphistomum*spp, from 0.02 to 1.73% for *S. indicum* and from nil to 0.12% for *F. gigantica.* On comparison of annual prevalence of *Paramphistomum* spp. for two agro-climatic regions, signi? cantly higher incidence was observed in sheep ? ocks of semi-arid region (2.37 – 15.64%) compared to ? ocks of arid region (0.10 – 3.48%). The in? uence of agro-climatic region on annual prevalence rates of *S. indicum*was inconsistent with relatively higher magnitude in semi-arid region on majority of years.The prevalence (overall as well as region-wise) of all the three ? ukes was found to be in? uenced signi? cantly by month and season. For *Paramphistomum*spp, the overall monthly prevalence varied from 0.15% (Nov) to 16.60% (Jul).

Almost similar pro? le of *Paramphistomum*spp, were observed in both the agro-climatic regions with signi? cantly higher magnitude in semi-arid region in all the months (except in Nov) compared to arid region. The seasonal prevalence was maximum during monsoon and minimum during winter. The occurrence of *F. gigantica* was sporadic in arid region as compared to regularity (though at low level) in semi-arid region. The monthly pro? le of *S. indicum*exhibited signi? cantly higher prevalence (>0.20%) from May to August in arid region and from July to October in semi-arid region. A signi? cant e? ect of agro-climatic region on prevalence of *S. indicum* was noticed only during monsoon season with higher incidence in semi-arid region (0.59%) as compared to arid region (0.25%).The study suggested that the ? uke infections are present in endemic pa in sheep ? ocks of Rajasthan (particularly in semi-arid region) and deserves serious a Therefore, it is important to obtain detail epidemiological investigation with regard to the host parasite relationship, available snail species which will aid for further control and prevention strategic development.

ABS (ORAL) : AHM-04

Mortality pa

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Mortality pa was analysedin an organized sheep farm of TANUVAS, Tamil Nadu. In the study period of one year from April 2017 to March 2018, the farm had average young stock of219 sheep and adult stock of 365 sheep. Overall survivability for the year was 97.71% in young and 99.45% in adults. Mortality numbers for di? erent age groups and their percentage were 0-3 months – 17& 3.37; 3-6 months – 6 &1.95, 6-12 months – 1& 0.43 and adults – 3& 0.55. Overall mortality numbers and percentage were 27& 1.7%. Month wise particulars revealed more incidence in April 2017 (10), followed by January 2018 (5) and June 2017(4). This did not reveal any pa corresponding with the season. Causes of mortality were predominantly pneumonia (8 numbers; 29.63%), followed by enteritis (5 numbers; 18.52%), poor birth weight (3 numbers; 11.11%) and ruminal impaction (3 numbers; 11.11%).
Various other causes contributed 5 numbers (18.52%). Pneumonia and enteritis were recorded more in young than adult animals indicating their vulnerability, in spite of treatment. Ruminal impaction due to polythene bags was noticed and necessary corrective measures have been undertaken. This type of analysis will help to take up necessary precautions and minimize the future loss.

ABS (ORAL) : AHM-05

Mapping of diseases prevalent in goats of Muza? arpur, Bihar based on focused group discussion with goat rearers and their personal interviews

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The mapping of goat diseases was performed in association of Aga Khan Foundation. The study was conducted in four blocks namely Sakara, Mushahari, Muraul and BochahaninMuza? arpur district, Bihar. It was observed during the study that female from weaker section of society were mostly involved in goat rearing and uplifting their economic condition. For this study the goat rearers were selected randomly from all the panchayats of the four blocks under study and information were gathered by focussed group discussion (FGD) and personal interview (PI) of goat rearers. Based on FGD & PI the distribution of Peste des petitsRuminants (PPR), Enterotoxaemia (ET), blue tongue (BT) and diarrhoeal cases were investigated in these blocks. A total of 60 FGD were conducted at di? erent places and 600 personal interviews were conducted. The analysis of data indicated that maximum numbers of death in goat were occurring due to PPR among all the important infectious diseases. This is followed by cases of Enterotoxaemia and Blue tongue. The study also indicated that maximum number of diarrheal cases was reported during the winter month while the cases of PPR were reported throughout the year. Mortality, vaccination and deworming pa in di? erent blocks of Muza? arpur depicted maximum mortality in Mushahari block where animal vaccination status was found meagre, moreover, the deworming seems to be satisfactory. Therefore it was concluded that the mortality reported in the goats were probably due to lack of vaccination against the common infectious diseases like PPR,ET,BT. It was further suggested that educatinggoat keepers to adopt improved managemental practices with proper housing and nutritional management will minimise animal losses due toinfectious diseases and will also improve the productivity and thereby pro? tability of farmers.

ABS (ORAL) : AHM-06

Isolation and Molecular Characterization of *Escherichia coli* O157:H7 from Sheep and Goats

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E. coli O157:H7 is an emerging food borne pathogen having zoonotic importance. Though the primary reservoir of this serotype is ca sheep and goats are also considered as main reservoir for *E. coli* O157:H7, which act as asymptomatic carriers. Conventional cultural methods are time consuming to detect *E. coli* O157:H7 in food borne outbreaks and have less speci?city and sensitivity. Multiplex PCR (mPCR) tends to be speci?c, more rapid and reliable. In the present study, faecal samples collected from sheep (n=517) and goats (n=450) from di?erent farms across North East Karnataka region during the period June 2016 to August 2017 were analysed. The samples were processed and analysed for the cultural isolation, biochemical characterization and latex agglutination test. An mPCR method for the detection and molecular characterization of *E. coli* O157:H7 was standardized using primer pairs targeting six speci?c virulent genes; *?iCh7*, *eaeA*, *r hly*, *stx1*, and *stx2*. The mPCR produced species-speci?c amplicons of the six targeted genes of the size; 625 bp, 397bp, 296 bp, 166 bp, 210 bp and 484 bp, respectively. In this study, mPCR was taken as con?rmative diagnostic test and the results obtained by cultural isolation, biochemical characterization and latex agglutination test were compared with that of mPCR to estimate the sensitivity and the speci?city.The percent of sheep and goats that showed shedding of *E. coli* O157 in the faeces was 3.86% (20 out of 517) and 2.88% (13 out of 450) respectively.The results obtained show that the standardized mPCR protocol is a rapid, highly sensitive, species-speci?c and reliable method for the detection of the pathogenic *E. coli* O157:H7 and could be used for identi?cation and molecular characterization of *E. coli* O157:H7 in suspected food and water borne outbreaks, disease investigations and routine analysis *etc.*

ABS (ORAL) : AHM-07

Management of Anthrax in Sheep and Goats

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Athrax is one of the oldest threats to humankind and remains endemic in animals in many parts of the world. Sixteen outbreaks of anthrax in ovines were recorded in (Kurnool-7, Nellore-3, Kadapa-3 and Ananthapur-3) Andhra Pradesh with 177 a and 168 deaths with an economic loss of Rs. 5,04,000/- due to death of 168 sheep. Sudden death, bleeding from ori?ces, subcutaneous hemorrhage, without prior symptoms or following a brief period of fever and disorientation should lead to suspicion of anthrax. The combined e?ect of antibiotics, vaccination and disinfectant were studied in acute and per acute anthrax a in 750 sheep and goats during 2017

and 2018, reported from the villages of Kadapa, Anantapur and Chi districts and found that the integrated management was highly e? ective and long lasting. Acute and per acute cases of anthrax reported during 2017 to 2018, to Sreepathi agencies, from Chi Anantapur and Kadapa districts, numbering 670 and 120 sheep and goats, respectively, were subjected to antibiotic therapy, vaccination with anthrax spore vaccines and spraying of sporicidal disinfectant. The antibiotics selected were one short acting antibiotic A C Vet Max (Intas Pharmaceuticals) and the other long acting Invemox LA, (Alivera animal health ltd). The vaccine is a spore vaccine fromIAH&VB, Bangalore and the Sporicidal agent, BioKleen (Neospark Drugs and Chemicals Private Ltd). Both short acting AC Vet Max and long acting Invemox 15% LA have proved their e? cacy, by controlling the mortality due to their speci? c action. The disinfectant BioKleen, proved e? ective due to the potent Sporicidal action as there were no subsequent Outbreaks in the following two years. The combined e? ect of antibiotics, vaccination and disinfectant were studied in acute and per acute anthrax a in 750 sheep and goats during 2017 and 2018, reported from the villages of Kadapa, Anantapur and Chi oor districts and found that the integrated management was highly e? ective and long lasting and there were no subsequent a during those two years.

ABS (ORAL) : AHM-08

Investigation of neonatal mortality and its causes at an organized sheep farm in Rajasthan

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Lambs survivability is an important issue in sheep ? ocks with average 9 to 20% lamb mortality rate in the most sheep producing countries, representing an important economic loss for farmers. In lambs, neonatal period is the most critical phase for lamb losses. Neonatal mortality is death of newborn lambs during the ? rst 28 days of life and includes (a) death during the ? rst week of life (hebdomadal) and (b) death subsequently to the ? rst week and until the 28 th day of life (Post-hebdomadal). In the present study the causes of death were ascertained on post-mortem examination and diseases / causes were grouped as non-speci? c (systemic), speci? c and lesion obscured as per disease data information system developed at ICAR-CSWRI, Avikanagar. The data from native, (Malpura, Patanwadi), crossbred (Avikalin) and proli? c (Garole, Kendrapada, GMM and Avishan) breeds at ICAR-CSWRI, Avikanagar were used for real-time assessment of neonatal mortality. During the period from April 2014 to March, 2018 a total of 5249 lambs born alive formed the base of study. The average overall annual neonatal mortality was 2.84%. The overall contribution of pre-weaning mortality to neonatal mortality was 61.4%. Among neonatal phase, 59.2% deaths were in 0-7 days old lambs (hebdomadal phase). Within hebdomadal phase an inverse relation was observed between mortality rate and age of lamb. Overall the a? ections of respiratory system (predominated by septicaemia) accounted for maximum (31.93%) deaths followed by septicemia (21.98%), neonatal inanition (12.15%), a? ections of alimentary system (11.25%) and mineral de? ciency syndrome

(4.26%). Higher contribution by a? ections of respiratory system and septicaemia was observed in all the stages. In addition, neonatal inanition was main contributor in 2-3 day old lambs. The contribution of exposure-inanition syndrome (debility, exposure and inanition) was signi? cantly higher in lambs of 0-1 day old lambs.

On histopathology, the lung a? ections were classi? ed as acute interstitial pneumonia (15), acute ? brinous bronchopneumonia (25), chronic ? brinous bronchopneumonia (11), suppurativebroncho pneumonia (14) and acute pulmonary congestion (9). On bacterial culture of lung tissue and heart blood *Pseudomonas aeruginosa, Alcaligenesfaecalis,Pasteurellamultocida,Enterobacteraerogenes, Morganellamorganii, Brevundimonasnejansanesis, Acinetobacterindicus, Kocuria sp., E. coli, Staphylococcus aureus, Morganellamorganii* and *Streptococcus* sp. were isolated and identi? ed by cultural characteristic, biochemical test and 16s rRNA PCR. On PCR examination of 41 pneumonic lung tissues, infection of *P. multocida* (*KMT-1* gene) and *M. haemoltica* (*PHSSA-1* and *RPT-2* gene) was identi? ed in one and six lambs, respectively. From faecal samples of 34 diarrheic lambs, bacterial isolates including *E. coli, Salmonella* sp *Klebsiella*sp, *Enterobacter* sp, *Pasteurella*sp, and *Acinetobacter*sp were isolated and identi? ed. The aborted/still born fetuses received for post mortem examination were targeted for detection of causes like *Brucella, Chlamydia* and *Toxoplasma* infections. The tissue samples like placenta, naval cord, spleen and liver were tested by PCR. Out of 44 DNA samples examined, none was found positive for *Brucella, Chlamydia* and *Toxoplasma* infection on PCR. A total of 627 faecal smears from lambs were observed for the presence of *Cryptosporidium* oocysts and none were found positive for cryptosporodial infection. On PCR examination out of 17 DNA samples examined, six samples were found positive for cryptosporodial infection.

ABS (ORAL) : AHM-09

Impact of shed disinfection on gastrointestinal disorders and mortality of Salem Black kids

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The study was carried out in Mecheri Sheep Research Station, Po The period of kid mortality was taken from 2013-2018. Total of 289 kids born during this period were considered for the study. Out of 289 kids, 51 kids had died during the period of study. The major causes for mortality were enteritis- 35.3% (18), coccidiosis– 21.6% (11), pneumonia – 11.8% (6), polioencephalomalacia – 7.8% (4), neurological disorders- 7.8% (4), poor birth weight- 5.9% (3) and other causes – 9.9% (5). It was observed that the gastrointestinal disorders caused huge impact on mortality of young kids- 56.9% (29). To overcome the gastrointestinal disorders, special consideration was given to prevention by management practices i.e. sheds were disinfected with glutaraldehyde, lime powder and bleaching powder. After that, less mortality has been observed in young kids. The conclusion of the study was that the most common cause for mortality in young kids was gastrointestinal disorders which can be controlled to a great extent by management practices like disinfection.

ABS (ORAL) : AHM-10

Sheep rearing practices and common diseasesin Jammu and Kashmir

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Sheep rearing is a major source of livelihood for poor farmers. Nomadic tribes such as Gujjars, Bhakerwals, Changpas rear sheep in Kashmir Valley, Jammu and Ladakh. The state hassheep husbandry, animal husbandry departments and agricultural universities to cater to the needs of the farmers. Vaccination coverage for sheep is provided by the state. Cases of Listeriosis at Dachigam Sheep breeding farm and foot rot at Traal were noticed. In case of Listeriosis, out of a total of 198 lambed ewes, 134 were live, 42 still births and 13 dystocic. One thousand sheep su? ering from foot rot were found in Traal. Trimming of hooves, application of povidone iodine locally and oxytetracycline parenterally were e? ective. Plant poisoning cases were also found in Traal and adjoining areas. Dwindling forage quality and coverage are areas of concern.

ABS (ORAL) : AHM-11

Antioxidant and calculolytice? ect of Lycopodium in male goats su? ering from obstructive urolithiasis

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The present study was conducted to observe the e? ects of Lycopodium to augment the antioxidant e? ects and dissolution of uroliths in male goats. Twelve male goats su? ering from partial urinary retention due to obstructive uroliths were randomly divided into two groups A and B with six animals each. In groups A and B urethral process amputationand urohydropropulson has been done while in group B homeopathic drug Lycopodium 200 potency incorporatedorally for three days. In both groups the ammonium chloride @ 450 mg/kg body weight has been given orally twice daily for 10 days. The haemato-biochemical parameters like PCV, Hb , Magnesium, Sodium, Protein, creatinine and Blood urea nitrogen value were increased but value returned towards normal range on recovered goats. The comparative studies showed that normal ? ow of urine started earlier in animals of group B which were incorporated with lycopodium. The Lycopodium was found to be e? ective drug for dissolving stones, when used in combination of

ammonium chloride. Decreased value of MDA along with increased value of SOD and catalase were observed in recovered animals in group B which showed the less oxidative stress. So, Lycopodium can be recommended for dissolution of urethral calculi in goats

ABS (ORAL) : AHM-12

Surgical management of ventral abdominal herniation of gravid uterus in a Doe

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Hernia is a protrusion of the contents of the body cavity through a normal or abnormal opening in the wall of abdominal cavity either to lie beneath the intact skin or occupy another adjacent body cavity.Severe trauma on abdominal wall, violent force or injury originated by blunt object, horn thrusts in ca kick in camel, abscess in abdominal wall, over stretching or straining of abdominal muscle due to pregnancy and partition causes weakness of the abdominal musclethat may lead to ventral hernias. It is mostly occurring in pluriparous animal at advance pregnancy in case of multiple foetus, which lead to fragility of abdominal muscle or prepubis tendon.A goat with the history of excessive enlargementof ventral, abdominal wall and udderduring advance pregnancy presented to the clinical complex at BVC patna-14. The owner claimed history of prolongedgestation periodwith anorexia and discomfort.Physical examination and USG con? rm ventral abdominal hernia due to gravid uterus with live foetuses and decided to deliver the foetuses through caesarean section. After aseptic preparation of surgical site right side of abdomen,anterior spinal analgesia wasperforming by using2% lignocaine. After skinincision gravid uterus was exteriorized and incisionwas made at grater curvature of uterus. Two live kids were delivered successfully through caesarean section. The uterine incision repaired in routine manner, the defect of the abdominal muscle was repaired with polyamide black using cross ma suture pa and subcutaneous and skin sutured in routine manner. A standard post operative protocol was followed and animal fully recovered in 8 days.

ABS (ORAL) : AHM-13

Congenital Goitrein Jamunapari Kids

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Congenitalgoitre is a clinical condition observed in newborns at the time of birth and it is

characterized by abnormal enlargement of thyroid glands, stunted growth, alopecia, thickened skin and very commonly death. In this paper, four cases of inherited goitre in Jamunapari breed of goats are presented.In a closely inbred herd of Jamunapari breed of goats,out of thirteenkiddingsfour singleton kids (30.7%) were born with enlarged thyroids. Three kids died in the ? rst hour of the kidding. Survived kid showed outward bowing of knee, sluggish a and dysphagia and died aged two months. All the born fetuses were fully grown with general alopecia, enlarged thyroid with intact ventral a andhigh vascularity of thyroid glands. The weight of the thyroid varied from 11.8 g to 208.6 g. Microscopically the thyroid gland showed hyperplastic type of goiter. There was hypertrophy and hyperplasia of lining follicular cells of the thyroid, with the formation of small papillary growths into the lumens of the follicles which contained li or no colloid. The lining epithelial cells were cuboidal containing deep acidophilic cytoplasms. Few follicles contained intensely stained colloid which was vacuolated and such follicles were interspersed between hyperplastic type follicles. In the same rearing conditions, Black Bengal goats were also maintained in the unit but such cases of goiter was not reported in that ? ock. The ? ock history of the a? ected Jamunapari herd revealed that it was a closed ? ock and no new bucks were introduced from outside the ? ock. The resulting inbreeding might be the possible cause of this incidence of congenital goiter in this ? ock of goats.

ABS (ORAL) : AHM-14

PPR Outbreaks and its Management in Black Bengal goats and PPR associated Reproductive Disorders in Bihar

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Outbreaks of Peste des petits ruminants (PPR) viral disease in Black Bengal goats were investigated from di? erent districts of Bihar. Clinical pro? le of PPR-a? ected ? ocks was recorded from four di? erent outbreak sites of the region. The clinical PPR disease outbreak was diagnosed based on clinical symptoms, disease history and serologically using commercially available sandwich ELISA kit. Relatively, low mortality rate (mean 26.75%) for PPR outbreak was recorded due to the endemic status of the disease in the state. Lower mortality rate was also recorded due to e? ective management of PPR outbreak cases using ? uid and electrolyte therapy and e? ective therapeutic regimen to control pneumonia and diarrhoea. The correlation of oxidative stress due to PPR and the resulting reproductive disorders in the female goats were evaluated. The abortion in pregnant does observed during PPR outbreak was proportional to debility and oxidative stress

manifested during PPR infection. The reproductive performance of recovered female goats in the period of 18 months of monitoring was signi?cantly compromised in terms of kidding and twinning frequency. The mortality rate in kids born from PPR-recovered goats was signi?cantly higher compared to those from health goats in the ?rst 9 months post-recovery. From the present study, it may be concluded that together with the PPR virus, infection in goats and the resulting oxidative stress play a vital role for abortion and reduced post-reproductive performance in Black Bengal female goat.

ABS (ORAL) : AHM-15

Seroprevalence of Bluetongue in Goats in Northern districts of Bihar

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Bluetongue is a vector borne viral disease, transmi by *Culicoides spp.* and a?ects multiple species. It most commonly a?ects sheep and wild ruminants. Goats and ca are also a?ected but clinically the disease remain subclinical or inapperent.The study was undertaken to assess the sero-prevalence of Bluetongue in goat rearing northern districts of Bihar. A total of 289 sera samples were collected randomly from goat population of Darbhanga, Madhubani, Supaul, Saharsa, Madhepura, Araria, Kishanganj, Purnea andkatihar districts of Bihar. Anti-BT antibodies were screened using Enzyme linked immunosorbent assay (ELISA). Out of the total 289 samples screened, 63.32% of goat sera samples were positive for BT antibodies. The highest seroprevalence of 75.55% was recorded from Katihardistrict whereas with 25.00 % sero-positivity Darbhanga district recorded the lowest sero-prevalence of Bluetongue.The three northeastern districts of Bihar i.e, Katihar, Kishanganj and Araria recordeda very high sero-prevalence of 75.56%, 74.29% and 52.38 respectively whereas Darbhanga, Suapaul, recorded sero-positivity of 25.00% and 36.36%, respectively.Thevery high sero-prevalence of bluetongue recorded in these districts indicates quite high circulation of Bluetongue virus in goat population of this region.

ABS (POSTER) : AHM-01

Management of urolithiasis in male goat using homoeopathic medicine Lycopodium

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The present study was conducted to observe the e? ects of Lycopodium to augment the dissolution of uroliths in male goats. Twelve male goats su? ering from obstructive urolithiasis randomly divided into two groups A and B with six goats in each group. In group A goats were treated by tube cystostomy while group B goats were treated by tube-cystostomy along with homeopathic drug Lycopodium 200 potency (orally for three days). Ammonium chloride treatment @ 450 mg/kg body weight orally twice daily for 10 days and amputation of urethral process have been performed in both groups. The comparative studies showed that normal ? ow of urine started earlier in animals of group B which were incorporated with lycopodium. The Lycopodium was found to be e? ective drug for dissolving stones, when used in combination of ammonium chloride. Biochemical assessment shows signi? cantly ($p<0.05$) decrease in Malondialdehyde (MDA) concentration along with signi? cantly ($p<0.05$) increase in Superoxide Dismutase (SOD) and catalase activity group B compare to group A. So, Lycopodium along with ammonium chloride can be recommended for dissolution of urethral calculi in uremic male goats.

ABS (POSTER) : AHM-02

Acaricidalbio-e? cacy of fractional extracts of *Spilanthes acmella* leaves against Hyalomma *anatolicum* (Koch) tick

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Heavy tick infestation on animal causes discomfort and annoyance which, apparently a? ecting milk /meat production and weight loss. Moreover, tick-borne diseases continue to be a serious animal health problems causing major economic loss to farmers. Chemical acaricides such as synthetic pyrethoids, organophosphates and some injectable compound such as ivermectin and doramectin are frequently used for control of ticks and as consequences of repetitive use, results

resistance in parasite and environmental pollution. Plants products o? er a best alternative over synthetic acaricides as they are ecofriendly biodegradable and cost e? ective. In this investigation , e? cacy of Petroleum, Hexane and Methanol extracts of *Spilanthes acmella* leaves was studied against the adult engorged female. Comparatively with highest e? ectiveness was recorded in Petroleum ether extract with the LC_{50}values of 769.48+ 114.81ppm (994.48 and 554.43ppm upper ? ducial limits and lower ? ducial limits) , whereas the Hexane extract exhibited LC 50 value of 3875.28+ 265.19(4395.06 and 3350.15ppm upper and lower ? ducial limits) and least in methanol extract with LC50 value of 13343.71+1562.04ppm (16405.0and 10282.0ppm upper ? ducial limits and lower ? ducial limits). GCMS-MS analysis revealed the presence of N-Isobutyl-2(E),6(Z),8(E)dectrinimede compound in all these types of extracts . Details will be presented.

ABS (POSTER) : AHM-03

Prevalence of *Haemonchuscontortus*Infection in local Goats of Neemuch District, Madhya Pradesh

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The present communication deals with the Infection of *Haemonchuscontortus*in local goats. During 2015 to 2017, a total of 98 goats were diagnosed in villages of Neemuch district and out of these, 79 were found positive for Haemonchosis. The e? ect of age, breed, sex and season on the occurrence of Haemonchosis werestudied. Based on age total number of goats were classi? ed into three groups Group I (0-6 months), Group II (6-12 months) and Group III (>1 year). Mostly observed clinical signs and symptoms include anemia, generalized oedemain some cases submandibular edema (bo jaw),weight loss, and ill thrift condition. Con? rmatory diagnosis was done by faecal examination revealing presence of large number of Haemonchus eggs. The percentage of Haemonchosis was highest ingroup I (44%)followed by group III (18.98%) and group II (36.7%) with signi? cant di? erence ($p<0.05$). The di? erence between sexes was also signi? cant between male and female goats with incidence observed to be more (53.5%) in female (68%) when compared to male (31.6%).In the present investigation, highest percentage of infection (43%) wasrecorded in monsoon followed by post-monsoon (35%), pre-monsoon (7.5%)and winter (6.3%).After diagnosis treatment was initiated including deworming by anthelmintic drug following symptomatic treatment. Fenbendazole administered orally at the rate of 5mg/kg body weight, along with B-complex and iron preparation.The present study indicates that the Hemonchosis infection is prevalent in the area with age and sex di? erence with highest cases observed during monsoon and post monsoon season which can be prevented by regular following deworming of the animals before and after monsoon.

ABS (POSTER) : AHM-04

Epidemiology of diarrhea due to cryptosporidiosis in barbarigoats and kids

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Members of genus *Cryptosporidium* spp are obligate intracellular protozoan parasite which are known for causing diarrhoeal disease in wide range of hosts. In goats this is caused by the protozoan parasites *Cryptosporidium parvum* and *Cryptosporidium xiaoi*. Cryptosporidiosis is a well-known disease of neonatal kids. It causes neonatal kid diarrhea and incurs signi? cant production loss to the goat husbandry. It is one of the major health problem among the neonatal goats kids. Apart from mortality (up to 60%), cryptosporidiosis causes decline in productivity, retarded growth, decreased feed e? ciency, delayed maturity, loss of fertility and overall ? nancial loss in the form of treatment of ailing animals. The situation is further worsened by the lack of any vaccine against the disease and cumbersome diagnostic procedures. Control measures against this disease are not well de? ned due to the fact that normally used anti-coccidials and antibiotics are ine? ective against this organism. Goat cryptosporidiosis is a potential zoonosis. The infection can be life threatening in children and immuno- compromised hosts. It is impossible to devise a suitable control strategy without evaluating scienti? c data on epidemiology of *Cryptosporidium* spp. causing cryptosporidiosis in goats. Therefore, the present study was undertaken with the aim to assess the epidemiology of the disease under farm condition in semi arid region of India.
Faecal samples were collected (n = 461) were collected from barbari goat kids once per week, were brought to the laboratory and was subjected to normal saline sedimentation. Finally, faecal smears were made and the smears were stained using modi? ed Ziehl-Neelson technique and observed under microscope. *Cryptosporidium* spp. oocysts were seen as pink/reddish pink spherical bodies against green background. The incidence of cryptosporidiosis was 57 % (263/461) based on the presence of oocysts in stained faecal smears. Highest incidence was recorded in 0-1 month old kids (72 %) followed by 1-2 month old kids (56 %) and lowest incidence was seen in 2-3 months age group, which was 29 %. It was also noticed that apparently healthy non- diarrhoeic kids showed the presence of oocysts in stained faecal smear, which is otherwise unlikely to occur. To search the source of infection the dam of kids positive for presence of oocysts in faeces were also investigated. Several lactating adult goats showed the presence of oocysts in their faeces, without any obvious clinical signs of diarrhea. However, the presence of oocysts in healthy adult animals is rare but in this case it may be due to the stress of lactation. Such healthy shredders increases the environmental burden of infection, which may be transmi to young animals and human

beings. The present study revealed that *Cryptosporidium* spp. are a major diarrhoeal pathogen in young goats, who probably get the infection from dam through faeco-oral route. Maintenance of proper hygiene and cleanliness in farm premises may minimize the incidence as well as chances of human infection.

ABS (POSTER) : AHM-05

Safety of long acting moxi? oxacin following intramuscular administration in goats

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In this study, moxi? oxacin, a fourth generation ? uoroquinolone, was made long acting by addition of some adjuvant in parent compound. Study was planned to evaluate Safety of long acting moxi? oxacin (LAM) by investigating haematological and blood biochemical changes if any induced after single intramuscular administration of 10% formulation of LAM given at the dose rate of 7.5 mg/kg in male Mehsana goats. A total of 9 blood samples per animal collected from 0 day (control or pre-drug samples) up to 7 th day of treatment. Haematological (TLC, DLC, HB, HCT, MCV, MCH, MCHC, RDW and MPV) and blood biochemical (ALT, AST, ACP, ALP, Creatinine, CK, Bilirubin, Blood Glucose and BUN) parameters were evaluated before and after drug administration. All above haematological and blood biochemical parameters were found trivially varied but within normal range and the mean values were not signi? cantly di? ered ($p<0.05$) from corresponding control values. In present study, LAM was found safe and well tolerated antibacterial agent to be used in goats.

ABS (POSTER) : AHM-06

Clinical management of prepartumcervico vaginal Prolapse in a Pregnant Doe

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A non-descriptgoat in advance pregnancy, aged about 5 years was presented to gynaecology clinic of TVCC, BVC, Patna with the complaint of prepartumcervicovaginal prolapse since 18 hrs.approximately.As per information of the owner, the goat was completely dependent on feeding of home wastage products such as bread, rice and vegetables. On clinical examination,everted cervicovaginal parts was carefully assessed and gross debris gently removed

and disinfected with potassiumpermanganate solution.The xylocainejelly and soframycinwas applied locally to the e? ected parts.The prolapsed mass was reposited to their originalplace by manually without using suturing to the vulva region followed by administration of PGF2α, Calcium borogluconate,Broad spectrum antibiotics,Multivitamins,Epidosinvet and DNS 5% solution. On administration of PGF2 alpha, parturition process was initiated in aforesaid goat and next morning the goat delivered four live healthy kids, further the goat did notpresent the condition likecervicovaginal prolapse till two weeks after parturition.

ABS (POSTER) : AHM-07

Detection of *Mannheimiahaemolytica* in culture and lung tissue samples of neonatal lambs by real-time PCR

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Mannheimiahaemolytica is one of the bacterial species involved in cases of ovine respiratorycomplex that has been implicated to cause signi? cant economic losses in sheep production system worldwide.*M. haemolytica* may cause serious outbreaks of acute pneumonia in neonatal, weaned and growing lambs. The present study was undertaken with the aim of evaluating a SYBR Green dye based real time PCR assay targeting O-sialo glycoprotein endopeptidase (gcp) gene for the detection of *M. haemolytica*in DNA isolated from culture and pneumonic lung tissue samples of neonatal lambs. The analytical speci? city and sensitivity of the PCR primers were evaluated. The test showedthousand fold more sensitivity than conventional PCR and detected down to 100femtogram of genomic DNA of pure *M. haemolytica*. The real-time PCR was found to be speci? c for*gcp* gene of*M. haemolytica*, as no cross reactivity was detected with a variety of known bacterial isolates characterized previously by species speci? c or 16S rRNA PCR. The real time PCR was employed to screen *M. haemolytica* in forty one ovine lung tissue samples collected from neonatal lambs, which showed improved level of detection as compared to conventional PCR. The speci? city of the PCR products was con? rmed by sequencing of the ampli? ed products of 227 bp size that showed perfect homology with the published sequences available in the NCBI database.It is concluded that, this assay may be used as a valuable diagnostic tool for the rapid and speci? c detection of *M. haemolytica* in clinical samples. By virtue of its high throughput format and its ability to accurately identify the bacterial DNA, the method may be useful in large scale epidemiological studies and clari? cation of pathogenesis.

ABS (POSTER) : AHM-08

Impact of anthelmintic treatment against ectoand endo parasites a? ected desi goat in Purneadistrict

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In the process of ? nding impact of anthelmintic treatment against ecto-and ednoparasites a? ected *desi* goat inPurnea district, an investigation was carried out to detect the e? ect of treatment on growth performance and haematological parameters.A total of 30 a? ected goats by endo and ecto parasites were selected for anthelmintic trial.The trial population was divided randomly into three groups designated as T_1 (Albendazol and Ivermerctin combination), T_2 (Albendazol and Ivermerctin combination and Deltamethrine) and C (Control) respectively and each group constituted of 10 goats. In T_1 group of goatsAlbendazol and Ivermerctin combination was given at the 1st day and again on 15th day of experiment. In T_2 group of goats along with the Albendazol and Ivermerctin combination, Deltamethrine was sprayed on 1 day st and again on 30 th day of experiment.To determine the gain in weight of di? erent groups of goat, the body weight was recorded on 1st day and on 60th day of experiment.Blood samples were drawn from animals, at pre and post-treatment.Signi? cantly higher body weight in desi goat during the experimental period of 60 days was recorded in T_3 groupand T_2 group than C group. The mean body weight of T_1 group of goats, on pre-treatment was 10.4±1.9 kg and increased to 12.9±1.2 kg at day 60 of the study period. The mean body weight of T_2 group of goats, on pre-treatment was 10.58±1.1kg which gradually increased and a to 13.2±1.1 kg during the study. However, the mean body weight of untreated control C_1 group had minimal change throughout the study period i.e. 10.45±1.5 kg to 11.05±1.54 kg.Hematological pro? les are good indicators of health and disease conditions in farm animals. Most of the hematological indices recorded in the present experiment were within the normal range and are non signi? cant in? uence on the RBC, WBC, Hb and PCV value but they were higher in T2 group followed by T1 and C1.The present ? ndings suggested that, the drugs have shown very satisfactoryperformances, in terms of body-weight gain and haematological parameters.

ABS (POSTER) : AHM-09

Detection of *Escherichia coli* O157:H7 in Faecal sample of Sheep and Goats in North East Karnataka

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E. coli O157:H7 is an emerging food borne pathogen having zoonotic importance. Though the primary reservoir of the serotype is ca sheep and goats are also considered as main reservoir for *E. coli* O157:H7, which act as asymptomatic carriers. Conventional cultural and biochemical methods are time consuming to detect *E. coli* O157:H7 in food borne outbreaks and have less speci? city and sensitivity. Latex agglutination test (LAT) tends to be speci? c, more rapid and reliable. In the present study, faecal samples collected from sheep (n=517) and goats (n=450) from di? erent farms across North Eastern Karnataka during June 2016 to August 2017 were analysed.

The samples were processed and analysed for the cultural isolation, biochemical characterisation and latex agglutination test. In this study, LAT was taken as con? rmative diagnostic test and the results obtained by cultural isolation and biochemical characterisation were compared with that of LAT to estimate the sensitivity and the speci? city. The percent of sheep and goats that showed shedding of *E. coli* O157 in the faeces was 3.67% (19 out of 517) and 2.88% (13 out of 450) respectively. The results obtained show that LAT is a rapid, highly sensitive, speciesspeci? c and reliable method for the detection of the pathogenic *E. coli* O157:H7 and could be used for identi? cation and molecular characterisation of *E. coli* O157:H7 in suspected food and water borne outbreaks, disease investigations and routine analysis.

ABS (POSTER) : AHM-10

HaemonchusContortus infection in Sheep and its therapeuticmanagement by blood transfusion

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Haemonchuscontortus infection is one of the most important nematodal disease of sheep and goat. 24 numbers ofSonadi and corridalecross breed sheep brought from central sheep breeding farm, Hisar to Instructional Lives stock Farm, BASU, Patna were the subject of study. The sheep were showing anorexia, weakness and loss of wool. 3 sheeps out of 24 died during the period of 15 days interval. The mortality percentage was found to be 12.5%. All sheep were showing diarrhoea with black colour stool. There was no response of antibiotic treatment. Haematological andfaecalexamination of all sheeps were done and it was found that most of them were su? ering from mild (8gm/dl) to severe (3 gm/dl) anaemia. Microscopic faecalexamination of sheeps were highly positive for *Haemonchuscontortus* infection. Biochemical examination revealed hypoproteinemia and hypoalbuminemia. All sheeps were given morantel citrate as chemotherapeutic agent @ 6 mg/Kg body weight and supportive therapy. Two cases of sheeps su? ering from severe anaemia were given blood transfusion by open method. All sheeps were found negative for *Haemonchuscontortus* after 21 days of treatment and their haemoglobin and blood protein level a toward normalcy.

ABS (POSTER) : AHM-11

Control and Prevention of suckling lamb mortality in Nellore breed

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A longitudinal and cross sectional studies on suckling lamb mortality, reared under two sub systems namely indoor and outdoor systems under free range being adopted by shepherds, in 51 Mandals of kadapa during 2006 to 2018, in the Nellore breed of sheep , were conducted to study the mortality pa , in suckling lambs in Nellore Breed. The cliunicaly e? cacy of shonclav,a brand of Schon Pharmaceutical limited ,Indore was studied, in 2,395,003 suckling lambs, reared under the indoor sunsystem of free range system of sheep rearing.Shonclav is a brand product ofSchon pharmaceuticals, Indore comprising Amoxicillin, a β-lactam an 200 mg and a β-lactamase inhibitor, Potassium clavulanate 28.5, , in 5 ml with two presentations of 100 ml and 30 ml dry syrup.Calcium liquid(calsakthi) with double strength and vitamin liquid(Intavita) was procured from, Intas pharmaceuticals, Ahmadabad. Ten ml of Calskthi was mixed with one milliliter of Intavita, thoroughly and supplement @ 5 ml per day, from day 4th for 14 days and @ 10 ml on 15 th day till weaning.The mortality in suckling lambs ,reared under the indoor coop system, practiced in 43 mandals, prior to 2009 was 12 to 15%. There was a gradual decline in the mortality rate after the administration of the Shonclav and vitamin mixed calcium, from 2009 onwards from 15 to 0.8%. The treated lambs were active and healthy, put on laudable weight of 14 kgs with shiny coat and glistening eyes. The reasons for low mortality (<1 %) in indoor system were due to availability milk to the lambs, throughout the day, frequent change of pens and healthy penning areas. The observed mortality was of non infectious origin.

ABS (POSTER) : AHM-12

Epidemiological and Haemato-Biochemical e? ect due toBursateWorm Infestation in Goats

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Infections by Gastrointestinal Helminthsremain a major threat to the health and welfare of small ruminants all over the world.The greatest losses associated with nematode parasite infections are subclinical, and economic assessments show that ? nancial loss of internal parasitism is enormous.This cross sectional study aims at determining the e? ect of bursate worms on epidemiological, haematological and biochemical parameters in goats. The prevalence study was undertaken from July 2017 to June 2018. A total of 400 goats were screened for the presence of gastrointestinal parasitism. The overall prevalence of gastrointestinal parasitism was 85.83%.Out of400 screened animals, there were 245 animals having single infection of bursate worms while 155goatshad mixed infection including bursate worms, Coccidia, Trichuris and Moniezia. The highest prevalence was found to be of bursate worm followed by Trichuris,Monieziaspp.andCoccidiaspp.Monthly distribution of data showed peak prevalence of

bursatewrom infestation was in the month July and August and lowest prevalence was in the month of December. Seasonal clubbing of data was found to be further con? rmatory of the observations as the bursate worm infestation was found to be more prevalent in rainy season followed by summer and lowest prevalence in winter season. Age, sex and season showed di? erent impact on prevalence. Goats over 2 yrs of age had more prevalence than other groups. Females were found more prone to all type of parasites.Comparison of a? ected animals with healthy group for haematological and biochemical pro? les of bursate worm infestation showed decrease in values of Hb, PCV and TEC with increase in value of eosinophils. In biochemical examination decrease in the values total protein, albumin and globulin was noted.GFHF.

ABS (POSTER) : AHM-13

Incidence of Gastrointestinal Helminth parasites in Gastrointestinal Tract of Goats

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Gastrointestinal helminth parasites are one of the important cause of losses in productivity & mortality in goat. The proposed study was designed to evaluate the incidence of various gastrointestinal helminth parasites infection in goat through gastrointestinal tract of goats obtained from localaba of Patna. About 100 gastrointestinal tract samples of goats were collected and examined by direct smear method during major three seasons summer (Mar-Jun), monsoon (Jul-Oct) and winter (Nov-Feb). The information regarding season, age, sex, breed and rearing system of sacri? ced goats were collected. Total samples of three age groups 1-12 months (young), 12.1 to 24 months(adult) and more than 24 months (old) were investigated. The breeds of selected goat for the examination were Black Bengal, Jamunapari, Sirohi, Barbari and Cross breeds.

Total 77 gastrointestinal tract samples were found positive for gastrointestinal helminth parasite infection out of 100 gastrointestinal tract samples. The rate of infection present were 84.41, 75.32, 57.14, 10.38,41.55, 3.89, 1.29, 11.68 and 32.46 % infection of *Haemonchus* sp., *Trichostrongylus* sp., *Strongyloides* sp., *Trichuris* sp., *Oesophagostomum*sp.,*Bunostomum* sp. *Monieziaexpansa,Fasciola* sp. and Amphistomes, respectively. The most prevalent parasite was *Haemonchus*sp. followed by *Trichostrongylus*sp. and *Strongyloides*species. The season wise percentage of infection in monsoon season (90%) is highest followed by winter (76.66%) and summer (60%).Highest infection to helminth parasites in GIT Sample of older age groups (>24 months) (91.66%) was noted as compared to kids (76.08%) and adult (73.80%), because of high maintenance and production stress and loss of immunity. Sex-wise incidence investigation revealed that the infection percentage in female (80.43%) is slightly high as compared to the male (74.07%) might be due to less immunity to the infection caused by production and maintenance stress.The highest infection percentage was recorded in Black Bengal goats as compared to other breeds in GIT samples investigation might be due to most popular breeds of goat for backyard rearing with poor management and lack of

awareness about the deworming. The breed wise infection rates observed were 88.09% in Black Bengal goats 80% in jamunapari goats, 58.33 % in Sirohi goats, 61.53% in Barbari goats and 62.5% in cross breed goat's GIT samples.

ABS (POSTER) : AHM-14

Surgical Management of Teat Fistula in Goat

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A 2-year-old goat was presented to TVCC with history of leaking of milk through teared teat. On examination showed that teat was ruptured longitudinally about 2 cm in length. Milk was coming out through the injured area. Sedation of goat done under the Xylazine and caudal epidural anaesthesia for suturing of the teat with the help of chromic catgut no. 1 in under lying layer and super? cial layer with the help of silk thread. The goat went to towards fencing area and suddenly teat was ruptured with pointed wire The wound was prepared aseptically for repair of teat. Teat was sutured with simple continuous in two layer in muscular area and interrupted suture in skin. Infant feeding tube no. 10 was inserted under the teat canal a teat with leucoplast for 30 days. Milking done with through the infant feeding tube. Teat was remained complete rest for one month. Post-operatively the animal was maintained with antibiotics and anti-in? ammatory drugs.

ABS (POSTER) : AHM-15

Isolation of *Escherichia coli*from milk of a household goat su? ering from clinical mastitis

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A goat reared at a household in Mhow was su? ering from clinical mastitis. The goat received treatment previously by a local practitioner but it was not responding to the treatment given and hence brought to college veterinary hospital.The a? ected udder exhibited signs of in? ammation (increase in size and reddish in color).There was also evidence of ? brosis in one of the teats.Milk sample was collected from the udder in sterile container and brought to microbiology laboratory for immediate processing. The milk samples were inoculated into Brain heart infusion broth and kept in the incubator for overnight duration. Overnight growth was

further used for pure culture isolation of bacteria by using streak plate culture on nutrient agar. Single colonies were further inoculated on McConkey's agar plates and incubated. Lactose fermenter pink colored colonies were observed on McConkey's agar. The smears from these colonies werestained by Gram staining that revealed characteristic rod shaped pink colored Gram-negative bacteria.Further colonies from McConkey'sagar were inoculated on Eosin Methylene Blue (EMB) agar. After overnight incubation colonies with metallic sheen characteristic to *Escherichia coli* were observed. The isolated bacterial strain of *Escherichia* coli is being used to study biochemical reactions for characterization of bacteria. Further, the isolated bacterial strain from a clinical case of a goat su? ering from mastitis can be used to study various virulence factors.

ABS (POSTER) : AHM-16

Assessment of comparative e? cacy of di? erent preparations to control ecto-parasites (Tick and mange) in Goats

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The study was conducted on ecto-parasite control of goat. External parasite creates many problems in all age groups of goat like anemia, Itching, loss of hairs (Alopecia) & decrease growth rate. In this study 24 goats were selected and divided into four groups to assess the comparative e? cacy of di? erent preparations to control ectoparasitses(tick and mange) in goats. In ? rst group were treated with cypermethrin preparation @2.5ml per litre of water twice fortnightly. In groups II goats were applied by desi cow urine 50ml with camphor 15gm twice daily for ten days. Application of desi cow urine 50ml,camphor 15gm and sulpher 10gm preparation twice daily for 10days in group III animals. In Group IV goats Karanj oil 50ml used twice daily for 10days .Result of trial indicated that the Application of desi cow urine (50 ml) + camphor- 15 gram+ sulpher 10 gm(group III) is the best e? ective in the control of ecto-parasite load in goat(83.3%) and gives longer protection(30 days) without any risk of chemical toxicity. Application of the recommended technology is easy and its ingredients are locally available. Lustureness, Shining and smoothness of skin increases after the removal of ecto-parasitic load. Colour of conjuctival mucous membrane showed pale pink after treatment. Progressive improvements in general health condition were observed in all the treatment.

ABS (POSTER) : AHM-17

Surgical management of anal atresia in a lamb

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Atresia ani is a failure of development of anal opening. It is a congenital abnormality, manifested clinically by dullness, anorexia, abdominal distension, discomfort and straining with unsuccessful a to defecate. Rectal lumen usually bulges subcutaneously at normal site of the anus when the abdomen is compressed. The condition is fatal in male unless surgical correction is carried out to provide anal opening, in female rectum frequently break through the vagina forming a rectovaginal ? stula and thus permit defecation via the vulva. It is the most common intestinal defect in lamb and is believed to be due to an autosomal recessive gene. Surgical treatment is the only course of action and its success depends on the extent of rectal development. A 10 days old male lamb was presented to the TVCC of Bihar Veterinary College Patne-14 with the complaint of not passing faeces since birth. On clinical observation absence of anal opening was noticed. The site was selected for operation and prepared for surgery. The animal was operated under local in? ltration anaesthesia with Lignocaine 2 % solution injected subcutaneously. After the cruciate skin incision, the blind rectum was identi? ed and opened, which voided faces and air on abdominal compression. The rectal wall sutured with skin by using nylon. Animal fully recovered and suture removed after 10 days.

TECHNICAL SESSION - V
(Post-Harvest Technology)

LEAD : PHT-01

Patenting of natural products and animal related Inventions in India

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The use of herbal products is increasing worldwide due to the distinct advantages. Herbal medicines include herbs, herbal materials, herbal preparations and ? nished herbal products that contain as active ingredients parts of plants, or other plant materials, or combinations (WHO, 2008).The protection of knowledge, innovations and practices of traditional and indigenous medicine has been in the forefront of international developments. Intellectual Property (IP) rights have been claimed over biological resources and/or traditional knowledge (TK) by modi? cations of known properties (Timmermans, 2003). The TRIPs agreement made IP an international obligation and has extended IP claims to TK also. IP is a strategic asset for industry and public health (Smith et al., 2009). Article 27 of TRIPS mandates patents to be made available for inventions, whether products or processes, in all ? elds of 'technology' (emphasis added), provided said inventions are new, inventive and capable of industrial application. This includes the puri? cation or characterization of active drugs and/or the development or the modi? cation of molecules based on TK (Ruiz, 2002). Isolation, puri? cation and structure elucidation of a new chemical entity from a medicinal plant; discovery and characterization of novel, unobvious and useful biological properties, synthesis of useful new analogues or derivatives, formulation for a combination of herbal medicine in new dosage form with higher therapeutic e? cacy are patent eligible subject ma Further, new indications, extraction and separation of active ingredients from herbal drugs used in the production of pharmaceutical substances, preparation and processing techniques of standardized extracts are also patentable (Kartal, 2007).

Traditional medicine is an important part of human health care in many developing countries and also in developed countries, increasing their commercial value. Although the use of medicinal plants in therapy has been known for centuries in all parts of the world, the demand for herbal medicines has grown dramatically in recent years. The world market for such medicines has reached US $ 60 billion, with annual growth rates of between 5% and 15%. Researchers or companies may also claim intellectual property rights over biological resources and/or traditional knowledge, after slightly modifying them. The fast growth of patent applications related toherbal medicine shows this trend clearly.

In India, the number of patent grants has increased signi? cantly in all the ? elds of agricultural sciences particularly in the ? elds of transgenic, agro-chemicals and animal vaccines after the introduction of patent reforms in 2005 and accumulation of the applications during the transit period (Kandpal et.al. 2015).

Criteria for Patentability:

1. Statutory Subject Ma — Invention must fall into one of the ? ve “statutory classes; Processes, Machines, Manufactures, Compositions of ma and New uses of any of it.
2. Utility —Invention must be useful and have real world utility; its use must be speci? c, substantial and credible.
3. Novelty —Invention must be truly new, and cannot have existed beforehand.

4. Non-obviousness — It is not enough for a new invention to be novel—it must also be “non-obvious” to a person having “ordinary skill in the art.”
5. Su? ciency of the Disclosure in the Patent Speci? cation as Filed —Patent applications disclose the best mode for carrying out the claimed invention and provide adequate wri description of how to make and use the invention.

Patentable Inventions:

- It must be related to a process or product or both. It should be new (novel)
- It must involve an inventive step i.e. technically advanced as compared to existing knowledge. It must have industrial applicability
- It should not fall under any of the categories of “Inventions- non-patentable” mentioned under Sections (3) and (4) of the Patents Act, 1970- Any device, apparatus or machine or method for commi theft / burglary, Any machine or method for counterfeiting of currency notes, Any device or method for gambling and An invention the use of which can cause injury to human beings, plants and animals.

Non-Patentable inventions:

- An invention which is frivolous or which claims anything obviously contrary to well established natural laws.
- An invention the primary or intended use or commercial exploitation of which could be contrary to public order or morality or which causes serious prejudice to human, animal or plant life or health or to the environment.
- The mere discovery of a scienti? c principle or formulation of an abstract theory.
- The mere arrangement or re-arrangement or duplication of known devices each functioning independently of one another in a known way.
- A method of agriculture or horticulture.
- Any process for medicinal, surgical, curative, prophylactic, diagnostic, therapeutic or other treatment of human beings or any process for a similar treatment of animals to render them free of disease or to increase their economic value or that of their products.
- Inventions relating to atomic energy

Types of Patent application

Three types of patent are granted under the provisions of the act, namely.

Provisional application

A provisional application is a temporary application which is ? led when the invention is not ? nalized and is still under experimentation. The advantage of such type of application that applicant gets 12 months' time to fully develop the invention and ascertain its market potential , helps to establish “priority” right over the invention, enables the applicant to use the term "patent pending” on their product, less expensive to prepare and ? le the application and enables the applicant to ? le International applications and claim priority within 12 months. Moreover, the provisional application should be su? ciently detailed and must be drafted very carefully to ensure that the priority rights are secured for your invention.

1. Ordinary Patent application: An application for patent ? led in the Patent O? ce without claiming any priority of application made in a convention country or without any reference to any other application under process in the o? ce is called an ordinary application. An ordinary application must be accompanied with a complete speci? cation and claims.
2. Patent of Addition: When an applicant feels that he has come across an invention which is a slight modi? cation of the invention for which he has already applied for or has obtained patent, the applicant can go for patent of addition if the invention does not involve a substantial inventive step. There is no need to pay separate renewal fee for the patent of addition during the term of the main patent and it expires along with the main patent.
3. Patent of Convention: An application for patent ? led in the Patent O? ce, claiming a priority date based on the same or substantially similar application ? led in one or more of the convention countries is called a convention application. Convention application refers to a patent application ? led in accordance with the terms of an international patent treaty like the Patent Cooperation Treaty. In order to get convention status, an applicant should ? le the application in the Indian Patent O? ce within 12 months from the date of ? rst ? ling of a similar application in the convention country.
4. PCT international patent application: A PCT Application is an international application governed by the Patent Cooperation Treaty, and can be validated in upto 142 countries. Advantages of ? ling a PCT Application is that A single international patent application can be ? led in order to seek protection for an invention in up to 142 countries throughout the world.

The Life of Patent:

In respect of an invention claiming process of manufacture of a substance intended to be used as food or medicine 5 yrs from the date of sealing or 7 yrs from the date of patent whichever is shorter. For all the technology, term of patent is 20 years.

IPR in herbal drug:

Herbal products like all other products can also be protected from copying and get various forms of rights from the government. Since the rights are granted by the state for a property that has emanated from the use of mind or intellect these are called as intellectual property rights. Four di? erent types of intellectual property rights (IPRs) are possible namely patents, trademarks, designs and copy rights. (DB Anantha Narayana Pharmabiz.com 2013)

Criteria for granting patents

The main points are Prior art (documented, published, in public domain); Inventive step; useful to Society (animals and man) and Obviousness. The Patents can be for Process; Product/composition; Process cum product.

Prior art

Prior art means what is known, include anything in public domain in published form ,can be even form ordinary publications like newspapers, magazines, books, and not necessarily in scienti? c journals/publications. Public domain also would include “presentations or talks given in public meetings, conferences, seminars, colloquiums etc”. Hence, scientists should avoid making presentations of any ideas, data, theories, ? ndings that can be patented in any seminars. Presentations within your own group in the lab does not become pu it in public domain. It is advisable that if you have any doubt about patentability of your materials/data it is be to ? le a provisional application before going public. The followings are patent search engine used to ? nd out the already work dine in area.

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Inventive step

Inventive step means a feature of invention that involves technical advance as compared to the existing knowledge or having economic signi?cance or both and that makes the invention not obvious to a person skilled in the art. Inventive step is important especially in case of herbals as a large pool of data is in public domain through traditional knowledge anddocumented books. In fact the traditional knowledge digital library (TKDL) created by the Government has actually reduced the possibility of obtaining patents for herbals known in traditional knowledge (Ayurveda). In India, the turmeric case eventually opened up the path to the creation of Traditional Knowledge Digital Library (TKDL), namely, an electronic database of traditional knowledge in the ?eld of medicinal plants. It aims to prevent the patenting of existing knowledge. Such a database would enable the patent o? cers all over the world to search and examine any prevalent use and thereby prevent incorrect grant of patent based on knowledge in public domain. The international acceptance of the TKDL project is also promising (Rawat, 2002)

Grantable patents in Herbal drug research

It is important to know the basics of what can be and what cannot be patented when it falls in herbals area. Patents are not granted for Non-obvious inventions; Those known already documented, traditional knowledge; Those occurring in nature e, new use of a known substance; simple combination of two or more plants and Frivolous inventions.Patents are grantable for processes that show improvements than known already e.g. be extraction processes, be dosage forms, stable formulations, be tastes/aroma; processes that can give plants that give higher yields (not just hybrids); processes that involve biotechnological interventions; processes that improve bioavailability; processes that provide synergy/antagonistic activity; and processes for standardization, fractionation, isolation, etc.

Patents are grantable for formulations that are novel , novel combinations involving selection of speci?c items/ingredients, speci?c proportion, combinations with synergy/antagonisms resulting in be er activity or lesser AEs and be er stability, be er absorption/bioavailability.

Filling of patent application

Patent system in India is administered under the superintendence of the Controller General of Patents, Designs, Trademarks and Geographical Indications (CGPDTM), appointed under sub-section (1) of Section 3 of the Trade Marks Act, 1999. The Patent O? ce comes under the Ministry of Commerce & Industry. The O? ce of the CGPDTM is located at Mumbai. The Head O? ce is at Kolkata. The branch o? ces are located at Mumbai, Delhi and Chennai.

Prescribed format can be downloaded from website of Patent India and ? ll it carefully . Form 1 , Provisional or Complete Speci? cation (Form 2) , Drawing in duplicate if necessary, Abstract of invention in duplicate, Information of Undertaking listing the no., ? ling date and current status of each, foreign patent application. (Form 3) in duplicate, Declaration of Inventor ship (Form 5), Power of A if ? led through patent agent (Form 26) and Form 18 for requesting ? rst examination , and early publication on form 9 . After examination of application by patent o? ce and objections, if any, are raised thereto and after removal of all the objections, the Patent is granted and is advertised for Opposition Purposes. The Patent is open for third party opposition, if any, for a period of one year from the date of advertisement.

The application can be submi through online portal (h or submit o? ine to concerned or nearby Patent o? ce. Similarly fee can also be deposited both way.

Fees

The fees payable under section 142 in respect of the grant of patents and applications therefore, and in respect of other ma for which fees are required to be payable under the act shall be as speci? ed in the ? rst schedule. On application for a patent accompanied by provisional/ complete speci? cation applicable to other except small entity is Rs 8800.00 and Request for Examination of Application for Patent is 22000.00 rupees. In case of renewal , the required fee is also deposied as per the Patent o? ce.

Patents in Agriculture and animal science in India

Based on study on the trend of patenting activity in agriculture sector during 2005 to 2012 in India based on 3,718 published patent applications and 1,041 granted patents of the Indian Patent O? ce, observed that there was gradual increase in patenting activity during 2005 to 2012 in di? erent sectors of agriculture. Maximum percentage of patent applications were ? led in biocides, pest repellents or a and plant growth regulators (60%), followed by new plants or processes for obtaining them (9.35%), animal husbandry, silk rearing or breeding new animal breeds (7.48%) and (5.91%) horticulture, cultivation, forestry (Mehta et.al. 2014)

The premier institute of ICAR , IVRI Izatnagar has obtained patents in treatment and diagnostic on animal diseases such as novel herbal formulation for the treatment of mange in animals, Cold process technology for preparation of urea molasses mineral block, Mineral Mixture for ca Novel immunosensor apparatus for rapid diagnosis of FMD , Recombinant antigen based rapid sero-diagnosis of Infectious Bursal Disease (IBD), Synthetic peptide antigen for diagnosis of peste des petits ruminants (PPR), A live a vero-cell based goatpox vaccine , A phyto-pharmaceutical preparation for the control of acaricide resistant tick infestations in animals. (www.ivri.nic.in). ICAR- National Diary research Institute (NDRI) granted patents in di? erent process of dairy products such as process for manufacture of spray dried cheddar ? avour base/ concentrate, preparation of low cholesterol ghee, Commercial Manufacture of Kradi., Kit for detection of detergent in milk, preparation of Milk Cake, kit for detection of adulteration of milk with soymilk, Preparation of Ready to Reconstitute Kheer Mix etc.

Priorities in animal diseases for herbal drugs research and patents

It is necessary to priotise the thrust areas to obtain the output of research e? orts and other resources. Several factors help in determining the priorities. These include the distribution of ? ora, national or regional disease pa availability of modern animal health care etc. In addition we have to keep in mind the global priorities in developing new drugs so as to get a good ? nancial return. Primary health care usually requires comparatively milder medication and the acceptability of herbal medicines for such conditions is also much more. The main considerations

should be adequate availability or possible cultivation on required scale, lack of toxicity and ease of formulation. There are some of very important area , which are prioritized by animal scientists such as haemato-protozoan diseases, ectoparastic infestation,, helminthic infections, bacterial diseases , wound healing, mastitis, reproductive disorders, in? ammatory diseases, immuno-stimulation , haematinics , growth promoters and coccidiosis etc .

Permission from National biodiversity authority on Form III

In contrast to TRIPS, the Convention on Biological Diversity (CBD) emphasizes on conservation, sustainable use and fair and equitable bene? t sharing of genetic resources. Post CBD, IP rights arising out of access to genetic resource or TK are possible only when the bene? ts are shared with the country/local community providing it. Rapid worldwide loss of biodiversity, misappropriation of TK and the violation of rights of the local communities that hold and develop the knowledge associated with the use of genetic resources have necessitated the development of various legal measures. The Indian Scientist should seek the permission from NBA , Chennai for conducting research on plants and signing MOU for transfer of bene? t to concerned areas . The NBA transfer the bene? t of share to State Biodiversity Board and in process SBBs may retain a share not exceeding 5% of the bene? ts realized towards administrative charges and the remaining 95% share of the bene? ts shall be passed on to the Biodiversity Management commi (BMC) concerned .

Red list plants at the global and Indian levels

Researcher should consider the plants listed in Red list in research . The IUCN Red List of Threatened Species (also known as the IUCN Red List or Red Data List), founded in 1964, has evolved to become the world's most comprehensive inventory of the global conservation status of biological species International Union for Conservation of nature and Natural Resources (IUCN) categorized red list plants, which are threatened(ICUN, 1994).

Patent and technology Management in ICAR

Every ICAR institute is running a Institute Technology Management unit for patent ? ling and management, Technology transfer under National Agricultural Innovation Find Scheme. An ICAR institute given a task as Zonal Agro-Technology Management Center (ZTMC) to coordinate and assist ITMUs. Such approach is very e? cient in IPR management in ICAR institute. Protecting intellectual property (IP) in veterinary science should receive an urgent a as institution in India generates number of technologies at in the ? eld of veterinary sciences, but need strengthening ofsystem in educational institutions.

References are available with the authors.

LEAD : PHT-02

Post-Harvest Technology in Small Ruminants

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Introduction

India is the world's 2nd largest producer of food next to China, and has the potential of being the largest with the potential of being the largest with the food and agricultural sector. There is an opportunity for large investments in food and food processing technologies, skills and infrastructure, especially in areas of canning, dairy packaging, frozen food / refrigeration and thermo processing. Fruits and vegetables, milk and milk products, meat and poultry, packaged / convenience foods, alcoholic beverages and soft drinks and grains are important sub - sectors of the food processing industry. Health food and supplements are other rapidly rising segments of this industry.

The term meat refers to muscle of warm blooded four legged animals. The chief one being ca sheep and pigs. Meat foods play a very imperative role in human health by providing all essential nutrients needed for growth and maintenance.Meat also includes the glands and organs of these animals. Meat products include many of the by-products from animal slaughter such as animal gut used for sausage casings, the fat in the manufacture of lard, gelatin and others.Being ? fth largest meat producer in the country, India holds tremendous potential in meat production, processing and marketing. India produces about 7.4 million tonnes of meat annually from all species comprising bu? alo meat (1.45 million tonnes), beef (0.34million tonnes), chicken (3.46 million tonnes), goat meat (1.04 million tonnes), sheep meat (0.56 million tonnes), and pork (0.47 million tonnes). The meat production estimate was 0.6 million metric tonnes.

Classes of Meat- Small Ruminants

Veal is the meat from ca slaughtered 3 to 4 weeks after birth. Calves Less than 3 to 8 months.Mu is the ? esh of young lambs of both sexes whose age is 12 months or under. Yearling mu is the Carcasses of young sheep usually from 12 to 20 months old one termed yearling mu mu is the Flesh of both male and female. Chevon is the meat harvested from Goats.

After harvest meat is liable to accelerated physiological, chemical, and microbial processes that invariably lead to deterioration and loss of wholesomeness. It is then necessary to institute some measure of processing such as reduction in moisture content, denaturation of endogenous enzymes and microorganisms, or packaging in order to curtail perishability. In the absence of such processing, massive post-harvest losses can ensue. It is the responsibility of the food scientist or technologist to understand the underlying processes contributing to food deterioration and spoilage and, to device appropriate measures and methods of preservation in order to ensure availability, acceptability, and safety of foods.

Value addition to meat products has assumed vital importance in our country due to diversity in socio-economic conditions, industrial growth, urbanization and globalization. It is not merely to satisfy producers and processors by way of higher monitory return but also with be taste and nutrition. Value is added by changing their form, colour and other such methods to increase the shelf life of perishables. Though, with the e? ort of Ministry of Food Processing Industry the growth of this sector is accelerated, however, there is need to discuss and sort out

various related issues amongst people of various categories to increase level of value addition and improve the quality of value added food products for domestic market as well as export.

Post-Harvest Technology- Importance and Role

Post-harvest loss reduction technology encompasses the usage of optimum harvest factors, reduction of losses in handling, packaging, transportation and storage with modern infrastructure machinery, processing into a wide variety of products, home scale preservation with low cost technology. Use of thermal processing, low temperature, drying, chemical and biological reactions coupled with other preservation techniques are applied to enhance the storability. Containers and packaging materials confer portability as well as extend the shelf-life. Adoption of these techniques could make available a large quantity of food by avoiding losses and provide be
and nutrition, more raw materials for processing, thus ensuring be returns to the farmers.

NUTRITIVE VALUE OF ANIMAL FOODS

	Energy (Kcals)	Moisture (g)	Protein (g)	Fat (g)	Mineral (g)	Fibre (g)	Carbohydrates (g)	Calcium (mg)	Phosphorus (mg)	Iron (mg)
Beef meal	410	8	79	10	2	0	0	68	324	19
Beef muscle	114	74	23	3	1	-	-	10	190	1
Buffalo meat	86	79	19	1	1	-	-	3	189	-
Duck	130	72	22	5	1	-	0	4	235	-
Egg, duck	181	71	13	14	1	-	1	70	260	2
Egg, hen	173	74	13	13	1	-	-	60	220	2
Egg, turtle	124	76	12	7	1	-	4	93	299	-
Goat meat lean	118	74	21	4	1	-	-	12	193	-
Fowl	109	72	26	1	1	-	-	25	245	-
Grey quail	103	75	22	2	1	-	-	22	282	-
Liver goat	107	76	20	3	1	-	-	17	279	-
Liver sheep	150	70	19	7	1	-	1	10	380	6
Mutton, muscle	194	71	18	13	1	-	-	150	150	2
Pigeon	137	70	23	5	1	-	-	12	290	-
Pork, muscle	114	77	19	4	1	-	-	30	200	2
Turtles meat	86	79	16	1	1	-	1	7	162	-
Venison	97	75	21	1	1	-	2	3	233	-

Source

Gopalan. C, Rama Sastri B.V. and Balasubramanian, S.C., 2004, Nutritive Value of Indian Foods, National Institute of Nutrition, ICMR, Hyderabad.

Curing of meat

Curing brings about the modi? cation in meat that a? ects preservation, unique ? avour, red colour and tenderness due to added curing agents. The ingredients used for curing are common salt, sodium nitrate or nitrite, sugar and spices. Nitrite ? xes the red colour of myoglobin, develops ? avour and inhibits *Clostridium botulinum*. Spices are added mainly for ? avour.

Cuts and grades of meat

Meat carcasses are commonly divided into relatively larger whole sale cuts and these are further divided into smaller retail cuts. Meats are also graded for quality. The quality, consistency

and character of juices or extractives contained in muscle ? bre also contribute to the quality.

PROCESSING DRY HEAT

Roasting

Roasting in pan over temperature of 163 celcius the adequate browing of meat for good ? avours and good appearance.

Broiling

It consists of cooking meat by direct radiant heat such as the open ? re of a gas ? ame, live coals or electric oven. Broiling is applied to tender cuts that are at least 2.5 cm thick. Thinner cuts will be too dry if broiled. Broiling is carried out at a temperature of 176

Pan Broiling

Meat is placed in a cold girdle and heated so that meat cooks slowly. Any fat that accumulates the pan is removed so that the meat will continue to pan broil rather than pan fry.

Frying

Two methods of frying are pan frying and deep at frying. Too high temperature results in inside uncooked and too low temperature results in greasier product.

Moist heat

This method is used for less tender cuts, meat become tender owing to the conversion of connective tissue to gelatin.

Braising

In this method meat is cooked with or without the addition of water, the meat is ? rst carefully browned on all sides by broiling, pan broiling or frying. Tomatoes and fruit juices may be added as liquids.

Stewing

Large pieces of tough meat are cooked in su? cient water until tender.

Pressure-cooking

This method takes less time. Pressure-cooked meats are less juicy and cooking losses are great.

CURING

Refers to modi? cations of the meat that a? ects preservation, ? avour, colour and tenderness due to added curing ingredients.Ageing still leaves the meat recognizable as a fresh cut. Curing grossly alters the nature of meat and produces distinct products such as

- smoked and salted bacon
- ham
- corned beef
- highly ? avoured sausages (frankfurters and Bologna)

Purpose

- to produce unique? avoured meat products
- to preserve the red color of meat after cooking

Principle ingredients used

- Sodium chloride – mild preservative and adds ? avour
- Sodium nitrate and /or sodium nitrite –help cure meat develop the unique ? avor -acts as preservative -anti botulinum activity -? x the red colour of the cured meat
- Sugar ---stabilizes colour and adds ? avour
- Spices --- mainly for ? avor

METHODS OF CURING

All the methods are combination of the two fundamental procedures

- Dry curing
- Pickle curing

Dry curing ---------curing ingredients added to meat without additional water

Pickle curing------ingredients dissolved in water which forms brine.

Dry salt curing

Use salt alone or salt in combination with nitrite and or nitrate, Mainly used in fa

fat backs, clear plates, jowls or heavy bellis, Dis advantage in end product is salty and color is lost.

Conventional dry curing

Modi? cations of dry curing

Modi? cations mainly in the containers used

Sausages are salted, and usually seasoned, chopped meat products that are generally, but not always cylindrical in shape.

PROCESSING STEPS

Grinding
↓
Mixing
↓
Chopping
↓
Emulsifying
↓
Stu? ng
↓
Linking and tying
↓
Smoking and cooking
↓
Chilling
↓
Peeling
↓
Packaging

Consumers eat sausages because of

1. Convenience
2. Variety
3. Economy
4. Nutritional value.

CLASSIFICATION

Some of the more common classi?cation systems are

Degree of chopping

- o Coarsely ground
- o Emulsion or ?nely chopped

Amount of cooking

- Uncooked
- Cooked

Amount of smoking

- Unsmoked
- Smoked - natural smoke, smoke ?avorings

Amount of water added

- No addition
- Addition of water

Amount of curing

- Uncured
- Cured

Amount of fermentation

- Unfermented
- Fermented

Amount of moisture in ?nal product.

SMOKING OF MEAT

Curing and smoking of meat are closely interrelated and are often practiced together.Smoking like curing has a preservative e?ect on meat.

Purposes of smoking

- Development of aroma and ?avor
- Preservation
- Creation of new products
- Development of color
- Formation of protective skin on emulsion type sausages
- Protection from oxidation

Summary

Post-harvest technology has potential to create rural industries. India, where 80 percent people live in the villages and 70 percent of them depend on agriculture has experienced that the process of industrialization has shifted the food, feed and ? bre industries to urban areas. This process has resulted in capital drain from rural to urban areas, decreased employment opportunities in the rural areas balance trade in favour of urban sector and mismatched growth in economy and standard of living between rural and urban people. It is possible to evolve appropriate technologies which can establish agricultural based rural industries. The farmer whose role has been reduced to producer can be transformed into producer cum processor and thus ge more dividends for hard labour, input, kind of risk taken and generating resource for socio-economic advancement keeping pace with the modern times.

Importance of Post-harvest technology lies in the fact that it has the capability to meet food requirement of growing population by eliminating losses making more nutritive food items from raw commodities by proper processing and forti? cation.

LEAD : PHT-03

Diversi? cation of Pashmina processing and Utilization through development of Knitwears

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Introduction

Textile industry is a well established industry involved in the production of apparels, furnishings, industrial fabrics etc. The industry utilizes the raw material in the form of natural and synthetic ? bres (Karim, 2009). Natural ? bres are used extensively in the textile market because of their natural and comfort feeling as well as a conscious environmental awareness among the consumers. These natural textile ? bres come from three sources viz; plant origin (co coir, jute etc); mineral origin (asbestos ? bres); and animal origin (wool, Pashmina, angora etc) (Wani *et al.*, 2010).

The ? bre of animal origin grows from animal skin with the primary objective of protecting them from deleterious e? ects of heat and cold. Among all the animal ? bres, wool is a predominant one (Karim, 2009), growing from sheep skin and is used in both the woolen and worsted sectors. Besides wool, the other group of natural ? bres obtained from certain animals of goat, rabbit and camel families, rarer than more commonly used ? bres and valued for some desirable properties like ? ne diameter, lusture and ability to impart pleasing hand (characteristics perceived by

handling) to fabrics, are known as speciality hair ? bres.(Wani*et al.*, 2014). The a and characteristics which give value to these ? bres are smooth and glossy surface, their rarity, warmth, pleasing hand, high price and their elegant and exclusive nature. Examples include pashmina, angora, mohair, yak and camel hair. These speciality? bres are sometimes used alone but often in conjugation with sheep's wool to produce special e? ects such as additional beauty, texture, colour, softness, resilience, durability and lusture.

Pashmina

Pashmina is one of the speciality hair ? bres and is considered a prince of speciality hair ? bres (Anon, 2005). It is a down ? bre or undercoat derived from domestic goat known as *Capra hircus*. It is well known for its ? neness, warmth, softness, desirable aesthetic value, elegance and timelessness in fashion. It is most the luxurious ? bre which is much softer than super? ne merino of the same diameter, and hence commands much higher price. It has occupied a unique position among the ? bres of animal origin because of its warmth,
lightness, handle and its ability to absorb dyes and moisture (Ganai*et al.* 2004). It is utilized for the development of aesthetic products like knitwear and woven fabrics. The most common type of products developed by kni include jumpers, hats, gloves, socks and other clothing whereas woven fabrics include outer coats, jackets, pants, scarves, blankets, shawls etc.

Pashmina Production

The world'stotal pashmina production is around 16000 MT. China is the leading pashmina producing country producing 72% followed by Mongolia (18%), Afghanistan (6%) and rest in other countries. India contributes only less than 1%. Out of 50 tons of pashmina produced in India, Jammu & Kashmir alone produced 40 tons (Wani and Wani, 2007). The pashmina produced in the state of Jammu & Kashmir is the best quality pashmina in the world. Although, overall pashmina production in J&K is meager with a total value of raw pashmina approx. INR 1500 lacs. However, the processing of pashmina leads to its value addition with the value of the ? nished product approx. INR 7500 lacs.

Pashmina Utilization

Pashmina is utilized for the development of aesthetic products like knitwear and woven fabrics. The most common type of products developed by kni es, socks and other clothing whereas woven fabrics include outer coats, jackets, pants, pajamas, scarves, blankets and other items. In India, majority of pashmina is utilized for preparation of shawls in Kashmir valley which is mostly hand spun and hand woven. Processing of pashmina is an age old practice in Kashmir Valley adapting traditional method giving these products a royal status (Yaqoob*et al*, 2012). Not only the quality of the ? bres but also the process of manufacturing involving sorting, dusting, spinning and especially weaving has given these pashmina products a special status in the world. The steps involved in processing of pashmina include pre-spinning (harvesting, dehairing combing, glueing), spinning, weaving and ? nishing (Yaqoob*et al*, 2012). Although, the quality of ? nal product is world renowned but the tools and techniques used are still primitive which are full of physical drudgery and less remunerative (Yaqoob*et al*, 2012). The Geographical Indication Registry, GoI has also awarded GI to *Kashmiri Hand spun Handmade Pashmina Shawls* under the name *Kashmiri Pashmina*.

Value Addition

Value addition in simple sense means the aesthetic exquisite and a e appearance of

the products which one intends to buy and in reciprocal it will create more sales, be customer's satisfaction, resulting in repeat customers and good reputation (Wani*et al.*, 2009). The value addition of pashmina can be achieved by the production of diversi? ed products as well as by dyeing, embroidering etc. It can also be achieved by the process of blending with low cost ? bresviz; wool so as to improve the performance on one hand while reducing the cost on other hand.

Blending

Blending is a technique of mixing two or more textile ? bres of di? erent origin with more or less similar properties (Wani*et al.*, 2010). Its basic objective is to give the end product certain characteristics which cannot be achieved with single ? bre such as strength, crease resistance, aesthetic feel, and superior handle and reduced price. It also enables the production of fabrics and products with a diverse range of properties. The wide range of ? brecharacteristics, give more opportunity to create blends of di? erent types, composition and fabric structure. The blending of natural ? bres can be achieved by intimate blending, mixture blending or composite blending. Intimate blending is that type of blending where ? bres of di? erent origin are spun together to produce a blended yarn. Mixture blending, also called union blending means using di? erent types of yarn during weaving or kni while as composite blending means combining di? erent fabrics in composite structure utilizing properties of di? erent fabrics in one single structure e.g. sports wears having woolen fabric towards inner side giving sweat absorbing ability and polyester towards outside (Wani*et al.*, 2010).

Product Development

On the basis of the methodology adapted for the product development, fabrics are divided into three groups viz; woven products, non-woven products and kni products. Woven products are processed by a process of weaving where there is an interlacement of threads in vertical and horizontal alignments known as warp and weft respectively e.g., suiting, shirting, shawls etc. Non-woven products are prepared by the process of felting, wherein there is an interlocking of ? bres in presence of moisture, lubrication, heat and pressure resulting in a ma structure e.g. felt, namda etc. On the other hand, kni products are those products which are prepared by a process of kni

Kni

Kni is the second most frequently used method, after weaving, that turns yarns or threads into fabrics (Anon, 2013). It is a process of fabric development where loops are interlaced in di? erent designs. It can also be de? ned as a process of using two or more needles to loop yarn into a series of interconnected loops so as to create a ? nished garment. There has been a growing interest in kni fabrics due to its simple production technique, low cost, high levels of clothing comfort and wide products range (Oglakcioglu and Marmarali, 2007). Kni fabrics of all kinds are generally popular because of its wrinkle-resistance (Anon, 2013), their ? exibility, stretch to a particular shape when worn as well as because of their general comfortable wear (Abramaviciute*et al.* 2011). Because of these added advantages, kni products ? nd wide application in the ? elds of sports, medical, hosiery, industrial, furnishing, construction etc (Lazar, 2010).

Diversi? cationOfPashmna Through Knitwears

In India especially J&K, the processing of pashmina is restricted to the production of woven products like shawls, stoles and mu? ers which are mostly handmade (Shakyawar*et al.*, 2012).The limited variety of pashmina products is one of the limitations in the marketing sector of pashmina

industry as it reaches to only elite group of the society. The pashmina is being utilized for the development of knitwear in di? erent regions of world (McGregor, 2001; McGregor and Postle 2009; and Hilbrick, 2012). Hence its diversi? cation through development of knitwears shall greatly improve its market and add to its value. Besides, its blending with other natural ? bres shall facilitate exploitation of their characteristics for preparation of lower cost fabrics (compared to pure pashmina) with desired functional, wearing and aesthetic properties, which will further widen the market of the products.

In India, the preliminary work on the processing and utilization of pashmina through development of knitwears has been carried by So? , 2018. He developed pashmina and pashmina blended knitwears in di? erent proportions with an aim to diversify the product range of pashmina. The pashmina, wool and nylon was blended in to ? ve di? erent proportions viz; T_1 (60:0:40); T_2(45:15:40); T_3(30:30:40); T_4(15:45:40) and T_5(0:60:40). Each blend was spun on a ring frame spinning machine into the yarn of three linear densities i.e. 24, 36 and 48 count, making a total of 15 types of yarn. The yarns were processed into 15 types of interlock kni fabrics on a circular kni machine. Half portion of each fabric was subjected to nylon dissolution. After dissolution of nylon, the ? nal blend composition of pashmina: wool in T_1, T_2, T_3, T_4 and T_5 remained as 100:0; 75:25; 50:50; 25:75 and 0:100 respectively. All the types of fabrics were subjected to the development of knitwearsviz; upper and lower thermals for kids. The study revealed following salient ? ndings:

- With the increase in the pashmina proportions in the blend, the unevenness percent, number of thick, thin and neps per km of yarn increased while with the increase in the yarn ? neness, the yarn imperfections increased. However, hairiness index showed a decreasing trend along the blend composition from T_1 to T_5 as well as along the yarn count from thicker to ? ner yarn.

- The tensile properties of pashmina and pashmina blended yarn revealed that with the decrease in the pashmina proportion in the blends, the breaking load, elongation percentage as well as tensile strength showed an increasing trend. However with the increase in the yarn ? neness the strength of the blended yarns decreased irrespective of the blend composition.

- The tensile properties of pashmina and pashmina blended fabrics revealed that along the blend composition, with the increase in wool proportion the strength showed an increasing trend along the wale as well as coarse direction. The fabrics after nylon dissolution showed a signi? cant decrease in strength as compared to the respective fabrics with nylon irrespective of blend composition and yarn count. Along the coarse way, it was found that there was a decrease in the strength and increase in the elongation percentage of fabrics as compared to the wale directions.

- The bending properties of the pashmina and pashmina blended fabrics revealed that in general as the proportion of pashmina in the blends decreases, the bending length increases re? ecting that the pashmina has a smooth handle as compared to wool. Similarly, along the

counts, it was observed that as the ? neness of the yarn used for product development increases, there was a decreasing trend in bending length. This proves that, ? ner the yarn lesser is the bending length, irrespective of the blend composition. Bending length also showed a signi? cant di? erence along the wale way and coarse way. Comparatively bending length was found greater along the wale way as compared to coarse direction. This was true in case of all the treatments irrespective of blend composition and yarn count. The di? erence in the bending length along the wale and coarse way is due to the variation in the constructional properties of the fabric in two directions. Similarly signi? cant di? erence was found in the bending length between the fabrics before and after nylon dissolution. Nylon being a carrier ? ber was used during spinning of yarn with a purpose to provide strength. As the nylon was dissolved by chemical treatments, the blend composition changed completely, which gets re? ected in the bending length of the fabric as the fabrics along both the wale way and coarse way showed more limpness as compared to the fabrics with nylon.

- It was also observed that with the increase in the proportion of pashmina in the blends, irrespective of the yarn count, the air permeability increases. With the increase in yarn count, the air permeability showed increasing trend in all blended kni fabrics. The decrease in the air permeability in the blends with more wool proportion could be a to the increase in the fabric mass per unit area which could be because of the decreased gaps in more compact heavier fabrics. Along the blend composition, the decrease in air permeability could also probably because of the increase in the tightness factor as well as decrease in the loop length. It was also observed that with the increase in the yarn ? neness, the air permeability increases in all the blends. It has been reported that air permeability has a direct relationship with the count of the yarn. Increase in yarn ? neness and more open structure of the kni fabric improved air permeability. With the removal of nylon from the kni fabrics, it was revealed that the air permeability of all the fabrics increases compared to the fabrics with nylon irrespective of blend composition and yarn count. The probable reason could be decrease in fabric compactness and mass per unit area of the fabrics.
- The study revealed that along the blend composition, there was an increasing trend in the thermal conductivity by decreasing the pashmina proportion and increasing the wool proportion in the blend. Similarly, along the yarn count irrespective of the blend composition, the thermal conductivity showed a signi? cantly decreasing trend with the increase in yarn ? neness. This proves that pashmina provides more warmth to the fabric as compared to pashmina woolen blends. Further, more the yarn ? neness, more is the thermal comfort provided by the fabric irrespective of its blend composition. The observation of thermal

properties of pashmina and pashmina blended fabrics without nylon revealed that thermal conductivity was signi? cantly lower and thermal resistivity was signi? cantly higher as compared to the pashmina and pashmina blended fabric with nylon, irrespective of the blend composition and the yarn count. The possible reason for increase in the thermal insulation is

that by nylon dissolution there is change in blend composition as well as fabric structure. The scales on the surface of animal ? bres create li pockets of air that serve as insulating barrier and give greater warmth (Shakyawar*et al.*, 2007). Since the fabrics after nylon dissolution has a composition of only animal ? bres in di? erent proportions, hence provides more warmth as compared to the fabrics which has a presence of 40% nylon.

- Drapeability coe? cient (%) of the fabrics showed signi? cant di? erence between the treatments with T1 showing lower value and T5 showing higher value, indicating that with the increase in the pashmina proportion in the blend, the softness and smoothness increases. Similarly, on the basis of yarn count, the fabric made from the 48 count yarn fabrics showed lower drapeability co-e? cient (%) as compared to the fabrics made from 36 and 24 count yarn. This indicates that the fabrics made from higher yarn count of any proportion are smoother and softer than fabrics made from yarn of lower count.
- The pashmina and pashmina blended fabrics with nylon of di? erent blends and counts showed a pilling assessment grade ranged from distinct surface fuzzing (2) to slight fuzzing (4). The fabrics without nylon showed the resistance to pilling grade ranged from 2-4. However, majority of the fabrics showed the moderate (3) to distinct (2) surface fuzzing as compared to the fabrics with nylon.
- The subjective assessment scores of pashmina and pashmina blended kni fabrics, both with and without nylon revealed that along the blend composition from T_1 to T_5 the sti? ness score showed a increasing trend whiles smoothness; softness and fullness; and total hand value showed an decreasing trend. However, along the yarn count, with the increase in yarn ? neness, the sti? ness score showed a decreasing trend while as smoothness; softness and fullness; and total hand value showed an increasing trend.

Conclusion

Currently, best grade pashmina produced in the state of J&K is utilized for the production of only woven fabrics.Some part of the comparatively lower grade pashmina gets wasted during processing as foundnot suitable for woven products. Besides, the pure pashmina products are of high cost, limiting its market to the elite class. With the vision of increasing pashmina production in the coming decade to approximately 3 times, it becomes inevitable to explore a parallel expansion

of its marketability. Diversi? cation of the products through development of knitwear and blended knitwear products shall help in:

- Increased international competitiveness.
- Diversi? cation of produce.
- Value addition of other specialty ? bresviz; angora, camel, yak by improving their functional and aesthetic properties.
- Increased market avenues.
- Utilization of low grade pashmina in blend knitwears.
- Increased returns.

References are available with the authors.

ABS (ORAL) : PHT-01

Unevenness and Imperfections of Pashmina and Pashmina Blended Yarns

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Pashmina, a prince of specialty hair ? bres is known for its ? neness, warmth, softness, desirable aesthetic value, elegance, lightness and handle. It is utilized in India for development of world renowned Kashmiri pashmina shawls, mostly hand spun and hand woven products.A study on the value addition of pashmina was conducted by blending pashmina with wool and nylon so as to develop pashmina and pashmina blended yarns for fabric development. Pashmina, wool and nylon was blended in to ? ve di? erent proportions, viz; T$_1$ (60:0:40); T$_2$ (45:15:40); T$_3$(30:30:40); T$_4$ (15:45:40); T$_5$ (0:60:40). Each blend was spun in to three types of yarn viz; 24, 36 and 48 metric count, making a total a 15 types of yarn. Yarns were subjected to quality evaluation in terms of yarn unevenness (%), yarn imperfections (thin, thick and neps per km of yarn) and hairiness index (%). The results revealed that with the increase in the wool proportions in the blend, the unevenness percent, number of thick, thin and neps per km of yarn decreased while with the increase in the yarn ? neness, the imperfections increased. However, hairiness index showed a

decreasing trend along the blend composition from T_1 to T_3 as well as along the yarn count from thicker to ? ner yarn. From the study, it can be concluded that pashmina alone cannot be spun on machine as it leads heavy yarn imperfections, hence needs blending to improve the quality of yarn for product development.

ABS (ORAL) : PHT-02

Development of Woollen Blankets Using Wool of Di? erent Sheep Breeds and Noil

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Eco-friendly blankets are prepared from natural ? bres. Among natural ? bres, wool is the preferred raw material. Indian market is dominated with blankets made from synthetic ? bres mainly of polyester or nylon. Polyester is inexpensive but as it is petroleum derivative, it causes environmental pollution during its manufacture. In addition to that, when compared to wool, polyester performs poorly in breathability, thermal insulation and moisture absorption characteristics. Wool blankets made out of ? ne wool are having excellent thermal insulation and breathability properties, but they are expensive. E? orts were made on preparation of blankets using coarse wool to make it cost e? ective. It has revealed that coarse wool blankets were harsh in feel and hence suggested to use ? ne wool in blends for making blankets, to optimize the acceptable quality and cost of blanket. A study was carried out on the wools obtained from various breeds namely Bharat Merino, Chokla and Avikalin. Yarns were prepared from 100% and 50%/50% blend compositions and the count was kept at 4.0 Nm. Blankets were prepared with ends per inch of 22 and picks per inch of 19. Blankets were studied for tensile, friction and thermal characteristics using standard test methods. Subjective evaluation of smoothness was also carried out with the help of experts. In the tensile characteristics, maximum breaking load of 318 N was observed for Chokla blanket followed by Bharath Merino/Chokla blanket at 292 N. Thermal insulation value of studied blankets ranged from 2.68 Tog to 3.88 Tog. In smoothness ranking of blankets, 100% Bharat Merino blanket found to have highest smoothness followed by Chokla+Bharat Merino blanket. Chokla wool can be blended at 50% with ? ne wool like Bharat Merino to get acceptable quality levels. In another study, four types of woollen blankets were prepared by varying comber noil from 10 to 40% during yarn making. The blankets were studied for smoothness through subjective evaluation. It was observed that increasing the comber noil % improves the smoothness of blanket. The lowest smoothness was observed for control sample where no noil is added and highest smoothness was observed for the blanket which is having 40% noil/10% Chokla and 50% Bharat Merino.

ABS (ORAL) : PHT-03

Waste to wealth: Development of value added product from goat rumen meat

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Development of value added products from goat rumen meat is very limited because it has typical unpleasant odour. It is also poor in functional properties due to high collagen content. Most of the rumen meat is sold at very low price or thrown away as waste. However , it is of high nutritional value. So, A study was conducted to develop functional food from goat rumen meat with the incorporation of dried jamun seed powder and sugarbeet root paste separately. An a was made to prepare goat rumen meat pa by standard method by addition of jamun and sugarbeet in rumen meat after its proper deodorization. The pa were cooked by two methods- pan frying and microwave cooking. results showed that addition of jamun powder and suger beet improved the functional properties in rumen meat as well as improved the nutritional value and overall acceptability of rumen meat. Sugar beet ? bre has been introduced in food processing as a ? bre source and natural colouring agent. Jamun fruit is good for diabetic persons and also used for curing bleeding piles and liver disorders due to containing lots of Ca, K, Vit. B complex ,Vit C. Thus Addition of extenders in rumen meat improves the ? avour and functional properties along with improving the nutritional value.

TECHNICAL SESSION - VI

(Socio-Economics of Small Ruminant Production)

LEAD : SESRP-01

Role of Goat Farming in DoublingFarmersIncome in India: Prospects and Potential

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Abstract

About 33.01 millionhouseholdsare maintaining goats and majority of them >90% are landless labourers (predominated by women), marginal and small farmers. Goat has been playing multiple roles in their livelihood by providing regular income, employment, nutrition, supporting crop production, manure and risk aversion in case of crop failure.The goats and its products contribute Rs. 38,590 crores annually to the national economy which accounts for 8.4% to total value of output from livestock sector. India has rich genetic resources with 34 breeds of great diversitydistributed in di? erent ecologies which are great performer in their habitat under optimum feeding and bear great degree of resistance for disease and climatic ? uctuations. However, their contribution in general and speci? cally in disadvantageous regions and among of poor has not commensurate with potential role in reducing poverty, food and livelihood security. Though, productivity of goats is by and large low due to diverse challenge and multiple constraints mainlydue to ine? cient and inappropriate production system, ine? cient utilization of germ-plasm (indiscriminate and uncontrolled breeding), diminishing feed resources and less adoption of production technologies,ine? cienthealth net-work, ine? cient natural resources management, knowledge gap, inadequate goat based specialized and integrated livelihood and business models andunorganized marketing.A at national level is very important for concerted breeding programmes, disease surveillance and prevention, minimization of knowledge gap and maximization of technologies adoption along with credit support for increased goat productivity and income. The productivity and income per female goat/year may easily become more than double i.e. from Rs 2500 to Rs5000 to 6000/goat/year by replacing extensive goat farming with semi-intensive/strategic/intensive management system.The success rate however, depend upon increasing genetic potential of dairy/meat goat breeds, establishment of large number of organized meatand dairygoat ? ocks, quality added value products development, storage and their e? cient marketing andpopularization and supporting goat based integrated and business models in di? erent regions of India.Considering poor economic conditions the input support (vaccine and drugs, bucks, credit and marketing) however, needs to ensure by government agencies for enhancing productivity of goats and doubling farmers income by 2022 as desired by Hon'ble Prime Minister of India. The present article also focused on imperativesalong with productionperformance of major breeds, goat based business and livelihood models,means-mechanism and strategies for aaccelerating goat productivity and pro? t besidespotential role of goat farming in income generation.Important researchable issues, development and policy issues have also enlisted.

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Socio-economic importance of goat in India

Nearly 72.2% populations of India are living in 6.38 lakh villages, mostly dependent upon agriculture and livestock for their livelihood. Crops productivity is largely restricted by uncertain

and erratic rainfall,scarcityof waterforirrigation and deterioration of soil health. Out of the 138 million Indian rural households, 33.01 million(24%)are maintaining goats. Households cultivating less than 2.0 ha of land (marginal and small) are the custodian of more than 76% of the total goats in the country. Goat has been playing multiple role in livelihood of the rural people by providing income, employment, nutrition, supporting crop production and risk aversion in case of crop failure.Landless menand women are increasingly relying on goatkeeping for their socio-economic upliftment.About 70% geographical area of India is drought e? ective (uneven, erratic and less rainfall) and goat as a relatively be adapted species which has many advantages over other livestock species for sustainable farmer's income and nutrition. Goat is an ideal animal for incomein the rain-fed regions where crop productionis uncertain, and rearing large ruminants is costly and competitive due to feed and fodder scarcity.In the mixed species grazing system which is prevalent in rural India, goats browse on plants which are less preferred by other species and thus add ? exibility to the management of mixed livestock keeping. Goat could be easily integrated with other livestock species, crops and perennial trees. Goat has much lesser potential for range degradation than sheep. Population of goat has been increasing by >3% annual growth in spite of about 56% slaughter and 15% mortality, which is strong indication of potential of species. Therefore, goat has become one of the most inclusive species of livestock. Goat rearing has many distinct economic and managerial advantages over other livestock because of its less initial investment, low input requirement, higher proli? cacy, extended breeding season,forage preferences to graze a wider spectrum of plants, early sexual maturity, be e? ciency of crude ? bre digestion from low grade roughages, ease in handling, round the year market and resistance to many diseases. Since goat milk has many advantages over other species milk (easy in digestion, non-allergic, naturally homogenized, improves immunity as it has anti-fungal and anti-bacterial properties), therefore, many commercial avenues have emerged for goat milk and its value added products. Similarly, goat meat has preference over other meat due to low cholesterol and less content of saturated fa acids.Presently commercial goat farming has emerged as important drivers of agriculture growth in India. Goat farming has huge opportunity in rural development as goat has potential for export of products, capital storage, household income, employment and nutrition. In spite of huge potential of good income from goat farming, income of goat farmers is at low level. The important reasons are poor recognition of its potential in raising income by policy makers, inadequate development programme and support services.

Role of Goat in National Economy

The meat production in the country was 6.6 million tonnes with a per capita availability of 4.94 kg (2014-15) and proportion of goat is 914 thousand tonnes, which is 19% of total meat production (3rd after poultry (36%) and bu? alo's meat (22%). More details are mentioned in Table 1.

Table 1: Contribution of Goats in National Economy

Items	Production (Th tons)	Value in crores
Meat	905	22625.00
Milk	4782	9564.00
Fiber	0.06	15.00
By-products	601.06	3005.28

Manure	10233.79	1535.07
Blood	103.04	206.08
Skin	149.07	1490.70
Increment in stock (Million heads)	0.7423	148.46
Total		**38590**
Output value from livestock at current price	459051 crores	
Share to value of output from livestock	8.41%	

Source: Author's estimates based on National Accounts Statistics (CSO) methodology

GoatProduction System in di? erent agro-climatic regions in India

India has 2.30% of land area of the world, maintaining nearly 18% of the world's human population and about 20% of the livestock. There are more than 135 million goats in India (16% of world population). It is not a mere coincidence that goat are reared in India primarily on waste land. Landholdings in general have negative association with small ruminant farming. The small size ? ocks predominately maintained by women becoming common in high crop intensity traditionally occupied by large ruminant. Flocks of large size (50-300) are reducing due to gradually shrinking of grazing land. Large ? ocks of goats are found either in rain fed or Trans Himalayan zone where abundant waste land is available for grazing. Lack of quality buck and their excessive use is major breeding problem of this region.Low productivity (growth, milk yield), reproductive e? ciency (age at ? rst kidding and proli? cacy) and survival is mainly a to low level of nutrition, inadequate housing and prophylactic support. Population of goat during last one to two decades is increasing in most of the eastern Himalayan regions.Goat has special signi? cance in arid and semi-arid regions of Indiaon account of coping up draught as compared to crops and large ruminants.Major forage sources in this region are rangelands, grazing land (common grazing resources, CGR) and post-harvest crop residues. Population of goat is highest in arid and semi-arid regions with maximum biodiversity for genetic resources (60%).Goat breeds of this region are large in body size, higher in body weight, milk yield with longer lactation period. There is high competition for feed resources between small ruminants and large one's in this region. Heavy stocking rate is major constraint of this region along with breed dilution, inadequate housing and prophylactic support. In southern arid and semi-arid region goats are kept with sheep in medium size ? ocks. Goats are maintained mostly on grazing or barren land with acute feed and fodder shortage in summer. Population of goat is increasing over the periods in southern region. Goats of this region have poor potential for milk but good in proli? cacy. Indiscriminate cross breeding and inadequate prophylactic measures, nutrition and housing are major constraints.The eastern region comprises of middle and an upper gangetic plain is predominated by high goat population intensity in India. Goat breed mainly reared in this region is Black Bengal which has maximum share to total population of descript breed. Flocks are small and reared under extensive and mixed farming systems.Goats of this region have poor milk yield potential, which is major reason of lesser pre-weaning growth and high kid mortality (10-25%).

Several management systems of goat are being practiced simultaneously in between and within agro-climatic region which can be described broadly under three systems viz. extensive, semi-intensive and intensive.

Extensive Goat Farming System:

More than 80%goatpopulation in India is rear under extensive system. Majority of goat keepers have big knowledge gap and do not provide adequate inputs. The system is based on low resource use thus productivity of goat is low, mortality high and pro? t is less. This system includes nomadic, transhumance, free range, pasture, tethering and range grazing management. Adoption of management practices/technologies is low. There is marked ? uctuation in feed availability and its nutritive value among di? erent regions, years and seasons,thus productivity and pro? t from goat highly varied. Flock sizes varied from small (02) to large (500) and unpaid family member is the main input. Bucks are mostly selected from own ? ock, mostly non-descript and utilized extensively for long period. Housing is highly inadequate (overcrowded) and improper. Disease incidence and mortality is high (20-60%). Studies have shown that the range grazing cannot support optimum growth and production thus additional supplementation with concentrate mixture (100-200gm/d) and/or leguminous fodders (500gm/d) are recommended for critical production stages and periods. The income under extensive management system ranges from Rs 2000 to 4000/adult female goat/year. The ratio of pro? t: cost mostly is 1.5 to 2:1. Critical Gaps of Goat Farming under extensive rearing are summarized in Table-2

Table-2: Critical Gaps in Goat Farming in di? erent regions of India.

Item (s)	**Gap (%)**	**Normal Value**	**Base Value**
Goat Stoking Rate (goat/hectare)	>400%	10	>50
Bucks Availability	150	1:40	1:100
Kids(< 3 month) mortality	250	10	35
Adult mortality	166	7.5	20
Fodder (lopped, cultivated etc.) availability (gm/goat/day)	233	1000	300
Concentrate availability (gm/goat/d)	400-500	200-300	25-50
Body weight at 12 month (kg) in medium size North temperate region	33	20	15
Body weight at 12 month (kg) in North-Western region goats	39	25	18

Body weight at 12 month (kg) in Southern region goats	38	22	16
Body weight at 9 month (kg) in East and north Eastern region goats	57	11	7
Milk Yield (kg/lac/goat) in North temperate region	50	60	40
Milk Yield (kg/lac/goat) in North and Western region goats	71	120	70
Milk Yield (kg/lactation/goat) in Southern region goats	50	90	60
Milk Yield (kg/lac/goat) in Eastern and North-Eastern region goats	150	25	10
Vaccination against infectious diseases	900	100	10
Deworming against endo-parasites	900	100	10
Services for treatment against ailment	500	60	10
Profit/adult female goat per year with (zero-input) and strategic input	72	4300	2500
Profit/adult goat per year with and adequate input and support services	100	5000	2500

Semi-Intensive Goat Farming System:

It is a combination of limited free range grazing and feeding in stalls. The animals are grazed for 4-6 hours and supplemented with kitchen wastes, concentrate mixtures, crop residues green, dry fodders and tree leaves etc. Level of nutrition is optimum. Substantial improvement in weight gain, proli? cacy, milk yield, kidding rate, wool yield, survival rate, quantity and quality of meat production can be achieved by supplementing with concentrate mixtures and leguminous fodders/ tree leaves. This is ideal system of goat production and speci? cally suitable production of goats for breeding purpose and milch breeds (Beetal, Jamunapari, Jakhrana) i.e. quality and quantity of milk production Results obtained from commercial goat farming indicated that income under semi-intensive management system supported by smart marketing ranges from Rs. 5000 to 8000/adult female goat/year. The ratio of pro? t: cost varied from 2.5 to 3.5:1 under this system.

Intensive Goat Farming System:

The intensive system includes grazing on developed pastures and/or feeding completely in stalls on cultivated fresh or conserved fodders, crop residues and concentrates, adequate housing and health coverage. This system is becoming popular now a day and suitable for those locations

where su? cient grazing land is constraint. Selection or suitability of breeds is important criteria for this system i.e. for meat production breeds like Barbari and Black Bengalare more suitable and pro? table. In India the intensive system is mostly practiced by those goat keepers who raise goats (male) for sacri? ces (Eid) under which they provide concentrate rich in protein. The pro? t from this system is almost similar to semi-intensive system. This system is pro? table when feed, fodder, labour cheap, health services and housing ensured and access of good market for goat and goat products is available. The feed requirement (dry ma) of goats should be provided 1/3rd by concentrate and 2/3rd by roughages (preferably 60% green and 40% straws).This system is objective oriented and more suitable for fa of kids at 3-9 months of age to harvest maximum feed conversion e? ciency.

Goat Genetic Resources of India

India is endowed with huge biodiversity of goats (34 breeds) distributed in di? erent agro-ecosystems throughout the country, which were developed by our wise ancestors as per the climatic conditions and then requirement ofpeople of those particular regions (Table-3). All these 36Indian goat breeds are great performer in their habitat under adequate feeding and bear great degree of resistance for disease and climatic ? uctuations.Chegu and Changthangi are reared in northern upper Himalayan region (Laddakh and Kashmir) above 3500 MSL, known to produce ? nest quality of under coat hair called 'Cashmere' or 'Pashmina' beside quality meat. Important goat breeds found in North-Western region areBeetal, Jamunapari, Barbari, Sirohi, Marwari, Jakhrana, Surti, Gohilwadi, Kutchi, Zalawadi, Mehsana. These goats are medium to large in body size, dual purpose with special a of higher milk yield (150-350 liter/lactation). Body weight at 12 month varies from 20-40 kg, liter size from 1.3 to 1.7 and kidding rate from1.3 to 1.6. The goats of North-Western region have potential to be developed as dairy goat and may play great role in sustainable nutritional security of poor people. Many breeds (Beetal, Jamunapari, Sirohi, Zakhrana, Barbari etc.) are candidate breed for grading up of non-descript goat of arid and semi-arid regions of India.

Table 3: Distribution of goat breeds over di? erent agro-climatic zones of India.

Agro-Climatic Zone	Goat breeds
Northern-Temperate	Gaddi, Changthangi,Chegue, Pantja, Bhakarwali
North-Western	Beetal, Jamunapari, Barbari, Sirohi, Marwari, Jakhrana, Surti, Gohilwadi, Kutchi, Zalawadi, Mehsana, Kahmi, Rohilkhandi
Southern	Sangamneri, Osmanawadi, Konkan Kanyal, Berari, Kannai-Adu, Kodi-Adu, Malabari,Black Attapady, Teresa, Salem Black, Nandidurga, Bidri
Eastern	Ganjam, Black Bengal, Assam hill, Sumi-nee

Large size breeds have potential to a 19-23 kg body weight at 6 months of age and 40-50 kg weight at one year of age.Barbari is one of the most demanding breed due to its suitability and performance under intensive/stall feeding. Sirohi goats are highly popular among traditional goat farmers due to its sustained productivity in harsh conditionsd.Osmanawadi,Sangamneri,

Malabari, and Kannai-adu are the main goat breeds of the Southern region. These goats possess are good in proli?cacy (40-65%) and a 20-24 kg body weight at 12 months of ageunder optimum feeding and 25-34 kg under intensive feeding. Black Bengal is main breed of eastern region of India. It is a dwarf size meat goat breed and has great recognition for proli?cacy (>80% females produces multiple birth), skin and carcass qualities however, low in milk yield. Body weight at 12 month varies from 10-20 kg. The production and economic characteristics of some important breeds of semi-arid and hot-humid eastern regions, maintained under semi-intensive or optimum inputs are presented table-4.

Table-4: Production and Economic Characteristics of major Goat Breeds of India

SN	Production Characteristics	Barbari	Jamunapari	Sirohi	Black Bengal
1	Suitable climate	Semi-arid	Semi-arid	Semi-arid	Hot-humid
2	Cost of adult female (Rs)	5000	8000	7000	3500
3	Age at First Kidding (months)	12-16	18-22	18-20	10-12
4	Kidding Interval (months)	9	10	10	8
5	Multiple Birth (number)	1.6	1.3	1.3	2.2
6	Kids produced in 3 years	6.4	4.7	4.7	10
7	Survival of kids up to 12 months (%)	92.5	92.5	92.5	80
8	Survived kids available in 3 years	6.4	4	4	8
9	Body weight at 12 months (kg)	22	27	27	16
10	Weight delivered/goat/year	42	38	38	42
11	Milk yield /goat/year	80	135	100	30
12	Surplus milk /year (liter)	25	78	60	0
14	Income surplus milk	625	1950	1500	-
15	Maintenance cost of adult female & its kid /year	4250	4550	4150	3840
16	Sale Price of kids/year (Rs)	8400	7300	7300	8440
17	Net profit per goat per year	4775	4700	4650	4600

Note: Productivity and economics are obtained of those goats which are maintained under semi-intensive feeding system where they will be provided about 50% feed-fodder requirement through supplementation and remaining 50% from grazing area.

Major constraints and challenges responsible for low productivity of goats are listed as below

Constraints of Goat Production

1. Ine? cient and inappropriate production system (extensive/zero-input)
2. Prevalence of non-descript or poor genetic-make-up of animals.
3. Under feeding of goats due to scarcitiesof feed-fodderwhich reduces the production and reproduction e? ciency of goat for present and lifetime production. It also deteriorate the survivability of goats thus decreases the pro? t from goat farming.
4. Large knowledge gap on improved/strategic management practices and technologies.
5. Inadequate space and improper housing of goats.
6. High mortality (15-40%) due to inadequate prophylactic measures/poor veterinary services.
7. Inadequate support for goat based specialized and integrated livelihood and business models suitable diversi? ed farming systems.
8. Unorganized marketing, distress sale of goatand poor infrastructure for value addition of goat products (meat, milk, skin, ? bre, manure etc.).

Challenges of Goat Farmers under prevailing production system

1. Acceleration and enhancement of goat productivity and pro? tability.
2. Goat keepers are unwilling to keep bucks due to high rearing cost.
3. Evaluation of potential of about 60% non-descript or non-characterized goat population.
4. Perfection in arti? cial insemination with frozen semen technology.
5. Check on uncontrolled slaughter and sale of high potential male.
6. Establishment of buck mother farms of di? erent breeds in their respective home-tracts.
7. Reduction in feed and fodder cost through technological innovations.
8. Checking depletion of grazing resources, uncontrolled grazing and high stocking rate.
9. Capacity building of uneducated traditional 30 million goat keepers.
10. Lack of well trained and experienced trainers.
11. Development of low cost goat shelter and house models suitable for di? erent farming systems under traditional and commercial farming.
12. E? ective health support services.
13. Development of dairy goat (3.0 liter milk/ day) for ensuring nutritional security of poor rural people and for marketable products.

14. Institutional credit to goat keepers.

Strategies for improving goat productivity for sustainable livelihood security

Goat based integrated and specialized farming may play lead role in transferring package of technologies and for improving income as it has scope to resolve the multiple challenges of livelihood, nutrition and employment of farmers.The extent to which goat keepers will be bene? ted will mainly depends at what rate and magnitude semi-intensive and intensive system replace largely followed extensive management system, access to technology, development of market, prophylactic support services, institutional credit and e? ciency production resource utilization.Technologies to improve productivity of goat do exist, however, the awareness and rate of adoption is consistently low, because of the existing extension set up, infrastructure etc.To improve sustainable income of goat keepers there is a necessity to launch short-term and long term improvement-cum development programme in di? erent regions/state/breed as per the requirement.

1. Promoting semi-intensive or strategic management system through ? eld demonstrations

Goat keepers (>95%) rear their goat on zero input and earn average pro? t of Rs. 12500/year from a unit of ? ve adult females. The pro? t from ? ve goats becomes double or more than that i.e. Rs 25000 by shifting goat management from extensive to semi-intensive or intensive management. Farmers may be charged cost of inputs and farmers are ready to paycost that incurred on vaccination, deworming, feed-mineral mixture and service from high potential buck. The impact of strategic inputs is elaborated in table-5, observed from farmers ? ock under NAIP-Component-3 project operated in Bundelkhand and AICRP on Goat Improvement.

Table-5: Case study on productivity and pro? t enhancement in Barbari goats

Character	**Performance of goats in Extensive Management System**	**Performance of goat with strategic interventions**
Kids mortality	25%	<8%
Adult goat mortality	15%	<5%
Lactation period	65 days	110 days
Lactation milk yield	40 Liter	65 Litre
Body wet at one year	16 kg	22 kg
Kidding interval (KI)	12 month	8 month
Age at first kidding (AFC)	18 month	14 months
Multiple birth (%)	40%	65%
Increase in number of kids/year/goat due to decrease in AFC and KI and increased multiple birth with 5 female	6 kids	9 kids
Number of surplus kids/year (average adult flock size of 5 and 25% kids mortality in Extensive management and 7% with strategic management)	07	11

Net income/goat/year due to increased productivity, reproduction efficiency and survivability.	Rs.3000	Rs.5000
Income from surplus milk/adult goat/year	Nil	625
Manure @ rs 1/goat/day	4300	5840
Income from sale of male @ rs 4500 under EMS Income from sale of male @ rs 6000 under SIM on account of higher weight (6 kg)	35000	66000
Survival of adult goat (0.6)	-	3000
Saving of feed and labour on account of reduction in AFK, Kidding Interval	-	5000
Book Value of 5 adult goats	25000	30000
Cost/goat/year @rs1550 goat/year (5 adult+7 kid) in EMS (labour, health etc) Maintenance cost @ rs 3000/goat(feed, health, housing) in strategic Management	18600	48000
Net profit with flock of 05 adult female/year	Rs. 16400	Rs. 32465

Pro? t per goat under extensive management from one adult Barbari goat is Rs. 3280 whereas with strategic feeding support it was Rs 6493. The pro? t increased with strategic inputs support on account of increased body weight (>40%), increased milk yield (80%), increased survivability (50%), increased multiple birth (50%), increase in premium value/ breed purity (20%) etc.

1.Development of Genetic Stock by Supply of High Potential Pure-bred Bucks

Selection of breeds adaptable to the existing agro-climatic conditions that can thrive well on un-conventional feed and fodder resources should be given top priority in goat based rural development cum breeding programme. There is need to encourage the farmers to breed local non-descript goat with *improver breed suitable for that particular agro-climatic conditions.Upgrading* of goats through elite purebred bucks should be seriously implemented along with prophylactic support. Establishment of Kids nursery farm of improver breeds in home tract of all important and high potential breed for regular supply of breeding bucks to goat keepers for improvement in genetic potential of goats. Progenies born out from superior bucks yielded 40-75% more production and also fetched 25-40% higher price in market as breed premium.

2.Promotion of Prophylactic Measures (*Goat health calendar*)

Goat keepers (>75%) were neither aware and nor adopting vaccination against infectious diseases such as *Peste des petits ruminants* (PPR), goat pox, enterotoxaemia and foot and mouth disease (FMD) which areresponsible for high economic losses (30-60% goat mortality). It was observed in a case study that vaccination and deworming of goats have reduced the mortality (< 10%) thus; increase in the survival of goat and net income of Rs 3500-4500/year with a unit of ? ve goats. It require expenditure of only Rs 300/year on ? ve unit of goats.

3. Development of Feeding Resources at Village Level

Fodder supplies in villages can be enhanced substantially by increasing the productivity of traditional food and forage crops. Inter-cropping with twin objective, using seed for human and leaves for animals, short duration and quick growing leguminous forage crops should be

promoted. Farmers are made skillful for processing and storage of fodder resources available during monsoon for meeting demand during the lean period and their nutritive/value addition. The degraded grazing lands and CPRs should be converted in to productive system like silvi-pastoral. Drought tolerant grasses, shrubs and fodder trees need to be promoted on ? eld bunds. Improvement in the natural rangelands by reseeding with perennial grasses (grass yield increase from 1.0 ton to 4.0 ton/ hectare/ year), intercropping of legumes, plantation of fodder trees and most importantly judicious utilization of natural resources. Agro-forestry and good grazing practices should be popularized among farmers.

4. Strengthening Support services and Extension network

Credit is very important asset for goat keepers to access technological interventions such as improved housing, purchase of concentrate, quality animals, value added products etc. It will encourage goat keepers to switch their goat from extensive (zero-input) to semi-intensive management system and up-scaling the introduced innovations.

5.Popularization of Package of Improved Management Practices

Goat keepers should be made aware for improved management practices such as breeding calendar (optimum age and weight of breeding at ? rst time, season/months of breeding to obtain maximum survival, production and pro? t from goats, health calendar, strategic feeding (timely colostrum feeding, supplementary concentrate feeding at advance pregnancy, ? rst 60-90 days of lactation, 3-9 months of ageduring kids growth, e? cient use of feed and fodder as per age, sex, productivity) and smart marketing and value addition of products. Avoid overcrowding of goats especially in growing kids. Floor should be cleaned regularly and kept dry by proper cleaning of waste materials and adequate sun light exposure. Replace old and caked soil once in a year in April-May with new soil mixed with lime @10kg/m^3 of soil. Goat sheds should have a provision of open as well as covered space. The area of open space is normally double of the covered area..A case study conducted in draught prone Bundelkhand region in 2012-13 revealed that a farmers earned an additional income of Rs 18348/year with a 5 unit of goat by proper adoption of improved management practices. Goat based interventions also provided employment to the tune average of 182 man day/year from a unit of 5 goats.

Table-6: Impact of improved management practices on income of goat keepers

Parameter	Before	After
Adult goat flock size	5	5
Multiple births (%)	20	45
Survivability (%)	74.5	90
Kids available up to one year	4.2	6.5
Body weight at 12 month (kg)	16.6	24.0
Income (Rs)from sale of kids @ Rs 160/kg live	10458	25056

weight		
Total milk yield/goat/year	49	83.5
Surplus milk yield(l)(sold/ consumed)	3	37.5
Income from milk@Rs20/liter	Fed to kids	3750
Total gross income(Rs)	10458	28806
Operational cost (Rs) per year	2092/goat	5761/goat
Net gross income (Rs) per year	6758	23706
Additional income (Rs)	-	18348
Additional income/goat (Rs)	-	3670
Net income (Rs)	1352	4741

6.Formulation of farmer's groups, SHGs cooperative, societies for transfer of technology

Such groups should be periodically empowered for credit access, knowledge on scienti? c goat farming and value addition of goat products and marketing of goat and goat products.

7.Development of technologies and models for low cost goat houses

Adequate goat housing due to scarcity of space and high of inputs/items cost is major constraints of majority of goat keepers, therefore, there is urgent need to conduct research to build multilayered and low cost outhouses.

8.Manure management:

Manure produced from goat is rich source of NPK and has long lasting e? ect on soil fertility and minimizing soil erosion. Technology pertaining to value addition, storage and utilization of manure should be made available to farmers.

9.Value addition of goat products to increase income and nutrition

Sustained livestock production to provide livelihood and ensure food and nutritional security is dependent on e? cient utilization of animal products. Processing of goat products to value added products can contribute to sustained demand for meat and milk and e? cient marketing of these products to earn reasonable returns by farmers. Such added value can be obtained in terms of shelf stability, improved technological functions, be sensory quality or even more convenience. Today's consumers are looking foreward for variety, nutrients and convenient ready-to-eat products. These convenient items are economical and cost-e? ective and provide options for changes of menu, having be shelf-life and acceptability than traditional products. Value addition of goat products may help farmers to increase their products sale and to get more net return.

10.Mitigation strategies for climate change

Occurrences of natural calamities at regular interval are outcome of erratic climate changes. It decreases productivity, pro? t and economic stability of goat like other livestock species. Therefore, it is imperative to modify goat production system such as selection of hardy/resistance breeds (genetic make-up), healthy housing and feeding practices and prophylactic support.

11.Popularization of Goat based business (livelihood) models of di? erent breeds

Recently many educated youth have set–up goat farms on semi-intensive or intensive

management. CIRG has been helping them in terms of technical and input support (Capacity building, purebred breeding male and females to establish foundation stock in the form of multiplier ? ock, providing region/location based knowledge on housing and marketing etc.) Such farms selling their goats to further create pure-bred breeding farms besides rearing goats for Eid and regular mu market. Pro? ts at these farms are range from Rs 5000 to Rs 8000/goat/year. Mortality due adoption of improved breeding, health, feeding and management practices is <3%. However, there were some minor problemsoccurred at initial stage which were overcome with constant advises and support from Institute. Commercial goat farmers of eastern region (Bihar, Bengal, Jharkhand and West Bengal) are advised to establish goat farms with high potential and pure-bred Bengal breed of goats. Feedback from goat farmers indicated that performance, survivability and pro? tability of northern breed like Barbari, Jamunapari and Sirohi were declined from 20- 35% in hot-humid eastern region climate. The most important aspect of commercial farming is genetic potential of goats being used as foundation stock in addition to breed purity. The net pro? t from di? erent breed in their respective home tract is similar as presented in table 4.

Goat based Integrated Livelihood Models for rain-fed/disadvantageous regions

For present model data was obtained under NAIP componenet-3 project operated in Bundelkhand during 2010-13. Model revealed that a landless /marginal household having 15 adult female goats and 25 poultry birds may yield Rs. 82727 per annum. Similarly, a landless/marginal/small household with 10 adult goats, 2 cows and 50 chicks and 1 ha rain-fed land may earn Rs. 100634 per year. Marginal, small and medium farmers with 5 adult female goats, 2 bu? alo, 2 cows and 2 ha of rain-fed land may earn Rs. 119000/year. Whereas, a semi-medium, medium and large farmer may earn Rs. 119000 per year with keeping 10 goats, 2 bu? aloes, 2 cows and crop production on 2 ha semi-irrigated land. These recommended models were highly adopted by farmers of draught prone Bundelkhand region.

Table-7:Goat based Integrated Livelihood Models

S.No	Model	Unit	Net income (Rs)	Suitability for household category	Household Covered under trial
1	**Goat+ Poultry**	15 adult F+ 25 Chicks	Rs 82727 (71115+11612)	Landless Marginal	64
2	**Goat+ Cow+ Poultry+ Crops (Rain-fed)**	10 adult F+ 2 cows + 50 chicks + 1 ha.	Rs 100634 (47410+22000+ 23224+8000)	Landless Marginal Small	142
3	**Goat+ Buffaloes+ Cows+ Crop (semi-irri)**	5 adult F + 2 buffaloes+ 2 cows + 2 ha.	Rs 109705 (23705+34000+ 22000+30000	Marginal Small Medium large	80
4	**Goat Buffaloes Cows Crop (semi-irri)**	10 adult F 2 buffaloes 2 cows 2 ha	Rs 119000 (47410+32000+ 22000+30000)	Semi-medium Medium Large	56

Conclusion

Goats have huge potential to play important role in providing sustainable income and nutritional security of poor people. It is life-line of millions of pastoralist and poorest people in climatically disadvantageous regions. Poor productivity, survivability and pro? t are major concernof goat farming a to sub optimal production conditions (zero inputs). Indigenous goat breeds have immense production potential under congenial environment/management. Capacity building of goat keepers, grading-up of non-descript goats, ensured availability of ccritical inputs with easy access, adoption of important technologies and management,value addition of goat products and organized marketing of goats are key factor in increasing farmer's income.Formation of goat breeder's cooperative/ societies/buck mother farm/multiplier ? ocks should be encouraged for holistic and sustainable goat development. Facilitation access of appropriate goat production technologies, models, linkage of farmers with market and restoration of grazing resources are equally necessary for poor goat keeper's sustainable income. The net income of majority of goat farmers (with zero-input) which ranges from Rs 2000 to 3000/adult female goat/year with an average of Rs 2500. The ratio of pro? t: cost mostly ranged from 1.5 to 2:1. However, by providing critical inputs, rearing good potential goats, adoption o? mproved management practices and smart marketing the productivity of goats have beenincreased by 90 to 160%. The gross income and net income goat/year mayincreases from Rs 7500 to Rs 9000 and 5000 to Rs 7500/goat /year, respectively.

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Challenges and Constraints in Goat production in Bihar

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Small ruminants particularly sheep and goats contribute signi? cantly to the economy of farmers in Mediterranean as well as African and Southeast Asian countries. The livestock sector has a signi? cant potential for round the year employment generation particularly in rural areas. These small ruminants are valuable assets because of their signi? cant contribution to meat, milk, and wool production, and potential to replicate and grow rapidly. This provides subsidiary source of livelihood to the people living below the poverty line due to lack of su? cient agricultural land to sustain, particularly in the draught prone, hilly, tribal and other remote areas where crop production on its own may not be capable of engaging them fully. The great Indian leader and freedom ? ghter M. K. Gandhi “father of the nation” designated goats as “poor man's cow,” emphasizing the importance of small ruminants in poor countries. In India, sheep and goats play a vital role in the economy of poor, deprived, backward classes, and landless labours. Bihar is poor of

the poorest states in India. The per capita annual income has been Rs 38,546 in 2016-17. The state is also a habitat of 41.4% people below poverty line whose livelihood depends mainly on livestock particularly goat.Being the 5 th largest goat population state (1,21,54,000 in numbers), Bihar contributes about 7.63% of India's total goat population (Department of Animal Husbandry and Dairying 2012). Despite being a strong contributor to the income and livelihoods of the poorest segments of the society, the sector has remained largely underinvested and neglected on the institutional front. The goat sector is constrained by various challenges such as poor breeds and poor management practices leading to low productivity, limited or no access to veterinary care leading to high mortality and issues related to marketing.

To make this small ruminant based economy viable and sustainable, there is urgent need to devise a strategy to address the constraints faced by farmers. Besides, this development of techniques for early and accurate diagnosis of diseases especially respiratory diseases. Out of them, bacterial diseases have drawn a due to variable clinical manifestations, severity of diseases, and re-emergence of strains resistant to a number of chemotherapeutic agents. However, sheep and goat su? er from numerous viral diseases, namely, foot-and-mouth disease, bluetongue disease, Maedi-visna, orf, Tick-borne encephalomyelitis, peste des petitsruminants, sheep pox, and goat pox, as well as bacterial diseases, namely, blackleg, foot rot, caprine pleuropneumonia, contagious bovine pleuropneumonia, Pasteurellosis, mycoplasmosis, streptococcal infections, chlamydiosis, haemophilosis, Johne's disease, listeriosis, and ? eece rot.

Various constraints faced by goat farmers are as follows:

1.Absence or Weak Livestock keeper Organisations

The development of small ruminant keepers is barred due to absence of or weak social organisation. They are unable to express their demands and requirements because the sector is not organised.

2.Transportation

Major constraint faced by commercial goat farmers is the lack of proper transportation guidelines for live goats. While transporting breeding stock from long distances farmers are charged lump sum by police in the name of well-being of animals. Considerable amount of illegal payments e.g. ? 2000 - ? 3000 per truck from Rajasthan to Maharashtra, ? 500 - ? 700 from U Pradesh to Delhi, need to be made to the concerned o? cials and police during the transit of the animals.

3.Disease

Mortality rate of goats are high and growth in kids is also poor. High mortality is due to diseases like PPR, diarrhoea, pneumonia, Tetanus, etc. There is dearth of knowledgeof be

methods of goat farming, low level of prophylaxis, lack of vaccines and lower accessibility to veterinary doctors. Furthermore, the funds allocated for veterinary services for small ruminant sector are less. Majorly small ruminants are located in remote areas and are migratory in nature; therefore the services available mostly do not reach them. For containment of important diseases is to be addressed by proper diagnostic, preventive and therapeutic intervention at appropriate time. The respiratory diseases represent 5.6 per cent of all these diseases in small ruminants. Small ruminants are especially sensitive to respiratory infections, namely, viruses, bacteria, and fungi, mostly as a result of de? cient management practices that make these animals more susceptible to infectious agents. The tendency of these animals to huddle and group rearing practices further predispose small ruminants to infectious and contagious diseases. In both sheep and goat ? ocks, respiratory diseases may be encountered a? ecting individuals or groups, resulting in poor live weight gain and high rate of mortality. This causes considerable ? nancial losses to shepherds and goat keepers in the form of decreased meat, milk, and wool production along with reduced number of o? spring. Adverse weather conditions leading to stress often contribute to onset and progression of such diseases. The condition becomes adverse when bacterial as well as viral infections are combined particularly under adverse weather conditions. Moreover, under stress immunocompromised, pregnant, lactating, and older animals easily fall prey to respiratory habitats, *viz. Streptococcus pneumoniae*, *Mannheimiahaemolytica*, *Bordetellaparapertussis*, *Mycoplasma* spp., *Arcanobacteriumpyogenes* and *Pasteurella* spp. Such infections pose a major obstacle to the intensive rearing of sheep and goat and diseases like PPR, bluetongue, and ovine pulmonary adenomatosis (Jaagsiekte) adversely a? ect international trade, ultimately hampering the economy.

Many times due to environmental stress, immunosuppression, and impropermanage mental practices, secondary invaders more severely a? ect the diseased individuals; moreover, mixed infections with multiple aetiology are also common phenomena.

For the prevention and control of fatal infectious respiratory diseases of small ruminants, various diagnostic strategies are adopted worldwide. The diagnostic tests as well as procedures adopted in di? erent parts of world incorporate combination of conventional and advanced diagnostic tests. However, the initial suggestive diagnosis involves the observation of clinical signs and post-mortem ? ndings followed by serological and molecular methods for the con? rmation of etiological agents. Common infectious respiratory diseases of small ruminants are as follows:

- Peste des Petits Ruminants (PPR)
- Caprine Arthritis Encephalitis Virus
- Enzootic Pneumonia or Shipping Fever
- Mycoplasmosis
- Nasal Myiasis

- Verminous Pneumonia
- Bluetongue
- Parain? uenza
- Ovine Progressive Pneumonia (Maedi-Visna)
- Enzootic Nasal Tumors and Ovine Pulmonary Adenomatosis (Jaagsiekte)
- Caseous Lymphadenitis

4.Breeding stock and its breeding

Farmers are unable to identify pure breed animals because of lack of knowledge. They also face di? culty in accessing good quality breeding animals. Finest breeds (mostly males) are usually sold to slaughterers, hence leading to shortage of be quality breeds.

5.Availability of inputs and services

There is unavailability of vaccines especially PPR and cost e? ective tagging materials.

6.Marketing

Goat farmers receive very low price for their animals since body weight is not considered in livestock markets. In addition, the availability of institutional credit is di? cult for small scale entrepreneurs (50-100 goats project) and possesses limited capital for collateral security.

7.Reduced access to credit and insurance

Low income farmers have meagre capital assets to ? nance their livestock enterprises for activities such as acquiring ? nest breeds, health care, feeding and management practices, etc. Furthermore, insurance support to livestock, particularly small ruminants has largely been neglected by insurance providers and banks.

8.Poor synergy between departments

There is a lack of convergence between policies/programmes of di? erent departments in small ruminant development. In addition, no consultation is done while formulating policies/ programmes with community, elected village council and related government departments such as animal husbandry, forest and agriculture. Due to lack of inter-state coordination, migratory men and women farmers face constraints during their transit to nearby states in search of grazing resources.To address the constraints in the goat production and management following recommendations would be helpful in mitigating the hurdles.

Recommendations are divided into following three headings:

A.Nature of action

1.An inter-departmental commi should be formed to explore possibilities of convergence in

policies/programmes. Animal Husbandry Department and Universities with the help of pastoral NGOs and livestock keepers should coordinate with concerned department in the neighbouring states for ? xing migratory routes, standard of care and hygiene during migration, and other related issues faced by the transporters.

2.A State level "Small Ruminant Cell" could coordinate the implementation of the "Small Ruminant Policy" with neighbouring states and all major stakeholders.

3.Small Ruminant Cell should undertake the function of enhancing infrastructure facilities required (for small ruminants). Many functions such as input, distribution, and marketing could be organised through public private partnership (PPP).

4.Financial scheme for supporting goat enterprises with Investment linked tax impetus and enticing credit facility should be formulated by Central and State government. Bank loans should be made easily available for goat farming.

5.In order to meet domestic and global meat requirements Government should adopt quality control and safety protocols. Advanced research tools should be developed to address meat adulteration, chemical residues, traceability, halal authentication, etc. Food testing laboratories should be established duly accredited by FSSAI to check adulteration.

6.Farmers should maintain di? erent types of farm records for smooth management of the goat farm. The various records include birth, health, medical, mortality, weighing, vaccination, etc.

B. Administrative reforms

1."Women Livestock Producer Associations" should be formed for training and empowering women in livestock development. They should be able to take advantage of credit, insurance, inputs, and marketing services from such association. They should be empowered to take decisions on small ruminant issues at household and organisation level.

2.A knowledge sharing platform should be formed at centre and state level comprising of representatives from Animal Husbandry Department, Watershed, Research Institutes, Veterinary Colleges, Rural development Department, Forest Department, Panchayati Raj Institutions, NGOs, and private sectors linked to small ruminant production.

C. Community awareness and capacity building

Development Department, Forest Department, Panchayati Raj Institutions, NGOs, and private sectors linked to small ruminant production.

Linkages need to be created between goat farmers, processors, and exporters. Farmers should not

sell their livestock when need arises, instead they should be sensitised on market demand to help realise be price in domestic market and produce healthy pure breed goats for export. If livestock keeper organisations already exist, they should be strengthened. NGOs can play an active role in awareness generation, capacity building, advocacy, building networks, bringing synergies and empowering the livestock keepers through producer groups, Self-help groups, networks, etc.

References are available with the authors.

ABS (ORAL) : SESRP-03

Goat Farming for Sustainable Livelihood Security in India: Present Status and Opportunities for Enhancing Farmers' Income

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Abstract

India is home to 135 million goats making about 15 % of the world goat population. Country stood second in population, ? rst in goat milk production and second in goat meat and goat skin production in the world. It is an important source of income to farmers particularly in disadvantageous regions in the country where crop failure is the recurring phenomenon. Incessant increase in domestic demand and market price of goat meat has opened the avenue for entrepreneurs to invest in this sector. By virtue of its simplicity, goat rearing is a preferred option among marginal and small farmers and even landless farmers, who depend on common grazing lands for fodder. Goat sector witnessed signi? cant increase in output of its products like meat, milk and skin. Goats and its products contribute Rs. 38,590 crores annually to the national economy. This accounts for about 9% to total value of output (at current prices) from livestock sector in 2010-11.However, actual productivity from goats is much less than their potential due to poor adoption of critical management practices and inadequate support services. Ownership pa of goats among di? erent land holding categories indicated that more than 76% goats have been reared by the marginal and small holdings. Demand for goat meat/mu has increased as increased in per capita income and other associated factors. The gap between demand and supply of goat meat /mu will widen in future as meat demand may grow at faster rate than that of production. Goat milk which is also known as natural functional food contributes 4% to central milk pool (127 million tonnes). However, the goat population in the country has declined by 5 million between 2007 and 2012. Studies revealed that in general, goat rearing contributes about 15% to the total household income of goat farmers and generates gainful employment to rural farm families. However, out of 135.04 million goats, 26.97% are pure bred, 11.77% are graded breeds and

remaining 61.26% are non- descript. Field studies indicated that income per goat per year was about Rs.3200.00, by and large low in productivity and fetch less price. With some li input on nutrition, health and management, the income per adult goat per year was improved to Rs. 4800.00(1.5 times). Goat farmers rearing goats under semi-intensive /intensive management system and with smart marketing may earn pro?t at the tune of Rs. 6500.00 per adult goat per year (double of extensive management system). By doubling income per goat per year, the contribution of goat rearing to the household's income may increase from 15 to 30%. Furthermore, through simple technological and marketing interventions- vaccination of goats, deworming, nutrition supplements, breeding with improved bucks and sale of kids at their commercial age may accrue economic gain of Rs. 5688 crore, net of cost at country level. To fetch this gain, e?orts should be made to make goat farming more structured, organized and less fragmented and dispersed. Bridging knowledge gap and veterinary support are the other key aspects for sustainable goat production and enhancing farmers' income.

1.Introduction

India is blessed with rich animal resources; it is a source of sustainable livelihood and support during the subsistence crisis of farmers. It contributes about 3.9% to national GDP and 24.8% to agricultural GDP (At 2011-12 Prices) in 2013-14. According to the report Situational Assessment of Agricultural Households by the NSSO, a compounded annual income growth rate of 13.7% was observed between 2003 and 2013. Restructuring agriculture processes & policy interventions required to increase the income in real terms (ICFA, 2016). Livestock particularly goat rearing in India is closely interwoven with crop farming. It works as safety valve during the subsistence oriented crop farming. Households cultivating less than 2.0 ha of land (marginal and small) are the main custodian and possess more than 76% goat population of the country respectively. It is the main source of income to farmers particularly of arid and semi-arid regions in the country where crop failure is the recurring phenomenon.

Country has the second largest goat population in the world. It is a home to 135.173 million goats making about 15% of the world goat population in 2012 (FAO statistics accessed in April 2016). Country stood ?rst in goat milk production, second in goat meat production and second in goat skin production in the world. However, goat population in the country has declined from 140 to 135 million between 2007 and 2012 livestock census periods. The growth rate in goat population was about 2.5 % during 2007 to 2012 in spite of higher slaughter rate and annual mortality. Goat sector witnessed signi?cant increase in output of its products like meat, milk and skin.Goats and its products contribute Rs. 38,590 crores annually to the national economy. This accounts for 8.4% to total value of output (at current prices) from livestock sector in 2010-11.Goat plays an important role in livelihood and nutritional security of millions of landless, marginal and small households. As more than 75% goats were reared by these categories of households.Despite the high and relatively stable overall growth of the economy, India's agriculture sector is underperforming and a vast section of the population remains undernourished(Gulati *et al.,* 2012)

Livestock contribute about 12.9% of global calories and 27.9% protein directly through provision of meat, milk, eggs and o?al and also contribute to crop production through the provision of transport and manure (FAO, 2011). In spite of growth in livestock population, consumption of livestock products, people are still de?cient in nutrients that can be supplied by

animal based foods. These foods are more important in context with low-income households. Milk, meat and eggs provide proteins, micro-nutrients, vitamins and calcium in which majority of people are de? cient. The increasing demand for goat meat coupled with high conversion e? ciency of roughages into protein, milk and meat with other advantages (high proli? cacy), short lactation interval and wide range of adaptability, these a has made sheep and goat rearing one of preferred and pro? table venture.

The demand for small ruminant is basically a derived demand necessitated by the demand for meat, milk, wool, hides, skins etc. High income elastic for livestock products, increasing domestic consumption due to increment in per capita income growth, variation in taste preference and urbanization are some of the driving factors of increasing demand for livestock products.Globally, the demand for livestock products, particularly for chevon and mu is on rise, due to the increase in per capita income in developing countries.In the present paper, an a was made to explore opportunities in goat farming for livelihood security of millions of resource poor farmer and enhancing family income. Its untapped potential and probable economic gains due to technological and marketing intervention were assessed.The inferences drawn from present analysis on country'sgoat production — would help in planning to formulate goat development programmes.

1.1 Goat Farming: Present status and opportunities

Country has 34 descript breeds of goats. Goat sector contributes about 8.5% to the total value of output (at current prices) from livestock sector in 2010-11. Ownership pa of goats among di? erent land holding categories indicated that more than 70% goats have been reared by the marginal and small holdings. It showed the importance of goat among resource poor people for their sustainable livelihood and nutritional requirement. The gap between demand and supply of goat meat /mu will widen in future as meat demand may grow at faster rate than that of production. Goat milk which is also known as natural functional food contributes 4% to central milk pool (127 million tonnes). However, the goat population in the country has declined by 5million between 2007 and 2012. Majority of goats in the country are reared under extensive production system and highly depended on common resources. Permanent pasture and grazing lands which is one of the most important commons is gradually shrinking.

1.2 Ownership Pa of Goat

More than 75% of goats are possessed by the marginal and small landholdings. The share of goat ownership has improved with marginal category by 2% between 2001-02 and 2006-07. Small and marginal together constitute about 83% of total land holdings.

Table 1: Distribution of goats according to land holding size (million)

Land Categories	1996-97	2001-02	2006-07
Marginal (<1.0)	51.5 (53.8)	60.4(52.6)	54.8(56.7)
Small (1.0 - 1.99)	18.8(19.7)	24.6(21.4)	18.8(19.4)
Semi-Medium (2.0 - 3.99)	13.4(14.0)	17.0(14.8)	12.9(13.3)
Medium (4.0 - 9.99)	8.1(8.5)	9.6(8.4)	7.5(7.8)
Large (10 and above)	3.9(4.0)	3.3(2.9)	2.7(2.8)
All groups	95.7(100.0)	114.9(100.0)	96.7(100.0)

Source: Input survey, Agricultural Census, Govt. of India

Moreover, ? ock size per goat rearing households has shown increasing trends among all the categories of land holdings (Table2). Unit level data from 59th and 70th rounds of NSSO (Land and livestock holdings) indicated that overall ? ock size has marginally increased between 2002-03 and 2012-13. The maximum increase was observed in large category of land class followed by landless and medium class. This may be due to increasing demand for goat products, increasing nutrition literacy among consumers, goat provide ready to cash option and easy market access. The goat rearing households has been increased by 17% during the same period.

Table 2: Average ? ock size in goat rearing households (no.)

Landclass	Flock size (per goat rearing hh)		All hh	
	2002-03	2012-13	2002-03	2012-13
Landless	2.88	3.40	0.24	0.36
Marginal	3.13	3.15	0.56	0.59
Small	3.48	3.48	0.62	0.62
Medium	3.86	4.20	0.62	0.77
Large	5.52	8.66	0.97	1.65
All	3.28	3.47	0.46	0.54

Source: 59th and 70th rounds of NSSO (Land and livestock holdings)

1.3 Goats and livestock economy:

Goat which is known as poor man's cow has now becoming a symbol of prosperity in rural India. The rural poor who cannot a? ord large ruminants, ? nd goat as the best alternative for supplementary income and milk. Demographic change in livestock population in the country showed a shift in favour of small ruminant particularly for goat (Dikshit et al. 2012). Moreover, goat has a tremendous potential to adapt in di? erent agro-climatic conditions and on wide range of feedings. The goats and its products contribute Rs. 38,590 crore annually to the national economy (Table-3). This accounts for 8.4% to total value of output (at current prices) from

livestock sector in 2010-11. Goat meat alone contributes about Rs. 22,625 crores (59%) to total value of output from goat sector followed by milk (Rs.9564 crores), by-products (Rs.3005 crores), manure (Rs.1535 crores).

Table-3: Contribution of Goats to Livestock Value of Output

Items	Production (000 tons)	Value (in croreRs.)
Meat	905	22,625.00
Milk	4782	9,564.00
Fiber	0.06	15.00
By-products	601.06	3,005.28
Manure	10233.79	1,535.07
Blood	103.04	206.08
Skin	149.07	1,490.70
Increment in stock (Million heads)	0.7423	148.46
Total		**38,590**
Value of output from livestock at current price (crores)	4,59,051	
Share to value of output from livestock sector	**8.41%**	

Source: Author's estimates based on National Accounts Statistics (CSO) methodology

1.4 Goat population dynamics: Compositional changes

There is signi? cant growth in population of goat in India during the last three decades. As per 19th livestock census 2012, goat population in India has increased from 95 to 135 million between 1982 and 2012(Table 4). The highest increase in goat population was recorded 16% during 1982 to 1987. About 13% increase has been recorded between 2007 and 2003.Growth in goat population is demand- driven. In urban areas, demand for livestock products rises faster than the other food groups when income starts to increase (Gandhi and Zhou 2010).However, The Goat population has declined by 3.82% over the previous census. This may be due to high rate of slaughter, e? ect of consumer shift resulting pressure on small ruminants, shrinking grazing lands and migrations. Compound annual growth has been worked out for di? erent sets of census periods. Annual growth in goat population was recorded about 3 per cent during 1982 to 1987. However, it has declined to 0.27% during 1997 to 2003 but further increase and maintained about 2.5% during 2003 to 2007. A negative annual growth (-0.78)was recorded between 2007 and 2012.

Table 4 Trends in goat population

Census year	Goat Population (million)	Periods	% increase/decrease	CAGR(%)
1982	95	-	-	-
1987	110	1987-82	15.79	2.96
1992	115	1992-87	4.55	0.90
1997	123	1997-92	6.45	1.26
2003	124	2003-97	1.34	0.27
2007	140	2007-03	13.01	2.48
2012	135	2012-07	-3.82	-0.78

To understand the goat production in the country, compositional change in goat population according to their age, sex and functional categories must be viewed which provide a complete scenario of goat population and its dynamics over the periods. Categorical growth has been divided into three periods i.e. 2003- 2007, 2007-2012 and overall 2003-2012.During 2003 to 2007, the growth in total goat population was 2.41% (Table 5). The overall growth between 2003 and 2012 was 0.84%. Annual growth rate in male and female goats were about 2.5%. However, it was marginally higher in male category than female. This may be due to majority of males wereareared for slaughter (one time se and receives be care. The annual growth rate in male kids (<1 year) was found impressive (2.65%) and higher than the total goat population growth rate (2.48%). Similarly, growth in males having age one year and above was also found 2.62%. The overall growth in male goats was recorded 2.64% between 2003 and 2007. Positive and high growth in adult male and male kids is an indicator of be goat meat production during the period. Similarly, growth in female category is most important indicator as it provide breeding base. Annual growth in female kids (1.81%) was lower than the male kids (2.65%) although in terms of absolute number, population of female kids was about 24% higher than the male kids. Interestingly, population of dry goats has declined from near 30 million to 25 million between the two livestock census periods. This might be due to slaughter of such goats on account of low productive performance (milk yield, poor proli?cacy and aged). However, growth in total female (2.41%) has mainly come from kids and in-milk animals.Be health, nutrition and general management practices may further improve the growth in population by cu down mortality in kids and adult animals. Major impediment in increasing the small ruminants' population is the dwindling area and productivity of pastures (Ray 1999).Shrinking pastures and grazing lands is more concern to goat keepers because they are resource poor and their dependency on such resources for grazing and gleaning grasses is very high (Dikshit *et al.*, 2012).

During 2007 to 2012, the total goat population of the country declined by 5 million. This period was not good for all the species of livestock and recorded decline in their numbers. Goat population declined by 0.65% annually during 2007 to 2012 (Table 5). Almost all the categories have shown deceleration in their numbers accept dry females. To make comparison between the census periods, category introduced in 2012 census “not calved once” is added to dry goat category.

Annual growth rate in male and female goats were about -1.34 and -0.37% respectively. However, it was muchhigher in male category than female. This may be due to majority of males weretargeted to slaughter. The annual deceleration in male kids (<1 year) was found more than four times (-1.18%) to female kids (-0.34%) even more than the total goat population. Similarly, growth in males having age one year and above was also found negative -1.54% almost ? ve times to its counterpart adult females (-0.37%).Exceptionally, population of dry goats has shown positive growth and grew with 5.34 % annually. As discussed earlier, the population of dry goats includes category "not calved once." Dry goat population (34759 thousand) includes (25305 thousand"dry goats" + 9453 thousand "not calved once"). Even if we exclude not calves once category from dry goats, population of dry goats declined by 0.56% between the periods in question. Analysis indicated that the decline in total goat population between 2007 and 2012 was due to decline in all the categories of male goats. High slaughter rate of male goats (kids and adult) may lead to paucity of improved/elite breeding bucks. Commercialization of goat farming in the country is going in favour of meat goats not in breeding goats. This may be due to quick return in small gestation period.

The overall growth rate in goat population between 2003 and 2012 was 0.84%. Number of female goats increased by roughly 1% while, it was 0.5 % in male goats. Growth in female kids was more than that of male kids (Table 5).

Table 5 Age, sex and function wise growth in goat population in India (2003-12)

('000 nos.)

Categories	2003	2007	2012	Annual Growth Rate (%)		
				2003-2007	2007-2012	2003-2012
Male:						
<1 year	19265	21955	20449	2.65	-1.18	0.60
1 year and above	16550	18839	17168	2.62	-1.54	0.37
Total male goats	35815	40793	37617	2.64	-1.34	0.49
Female:						
<1 year	24767	27092	26545	1.81	-0.34	0.70
1 year and above						
In-milk	34241	37043	36252	1.59	-0.36	0.57
Dry	29535	25446	34759	-2.94	5.34	1.64
Total female goat	88543	99744	97556	2.41	-0.37	0.97
Total goats	**124358**	**140537**	**135173**	**2.48**	**-0.65**	**0.84**

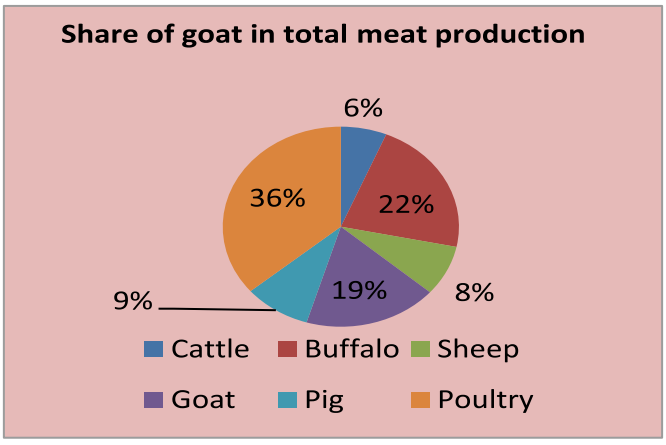
Source: 17th, 18th& 19th Indian livestock Census.

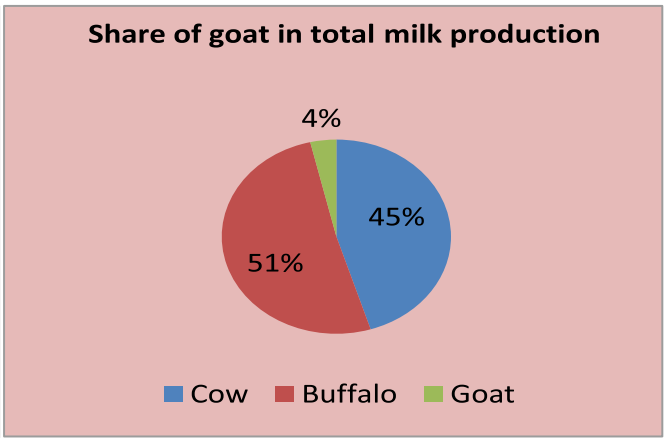
Adoption of improved management practices will increase population growth by cu down mortality among kids and adults. Major impediment in increasing small ruminants' population is the dwindling area and productivity of pastures.Shrinking pastures and grazing lands is more concern to goat keepers because majority of them are resource poor and largely dependenton such resources for grazing and gleaning grasses. Analysis indicated that the decline in total goat population between 2007 and 2012 was due to decline in all the categories of male goats

including breeding bucks. Commercialization of goat farming in the country is going in favour of meat goats not in breeding goats, which need to be balanced by educating such goat farmers.

1.5 Production performance of goats: Milk and Meat

Goat meat is a main staple red meat in human diets without any social restrictions. Goats are an important nutrient (protein) source, particularly for people situated mainly in the tropics. These regions account for more than 90% of the world goat population, with approximately 56% in Asia, 33% in Africa and 7% in South and Central America and the Caribbean (FAO, 1988). Goat contributes 19 per cent to country's total meat production however, poultry is having lion share (36%) to the total meat production from all the species (? g-1).





Goat meat production increased from 0.398 to 0.914 million tons with an annual growth of 7.17% between 2003-04 and 2012-13 (Table-6). However, meat yield increased from 9.64 to 10.74 kg/animal during 2003 to 2013. Similarly, goat milk production increased from 3.7 million tonnes in 2003-04 to 5.1 million tonnes in 2012-13. However, milk yield has increased only by hardly 100 grams/animal over the above period. The impressive growth in meat production in the country resulted mainly due to increase in number of animals slaughtered. Productivity of goat for meat and milk is low and a mainly to poor adoption of technologies.

Table-6: Trends in Goat Milkand Meat Production in India

Year	Goat Milk Production (million tonnes)	Goat Meat Production (million tonnes)	Milk yield (kg/animal)	Meat yield (kg/animal)
2003-04	3.71	0.398	0.314	9.64
2007-08	4.48	0.488	0.39	11.00
2012-13	5.05	0.941	0.43	10.74

Source: Basic Animal Husbandry Statistics (various issues)

1.6 Enhancing farmers' income through improved goat management practices

1.6.1 Average monthly income of agricultural household

As per NSSO Rounds (59 th and 70 th), the average monthly income of farmer household between 2003 and 2013 was increased by 12% annually (Table-7). However, net receipt from animal husbandry was increased by 24% for the same periods, much higher than other income sources i.e. cultivation, wages and non-farm business.

Table-7: Change in Average Monthly Income of Farmer's Household (Rs.)

Sources of income	2003(59th round)	% to total	2013(70th round)	% to total	CAGR (%)
Cultivation	969	45.82	3078	47.90	12.25
Wage earning	819	38.72	2069	32.20	9.71
Non-farm	236	11.16	514	8.00	8.10
Animal husbandry	91	4.30	765	11.90	23.72
All	2115	100.00	6426	100.00	11.75

Source: 59th and 70th rounds of NSSO

Perusal of table-7 indicating that, the contribution of animal husbandry has been substantially increased from 4.30% to 11.90% over a decade. Thus, animal husbandry has great potential to improve farmers' income. However, net receipt from farm business (cultivation andfarming of animals) accounted for more than 50% of the average monthly income per agricultural household in the country during both the rounds. Furthermore, households belonging to the lowest size class, farming of animals fetched more income than cultivation during this reference period.

1.7.2 Contribution of goat rearing in present household income

As discussed earlier, goats are reared by marginal and small households under extensive management system. Studies revealed that in general, goat rearing contributes about 15% to the total household income of goat farmers and generates gainful employment to rural farm families. However, out of 135.04 million goats, 26.97% are pure bred, 11.77% are graded breeds and remaining 61.26% are non- descript. Field studies indicated that income per goat per year was about Rs.3200.00, by and large low in productivity and fetch less price. With some li input on nutrition, health and management, the income per adult goat per year was improved to Rs. 4800.00(1.5 times). Goat farmers rearing goats under semi-intensive /intensive management system and with smart marketing may earn pro?t at the tune of Rs. 6500.00 per adult goat per year (double of extensive management system). By doubling income per goat per year, the contribution of goat rearing to the household's income may increase from 15 to 30%. It needs e?ective support services (prophylactic) from state animal husbandry department, micro credit facilities from ?nancial institutions for increased adoption of technologies and se up of commercial goat farms, market and cooperative departments.

Suggestive Model for Sustainable Income

Goat which is known as poor man's cow has now becoming a symbol of prosperity in rural India. Goat rearing plays an important role in livelihood security of millions of landless, marginal and small farmers. Starting of dairy farm with cows and bu? aloes has become an expensive business as it requires high capital cost in the beginning. Therefore, goat farming is now preferred small scale business among resource poor farmers. A farmer initiate goat rearing with 50 goats of Barbari breed require a capital of about Rs.6.5 lakh. Goat rearing at small scale may utilize family labour (women labour) e? ciently and the problem of malnutrition in women and children may also solved. An economic analysis of goat unit with 50 does and 2 male bucks of Barbari breed is given below:

Economic analysis of goat unit of 50 does:

A. Expenditure (Rs.):

a.	Capital cost:	
(i)	Goat shed	1,25,000.00
(ii)	Equipment	20,000.00
(iii)	50 Barbari goats @ Rs.6000/- per goat (pregnant)	3,00,000.00
(iv)	2 Breeding buck @ Rs.8000/- per buck	16,000.00
Total capital cost		4,61,000.00
b.	Recurring cost:	
(i)	Feed cost (concentrate feed)	1,08,540.00
Adult does, bucks and kids (@		250-300 gram
per adult goat & kid per day for		200-220 days)
(ii)	Health managementcost (@Rs.80/animal/year)	10,560.00
(iii)	Labour (imputed value of grazing) @ Rs.4000/month	48,000.00
Total recurring cost		1,67,100.00
Gross cost		6,28,100.00

B. Income (Rs.):

(i)	Sale of kids (76 kids of 20-22 kg body weight at 9-10 month @ Rs.250/kg/live weight)	4,18,000.00
(ii)	Value of 52 adult goats at the end of year	3,31800.00
(iii)	Depreciated value of shed (@10% per year)	1,10,500.00
(iv)	Sale of milk (after feeding kids)	21,600.00
(v)	Value of goat manure and others	10,000.00
Total income		8,91,900.00
Net income		2,63,800.00
Net income per month		21,983.00

Net return per doe 5,276.00

It is clear from economic analysis that, a farmer start goat rearing with a unit of 50 goats and adopt scienti? c practices, he may earn net income about Rs.2,64,000.00 annually. Per goat per year net income would be about Rs.5300.

1.8 Goat based integrated livelihood models forrain-fed/disadvantageous regions

Livelihood models for di? erent categories (resources) farmers were suggested based on implemented interventions among goat farmers in Bundelkhand region of U (Table-8). Model revealed that a landless /marginal household having 15 adult female goats and 25 poultry birds may yield Rs. 82727 per annum. Similarly, a landless/marginal/small household with 10 adult goats, 2 cows and 50 chicks and 1 ha rain-fed land may earn Rs. 100634 per year. Marginal, small and medium farmers with 5 adult female goats, 2 bu? alo, 2 cows and 2 ha of rain-fed land may earn Rs. 119000 per year. Whereas, a semi-medium, medium and large farmer may earn Rs. 119000 per year with keeping 10 goats, 2 bu? aloes, 2 cows and crop production on 2 ha semi-irrigated land. These recommended models were highly adopted among farmers as they were developed through participatory research with farmers.

Table 8: Goat based Integrated Livelihood Models

S.No	Model	Unit	Net income (Rs)	Suitability for household category	Number of HH Covered under trial
1	Goat+ Poultry	15 adult F+ 25 Chicks	Rs 82727 (71115+11612)	Landless Marginal	64
2	Goat+ Cow+ Poultry+ Crops (Rain-fed)	10 adult F+ 2 cows + 50 chicks + 1 ha.	Rs 100634 (47410+22000+ 23224+8000)	Landless Marginal Small	142
3	Goat+ Buffaloes+ Cows+ Crop (semi-irri)	5 adult F + 2 buffaloes+ 2 cows + 2 ha.	Rs 109705 (23705+34000+ 22000+30000	Marginal Small Medium large	80
4	Goat Buffaloes Cows Crop (semi-irri)	10 adult F 2 buffaloes 2 cows 2 ha	Rs 119000 (47410+32000+ 22000+30000)	Semi-medium Medium Large	56

The growth (productivity and pro? t) in goat rearing can be improved by technological interventions for cu ing down mortality among kids and adult animals and enhancing productivity. The diseases in goats result in mortality ranging from 5 to 25% in adults and 10 to 40% among kids. With large population base and untapped potential of goats, there is a scope to harvest more bene? ts in short period of time. Study ondisaggregated analysis of net gain by individual intervention has been indicated that breeding intervention has been focused to yield economic gains of Rs. 23713 million, which include Rs. 9977 million as cost of intervention. The healthcare intervention, which includes vaccination against important diseases, may generate an additional income of Rs. 24064 million. An additional net gain ofRs. 14002 million has been estimated through nutritional intervention after deducting 29651 million as the cost of nutrition intervention. The net economic gain through marketing of kids at commercial age has been estimated to beRs. 11842 million. This has been worked out after
deducting cost ofRs. 13534 million for keeping animals for additional 4 months to a the commercial age (Table 9). The order of magnitude can be gauged that opportunity cost of technological interventions on health care, nutrition and marketing together are equivalent to about 1.24% of total value of output (at current prices) from livestock sector in 2010-11 and 14.74% of the value of output from goat sector for the year 2012.

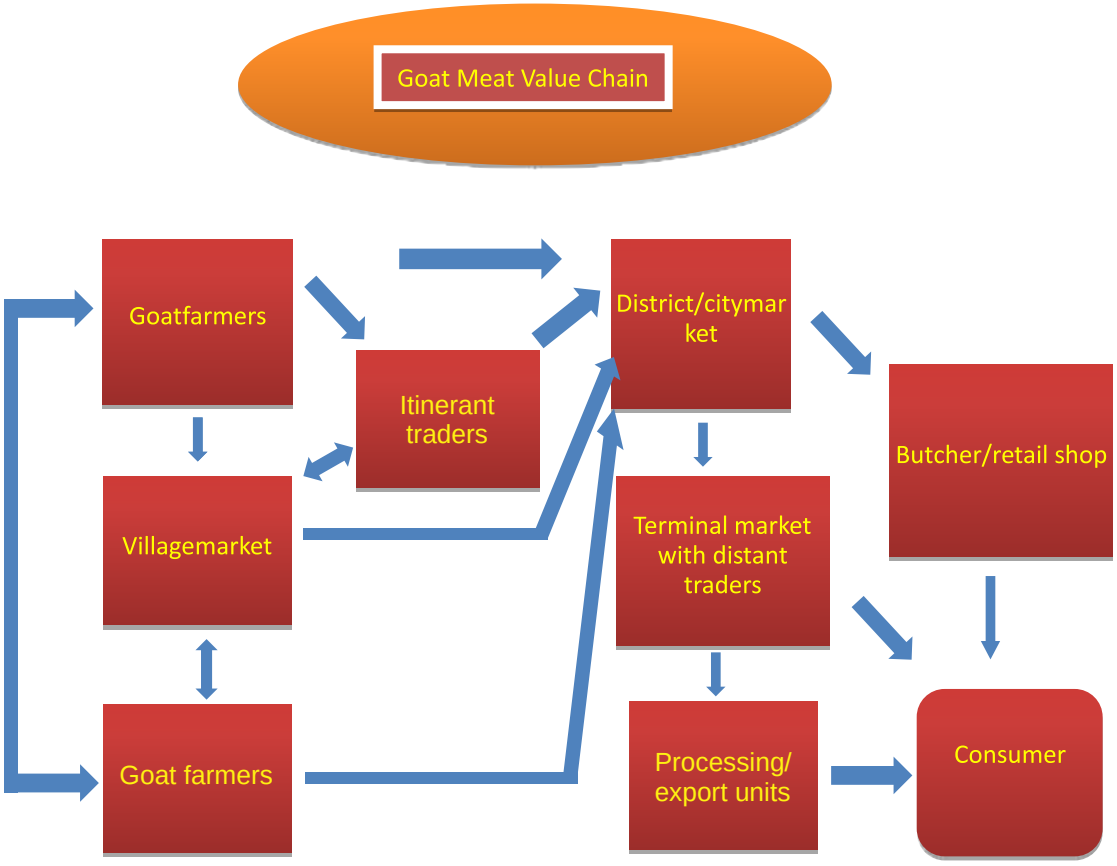
Table 9: Net economic gains from proposed technical interventions in goat production

Interventions	Gross gain	Cost of intervention	Net gain	Gross gain to cost ratio
Breeding				
Additional kids born and survived due to improved prolificacy	10834	5318	13735 (24.15)	2.38
Improvement in body weight	6703	4659		
increment in milk yield	6175			
Healthcare				
Reduction in mortality due to health intervention	24064	6758	17306 (30.42)	3.56
Nutrition				
Body weight gain due to nutrition intervention	19795	11757	14002 (24.62)	1.47
Improvement in milk yield	23859	17894		
Marketing				
Sale of kids at their commercial age	25376	13534	11842 (20.82)	1.87
All	116809	59922	56887 (100.00)	1.95

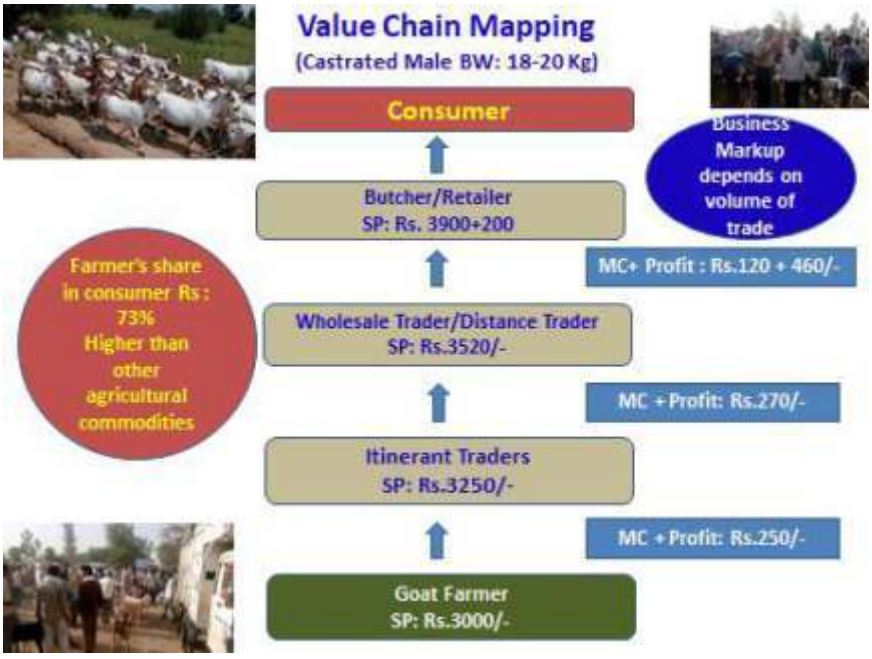
Source: Dixit *et al.*, 2015

2. Marketing of Goats: Current status and issues

Sustained economic and income growth, fast-growing urban population and integration of global agri-food markets are some driving factors of growth in demand for animal food products. By virtue of its simplicity, goat rearing is a preferred option among marginal and small farmers and even landless farmers, who depend on common grazing and forest lands for fodder. There is a rapid growth in the demand for goat meat due to availability of huge domestic market. Goat farmers sell their goats to itinerant traders (Primary trader) or directly to butchers at the age of 10-12 months. These goats are further travel to secondary traders at district level, small butchers, or may be forwarded to distance traders (from other states). Slaughter at slaughter house/ urban butchers and reaches to ultimate consumers.The bene? ts from improved goat technologies can be harvested with improving knowledge and tools of goat farmers who need to increase their on-farm production and link to stable and organized markets. Despite the economic importance of this species to poor households, its marketing is a major challenge for most of the goat farmers. Furthermore, widening gap between demand and supply leads to price rice and quality compromises. There is a need toexplore possibilities of integration of small scale producers with supply chain,suggest farmers' e? cient marketing channels, support to eliminate bo ailing goat value chains for meat animals in the country are as follows:



Goat marketing facility is inadequate and often unorganized in the country. Lack of proper marketing facilities and required infrastructure are the major constraints for lowing realizations of goat enterprises. Small marketable surplus at farm level, lack of collectiveness, lack of e? orts to improve market infrastructure, its outside the ambit of market regulations, weak food safety regulation on production and processing units, lack of proper transportation facilities of live goats, lack of processing facilities, cold chain infrastructure to support distance trade and export and lack of capacity building on scienti? c goat production and product technologies for processing demand driven non-traditional goat milk and meat products are some of the important constraints in goat marketing. It is needed to create necessary infrastructure, policy and procedures to organize goat trade for be price realization and faster growth of goat sector. Moreover, majority of goats being reared under extensive management system and need marketing linkages to ensure remunerative returns Public Private Partnership (PPP) initiatives for this purpose need to be supported and encouraged to organize as SHGs, Farmer Producers' Organization, Producers' Companies etc. to have be access to credit, inputs and marketing opportunity. The new marketing system is expected to improve marketing e? ciency and induce a shift in goat production from subsistence to a commercial venture. This needs an integration of small scale producers on the supply chain as majority of goats are reared by the poor farmers.



The net income may increase if farmer target festive season sale. E? orts should be made to make goat farming more structured, organized and less fragmented and dispersed. Bridging knowledge gap and veterinary support are the other key aspects for sustainable goat production and enhancing farmers' income. The emerging value chains are presently con? ned to urban areas (inmetros) only.

2.1Challenges in small farm goat rearing

In spiteof having potential of good economic returns from goat rearing, goat farmers havevery poor income levels. There may be a number of reasons for it and summarized brie? y as follows.

i. Knowledge gap onscienti? c interventions and technologies have not yet been e? ectively disseminated and adopted by thegoat keepers.
ii. Prevalence of non-descript or poor genetic-make-up of animals in want of selection and breeding practices.
iii. Scarcity of superior bucks-Breed dilution is common feature due to indiscriminate breeding. Sale of males with higher growth rate at 3-6 months of age and small ? ock holders are not willing to keep breeding buck, thus low potential males are being used for breeding the goats. The availability of purebred breed bucks of high genetic merit is very –very low (1:80-100 does) in goat keepers ? ock.
iv. Scarcity of feed and fodder: Under feeding and inadequate housing further deteriorate the immunity level of animals and made them vulnerable for diseases.During last few decades' goat ? ock and herd sizes were reducing due to shrinkage of common grazing resources and de? ciency of biomass in rangelands.
v. Higher mortality on account of very low adoption of prophylactic and curative health measures: Prophylactic health measures were highly uncertain and followed by few (<10%) farmers.
vi. Inadequate housing- goats were housed predominately in human dwelling, in open and under enclosures made up bush and shrubs (50-55%).
vii. Depletion of grazing resources due to over grazing on account of very high stocking rate and poor management of grazing resources.Expenditure on feed and fodder account for more than 60% of recurring cost, which ma for landless goat keepers and small land holders. During draught or ? ood the availability of biomass from CPR reduces from 3.5q/ha to 0.5q/ha per year. Thus productivity, survivability and income go down upto70%.
viii. Low availability of veterinary and other support servicesmainly institutional credit to goat keepers- Veterinary services are very poor and not reaching to majority (>82%) of farmers.
ix. Low price realization due to unorganized marketing and lack of milk cooperatives.Majority of small ruminants was sold through middlemen and share of middle man in total income varied from 15-35%. Distress sale of goat due to very urgent natures of domestic needs and thus farmers realized lesser share.

3.Conclusion

Goat development has tremendous potential for providing sustainable livelihood to

resource poor farmers speci? cally in arid and semi-arid regions where crop failure is the recurring phenomenon.Present goat productivity could be increased many folds by improving feed and fodder availability, improvement in genetic potential and health measures with improved delivery services. Goat productivity improvement along with appropriate package of practices and their e? ective adoption could enhance income and employment of people. Promotions of goat based integrated livelihood models is key to improve the economic and social status of farmers and other stakeholders. Strengthening of superior bucks supply, credit and market structure are some of the important strategies to make the goat rearing as pro? table venture.

References are available with the authors.

LEAD :SESRP-04

Scope and Prospects of Dairy Sheep Farming in India for Functional and Healthy Milk and Cheese Production

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Dairy sheep and goats account for approximately 21% of small ruminants in the world, produce around 3.5% of the world's milk, and are mainly located in subtropical-temperate areas of Asia, Europe, and Africa. World sheep population is 1172 million, out of it 246 million (21%) are dairy sheep contributing 11.12 million tonnes of milk. Dairy sheep are concentrated around the Mediterranean and Black Sea regions, where their dairy products are typical ingredients of the human diet. Dairy small ruminants account for a minor part of the total agricultural output in France, Italy, and Spain (0.9 to 1.8%) and a larger part in Greece (8.8%). Sheep farming for milk production is predominately con? ned to Middle East and Mediterranean countries. These countries contribute more than two-third of total sheep milk produced in the world. In Mediterranean countries, 60% of sheep are totally or partially milked daily and >95% of milk is transformed into di? erent types of cheese. In India, about Rs 2000 crore cheese market is growing at 10-12% annually. Although cheese has always been acquired taste in India, its consumption has been growing signi? cantly driven by pizza chains and consumers adapting to new forms of cuisines in metros. Cheese prepared from sheep milk has special preference among consumers in Europe. Assaf (Israel), East Friesian (Germany), Lacaune (France), Sarda (Sardinia), Chios (Greece), Manchega (Spain) are some of the well-known dairy sheep breeds improved and reared under intensive system for milk (>200kg milk/lactation) and cheese production.Fat tailed sheep found in Middle East and Mediterranean countries also contribute sizably to milk production (Mohapatra and Shinde, 2018). Sheep milkis an important source of dietary protein to people in Middle East

countries, mainly smallholders, landless people, nomads and peasants while in Mediterranean countries, it is processed into high quality dairy products like cheese and yogurt. Sheep milk gives a high cheese yield (~15% as compared to 10% for cow milk). Some cheese manufacturing channels (Roquefort in France, Manchego in Spain and Feta in Greece) are well organized and are linked to more intensive sheep farming systems that include, milking machines, feed supplementation and three lambing in two years.

World Sheep population	1172 million
Dairy Sheep	246 million
Milk production	10.12 million tonnes
Traditional Dairy Farming	Middle east (Syria, Israel, Jordon, Palestine, Iraq)
Commercial Dairy Farming	Mediterranean countries (France, Germany, Italy, Spain)
Well known dairy sheep breeds	Awassi (Israel), Assaf (Israel), East Friesian (Germany) Lacaune (France), Sarda (Sardinia),Chios (Greece) Manchega (Spain)
Milk yield	>200 lit./lactation

Milk yield of Indian sheep breeds is small and su? cient to meet out requirement of their o? spring and contribute li
certain areas also converted into ghee and curd (Shinde and Naqvi,2015). There is no dairy sheep breeds in India, Patanwadi and Malpura in comparison to other breeds haverelatively higher milk yield (0.8-1.0kg of milk daily in early lactation). This paper reviews present status of sheep milk production and exploring possibility of introducing dairy sheep in the country to increase milk production and cheese production for growing fast food market.

Dairy sheep in Indian context

In the country, sheep milkis produced in small quantityin low-input systems managed by local communities and contributing to the food security of people in unproductive areas such as desert, steppe, high mountains, swamps etc. (Shinde and Naqvi, 2015). Sheep milk is produced in extensive traditional production system and high mobility (migratory) and source of nutrition for nomadic peoples. It is rich in organoleptic properties and physico-chemical composition and contributing to health bene? ts of ruralmasses. Improvement of productivity for native sheep for dairy purposeswill improve the nutritional security of people living in harsh climate and also below poverty line.

At present, sheep are milked in rural areas for their household milk requirement, although individual animal yield is smallbut collectively from a ? ockof 40-50 sheep suppor milk requirement and nutrition of children. There is no speci? c market for sheep milk, it either used in household preparation or mixed with milk of other species and sold in the market. Introduction of dairy sheep in the country would generate regular income to farmers fromsale of milk and value addition in form of cheese, paneer, yogurt etc.Further it would provide diversi? ed and nutritious milk products to consumers in urban market. Secondly increased milk yield of dam would directly bene? t the lamb growth during pre-weaning stages and be return to farmers from sale of heavier lambs. The demand of cheese in Indian market is increasing noticeably during the recent past with growing demand of pizza and other fast foods. The cheese of sheep milk has great demand than cheese prepared from milk of other species. In present trend of growing fast food, there is a good demand of cheese in Indian market. Further organic nature of sheep milk adds to Special Avenue to it. Because majority of sheep are maintained on grazing lands in deserts and hill and mountain regions and milk from it, is free from pesticides and other chemical residues.

In the country, milk yield of native sheep breeds like Malpura and Patanwadi can be improved by crossbreeding with Awassi or Assaf breeds of Middle East and can be developed as triple purpose (Meat, wool and milk) animals. The introduction of dairy sheep in India may serve two purposes (i) Milk from sheep will provide regular source of income and be nutrition to farmers in harsh and dry zones of the country (ii) Milk products from dairy sheep will meet the demand of urban people, especially cheese prepared from sheep milk. It will create great demand in the country because of nutritious, be ? avour, stretch-ability and used in pizza food chain. In general, dairy sheep will break the vicious circle of poverty and bring sizable contribution to livelihood and source of income to farming communities in the country.

Sheep milk production

Sheep milk is mostly producedin the Mediterranean area. Native dairy sheep are reared in these areas which are well adapted to environment and local feed resources. Awassi sheep is a fat-tailed breed, found extensively in Turkey, Iraq, Syria, Lebanon, Israel, Jordan and there are about one million Awassi sheep in Turkey. In US, sheep rearing for milk production is still a budding industry. There are about 100 commercial sheep dairies, located in the upper Midwest and the New England states, but very few in California. Europe has a much stronger dairy sheep industry, with France and Spain leading the market. China leads the world in sheep milk production. China produces over 1.5 million tons of sheep milk annually. Most of the sheep dairy farming found in Qinghai and Tibetan Plateau. About 4.00 million farmers in Turkey rear sheep and produce one million tons of milk annually. Turkeypeople prefer sheep milk over goat milk. They also love sheep milk products like cheese and yogurt. Besides, they rear sheep for sacri? ce in a traditional ceremony, about 2 million sheep are sacri? ced annually. The most popular breed for sheep milk in Turkey is the white Karaman. Turkey exports dairy sheep products to Lebanon, Kuwait, and Dubai.Sheep rearing for milk is one of the most vibrant economic activities in Greece and produce 732095 tons annually.

Chios breed is one of the most popular dairy breeds of sheep in Greece. The sheep milk in Greece is used for consumption and processing of yogurt and cheese.Awassi is the most popular breed of sheep in Syria. Syria produces approximately 644561 tons of sheep milk annually. The sheep are grazed in the mountains during spring and moved to the desert during winter. Sheep milk top the list of the most consumed livestock products in Syria. Besides, consumption, sheep rearing is one of the major contributors to Syria's economy. Annual milk production in leading dairy sheep farming countries given in table 1.

Table 1. Sheep milk production in leading dairy sheep farming countries

Country	Tonnes	Country	Tonnes
Afghanistan	206675	Hungary	1149
Algeria	284684	Indonesia	159871
Austria	11982	Iran (Islamic Republic of)	449718
Bulgaria	69375	Iraq	57297
China	1540000	Israel	19745
Cyprus	29840	Italy	410380
Egypt	99322	Pakistan	38470
Ethiopia	87154	Syrian Arab Republic	644561
France	270000	Turkey	1344779
Greece	732095	**TOTAL**	**10122522**

Source: FAOSTAT 2017

Dairy sheep breeds and distribution

Country	Dairy sheep breeds
Israel	Awassi, Assaf
Greece	Chios, Karagouniko
Spain	Churra, Lacha, Manchega
Italy	Comisana, Massese
France	Lacaune
Sardinia	Sarda
Germany	East Friesian

Awassi is a triple purpose sheep (milk, meat and wool) belonging to fat-tailed group. They are widely found in Middle East (Israel, Syria, Lebanon, Jordan and Iraq) and southern Turkey. Awassi ewe produces 40-60 and 70-80 kg of milk per 150-day lactation period under traditional and improved production systems, respectively, in addition to the suckled milk left for lambs until weaning. The improved Awassi may produce up to 506 litres of milk in 214-day lactation period. Intensive e? orts have been made in di? erent part of the world for improving milk yield of this breed. The Awassi sheep, a breed originally from Iraq was improved in Israel around 1960 and has since spread to 15 countries in southern and eastern

Europe, Central Asia, Australia, Near and Middle East (Fig. 1).
Assaf breed was developed in 1955 in Israel by crossing the East Friesian with the Awassi. In Israel, the Assaf breed is managed under intensive production system and produce 334 litre of milk in 173-day lactation with mean li size of 1.57 lambs/ewe lambing and lambing interval of 272 days. Assaf produce less milk during a shorter lactation than the Awassi, but its greater li size made it a more pro? table breed. Manchega is a native Spanish breed, developed in the 19th century in the region of La Mancha. Manchega breed is well adapted to harsh environment. Average milk production of the breed is 126.9 litre in 120 days of lactation with 7.3% fat, 5.6% protein and 18.5% total solid contents. The milk is mainly used for production of Manchego cheese, a highly appreciated product for consumers in Spain. In the Lacaune ? ock, average milk yield increased from 80 litre in 135-day in 1960 to 270 litre in 165-day in 1999 by implementing an e? cient breeding strategy for a d n of more than half a million ewes for the milk market in France.

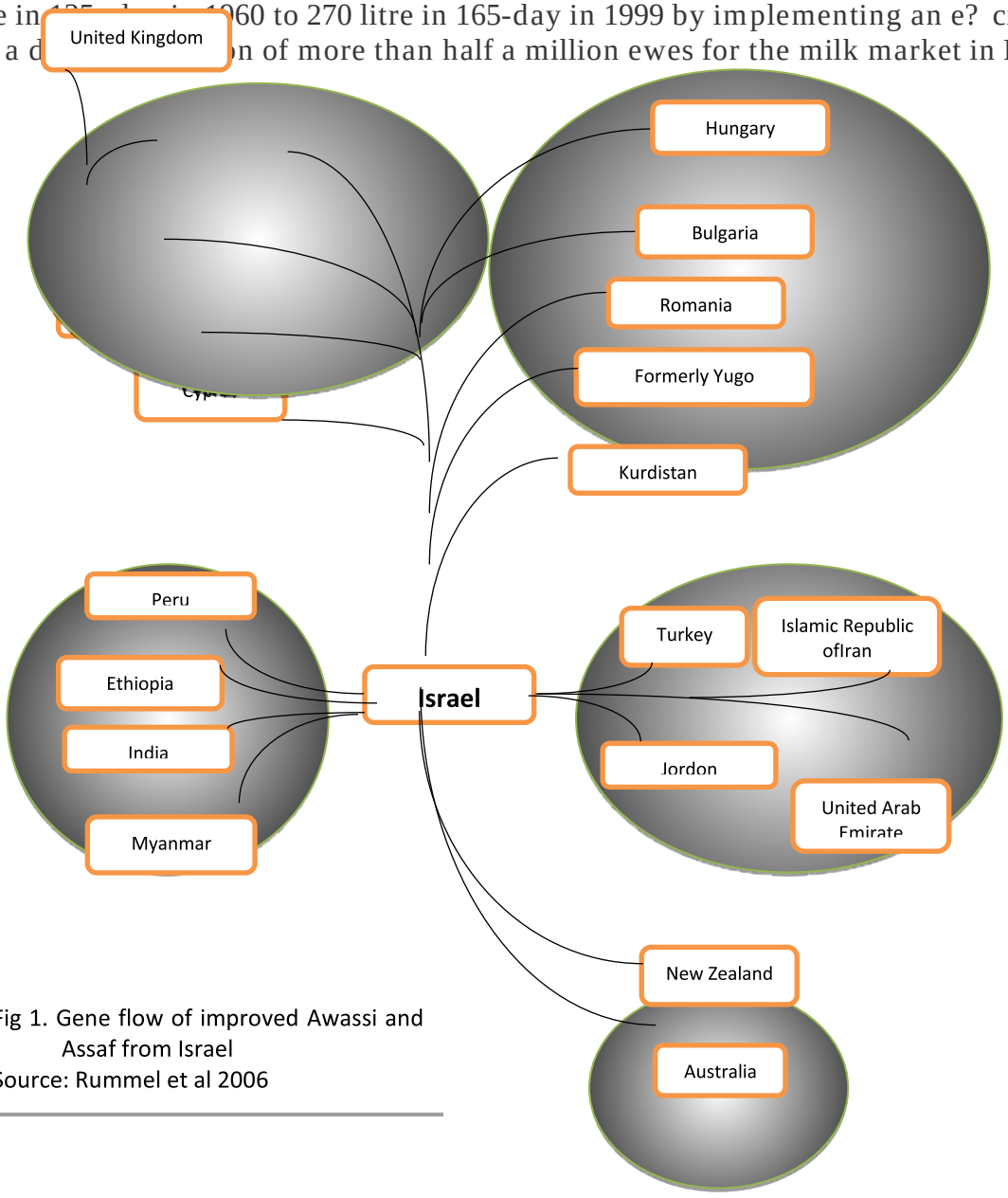

Fig 1. Gene flow of improved Awassi and Assaf from Israel
Source: Rummel et al 2006

East Frisian is highest milk yielding sheep breeds originated from East Frisia in northern Germany. In Austria East Frisian ewes yield 374±106 kg with highest yield of 496±125 kg in a lactation period of 240 days with 5.62% fat and 4.91% protein. East Frisian sheep milk yield of 161kg in 186 days of lactation in Mediterranean environmenthas been reported. Milk yield of dairy sheep reared under di? erent feeding system in sheep rearing countries are given in Table 2.

Table 2. Milk yield of dairy sheep breeds

Country	Breed / Strain / Cross	Milk yield (kg)	Lactation length (Day)	References
Sardinia	Sarda	327.0	168.0	Kassem (2005)
Iraq	Awassi	97.40	88.96	Al-Samarai and Al-Anbari (2009)
Jordon	Awassi	134.12	106.2	Khaleel Jawasreh et al. (2013)
	Awassi	85.0	120.0	ACSAD (1983)
Croatia	Cres sheep	58.48	172.0	BoroMioc et al. (2009)
USA	East Friesian	209.4	161.4	Thomas et al. (2014)
	Lacaune	194.8	155.2	Thomas et al. (2014)
Israel	Awassi	506.0	214.0	Rummel et al. (2005)
Turkey	Awassi	222.5	187.0	Gursoy et al. (1992)
Spain	Assaf	334.0	173.0	Pollott and Gootwine (2004)
	Manchega	154.0	120.0	Pollott and Gootwine (2004)
	Churra	127.0	120.0	Pollott and Gootwine (2004)
Austria	East Frisian	374.0	240.0	Fuerst-Waltl et al. (2005)
France	Lacaune	297.8	166.0	Institut Del Ele Vage (2012)

Indian sheep breeds and milk yield*:* Milk yield of Indian sheep breeds is low and no a have been made in India for improving milk yield of native sheep under genetic improvement programme. Milk yield of Indian sheep breeds has been estimated by several workers and

presented in Table 3.

Table 3. Milk production traits of Indian sheep breeds and crossbreds

Breed / strain	Daily milk yield (g)	Milk yield (kg) 90 days	References
Malpura	418.5	-	Narula et al. (1999)
	531.6	-	Mishra et al. (2009)
Awassi x Malpura	472.3	-	Arora et al (2004)
Rambouillet x Malpura	-	69.9 (A) & 53.6 (S)	Sahni et al. (1975) Sahni et al. (1975)
Rambouillet x Chokla	-	60.7 (A) & 46.3 (S)	Sahni et al. (1975)
Chokla	-	50.6 (A) & 41.4 (S)	
Garole x Malpura	436.6	-	Mishra et al. (2009)
Muzaffarnagri	500.0	-	Acharya 1982
Jalauni	500.0	-	Acharya 1982
Bharat Merino	514.0	-	Singh (1997)
Rambouillet	418.0	-	Singh (1997)
Patanwadi	783.7	-	Saha et al. (2009)
Malpura	515.7	-	Saha et al. (2009)

Autumn (A) & Spring (S) season

A ? ock of 30 improved dairy sheep of fat-tailed Awassi breed was imported by Nimbakar Agriculture Research Institute, Phaltan (Maharashtra) from Israel to improve the milk production and growth rates of the local Deccani sheep. Pure Awassi ewes at NARI produced 475 kg milk (fat content 7-9%) in 238 days (www.nariphaltan.org/nari/about-tech-3.php). At ICAR-Central Sheep and Wool Research Institute, Avikanagar (Rajasthan) Awassi rams brought from NARI were crossed with Malpura. Awassi x Malpura ewes produced 29% (472g) more milk yield than Malpura ewes (366g). Later on research programme was terminated due toless number of pure Awassi rams and chances of inbreeding. Daily milk yield of 783.7g in Patanwadi and 515.7g in Malpura sheep was recorded in semi-arid region of Rajasthan. Daily milk yield of 672.73±15.60g and total yield of 63.02±3.39 kg in 90-days lactation yield in Avishaan sheep was reported by Ved Prakash et al (2019) (Personal communication).

Sheep milk composition

Sheep milk is rich in proteins, minerals and lipids and its composition is close to that of

bu? alo milk. The milk contains more calcium, phosphate and magnesium and the lipid fraction contains higher proportions of middle-chain fa acids. For many people, especially infants, the milk of sheep is a medical necessity as an alternative to cow milk. Traditionally sheep milk is used in arthritis and also fast healing of fracture cases. Such a of sheep milk has received li medical research a but they are supported by much anecdotal experience. Food allergies and gastrointestinal disorders have been helped by goat and sheep milk in many anecdotal but poorly researched reports. Sheep milk contains higher total solids and major nutrients than goat and cow milk (Table 4)

Table 4.Average composition of basic nutrients in goat, sheep and cow milk

Composition	Sheep	Goat	Cow
Fat (%)	7.9	3.8	3.6
Solids-not-fat (%)	12.0	8.9	9.0
Lactose (%)	4.9	4.1	4.7
Protein (%)	6.2	3.4	3.2
Casein (%)	4.2	2.4	2.6
Albumin, globulin (%)	1.0	0.6	0.6
Non-protein nitrogen (%)	0.8	0.4	0.2
Ash (%)	0.9	0.8	0.7
Calories /100 ml	105	70	69

Source Park et al (2007)

Casein is major protein in sheep milk (76-83% of total protein). Sheep milk whey protein accounts for 17-22% of total protein. Sheep milk rich in cysteine and methionine. Lactose in sheep milk in comparison to goat and cow are similar and less in proportion to their total solid. Carbohydrates other than lactose found in sheep and goat milk are oligosaccharides, glycopeptides, glycoproteins and nucleotide sugar in small amount. Milk oligosaccharides have considerable antigenic properties and are valuable in growth promotion of the intestinal ? ora of the new born. Sheep milk has smallest fat globule of 3.30 µm than 3.49 µm in goat and 4.55 µm in cow milk. This is advantageous for be digestion and e? cient lipid metabolism. Five fa acids ($C_{10:0}$, $C_{14:0}$, $C_{16:0}$, $C_{18:0}$ and $C_{18:1}$) account for >75% of total fa acids in sheep milk. Caproic ($C_{6:0}$), caprylic, ($C_{8:0}$), capric ($C_{10:0}$) and lauric ($C_{12:0}$) are signi? cantly higher in sheep milk than cow milk and associated with characteristic ? avour of cheese. Total conjugated linoleic acid (CLA) content in ewe, cow and doe found in following order ewe>cow>doe milkfat, 1.08, 1.01 and 0.65%, respectively.

The levels of Ca, P, Mg, Zn, Fe, and Cu are higher in sheep than in cow milk, the opposite appears to be the case for K and Na. Sheep milk is richer than cow milk in most of the vitamins. Goat and sheep milk are characterized by higher vitamin A concentrations in comparison with cow milk. All of the β-carotene in milk from goats and sheep is converted into retinol, resulting in the white color of

milk.

Bio-peptides in sheep milk

Sheep milk during gastrointestinal digestion and fermentation of food materials with lactic acid bacteria produced functional and physiological active peptides of proteins. The liberated bioactive peptides (BPs) exhibit a wide variety of physiological functions in the human body such as gastrointestinal, cardiovascular, immune, endocrine and nervous systems. The function of these bio- peptides in human health and physiology are antihypertensive, antimicrobial, antioxidative, antithrombotic, opioid, anti-appetizing, immunomodulatory and mineral-binding activities. Sheep milk peptides are considered as health promoting foods or pharmaceutical applications. Recently, marketing of bioactive sheep milk ingredients have emerged as new sector for bio-peptide industries. Many of these components are used in both dairy and non-dairy food formulations and even pharmaceuticals (Korhonen and Pihlanto, 2007). These products have enhanced bioactive functions in human health including the immune system, reduce elevated blood pressure, combat gastrointestinal infections, help control body weight and prevent osteoporosis (Hartmann and Meisel, 2007).

Sheep and goat milk proteins are also important sources of bioactive ACE inhibitory peptides and antihypertensive peptides. They can provide a non- immune disease defense and control of microbial infections. A variety of naturally formed bioactive peptides have been found in fermented dairy products, such as yoghurt, sour milk and cheese. Bio-peptidesare used in the formulation of health-enhancing nutraceuticals, and have well-de? ned pharmacological e? ects (Atanasova and Ivanova, 2010).

Dairy Sheep Production System

Dairy sheep farming is predominated in border countries of Mediterranean and Black Seas and Middle East. Sheep milk production systems in di? erent countries are:

(i) In Middle East countries, milk is suckled by the lambs up to weaning (3-4 month of age) thereafter ewes are dried up.Yogurt and cheese are the main dairy products from sheep produced by households and small scale local processors by traditional methods. Some traditional products like Jameed in Jordan and Shanklish in Syria and Lebanon are also preparedfrom sheep milk (El Balaa and Marie, 2008; Wurzinger et al., 2008).

(ii) In Central and Eastern Europe, milk is suckled by lambs for 3-4 month and ewes are milked for one month after weaning of lambs.Milking machine is used for milking of sheep and rapidly developing and used in Romania, Bulgaria, Slovakia Spain, France, Greece and Italy. Manchega, Assaf, Churra, Lacaune, Sardinia, Chios are dominant sheep breeds for milk production and yield upto 180-200 litre per lactation. Manchego, Roquefort and Feta are major cheese brand sold from sheep milk. In certain units of Spain, France and Greece, sheep are stall fed and milked by rotary parlour with automatic cluster removal. Assaf ewes are maintained in Israel under an intensive system, and milked from lambing and

lambs are transferred at birth to arti? cial rearing units.

(iii) In Mediterranean countries, milk is suckled by lambs up to weaning at 4 week of age then ewes are milked for 5 month. Initially, the ewes are milked twice daily then gradually shifted to once daily with termination of lactation.Practically 60% of all ewes are milked totally or partially, and about 95% of sheep milk is transformed into cheese.Lambsare considered as by-products of the sheepdairy sector.

(iv) In nomadic ? ocks in desert and steppe areas of Asia, Near East and North Africa, ewes are milked in evening before lambs are allowed to suckle. Then about 4 weeks after lambing, the ewes are milked once a day before lambs are allowed to suckle.

(v) In Israel and Cyprus, milking starts 2 or 3 day after lambing and in Spain about 2 week after lambing in intensive system. Sheep breeds with high-milk yield maintained under high levels of nutrition milked once a day and started soon after lambing and continued until lambs are weaned at about 6-8 weeks.

(vi) In high yielding eweslike East Friesland in Northern Germany, lambs are removed within few hours of birth and ewes are milked for 10 months. This system has generally been adopted in the small sheep milk industry recently started in Britain and Holland.

Sheep Milk Products

Major portion of sheep milk is used for cheese making in most of the countries. Sheep milk cheese is rich in calcium with excellent bioavailability. Cheese of sheep milk rich in CLA and vary between 3.4–4.5 mg/g of fat (Lin et al., 1995). Some 75% or more of CLA in cheese is *cis*9, *trans*11 CLA isomer, while trace levels of *trans*10, *cis*12 CLA isomer are also present. The *cis*9, *trans*11 isomer stimulates the growth, reduces the severity of diabetes, strengthens bones, decreases cholesterol levels and has anti-atherogenic properties.

Indian sheep milk products

The sheep milk is rich in many of the components. The value addition to sheep milk can create variety of milk products. The sheep milk was utilized for development value added milk products.Mozzarella cheese is rich (33%) in proteins, ? avour milk, paneer, gulabjamun, peda, kulfees etc.are developed from sheep milk. The carrot ? avoured sheep milk is highly acceptable. Paneer obtained from sheep milk contained 26% protein and 11% fat with 18% yield. The sheep milk paneer had desirable texture and was highly acceptable. Sheep milk yield 22.4% khoa. All these products are rich in nutrients and also well accepted by the consumer, there is no problem of ? avour, taste and other issues like goat milk(Gadekar et al 2018).

Conclusion

Sheep milk is nutrient dense food. E? orts must be directed towards developing dairy sheep in India either by crossbreeding with exotic dairy sheep or by importing exotic germplasm. This would not only help in nutritional security of sheep farmers but would also increase theirincome through sale of surplus milk, improve the lamb growth at faster rate and thereby more incentives to the farmer. Therefore, sincere e? orts must be directed towards developing dairy sheep in India to make it a triple purpose animal and for livelihood and nutritional security to sheep farmers.

References are available with the author.

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Migratory Sheep and Goat Production in North-WesternHimalayas: An Overview

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The north-western Himalayan region comprises the states of Jammu & Kashmir, Himachal Pradesh and U Jammu and Kashmir comprises three distinct regions of Leh, Kashmir valley and Jammu. Leh slopes gradually towards north and north-east while the Kashmir valley slopes toward the south of Himalayan axis. The hilly region of U consists of a Himalayan tract in the extreme north and comprises Almora, Garhwal and Nainital. Himachal Pradesh is traversed by hills ranging in altitude from low to high. Pastoral based migratory sheep and goat production is being practiced in the region.

Pastoralism is ancient but viable mode of mobile livestock production in mountainous regions of the northern India. Pastoralists are the one which raise livestock under extensive conditions using natural rangeland as the main forage for the animals. Pastoralists inhabit zones where the potential for crop cultivation is limited due to steep terrain, extreme temperatures and low and highly variable rainfall. Within this unpredictable, vulnerable and dynamic environment, they have developed successful mechanisms of adaptation to maintain an ecological balance

between themselves and natural environment.

Pastoralism is making signi? cant contribution to the hill livestock farming in terms of income, employment and nutrition. It also plays an important role in Indian economy by contributing to food security (mainly milk) and provision for draught animal, as well as foreign exchange by export of meat and ? bre, e.g. pashmina (Bhasin 2011).Sheep and goats are commonly reared in most of the pastoral system. These are well adapted to the climatic conditions of arid regions and more tolerant to the diseases. Pastoralist often rear more than one species to bu? er risk of livestock losses. Moreover, this also leads to be exploitation of the rangeland due to di? erent feeding habits of livestock species.

Types of pastoralists

- *Nomadic*
  Nomadic pastoralism is a form of pastoralism where livestock are herded to ? nd fresh pastures to graze. These pastoralists lack permanent se and usually cover great distances with their livestock, following the pasture availability throughout the season. This term is used when mobility is high with irregular pa
- *Transhumant*
  Pastoralists using regular seasonal movement between relatively ? xed locations. Movement could be vertical i.e. from high altitude to low altitude or between high and low rainfall areas (in tropical system)
- *Agro pastoralist/ sedentary pastoralist*
  These are the se pastoralist who cultivate su? cient areas to feed their families form their own production (Blench, 2001). The herd size of livestock in these is smaller when compared to other pastoralist.

Pastoralist derive most of their family incomes (more than 50 %) from livestock and livestock products, whereas agro-pastoralists derive most of their family income from cultivation and only a small amount from livestock production (IFAD 2008). True nomads follow an irregular pa of movement, in contrast to transhumance where seasonal pastures are ? xed. However, this distinction is often not observed and the term nomads used for both. Nomadic pastoralism is very common in the Himalayas and a number of nomadic communities practise this (Misri, 1998).

Pastoralism in North-Western Himalayas

Pastoralism in North-Himalayas is based on transhumance production system involving cyclical movements from lowlands to highlands to take advantage of seasonally available pastures at di? erent elevations (Bhasin 1988). Mobility is one of the most important modi? cations in the pastoral community of the Himalaya, through which pastoralist successfully manage their environment with a high degree of diversity.Pastoralism help in converting low values plant resources in remote areas in to high values of animal products through migratory grazing.The nomadic pastoralists of Himalayan region make e? cient use of the seasonally abundant natural resources, and upholds soil fertility by generating organic manure from livestock, while grazing also controls spread of invasive plant species (Bhasin, 2011). Some of the herding communities in the north-western Himalayan region include; goat and sheep herding Bakrawals of Jammu and

Kashmir, bu? alo herding Gujjars in Kashmir, parts of Himachal Pradesh and U Pradesh, goat and sheep herding Gaddis, Kanets, Kaulis and Kinnauras in Himachal Pradesh.

Gaddipastoralist

Gaddi is a distinct tribe of nomadic pastoralists found in the Himachal Pradesh state of India. The word *Gaddi* refers to a territorial group, or a special class of people who wear distinctive clothes. The Gaddis, in all, have derived their name from their native land, the Gadheran, which lies on both sides of the Dhauladhar ranges. In its north east the Dhauladhar leads to the higher Himalayas, while towards its south west it touches the Shiwaliks - the lesser or outer Himalaya which merge into the plains. This continuity of the plains up to the higher Himalayan ranges o? er an excellent migratory route to the Gaddis. Giddies are distinct from other nomads in having a permanent house somewhere in the area. Gaddi habitations are situated on the Dhauladhar between altitudes of 1000 - 2500 m above MSL.

"Gaddi" also known as "White Himalayan goat" is the predominant goat breed of high altitude, Western temperate Himalayas with its true home tract in hills of Himachal Pradesh but distribution extending to adjoining hilly areas of Jammu and Kashmir and U (Acharaya, 1982). These goats are generally reared by the traditional Gaddi shepherds.

Migration pa

Gaddis practice long distance herding of sheep and goats. Earlier Gaddis were considered to be nomadic or semi-nomadic from Kangra valley, but most Gaddis are now semi-nomadic and not nomadic, having permanent dwellings in Kangra valley.The *Gaddis* move from high pastures to low pastures during the year, leaving for the lowhills and plains in October and returning to their ? elds in April. During winter, the ? ocks graze in the valleys, while in summer they move to higher altitudes. Movement of people andtheir livestock proceeds between previouslyearmarked sites, which become more or lessregular seasonal encampments or bases (Brahmi et al., 2011). The main reason for their migration to the lower hills during winter is the absence of grazing pastures due to heavy snowfall in the high altitude areas. The shepherds migrate from middle hills to plains in the month of November and return back to same place in month of April. From April on wards they migrate to high altitudes (8500-9000 feet above MSL) and remain there up to May and from June to August in higher hills (10000- 12000 feet above MSL) of Lahual and Spiti, Churah, Satrundi and Rohtang. These animals are well built, sturdy and adapted to long distance migration.

Population dynamics

The sheep and goat population of the state of H.P as per 2012 census is 8, 04,871 and 11,19,491, respectively. Sheep and goat both recorded decline in population over the years, the reduction in sheep was more marked than goat. Contrary to sheep, over last 15 years, goat population had shown positive growth during 2003-2007 periods. The contribution of goat to total livestock population remained more or less same for past four livestock census, while sheep had shown a clear cut decreasing trends (BAHS; 1997 to 2012).The decline in the goat population per year is 5 times less when compared to that of sheep.This could be a to the fact that during last 10 -15 years, the wool growth in state had shown negative trend and wool remained no more lucrative to the farmers. On the other hand, due to consumer preference the demand for chevon has increased over the years as compared to mu In spite of reduction in proportion of sheep in migratory ? ocks, it still occupies substantial proportion, albeit lower as compared to a decade earlier.

Table 1: Livestock population of studied area over period of 15 year

Census	Goat (millions)	Sheep (millions)	Total Livestock (millions)	Goat (%) of TL	Sheep (%) of TL	Sheep and Goat (%) of TL
1997 (16th)	1.17	1.08	5.22	22.41	20.68	43.10
2003 (17th)	1.13(-3.42)	0.93(-13.88)	5.21(-3.83)	21.68 (-3.25)	17.85 (-16.5)	39.54(-8.26)
2007 (18th)	1.24(+9.73)	0.90(-3.23)	5.05(-3.07)	23.96(+10.5)	17.82(-0.02)	42.38(+7.1)
2012 (19th)	1.12(-9.67)	0.81(-10.0)	4.85(-3.96)	23.09(-3.63)	16.70(-6.28)	39.79(-6.11)
Annual change/ year (1997-2012)	-0.3%	-1.67%	-0.47%	+0.20%	-1.28%	-0.51%

TL: Total Livestock, Figure in parenthesis indicate percent change in particular category over the previous census

SWOT analysis of migratory Sheep and Goat production in north-western Himalayas SWOT is a strategic planning method used to evaluate strength, weakness, opportunities and threat involved in any venture.

Strengths	**Weakness**
Low input system	Poor health care facilities
Resistance to diseases	Attack of predators
Well adopted breeds for migration	Accidental deaths
More than 90% of state's (Himachal Pradesh) sheep and around 70% of goat population is reared under this system.	Incidence of disease and poisonings
Integral part of agro-economic of hill farming	Environmental stress
Cultural heritage	Ignorance in government polices

Opportunities	**Threat**
Unorganised marketing	Climatic change
Nearly organic meat production	Adoption of agriculture and horticulture
Ample scope of improvement in health and productivity	Population growth and land fragmentation
	Shrunken pasture

The SWOT analysis clearly shows that the strength and opportunities clearly outweigh the weakness of the pastoralism. Threats and weakness can only be overcome by opting the strategic mangemental interventions, framing policies focusing on sustainable outcomes, e? ective pastureland management, reducing pre-weaning losses. Sankhyan*et al.* (2014); reported that pre-weaning losses in migratory Gaddi ? ocks were mostly due to sub-optimal health management. Developing lucrative marketing channels and incorporating strategic breeding, feeding and health management inputs, can help in increasing production from these small ruminants and will further add in maintaining socio - ecological balance and preventing the biodiversity loss in the western Himalayas.

E? ect of strategic management in migratory goat and sheep ? ocks in Western–Himalayan region of Himachal Pradesh

A study was conducted in the sub-Himalayan ranges of Himachal Pradesh, India .The data of migratory ? ocks were collected through personal interviews by structured questionnaires. Four di? erent migratory routes were selected in entire state and 30-40 migratory farmers from each migratory route were interviewed.To understand the characteristics of migratory goat and sheep husbandry, after conducting the survey, four medium sized ? ocks, one from each migratory route, were adopted and monitored continuously during their migration for data recording. Out of these four units, two were exclusive goat units and two were mixed sheep and goat units.The data recording was done only for goats although various inputs were provided to all the ? ocks irrespective of the fact whether animals were included in the study or not. All the animals were identi? ed by ear tagging.Strategic breeding (supply of improved bucks), feeding (Mineral mixture and concentrate mixture) and health control (vaccination against PPR, FMD, timely deworming and dipping plus on the spot treatment of ailments) inputs were provided to these ? ocks throughout the year along with data recordings.The primary or secondary data so generated was organized and subjected to statistical analysis.

Flock structure and socio-economic characteristics:

The primary data generated through surveys revealed that majority(50%) of ? ocks were medium sized (200-350), followed by

40.2% small ? ocks (100 animals) and 9.2%larger sized ? ock (>350 animals). Each ? ock has 3-4 ponies for carriage of loads during migration and 2-3 dogs (of distinct *Gaddi*breed) for watch and ward. Overall proportion of sheep, goat and other animals (ponies, dog etc.) was found to be 57.44%, 41.92% and 0.76 % respectively. The overall average family size and land holding observed was 5.76±0.15 and 8.15±0.60 Bigha, respectively (Table 2). On an average, these farmers derived more than 60% of their income from migratory goat and sheep husbandry and in many cases this accounted to even 100%. The annual average income as per survey results was around 56,960 INR (876 USD) /annum, which may be an underestimate as many a times the farmers were reluctant enough to reveal the actual income and disclosed ? gures towards lower side.

Table 2: Flock structure and Socio- economic characteristics of migratory sheep and goat farmers.

Particulars	**Flock**			**Overall**
Flock Characteristic	**Small**	**Medium**	**Large**	
Flock (No)/ Proportion of total	40(40.8)	49(50)	9(9.2)	98
Total flock size	2477	7529	3416	13422
Average flock size (Mean ± SE)	64.5±2.72	153.7±6.36	379.6±15.45	136.9±10.49
Sheep (%)	56.51	56.71	59.25	57.44
Goat (%)	42.83	42.57	39.81	41.92
Others (dogs, ponies etc.)	0.65	0.71	0.94	0.76
Social characteristics				
Average family size (Mean ± SE)	5.53±0.22	5.74±0.27	6.89±0.91	5.76±0.18
Land holding,(Mean ± SE),Bigha	8.87±0.95	7.25±0.88	9.94±1.03	8.15±0.60
Economic characteristics				
Income (all sources)/year , INR	53,625	57,143	71,111	56,990
Income (migratory farming/year), INR	26,875	36,120	43,333	32,959
Proportional income from migratory farming (%)	57.25	63.03	60.54	60.94

Breeding management

Farmers owned ? ock was the primary source (68.4%) of breeding buck followed by buck purchased from middleman (20.4%) and only in limited cases (10.2%) the buck was purchased from fellow farmer's ? ock. Irrespective of the size of ? ock, the number of breeding bucks used at a given time in the ? ock usually ranged between 1- 3 while majority of the ? ocks maintained 2 bucks only (Table 3). These breeding bucks were found to be used continuously for 4-5 breeding seasons before their replacement. The male buck selection was based on indigenous knowledge, traditional wisdom and certain myths which were passed from one generation to the other.

Table 3: Breeding management of migratory sheep and goat farmers

Particulars	**Flock**			**Overall**
Flock Characteristic	**Small**	**Medium**	**Large**	
Source of breeding buck Own Flock	24(60.0)	36(73.5)	7(87.5)	67(68.4)
Fellow farmer	6(15.0)	4(8.2)	0(0)	10(10.2)
Fairs/middleman	10(35.0)	9(18.3)	1(13.5)	20(20.4)
No of buck in flock	1-2	1-3	1-3	1-3
No of years buck used	3-4	4-5	4-5	4-5

Figure in parenthesis indicate the relative proportion of particular class compared to overall

E? ect of improved management practices in adopted ? ocks:The study continued further to see the e? ect of intervention on production potential of migratory goat system and results are summarized in Table 4 and 5. The results revealed average % improvementover the base yearly body weights at di? erent ages ranging from 0.96 to 13.63, which could be a to imparting strategic manage-mental and breeding inputs. Analysis of various reproductive parameters revealed average % improvementover the base yearin population growth (8.21), kidding rate (13.68), percent twin birth (13.61) and decrease in the incidence of abortion/still birth over the years (Table: 4 & 5). Acceptability of the breeding buck is very high among the ? ock owners and they are now having more accommodative approach to response to breeding management compared to initial phases of implementation of study, when they were reluctant to change their buck.

Table 4. Body weights (Kg) in Gaddi Goats at di? erent ages

Factor	**Weight at**				
	Birth	**3M**	**6M**	**9M**	**12M**
Overall Mean	2.96±0.03 (1100)	15.02±0.14 (1247)	19.28±0.19 (984)	23.53±0.14 (932)	27.14±0.21 (970)
Year of Birth					
2011-12*	2.70±0.02 (158)	14.91±0.39 (178)	18.18±0.21 (118)	21.16±0.34 (142)	26.21±0.23 (150)
2012-13	2.91±0.03 (171)	14.88±0.13 (235)	19.32±0.20 (142)	23.65±0.16 (128)	27.32±0.23 (169)
2013-14	2.98±0.02 (206)	15.03±0.13 (209)	19.17±0.17 (173)	23.57±0.12 (163)	26.80±0.18 (213)
2014-15	3.01±0.03 (185)	14.99±0.13 (196)	19.48±0.16 (165)	23.60±0.11 (171)	27.45±0.20 (181)
2015-16	3.03± 0.03 (161)	15.02±0.20 (117)	19.51±0.21 (129)	24.21±0.17 (125)	27.55±0.24 (119)
2016-17	3.05±0.03 (153)	15.09±0.12 (160)	19.55±0.17 (117)	24.53±0.17 (97)	27.60±0.21 (102)
2017-18	3.12±0.07 (66)	15.31±0.14 (152)	19.67±0.15 (140)	24.71±0.18 (106)	27.85±0.37 (36)
Average improvement form the base year (%)	11.73	0.96	6.99	13.63	4.65

*** 2011-2012 is taken as base year to see the effect of adopted strategies**

Table 5: Effect of improved managemental interventions in migratory Gaddi goat flocks over period of four years

Year	Population growth	Kidding rate	% of twin birth
2011-12*	99.47	1.06	18.14
2012-13	112.66	1.24	23.85
2013-14	106.14	1.19	19.96
2014-15	104.73	1.21	21.19
2015-16	107.59	1.20	20.25
2016-17	109.45	1.21	21.51
2017-18	105.28	1.18	18.39
Average % Improvementover the base year	8.21	13.68	13.61

*** 2011-2012 is taken as base year to see the effect of adopted strategies**

Percentage of abortions and overall mortality

Year	% of Abortions	Overall mortality
2011-12	6.19	-
2012-13	9.33	6.07
2013-14	6.71	6.65
2014-15	6.54	10.92
2015-16	12.23	7.49
2016-17	10.06	7.11
2017-18	8.66	6.78

Conclusion

- Potential sources in large ecological zones of the north-western Himalayas can only be used in sustainable manner through pastoral mobility.
- Gaps in the knowledge and practices need to be surfaced which could help in improving the productivity and health of the livestock
- Multidisciplinary approach is needed for combating socio-economic problems faced by the nomads
- With the rising development activities there is an urgent need to frame policy and programmes for sustainable use of rangelands
- Sustainable migratory sheep and goat farming would be in? uenced to a greater extent by

developing solutions for existing constraints, and it will require institutional and extension support.

- There must be some e? ective mechanisms to assess the e? ect of improved strategies which ultimately would require allocation of su? cient funds and maximizing the research contribution. The studies should focus on developing

  a. Strategy to ensure optimum feeding including supplementary concentrate feeding of at least pregnant animals and breeding bucks during migration.

  b. Management of rangeland and grazing area and formulation of new policies to minimize con? icts with the locals and forest o? cials during migration.

  c. Characterization and estimation of nutritional potential/anti-nutritional e? ects of various types of fodder which animals consume during migration.

  d. Recognition of chevon and mu from migratory animals as brand in contrast to mu and chevon from stall fed animal to fetch premium prices.

References are available with the authors.

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Sheep production system and prospects in north temperate region of India

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Introduction

The crop production as well as animal husbandry has been the backbone of rural economy in our country since ages. Today, uncertainty in the crop production in most of the regions, particularly in arid and semi-arid regions of Indiais animpeccable fact due to low and erratic rainfall. Currently, livestock is one of the fastest growing agricultural subsectors in developing countries. Its share of agricultural GDP is constantly and steadily increasing over the years. The farmers counter the risks of crop failures through livestock rearing as they are more tolerant to harsh climatic conditions compared to crops. This sector acts as a cushion in substantiating the farmer's livelihood during ? nancial distress. Such necessities lead to gradient increase in the contribution of livestock in agricultural sector that was 14 % in 1980-81, 23 % in 1997-98 to 35 % in 2001-02 (Sharma, 2004). This growth rate is also due to the increasing demand for livestock

products, population growth, urbanization and be incomes in developing nations.

Ca Bu? alo, Camel, Sheep, Goats, Yak and Mithun are the preferred ruminant livestock reared in various parts of our country owing to their adaptability.Small ruminants (Sheep and goat) contribute substantially to the livelihood to two-third of rural communityand accounts for 4.2% of the total milk production and 15 % of the total meat production. Sheep with its multi-facet utility for meat, wool, milk, skins and manure, forms an important component of sustainable rural livelihoods particularly in the arid, semi-arid and mountainous areas of the country. It always remains as a dependable source of income to the shepherds and economically weaker farmers throughout the year especially in areas where crop and dairy farming are not cost-e? ective. Sheep farming also act as a means of asset retention with high liquidity and help in absorbing unemployed family labour (Suresh et al., 2007). Sheep are very much compatible for breeding because of their hardiness and adaptability to di? erent feed stu? s and various climatic conditions. Though the productivity of Indian sheep is low compared to their counterparts in developed countries, their productivity cannot be regarded as ine? cient because of the available nutritional and physical environments.The major reasons for low productivity are inadequate grazing resources, diseases causing high morbidity and consequent reduced production, and serious lack of e? ort by farmers for bringing genetic improvement (DAHD, GOI).

Land and livestock holdings and utilization pa

The total land area of the country is around 304 million hectares. Of the total area, about 22.5 % is under forest cover, 3.6 % is under permanent pasture, 1.2 % is under tree crops and groves, 6.2 5 % is barren and uncultivable land, 4.5 % is under waste lands and 8.0 % is under fallow lands. The total area available for livestock grazing works out to be about 46 % of the total land in the country. Permanent pastures occupy over 5.0 %, forest cover over 14 % and wastelands over 12 % in the semi-arid regions of the country.

Sheep farming in the North temperate regions:

India with its vast geographical landscapes supports diverse ovine germplasm and is one among the very few countries having such a large number of breeds with wide genetic diversity.Our country has 43 registered breeds of Sheep. The total sheep population in India is 66 million and out of which 80% is located in 6 states. In this 40 % are non-descript animals and rest comprise of pure/graded, cross bred or exotic animals. Out of these, only 14 breeds namely Deccani, Nellore, Nilgiri, Coimbatore, Mecheri, Bellary, Bonpala, Chokla, Cho Gaddi, Marwari, Muza? arnagari, Patanwadi and Malpuraare considered as indigenous registered breeds with high genetic merit (more meat / milk / wool yield per animal). These 14 breeds of Sheep with high genetic worth have a population of 1.77 crore (27.23%) out of the total population 6.5 crore.

The sheep breeds in India, have been classi? ed on the basis of agro-ecological regions viz. i) North temperate region, ii) North-Western arid and semi arid region iii) Southern peninsular region and iv) Eastern region.

The Northern temperate region comprises Jammu and Kashmir, Himachal Pradesh and hilly regions of U The entire northern hilly region falls under the in? uence of the Himalayas. Most ? ocks are small and stationary. However, about 20% of the ? ocks are migratory and are comparatively bigger in size. Most of the populations in this area have been evolved over the last few years by cross-breeding with exotic ? ne wool breeds for increasing apparel wool production.The following are the sheep breeds available in the North temperate climatic regions of our country.

Sl. No.	Breed	Home tract
1	Bhakarwal	Jammu and Kashmir
2	Changthangi	Jammu and Kashmir
3	Gaddi	Himachal Pradesh
4	Gurez	Jammu and Kashmir
5	Karnah	Jammu and Kashmir
6	Poonchi	Jammu and Kashmir
7	Rampur Bushair	Himachal Pradesh

Sl.No.	Particulars	Details
1	States	J&K, Himachal Pradesh and hilly regions of UP
2	Population (millions)	3.99
3	Population (%)	9.64
4	Wool production (million kg)	4.52
5	Wool production (%)	12.33
6	Meat production (million kg)	12.72
7	Skin production (million Kgs)	2.82
8	Breeding programmes	Sizeable proportion of sheep in this region consists of crosses between indigenous breeds and exotic fine wool breeds
9	Staple length (cm)	5.33-10.27
10	Fibre diameter (μ)	25.14-33.11
11	Medullation (%)	5.47-17.59
12	Wool quality (counts)	36-58/80

In India, Sheep are mainly reared for the production of meat and wool. Production practices usually vary according to the purpose of the ? ock.The north temperate climate is highly suitable for the production of ? ne wool sheep breeds suitable for apparel making. However, sheep breeds in this region are reared as dual purpose breeds by the farming community. Wool was the ? rst commodity to be traded internationally and is the product the public most commonly associates with sheep. However, the importance of wool (as a product) relative to meat is less because of the major quantity/quality of the wool produced in India is coarse and carpet type because of various breeds and agro climatic conditions. The production of ? ne wool though fetches money in the commodity market is very much limited to the northern temperate regions especially Himachal Pradesh and Jammu & Kashmir. Feeding, housing, health care, handling, and harvesting is all critical to the production of high quality ? ne wool.

Feed and fodder resources:

The major feed resources in our country are grasses, grazing, crop residues, cultivated fodders, edible weeds, tree leaves and agro-industrial by-products. Crop residues and by-products constitute the main feeds accounting for 40 % of the total consumption of di? erent livestock. Green fodders contribute 26 %, the concentrates 3 % and the rest is coming from grazing (Mathur, 2004). The feed scarcity is mostly due increasing human and livestock population, deterioration of common grazing lands both in quality and quantity, lack of adoption of feed and fodder production and processing technologies and low priorities given for identifying, improving and utilizing the newer feed and fodder resources (Pradhan, 2003). The feed resources available for ruminants include seasonal and perennial grasses, stubbles, shrubs and bushes while grazing on the community range lands, roadsides, canal banks and harvested ? elds. Top feeds, crop residues, agro-industrial by-products and agricultural waste materials are also fed to the ruminants depending on their availability.

In the north temperate hilly terrains, the natural/community grazing lands are under poor to very poor condition mainly due to high stocking. These lands have never been protected, harrowed, reseeded, irrigated and properly managed. The biomass yield of these community rangelands is 2, 4.5 and 6.5 quintal DM/hectare during summer, winter and monsoon season, respectively (Santra et al., 2007). The annual biomass yield of community rangeland (4.3 quintal DM/h) is su? cient to maintain at the best 1 ACU (6 sheep or goats) round the year. However, the stocking density (2 to50 ACU per hectare) on these lands far exceeds its carrying capacity. The natural rangelands are undergoing extensive degradation and ecological changes due to prevailing grazing pressure. Inadequate energy supply round the year and protein supply half the year is the major limitation natural rangelands and pastures in arid region. During the lean period from January to June, energy supply is acute as the intake is lower than even maintenance requirement of animals. The topfeed resources (shrubs and trees) are lopped and fed to ruminants during lean period to overcome the feed shortage.The top feed resources invariably contain some

anti-nutritional factors. Farmers apply the dilution technique for feeding of top feeds to their ruminants as they never maintain their animals on sole feeding of tree leaves.Farmers with their sheep and goats migrate from high altitude sub-temperate and temperate ranges to foot hills of Himalayas during winter and return back to their native tract at onset of summer in north temperate parts of our country(Santra et al., 2007).

Feeding practices

Feeding practices of livestock are variable throughout the World and these are mainly dependent on climate, feed and fodder availability, socio-economic status of farmers, type of species and breed, level of production etc. in a particular area. Three feeding management system viz. extensive range management, intensive and semi-intensive are in vogue in Indian conditions. The most common system in vogue in North temperate regions is extensive system which is principally one of low resource use and a low level of productivity. There is marked ? uctuation in feed availability and its nutritive value in di? erent regions, years and seasons. The greatest limitation in Indian rangelands and natural pastures is on the availability of adequate energy throughout the year and adequate amounts of protein for more than half the year (Singh and Chaturvedi, 2004). Although the grazing on the rangelands is considered as the cheapest method of livestock production, the over grazing/over stocking on available lands has caused serious problems of vegetative destruction, soil erosion and land degradation. Feeding of adequate roughage and concentrate in a proper ration either as mixed feed or individually in stalls is known as intensive feeding management. A kind of compromise between extensive and intensive systems is known as the semi-intensive system of feeding management which is adopted by small farmers maintaining tens of animals in the backyards. This system is mostly followed in the rural villages It is a combination of limited free range grazing on available pasturelands and feeding in the stalls with feed and fodder supplements. Sheep and goats are mostly grazed in mixed grazing on community/public rangelands for about 8-10 h a day (Chaturvedi et al., 2002).

Ruminant production in north temperate regions is mainly based on forest areas, rangeland pastures and/or stubble grazing. Such pastures produce low quality forages which are ine? ective to provide a sustained supply of nutrients to ruminants. Grazing ruminants are supplemented with top feeds during lean season to meet their nutritional requirements. These rangeland are covered with a wide variety of vegetation mainly grasses, bushes, shrubs and trees. Limited concentrate supplementation in addition to free grazing on community rangeland substantially improved production performance of ewes (Chaturvedi et al., 2001a; 2003) and growth performance of lambs (Chaturvedi et al., 2000; Santra et al., 2002). Supplementation of concentrates not only improved growth (McDonald et al., 1996) but also enhanced reproductive performance (Njoya et al., 2005; Chaturvedi et al., 2006), fertility rate (Molina et al., 1994) and overall sheep productivity (Stephenson and Bird, 1992) on low quality forages. Utilization of poor quality feeds by ruminants can be improved through concentrate supplementation, which increases the

digestibility of nutrients (Santra et al., 2002) through stimulating rumen fermentation (Sultan and Loerch, 1992).Digestible organic ma intake improved due to supplementation of maize and soybean meal on wheat straw based diets (Abebe et al.,2004). Similarly supplementation of peanut oil meal (2.5g/kg live weight) resulted in higher average daily gain and was economic for growing kid production (O et al., 2004). A supplementation of 400g concentrate in addition to grazing has been recommended to raise sheep under extensive production system in temperate regions.

Migration of sheep in temperate region:

Most important communities practicing migratory livestock rearing in the Himalayan states of Jammu & Kashmir, Himachal Pradesh and U as, Jahads, Changpas, Bakarwals and Gujjars (Misri, www.fao.org). Changpas are nomads of Changthang, who raise herds of sheep and Pashmina goats, yaks and horses. Gaddis of Bharmour are agro-pastoralists and raise large number of sheep and goats. Bhutias of North Sikkim are agro-pastoralists and raise local cows, ox, yak, sheep, goats and ponies. Unlike Gaddis and Bhutias, Changpas living at high altitude of 3500-4000 meters in the cold deserts of Ladakh are completely nomadic and change places all over the year according to pasture availability (Bhasin, 2013).

Alpine pastures are located between 3000-4500 meter altitudes in Himalayan region of our country. These highland pastures remain covered with snow from October to April and are available for ruminant grazing from May to September. Sheep migration from low land to high land pasture is a traditional system of sheep rearing in Himalayan region. High land pasture migration is sustainable, high yielding and cost e? ectivemethod of sheep husbandry under Himalayan region.

Sheep are reared mainly for the meat purpose in Himalayan region, while production of wool is also important source of income. Sheep? ock size ranges from 50 to 300. The farmers follow di? erent migration routes to reach the highland pasture. The animals remain con? ned to the lower hills or plains during the winter but migrate to the alpine pasture land during summer season and stay there till the onset of winter. Migrants face many problems during migration viz. non-availability of grazing permit, harassment by forest o? cials and by toll tax o? cials, lack of security arrangement in forest area, lack of grazing land during migration, lack of medical facilities for animals as well as for men and near absence of marketing facilities for wool during winter migration.

Migration of sheep in Jammu and Kashmir:

Gujjars are the major nomadic community in Jammu and Kashmir (J&K).However, an insigni? cant proportion of Gujjars of J&K practice migration to sub-alpine and alpine pasture during summer. During winter, they stay in Shivaliks, i.e. Lowermost hills adjoining plains. Migration starts by middle of February towards up-hills. Grazing in alpine and sub-alpine pasture continues till mid September, and then they start migrating downwards. Though migratory ? ocks are accompanied by the males as well as females of the family, but the females stay in their houses built in sub-alpine areas along with ca and bu? aloes and the males go to the alpine pasture along with sheep and goats. Though, migration of sheep for grazing is declining at high rate in case

of Gujjars, while Bakarwal tribes still practicing the migration (Misri, www.fao.org). Similar to U large number of sheep ? ocks remain under migration in J&K.

Migration of sheep in Himachal Pradesh:

Sheep and goat ? ocks of Bharmour and Lahaul start migration to Kangra valley and Pathankot at the onset of winter during October-November. The ? ocks return to their village to manure the agricultural ? elds during April. Thereafter, the shepherds (Gaddi Community) gather ? ocks of the whole village and start migration to pasture on high mountain peaks for summer grazing. The ? ocks start to return from high altitude areas during September. The ? ocks spend four to ? ve months for winter grazing in the lower ranges located nearly horizontal to the foothills south of Dhauladhar from Pathankot/Nurpur to Bilaspur.

A study resulted direct relation between the ? ock size and resource endowment in Kangra valley.Labour cost was the major component in migratory production system. Though, sheep rearing contributed more to the gross income, whereas goat rearing provided higher income per animal. Net income was meager for small ? ock owners and nominal for large ? ock owners. The problems faced by nomadic graziers (Gaddis) were lack of veterinary facility in high altitudes, sudden natural calamities like ? oods and landslides, scarcity of fodder availability at foothills and plains during winter, lack of marketing and processing infrastructure, low price of produce, high morbidity rate and predation by wild animal (Singh et al, 2006). About 27% of sheep are migratory and 73% are stationary in Himachal Pradesh.

Migration of sheep in U

Bjotyas, living in the north part of Pithoragarh district of U are transhumant. They are mainly agro-pastoralists and a few of them are completely nomadic shepherds. They start up-word migration from mid April to May to summer habitations at high altitudes to sow crops using short growing season with harvesting done by end of September. They return to their winter home in October. Transhumance practice not only helps them do agriculture at hills and collect rare Himalayan herbs, but also to utilize marginal resources like alpine pasture/meadows for rearing sheep and goats with higher productivity than sedentary ? ocks. Migratory transhumance practice is in a steep declining condition, which evident from the number of migratory transhumant households in Johaar valley that declined from 1475 in 1961 to 61 in 2007 (Negi, 2007). About 87% of sheep are migratory and only 13% are stationary in U

Migration of sheep in Sikkim:

In Sikkim, Gurungs have been following semi-nomadic sheep rearing. Sheep is reared for wool and meat. Wool of Indigenous sheep (Bonpala breed) is used for preparing indigenous products like Bhurkasan, Radi and Lukuni using traditional handlooms and natural dye. Sheep herds start

migrating to high altitude in late spring and return to their villages during autumn. During winter, sheep are penned in paddy ? elds in alpine meadows for manure. The ? eld owner in turn provides shelter, ration and fodder to the herders. Due to adoption of multiple cropping pa availability of empty crop land is declining, causing fodder scarcity during winter, which has been a major cause of decline in migratory sheep rearing and shifting towards large animal (TambeandRawat, 2009).

Challenges

1. Low yielding poor quality breeds- Introduction of new and high yielding varieties as per the consumer/market need of the region should be taken up by the respective governments of the regions for encouraging the farmers for sheep rearing.
2. Shrinkage of pasture land: Since, a large number of sheep remain in migration in temperate region, the shrinkage of common grazing area especially at alpine and sub alpine region is becoming a great concern. Encroachment by local farmers as well as pressure by forest department and other developmental activities seems major cause of the shrinkage. Shrinking of common grazing areas / land holdings / pastures including those in the alpine region is adversely a? ecting the sheep husbandry, as sheep are primarily grazing animals. In addition, non availability of be grasses in the pastures / grazing lands along with lack of scienti? c grazing and conversion of these pastures / grazing lands for other purposes is a? ecting the sheep husbandry directly.
3. Lack of/inadequate insurance and other risk coverage: Inadequate and marginally covered insurance of the animals is also a weak point for sustainable sheep rearing.
4. Losses during migration: Migratory routes are not well de? ned by the government;therefore migratory ? ocks face a lot of danger due to non availability of shelters during natural calamities, accidents, theft etc en route.
5. Inadequate nutritional support during winter.
6. Lack of marketing chain and lower remuneration for wool is discouraging newer generation to take up sheep husbandry.
7. Sheep-rearing continues to be a backward subsistence based side occupation, primarily in the hands of poor, landless or small and marginal farmers who own either an uneconomical holding or no land at all, and thus graze their sheep on natural vegetation and crop stubbles supplemented by tree loppings. There should be a paradigm shift in this and large farmers should take up sheep farming on modern platform with farm to consumer approach.
8. With the growing education in the society, young generation preferably opt for other more lucrative job in public and private sector.

Way forward

1. Native mu carpet and ? ne wool breeds are available in our country, which are well adapted to the various agro-climatic conditions. These breeds could be improved further, by

incorporating germ-plasm from high yielding sheep breeds.

2. Adaptable climatic conditions for speci? c production
3. Maximization the use o quality grazing area
4. Increasing high market demand
5. Enhancing the social acceptance of sheep and its products through proper marketing and advertising.
6. Incidence of diseases is low hence the cost of treatment and vaccination is less.
7. Alpine pastures available in the north temperate region serve a good source of grazing during summer months and are essential to sustain the sheep husbandry through migration under free range system. The farmers are well conversant with the sheep husbandry over the generations.

Constraints

Presently, sheep husbandry is an unorganized sector in the Country, which needs to be put under proper monitoring and marketing mechanism; so that farmers could get higher and pro? table remuneration to their sheep produce. In addition, the sheep husbandry needs to be regulated scienti? cally in harmony to the available grazing resources with aimed higher productivity in terms of body mass, wool, meat, by-product, etc. This farming lack risk management covers via provision of insurance to the animal. Slaughter of animals at early age for immediate money gains also renders this profession less economical.

Remedial measures to improve sheep farming in North temperate regions

1. Exotic rams should be provided at nominal charges during breeding season in this area. These rams can be maintained be at ram depots (Ram lamb centres) of Animal Husbandry Department during non-breeding season. Cross breeding with Rambouillet and/or Marino should be undertaken for improvement of ? ne wool. Up grading of the native germplasm should be taken up for be returns to the farmers.
2. In order to reduce the pressure of livestock on land resources, fodder and pasture improvement programmes should be undertaken in the State. Productivity of grass in pasture need to be improved through fertilizer application and introduction of high yielding grasses and legumes. Quick growing and high yielding fodder tree species suitable to the area need to be distributed to farmers. The development of village grazing lands should be entrusted to Panchayats or sheep breeders' cooperatives.
3. Sheep and wool extension agencies of the State Animal Husbandry Department should educate the breeders regarding improved shearing practices and also provide the necessary equipment on subsidy.
4. Youth should be retained/a in this farming through regular skill development training/extension programmes on scienti? c rearing practices and be linkages with the di? erent agencies involved in the sheep rearing.
5. It is necessary to have organized markets in wool producing areas of the State. wool prices of important markets in the country should be available on various media including print, TV

radio and internet. Market yards for sale and purchase of sheep should be set up in the major sheep rearing areas.

6. There is a greater scope of development of wool based co scale industries for post harvest technologies in this area. This will generate employment to the local youth and also fetch be price for their produce from the ? nished products.
7. Under the sheep distribution scheme, it is suggested that a direct link between the ? nancing bank and borrowers be ensured so as to prevent compromises in technical standards. The present unit cost should also be reviewed periodically. In view of the limited production capacity of State Breeding Farms, individual farmers willing to take up breeding of cross-bred sheep should be encouraged to do so to improve the availability of cross-bred sheep. A more e? ective monitoring at bank level is necessary to prevent misuse of loans and voluntary default in loan repayment.
8. Government should introduce special welfare schemes to the nomadic population engaged in the sheep farming.

References are available with the authors

ABS (ORAL) : SESRP-01

Performance and Income Status of goat farmers through Multiplier Flock of Barbari Breed

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Multiplier ? ock scheme at Barbari goat nucleus farm unit under All India Co-ordinated Research Project on goat improvement was initiated at Central Institute for Research on Goats in the year November, 2014. The major objectives of this scheme are to (i) Promote scienti? c goat farming among farmers with performance and progeny data recording (ii) Conservation of Barbari breed(iii) Development of goat based livelihood and business models (iv) Development and up gradation of package of management practices suitable for di? erent ? ock size (small, medium and large)and di? erent resource levels atgoat farm (v)Pro? t and adaptability evaluation of Barbari breed of goats in farmers ? ock(v) Horizontally popularization of Barbarigoat breed in it's native tract through backward and forward linkages.Under this scheme 5 male and 5 female of 3-6

months of age, 5 adult female and one buck of Barbari breed was provided as seed stock to selected bene?ciaries to multiply high potential and pure-bred germplasm (seed) in ?eld besides up gradation of non-descriptgoats. Such multiplier farms remain under regular observation and monitoring by Scientists of Project for a period one year and technical support and services are provided during this period. The scheme has a many educated youths (Men and women) with 35 numbers of registrations. Purposefully 15% women with low to moderate resources have been registered to design women friendly livelihood models. The performances of goats at di?erent multiplier ?ock centers were remarkably good for productivity, survival and pro?t. The current ?ock size of Barbari goats with these multiplier ?ocks ranged from 22 to 350. These multiplier farms are mainly operating with following income activities (i) Supply of pure-bred Barbari goats to up-coming commercial and other goat farms. (ii) Supply of surplus males for EID and Lohadi (iii) Sale of Surplus milk (iv) Consultancy for new goat farm establishment.The body weight of one year old male and females at multiplier farms were 26 Kg (23-32 kg) and 23 kg (19-26 kg) respectively. The 90 days milk yield was50 to79 liters and the kidding rate was 1.41 to 1.81. Due to proper housing, hygiene, vaccination, feed and scienti?c management ?ock, mortality of goat was *less than 3%*. The average rearing cost up to one year was ranged fromRs. 4100- Rs6700. The sale price of breeding male and females were Rs. 12,000/ and Rs. 10,000, respectively.The sale price of castrated male at the age 16 months was ranged from Rs12000 to 18000. The net pro?t per goat per year was ranged from of Rs. 5600 to 7900. Some farms are also selling goat milk and manure and earning additionally Rs 1000 from milk/goat and Rs 356 from manure per goat.Barbari has become choice breed for commercial goat farming under intensive management system in North India. Major impact of this programme is wider adoption of scienti?c practices among goat keepers, creation of organized marketing, pro?table goat farming models and conservation of Barbari breed with more than 5000 females and 200 males with goat keepers round the year.

ABS (ORAL) : SESRP-02

Fertility and Productivity of Ganjam goats of Odisha

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Data on fertility and kidding Ganjam breed of goats were collected from the native tracts of these goats i.e. Chhatrapur, Rambha, Khallikote areas of Ganjam district of Odisha.A total of 658 goats were identi?ed with polyurethane tags and were tracked through out the years from April 2017 to March 2018. The details of the kidding were recorded for each of these goats and the kids were weighed at the end of the year on 31st March 2018 to calculate the total average live weight in terms of the body weight of kids generated by the does in a year. The total number of does available for

breeding at the start of the year were 198, 256 and 204 for Chhatrapur, Rambha and Khallikote respectively, out of which 184, 221 and 192 does kidded resulting a tupping percentage of 92%, 86% and 94% for Chhatrapur, Rambha and Khallikote centers respectively. The total number kids produced were 277, 297 and 290 for Chhatrapur , Rambha and Khallikote which translated to a kidding percentage of 139.8, 116.0 and 142.1 percent respectively. As only two cases of twinning was observed in the total the same average fertility rate i.e number of parturition per doe per year could be ascribed for each center as that of the kidding percentage. All the kids that survived from all the 658 does tracked were again weighed on 31st March 2018 to calculate the average live weight generated per doe in a year. The total live weight generated were 2404, 3372.6, and 3431.2 kg in Chhatrapur, Rambha and Khallikote respectively which translated to the average live weight generated per doe to be 12.14, 17.03 and 16.81kg respectively. The overall average live weight produced by a Ganjam doe in a year was calculated to be 13.99kg. Considering the cost of per kg live weight of goats at Rs 225/- the potential productivity of a Ganjam doe was calculated to be Rs 3148.56 per year, which is without considering the income generated from manure and milk.

ABS (ORAL) : SESRP-03

Scaling up Goat based Interventions to bene?t the poor under Farmers First Project

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Goats have been part of rural livelihoods for millennia, and have been instrumental in poverty reduction in resource poor areas. They thrive in nearly all ecosystems, including harsh, frigid and arid ones and can be handled easily. Since goats require less space and feed than ca they can be owned even by the landless. They are integrated into complex livelihood systems, and are “multifunctional” by providing milk, meat, manure, cash, savings and status, and often have social or religious uses. The poor are more likely to own goats than ca so support for goat-keeping can be a valuable entry point into poor communities to end poverty and hunger.

This study under Farmers First Project reveals many successful solutions for delivering services, increasing production, expanding markets and improving the policy environment for smallholder goat producers. We also demonstrate innovative water and land management to provide be goat production. In Nagri block of Ranchi district of Jharkhand farmers with tiny landholdings could raise high meat producing goats under semi-intensive system. Black Bengal goats selected for high growth production under harsh conditions were introduced among

villagers to improve genetics. Signi? cant improvement in body weight (12-13 kg in 10 months as compared to 7-8 kg before intervention) and reproductive performance (69% twinning and triplets as compared to 37% earlier) were observed. Mortality among kids were reduced to less than 10% and mortality due to contagious diseases especially PPR were also prevented after intervention.

ABS (POSTER) : SESRP-01

The e? ect of awareness programme on production of Black Bengal Goat in tribal village of Banka district, Bihar

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Bengal Goat is main breed reared by tribal population of Banka district. Mostly the women (98.5%) of the tribal families in Bankarear goat. Goat rearing is a subsidiary income source to tribal people along with agriculture. In majority of casesthe ? ock size ranges from 1 to 4 (88%). There was not tradition of adult male rearing was observed. Thegoats were mostly housed along with residential housing (98.1%); houses are mostly kachhatype (85.63%) withearthen ? oor (86.47%) and straw roof (91.33%). Almost all the farmers used to graze their goats for feeding. Hand-pump water was the major source for drinking water (52.12%) of goats. Black Bengal Goats have natural resistant power tomany diseases but are vulnerable to PPR, cold, water logging situation, diarrhoea, ecto and entro parasitic infestation andrespiratory diseases. The adult mortality rate was reduced from 47% to 5.63% and kid mortality rate was reduced from 30.67% to 15.85%. Age of ? rst conception reduced from 10.20 to 6.5 month and average inter-kidding period was reduced to 6.30 month.

ABS (POSTER) : SESRP-02

Factors a? ecting various body weight traits of broiler rabbits under an organized rabbitary

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The study was carried out to analyze the e? ect of di? erent genetic and non-genetic factors in? uencing the body weight in Soviet Chinchilla and White Giant rabbits under organised farm. Rabbits were maintained at the rabbit farm of LPM department of Veterinary College, SDAU. The traits under study were body weights at weekly interval, starting from 4th week to 12th week. The non-genetic factors considered for the study were sex of the kit, season and year of the birth of kits. E? ect of breed of rabbits were also observed on these body weights. The average weight at 4th, 5th, 6th, 7th, 8th, 9th, 10th, 11th and 12th week were 0.509, 0.682, 0.915, 1.092, 1.305, 1.517, 1.730, 1.925 and 2.122 kg respectively. Almost all the body weight traits were signi? cantly in? uenced by the season and year of birth of the kits. The sex of the kit did notsigni? cantly in? uence any of the traits except 7th and 8th week body weight. The di? erence between the body weights at di? erent ages were not signi? cant among the two breeds studied except for the weight at 12th week. Signi? cant in? uence of various non-genetic factors on di? erent body weight warrants the correction of records before the estimation of genetic factors.

ABS (POSTER) : SESRP-03

Designing of improved Goat shed andFeeding troughs for resource constrained goat farmers

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The goat feeding trough designs of CIRG and Tamilnadu Veterinary and Animal Sciences University were studied and found that these designs are very costly and are based on iron and concrete which is hard to adopt easily by resource constrained goat farmers. They are highly specialized designs and are not locally available. In light of this study made scienti? cally designsgoat shedbased in locally available cheap materials which is environmental friendly. E.g.- bamboo in the place of iron, steel and concreteand it is also minimizes dependency on the market. A concrete shed costing aroundrs. 5 Lakh may easily be replaced by a bamboo shed costing less than rs. 50 thousands. Di? erent types of feeding trough designed with the help of bamboo, clay and minimal iron sheet. This are serving the complete purposes, is cheap, potable and environmentally friendly. A rough calculation says that a design made of iron feeding trough for10-12 goats costs are aroundrs 5-6 thousand but thisdesigns are capable of feeding 40-50 goats will cost aroundrs. 1500/-. It has already successfully experimented at many places in districts of Bihar and Jharkhand. Several goat farmers have adopted this design.This design can spur the target group to help a successful transition from Goat keeping to Goat farming. The goat shed and feeding troughwas used by altogether 115 goat farmers in the di? erent districts likeSheohar, East Champaran, Gaya, Samstipur of Bihar and Godda of Jharkhand after ge technical knowhow. Finally, the model was adopted by 97 farm families which is nearly 84%. This is indicates a signi? cant rate of adoption.

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बिहार कौशल विकास मिशन

श्रम संसाधन विभाग, बिहार सरकार

माननीय मुख्यमंत्री, बिहार सरकार

बिहार कौशल विकास मिशन का उद्देश्य कौशल विकास के विभिन्न कार्यक्रमों का क्रियान्वयन सुनिश्चित करने, नियमित अनुश्रवण करने तथा वैश्विक बाजार में राज्य के युवाओं को कुशल बनाकर प्रतिस्पर्धात्मकता सुनिश्चित करना है।

श्रम मंत्री, श्रम संसाधन, बिहार सरकार

प्रमुख कार्यक्रम

कुशल युवा कार्यक्रम

कुशल युवा कार्यक्रम सरकार के सात निश्चयों में से एक निश्चय "आर्थिक बल युवाओं को बल" का एक भाग है। इसे बिहार कौशल विकास मिशन के प्रमुख कार्यक्रम के रूप में प्रारंभ किया गया है, जिसका उद्देश्य बिहार के युवाओं की रोजगारपरकता को बढ़ाना है।

- कुशल युवा कार्यक्रम के कोर्स के तीन मुख्य भाग है:– व्यवहार कौशल, हिन्दी और अंग्रेजी संवाद कौशल एवं बेसिक कंप्यूटर कौशल। कुल 240 घंटे का कोर्स जिसमें 120 घंटे का बेसिक कंप्यूटर ज्ञान, 80 घंटे का अंग्रेजी संवाद कौशल तथा 40 घंटे का व्यवहार कौशल को शामिल किया गया है।
- प्रशिक्षण के दौरान ई–लर्निंग शैली का प्रयोग किया जा रहा है अर्थात कंप्यूटर लैब के माध्यम से प्रशिक्षण दिया जा रहा है।

कुशल युवा कार्यक्रम

कुशल युवा – समृद्ध युवा
सपना अपका – संकल्प हमारा

कुशल युवा कार्यक्रम के अंतर्गत उपलब्ध कोर्सेस.....

BS-CIT	**BS-CLS**	**BS-CSS**

डोमेन स्किलिंग कार्यक्रम

बिहार कौशल विकास मिशन ने विशिष्ट मांग के अनुरूप 26 सेक्टरों में कार्यबल तैयार करने के लिये 15 से 59 आयु वर्ग के ऐसे नवान्तुकों को जिनका पूर्व में अनुभव नहीं है, उनके डोमेन स्किल में प्रशिक्षण के लिए वातावरण तैयार किया है। ताकि वे इन प्रशिक्षणों के उपरान्त ये संबंधित क्षेत्र में रोजगार या स्वरोजगार प्राप्त कर सकें।

राज्य सरकार के 16 विभागों द्वारा विभिन्न योजनाओं के अन्तर्गत कौशल विकास किया जा रहा है । इसमें अल्प अवधि, मध्यम अवधि एवं दीर्घ अवधि के पाठ्यक्रम शामिल किये गये हैं।

नियुक्ति–प्रशिक्षण–तैनाती(RTD) कार्यक्रम

नियुक्ति–प्रशिक्षण–तैनाती बिहार कौशल विकास मिशन–BSDM की एक नूतन पहल है, जिसके अन्तर्गत उद्योग एवं औद्योगिक घराने, जो भारत या भारत के बाहर कारोबार करते है, उन्हें अपना सहभागी बनाना। इस पहल के अन्तगर्त कौशल विकास के इकोसिस्टम के कुछ प्रकियाओं को बाइपास अथवा सहज करके उद्योगों की आवश्यकता के अनुसार कुशल श्रम बल उपलब्ध कराना है।

बिहार कौशल विकास मिशन ने बिहार के युवाओं को रोजगार उपलब्ध कराने एवं उद्योगों की जरूरतों को पूरा करने के लिए सहज एवं लचीला कदम उठाया है।

प्रधान मंत्री कौशल विकास योजना के अंतर्गत डोमेन स्किलिंग कार्यक्रम

बिहार कौशल विकास मिशन ने "केन्द्र सरकार द्वारा प्रायोजित एवं राज्य सरकार द्वारा प्रबंधित कम्पोनेंट" के अंतर्गत प्रधान मंत्री कौशल विकास योजना PMKVY कार्यक्रम का संचालन किया जा रहा है। इसके अंतर्गत कुल 36 प्रशिक्षण प्रदाता एजेन्सियों के 142 प्रशिक्षण केन्द्रों का चयन किया गया है। भविष्य में और अधिक केन्द्रों के खोले जाने की प्रकिया जारी है।

पूर्व शिक्षण की मान्यता Recognition of Prior learning-RPL

पूर्व शिक्षण की मान्यता RPL एक असंगठित क्षेत्रों में कार्यरत लोगों के उन्नयन /प्रमाणीकरण के लिये एक अनोखी और उपयोगी योजना है जिसके अन्तगर्त ऐसे लोगों का औपचारिक प्रमाणीकरण किया जाता है, जो असंगठित क्षेत्रों में कार्यरत है या जिन्हें विशिष्ट डोमेन का अनुभव है। RPL के अन्तगर्त मूलत व्यक्ति की मौजूदा कौशल के प्रमाणीकरण के लिये पूर्व मूल्यांकन/ब्रिज प्रशिक्षण व उसके बाद अंतिम मूल्यांकन की प्रकिया अपनायी जाती है। RPL के अन्तगर्त किया गया प्रमाणीकरण किसी भी कौशल विकास के प्रमाणीकरण तरह मान्य होता है। साथ ही यह व्यक्ति को बेहतर कौशल और आजीविका प्रदान करने का अवसर प्रदान करता है।

इस कार्यक्रम के लिये प्रशिक्षण प्रदाता एजेन्सियों की चयन प्रकिया प्रगति पर है।

बिहार कौशल विकास मिशन

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