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निदेशक
केन्द्रीय भेड़ एवं ऊन अनुसंधान संस्थान
अविकानगर

प्राक्कथन

केन्द्रीय भेड़ एवं ऊन अनुसंधान संस्थान भेड़ एवं खरगोशों में उत्पादन बढ़ाने एवं उत्पाद उपयोग से संबंधित अनुसंधान करता है। भेड़ पालन गरीब किसानों की आजीविका एवं आर्थिक स्वालंबन में महत्वपूर्ण भूमिका निभाता है। संस्थान भेड़ों से अधिक उत्पादन लेने के लिए प्रजनन, पुनरुत्पादन, पोषण, स्वास्थ्य, प्रबंधन एवं तकनीकी स्थानान्तरण की एकीकृत प्रक्रिया से अनुसंधान कर रहा है। अनुसंधान उपलब्धियों में बहुअज भेड़, हिमांकस कन्टार्डस के विरुद्ध भेड़ों में प्रतिरोधक क्षमता, चयनित लक्षित विधि द्वारा जठरांत्र कृमियों पर नियंत्रण, आहार में विलायती बबूल की फलियों का मिश्रण एवं दो वर्ष में तीन मेमनें प्राप्त करना आदि प्रमुख हैं। तीन नस्लों की संकरित (GMM x Patanwadi) भेड़ों में 30 प्रतिशत बहु जन्म के साथ 6 एवं 12 माह की आयु पर शारीरिक भार 31.8 एवं 39.3 किग्रा. प्राप्त किया गया। इसी प्रकार अविकालीन एवं मालपुरा नस्लों के प्रतिरोधक समूह विकसित किए गए एवं इन्हें बिना अन्तःकृमिनाशक दवा पिलाए रखा गया। 636 दिनों में 72 प्रतिशत पशुओं से तीन मेमनें प्राप्त किए गए। आहार में बिना किसी हानिकारक प्रभाव के विलायती बबूल की फलियों को 40–50 प्रतिशत मिलाया जा सकता है। किसानों के रेवड़ों में 3–4 बार दवा पिलाने के स्थान पर एक बार दवा पिलाने को क्रियान्वित किया गया एवं इस तकनीक को राजस्थान में सफलता पूर्वक प्रदर्शित किया गया।

देश में पिछले कुछ समय से जलवायु परिवर्तन के कारण कठिन जलवायु में भेड़ पालन अत्यधिक प्रभावित हुआ है जिसमें भेड़ संख्या एवं उपयोगिता में बदलाव, नस्ल की बनावट, किसानों की आजीविका एवं पौषणिक सुरक्षा के मामले, नई बीमारियों का प्रादुर्भाव एवं पुनःप्रादुर्भाव आदि शामिल हैं। यह देखा गया है कि जलवायु के प्रभाव की विषम परिस्थितियों एवं इसके दुष्प्रभावों के दौरान अन्य पशु प्रजातियों की अपेक्षा भेड़ें अच्छा प्रदर्शन करती हैं। निष्क्रमण द्वारा भेड़ों को सूखा एवं अकाल प्रभावित क्षेत्रों से अन्य क्षेत्रों में ले जाया जाकर इन्हें प्रतिकूल प्रभाव से बचाया जा सकता है। संस्थान द्वारा जलवायु परिवर्तन के दौरान लघुरोमन्थी उत्पादन के चिरस्थायीत्व, प्रतिकूल वातावरण से भेड़ों के बचाव हेतु शरण प्रबंधन तथा आँत से उत्सर्जित मीथेन को कम करने हेतु पौधों के द्वितीय चयापचयी पदार्थों पर अनुसंधान कार्यों को प्रारम्भ किया गया है। भेड़ों एवं अन्य पशुधन पर वातावरणीय दबाव के प्रतिकूल प्रभावों से निजात पाने के लिए विकसित तकनीकें अत्यधिक उपयोगी साबित होंगी।

संस्थान के वैज्ञानिकों, तकनीकी एवं प्रशासनिक कर्मचारियों के अथक प्रयासों से ही संस्थान के अनुसंधान क्षेत्र में प्रगति संभव हो पाई है। इस अवसर पर मैं डॉ. एस.अयप्पन, सचिव, कृषि अनुसंधान एवं शिक्षा विभाग तथा महानिदेशक, भारतीय कृषि अनुसंधान परिषद, कृषि मंत्रालय भारत सरकार, नई दिल्ली द्वारा संस्थान की कार्यप्रणाली के लिए दिए गए बहुमूल्य मार्गदर्शन के लिए कृतज्ञता प्रकट करता हूँ। मैं डॉ. के.एम.एल. पाठक, उप-महानिदेशक (पशु विज्ञान) एवं डॉ. एस.सी. गुप्ता, सहायक महानिदेशक (पशु उत्पादन एवं प्रजनन) द्वारा संस्थान के क्रियाकलापों में अत्यधिक रुचि दिखाने एवं प्रोत्साहित करने के लिए कृतज्ञता प्रकट करता हूँ। इस वार्षिक प्रतिवेदन को समय पर प्रकाशित करने हेतु किए गए प्रयासों के लिए डॉ. ए.के. शिन्दे एवं डॉ. सी.पी. स्वर्णकार का आभार व्यक्त करता हूँ। हिन्दी अनुवाद के लिए श्री एम.एल. गुप्ता, छायाचित्रों के लिए श्री बी.एल. शर्मा तथा तकनीकी सहायता के लिए श्री बी.एल. बैरवा का भी धन्यवाद ज्ञापित करता हूँ।

(एस.ए. करीम)

Blanck



Director
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PREFACE

Central Sheep and Wool Research Institute conducts research and extension for enhancing productivity and product utilization of sheep and rabbit. Sheep husbandry plays an important role in livelihood and economic sustenance of poor farmers. Institute is pursuing research on sheep through integrated approach of breeding, reproduction, nutrition, health, management, product utilization and transfer of technology for optimizing productivity. The fruitful results have been achieved in research areas of prolific sheep, resistance sheep to *Haemonchus contortus*, controlling GIN by targeted selective approach, incorporation of *Prosopis juliflora* pods in ration and three lamb crops in two year. Body weight of 31.8 and 39.3 kg at 6 and 12 month of age has been achieved in three breed cross sheep (GMM x Patanwadi) with multiple birth of >30%, similarly resistance line of Avikalin and Malpura developed and maintained without anthelmintic drenching. Three lamb crops in 636 days have been achieved in 72% of animals. *Prosopis juliflora* pods can be incorporated in the ration upto 40-50% without any deleterious effect. Targeted approach of single drenching in farmer flocks as against 3-4 drenching has been implemented and demonstrated in Rajasthan with success.

In the recent past, climate changes adversely affected the sheep husbandry in harsh climate of the country leading to shifting population and utility, breed composition, hardship of livelihood and nutritional security of farmers, emergence and reemergence of newer diseases etc. It has been observed that sheep in relation to other livestock species are well appreciated in many situations of climate effects and its vagaries. They can escape from drought or famine affected areas to other areas by migration and withheld its adverse effect. Institute has initiated research programme on resilience of small ruminant production under changing climate, shelter module and enteric methane production. The developed technologies would be of great use for mitigating adverse effect of climate change and environmental stress on sheep and other livestock species.

The advancements in research portfolio of Institute have been possible with sincere efforts of scientists, technical and administrative staff of the Institute. I would like to express my gratitude to Dr S. Ayyappan, Secretary, DARE and Director General, ICAR, Ministry of Agriculture, New Delhi for his invaluable guidance in the working of the Institute. I am grateful to Dr K.M.L. Pathak, DDG (AS) and Dr S.C. Gupta, ADG (AP&B) for their keen interest and generous support in the activities of the Institute. I appreciate the efforts of Dr A.K. Shinde and Dr C.P. Swarnkar in bring out this document. Sh M.L. Gupta helps for hindi translation, Sh B.L. Sharma for photographs and Sh B.L. Bairwa for technical in puts are gratefully acknowledged.

(S.A. Karim)

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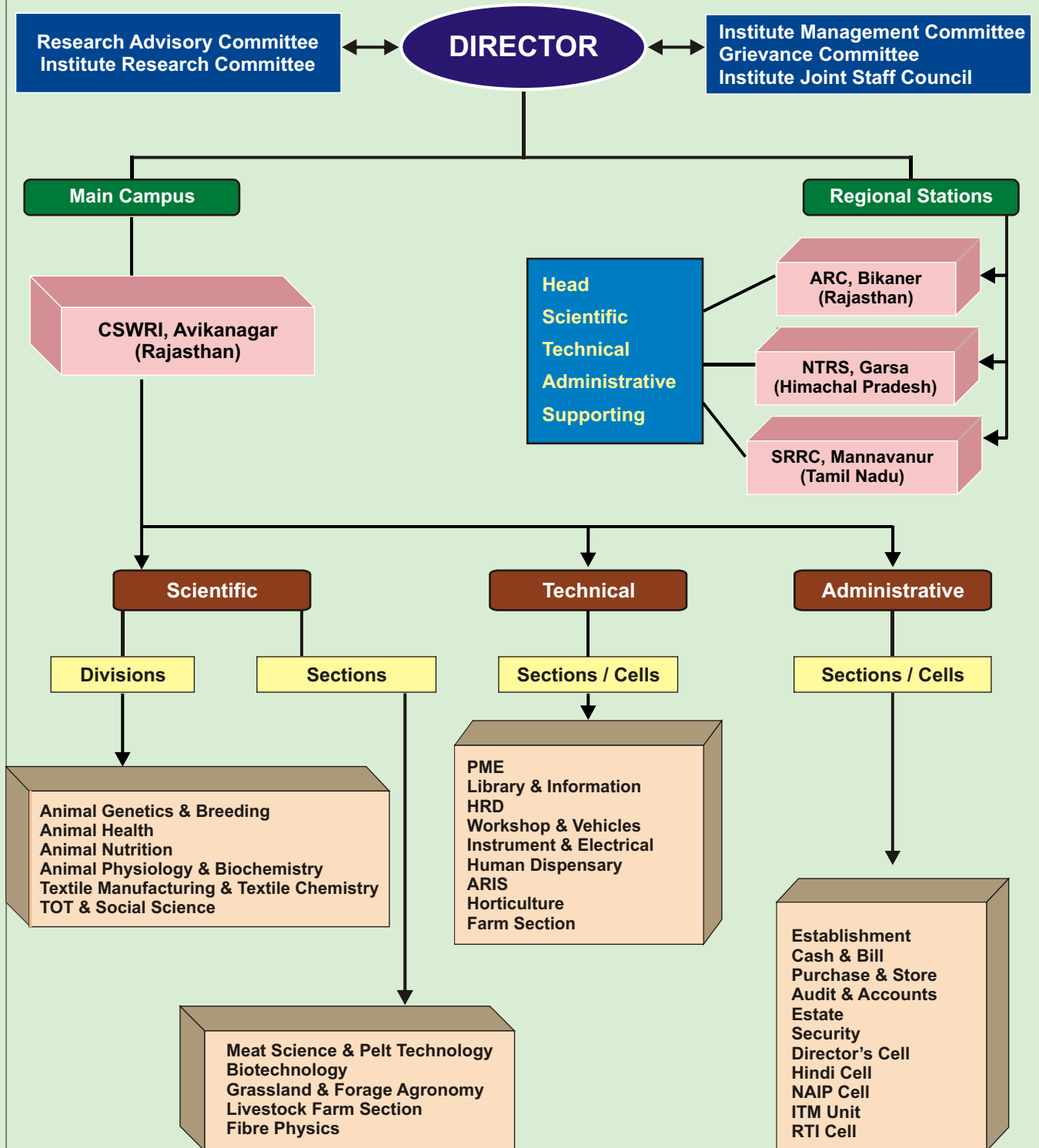
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सारांश

केन्द्रीय भेड़ एवं ऊन अनुसंधान संस्थान, अविकानगर भारतीय कृषि अनुसंधान परिषद, नई दिल्ली के पशु विज्ञान संस्थानों में से एक संस्थान है। इसकी स्थापना वर्ष 1962 में भेड़ एवं खरगोश उत्पादन, स्वास्थ्य एवं उत्पादन उपयोग से सम्बन्धित समस्त मूलभूत एवं व्यावहारिक अनुसंधान कार्य हेतु की गई। अनुसंधान सलाहकार समिति (RAC), संस्थान प्रबन्ध समिति (IMC) एवं पंचवर्षीय समीक्षा समिति (QRT) की बैठकें अनुसंधान कार्यक्रमों की समीक्षा, प्रशासनिक एवं अन्य गतिविधियों का निरीक्षण एवं संस्थान के अनुसंधान, प्रशासनिक एवं तकनीकी विभागों में उचित परिवर्तन करने हेतु समय-समय पर आयोजित की जाती हैं। संस्थान में 91 वैज्ञानिक, 154 तकनीकी एवं 87 प्रशासनिक अधिकारी एवं कर्मचारियों के पद स्वीकृत हैं। संस्थान के अनुसंधान कार्यक्रमों को पूरा करने के लिए वर्ष 2010-2011 के दौरान योजना मद में 400.00 लाख रुपए एवं गैर योजना मद में 2008.00 लाख रुपए आवंटित किए गए। वर्ष 2010-2011 के दौरान संस्थान द्वारा फार्म उत्पाद, तकनीकों, जीवित पशुओं, पशु उत्पाद (ऊन, मांस एवं दूध), प्रशिक्षण एवं परामर्श सेवाएँ प्रदान कर 100.64 लाख रुपए का राजस्व अर्जित किया गया।

संस्थान ने देशी भेड़ों (चोकला, मालपुरा, मागरा एवं मारवाड़ी) की नस्लों में आनुवंशिक सुधार, तीन नस्लों की संकरित बहुअज भेड़ का विकास, बढ़वार वाले मेमनों का पोषण एवं चराई, अनुत्पादक भेड़ों के लोथ की पुनः संरचना, कृषि वानिकी पद्धति का विकास, त्वरित जनन पद्धति, भेड़ों की नस्लों का आनुवंशिक विश्लेषण, हिमांकस कन्ट्राट्स के विरुद्ध आनुवंशिक प्रतिरोधकता, बीमारियों की व्यापकता, निदान व रोकथाम, देशी ऊन से गलीचा, तकनीकी वस्त्र एवं परिधान बनाना, मूल्य संवर्धित उत्पाद एवं स्थानान्तरणीय, व्यवसायिक एवं एकाधिकार तकनीकों का विकास करने में महत्वपूर्ण प्रगति की है।

अविकालीन भेड़ का 6 एवं 12 माह की आयु पर शारीरिक भार क्रमशः 26.56 एवं 33.56 किग्रा. प्राप्त किया गया। प्रथम एवं द्वितीय छमाही कतरन पर चिकनाई युक्त ऊन उत्पादन क्रमशः 1034 एवं 975 ग्राम पाया गया जबकि तन्तु का व्यास एवं मेडूलेशन क्रमशः 32.44 माईक्रॉन एवं 37.50 प्रतिशत पाया गया। स्थानीय भेड़ों में सुधार हेतु कर्नाटक राज्य के प्रगतिशील किसानों को 59 प्रजनक मेढ़े बेचे गए। मालपुरा भेड़ों में 6 एवं 12 माह की आयु पर शारीरिक भार क्रमशः 25.74 एवं 31.90 किग्रा. प्राप्त किया गया। भेड़ों में आनुवंशिक सुधार हेतु 79 प्रजनक मेढ़े किसानों को बेचे गए। जी.एम.एम. (GMM) x पाटनवाड़ी (3 नस्लों से संकरित) एवं पाटनवाड़ी x जी.एम.एम. (GMM) नस्लों के पारस्परिक संकरण से 6 एवं 12 माह की आयु पर शारीरिक भार क्रमशः 31.82 एवं 39.35 तथा 20.42 एवं 29.14 किग्रा. प्राप्त किया गया। इस वर्ष गैरोल नस्ल की अपेक्षाकृत अधिक शारीरिक भार वाली बहुअज केन्द्रपाड़ा भेड़ को उड़ीसा

राज्य के मूल क्षेत्र से क्रय किया गया। चोकला भेड़ों में 6 एवं 12 माह की आयु पर शारीरिक भार क्रमशः 25.09 एवं 30.11 किग्रा. प्राप्त किया गया। तन्तु का व्यास, लम्बाई एवं मेडूलेशन क्रमशः 35.39 माईक्रॉन, 7.10 सेमी. एवं 38.50 प्रतिशत के साथ वार्षिक ऊन उत्पादन 2.43 किग्रा. प्राप्त किया गया। केन्द्रीय ऊन विकास मण्डल, जोधपुर के सौजन्य से चलाई जा रही मेढा पालन परियोजना में उनके मूल क्षेत्र में वितरण हेतु 41 प्रजनक मेढों को बेचा गया। मारवाड़ी एवं मागरा भेड़ों में 6 एवं 12 माह की आयु पर शारीरिक भार क्रमशः 20.07 एवं 31.87 तथा 22.96 एवं 31.41 किग्रा. प्राप्त किया गया। मारवाड़ी भेड़ों के प्रजनन क्षेत्र एवं आंध्र प्रदेश में 10 वयस्क मेढे एवं 99 नर मेमनें बेचे गए। इसके अतिरिक्त भेड़ प्रजनन फार्म, फतेहपुर (सीकर) में मारवाड़ी यूनिट की स्थापना हेतु 92 वयस्क भेड़ एवं 64 युवा मादा भेड़ें बेची गईं जबकि किसानों के रेवड़ में आनुवंशिक सुधार हेतु मारवाड़ी नस्ल के 77 मेढे एवं 30 युवा नर मेमनें बेचे गए। दक्षिणी क्षेत्रीय अनुसंधान केन्द्र, मन्नावनूर की शीत जलवायु में महीन ऊन उत्पादन करने वाली भारत मेरीनो भेड़ का 6 एवं 12 माह की आयु पर शारीरिक भार क्रमशः 20.73 एवं 34.86 किग्रा. पाया गया तथा नर एवं मादा का वार्षिक ऊन उत्पादन क्रमशः 2.00 एवं 1.65 किग्रा. पाया गया। अंगोरा खरगोशों से प्रथम से पंचम कतरन में क्रमशः 167, 170, 154, 149 एवं 155 ग्राम ऊन के साथ तन्तु की लम्बाई, व्यास एवं सुरक्षा बाल क्रमशः 6.26 सेमी., 12.84 माईक्रॉन एवं 4.99 प्रतिशत पाया गया। दक्षिणी क्षेत्रीय अनुसंधान केन्द्र, मन्नावनूर में व्हाइट जाइंट एवं सोवियत चिंचिला खरगोशों का शारीरिक भार क्रमशः 1.962 एवं 1.916 किग्रा. प्राप्त किया गया तथा कर्नाटक, तमिलनाडू, केरल एवं पांडुचेरी राज्य के 64 किसानों को 1182 प्रजनक खरगोशों की आपूर्ति की गई।

देश के चारा संसाधनों में विलायती बबूल चारे का एक महत्वपूर्ण स्रोत है। विलायती बबूल की सूखी पत्तियाँ एवं फलियाँ भेड़ों की खिलाई में प्रयोग की गईं। यह पाया गया कि बिना किसी हानिकारक प्रभाव के भेड़ों के राशन में सूखी पत्तियों एवं फलियों को क्रमशः 10–20 एवं 40–50 प्रतिशत तक प्रयोग में लिया जा सकता है। मांस उत्पादन बढ़ाने के लिए मेमनों को रोमन्थ में अविखंडनीय 4 प्रतिशत वसा के साथ विटामिन-ई खिलाने पर मेमनों के शारीरिक भार एवं ऊन उत्पादन में वृद्धि हुई। इसी प्रकार आहार में सोडियम सल्फेट के रूप में 0.3 प्रतिशत सल्फर (गंधक) खिलाने से ऊन उत्पादन एवं तन्तु व्यास में वृद्धि हुई जबकि बालयुक्त ऊन एवं मेडूलेशन प्रतिशत में कमी पाई गई। अधिक संख्या में स्थानीय वनस्पतियों, झाड़ियों, मसालों के भूसे, औषधियों एवं अन्य फसल अवशेषों का आहार तैयार करने हेतु तथा आंत्र द्वारा मीथेन उत्सर्जन को कम करने हेतु मूल्यांकन किया गया।

तरल रूप में वीर्य का 4–8 डिग्री सेल्सियस पर 24 घंटे तक संरक्षण शुक्राणु श्लेष्मा की प्रोटीन संरचना को प्रभावित नहीं करता है तथा इसे कृत्रिम गर्भाधान हेतु संरक्षित किया जा सकता है। अल्पावधि के लिए संरक्षित वीर्य से 64.4 प्रतिशत मेमना जनन दर प्राप्त की गई। भेड़ों की पुनरुत्पादन क्षमता में सुधार के

अन्तर्गत 243 एवं 636 दिनों की लक्षित अवधि के अन्दर 57.2 एवं 72.7 प्रतिशत भेड़ों से 2 वर्ष में 3 मेमनें प्राप्त किए गए। भेड़ों में बहु तनाव (तापीय, पौषणिक, निष्क्रमण तनाव) अध्ययनों के अन्तर्गत तापीय तनाव से प्लाज्मा टेस्टोइस्टीरोन (Plasma testosterone) की कमी तथा प्लाज्मा कुल प्रोटीन, कोलेस्ट्रॉल, अकार्बनिक फास्फोरस एवं मैग्नीशियम की मात्रा में वृद्धि पाई गई।

संस्थान के रवेड़ों में सामयिक स्वास्थ्य पद्धतियाँ अपनाई गईं तथा वर्ष के दौरान किसी भी विशेष बीमारी का प्रकोप नहीं देखा गया। अविशिष्ट बीमारियों में मृत्यु के मुख्य कारण निमोनिया, सेप्टीसीमिया, आंत्रशोथ एवं अफारा थे। नस्लवार वार्षिक तुल्यांक औसत मृत्युदर (EADR) से ज्ञात हुआ है कि यह सबसे कम पाटनवाड़ी में (0.090) तत्पश्चात् पाटनवाड़ी संकर (0.203), मालपुरा (0.228), जी.एम.एम/एम.जी.एम (GMM/MGM) (0.274), चोकला (0.281), गैरोल x मालपुरा (0.318), अविकालीन (0.399) एवं गैरोल (0.768) भेड़ों में पाई गई। वर्ष के दौरान स्वास्थ्य उपायों पर प्रति भेड़, बकरी एवं खरगोश पर वार्षिक खर्च क्रमशः 45.03, 41.29 एवं 7.09 रुपए पाया गया। जॉन्स रोग, ओवाईन पलमोनरी एडिनोमेटोसिस (ovine pulmonary adenomatosis) एवं केजियस लिम्फेडिनाइटिस (caseous lymphadenitis) की जाँच हेतु पी.सी.आर. (PCR) विधियों का मानकीकरण किया गया। वयस्क एवं एक वर्षीय भेड़ों में पेट एवं आँतों के कीड़ों के कारण समग्र वार्षिक हानि क्रमशः 125.78 एवं 94.29 रुपए प्रति इकाई आँकी गई। भेड़ों में पेट एवं आँतों के कीड़ों का योजनाबद्ध नियंत्रण (एक बार दवा पिलाना) 45 से 59 प्रतिशत तक हानि की रोकथाम करने में सक्षम पाया गया। वर्धनशील मेमनों को उच्च एवं मध्य मात्रा वाला प्रोटीनयुक्त आहार खिलाने से हिमांकस कन्टार्स के संक्रमण से उत्पन्न रोगीय प्रभावों का सामना करने की क्षमता में सार्थक सुधार हुआ।

वस्त्र निर्माण एवं वस्त्र रसायन अनुसंधान कार्यक्रम के अन्तर्गत कुल 728 कम्बल एवं 185 शॉलें, 3 गलीचे एवं 119 नमदों का निर्माण करके उनकी गुणवत्ता की विशेषताओं का आँकलन किया गया। नॉयलान मिश्रित कम्बलों में स्पर्श अनुभव, मजबूती एवं रंगों की चमक विशेषताओं में सुधार हुआ किन्तु विशुद्ध ऊन के कम्बलों में घर्षण हानि में कमी तथा तापीय अवरोध में वृद्धि पाई गई। हथकरघा एवं यांत्रिक करघा से निर्मित कम्बलों में समान तापीय प्रतिरोध क्षमता पाई गई। अंगोरा खरगोश के बालों के साथ भारत मेरीनों ऊन के क्रमशः 60:40 के मिश्रण से निर्मित शालों में मिश्रण लम्बाई, घर्षण बल, घर्षण हानि, तापीय अवरोध विशेषताओं में वृद्धि पाई गई। बीकानेरी चोकला ऊन की तुलना में मागरा ऊन (सितम्बर माह की कतरन) से निर्मित गलीचे में चमक एवं दबाव क्षमता में सुधार देखा गया। बीकानेरी चोकला ऊन से निर्मित गलीचे में बढ़ी हुई दबाव क्षमता के साथ कम चमक पाई गई।

जैव तकनीकी विधियों के अन्तर्गत फ़ैक बी (*Fec B*) जीन के समायोजन द्वारा मांस उत्पादन बढ़ाने हेतु केन्द्रपाड़ा नस्ल की भेड़ को उसके मूल स्थान से क्रय

किया गया तथा बहुअजता जीन के लिए चिन्हित किया गया। रेवड में लगभग 84 प्रतिशत भेड़ों में फैंक बी जीन पाया गया। गुणवत्तायुक्त रेशे जैसे पश्मीना को अपमिश्रण से बचाने के लिए विभिन्न पशुओं के रेशों जैसे ऊन, पश्मीना एवं अंगोरा की पहचान हेतु डी.एन.ए. (DNA) प्रथक किया गया तथा पशु विशेष के लिए पी.सी.आर. (PCR) परिस्थितियों का मानकीकरण किया गया। भेड़ों में हिमांकस कन्टार्टस के प्रति आनुवंशिक प्रतिरोधकता के अनुसंधान कार्यक्रम के अन्तर्गत मेढावार औसत संक्रमण तीव्रता (दवाई पिलाने के बाद) के आधार पर मेढ़ों को क्रमबद्ध चयन कर उनकी संतानों का अन्तःकृमियों के प्रति ग्रहणशीलता (S) अथवा प्रतिरोधक क्षमता (R) के गुणों हेतु चयन किया गया। मालपुरा एवं अविकालीन संतानों में R-समूह की अपेक्षा S-समूह में औसत संक्रमण की तीव्रता 3 से 10 गुणा अधिक पाई गई। R-समूह वाले पशुओं को बिना किसी अन्तःकृमिनाशी हस्तक्षेप के रखा गया।

शुष्क एवं अर्ध-शुष्क क्षेत्रों के पानी की कमी वाले हिस्सों में पशुधन के लिए चारा उगाना कठिन है। अधिक चारा उत्पादन करने के लिए कृषि वानिकी पद्धति, प्राकृतिक संसाधनों का संरक्षण एवं प्रबंधन तथा ढालू भूमि पर चरागाह स्थापन का विकास कर मूल्यांकन किया गया।

मेमनों एवं छँटनी की गई भेड़ों को रोमंथ में अविखंडनीय 4 प्रतिशत वसायुक्त आहार खिलाने से उनके वध करने से पूर्व शारीरिक भार एवं चरबी रहित मांस उत्पादन में सुधार हुआ किन्तु मांस की गुणवत्ता में कोई सुधार नहीं देखा गया। उपभोक्ता की पंसद हेतु नगेट्स, सलामी, गुलमा एवं कोफता तैयार कर उनका मूल्यांकन किया गया। कुल 124.35 किग्रा. मांस उत्पाद तैयार करके उपभोक्ताओं को बेचा गया। कुल 292 (202 भेड़, 34 बकरियाँ एवं 56 खरगोश) पशुओं का वध किया गया तथा उनके मांस का ऑकलन किया गया।

तकनीकी स्थानान्तरण कार्यक्रम के अन्तर्गत प्रक्षेत्र की भेड़ों की उत्पादकता में सुधार हेतु एकीकृत विधियों को अपनाया गया। प्रक्षेत्र के रेवडों में जन्म, 3, 6, 9 एवं 12 माह की आयु पर मालपुरा नस्ल की भेड़ों का शारीरिक भार क्रमशः 3.43, 13.61, 20.22, 26.06 एवं 20.55 किग्रा जबकि खेरी नस्ल में उसी क्रम में क्रमशः 3.56, 13.65, 21.36, 27.50 एवं 30.19 किग्रा पाया गया। अचक्रीय भेड़ों में अन्तःयोनि प्रोजेस्ट्रानयुक्त स्पंजों एवं पी.एम.एस.जी. (PMSG) (100 IU) का प्रयोग तत्पश्चात उन्हें अल्पावधि के लिए संरक्षित हिमीकृत वीर्य से कृत्रिम गर्भाधान करने पर 65.90 प्रतिशत जनन दर प्राप्त की गई।

चारा उत्पादन हेतु किसानों के खेतों में चारा फसलों की विकसित किस्मों, रसायनिक एवं जैविक उर्वरकों के प्रयोग प्रदर्शन लगाए गए। चारा प्रदर्शन के अतिरिक्त चारे के कमी के दिनों में उत्तम गुणवत्ता वाले चारे की उपलब्धता सुनिश्चित करने हेतु सामुदायिक चरागाह भूमि पर 150 चारे एवं फलदार वृक्षों के पौधे लगाए गए।

भेड़ों को गर्भावस्था के अन्त में तथा दुग्धावस्था के प्रारम्भ में रातिब मिश्रण की पूरक खिलाई से उनके दूध उत्पादन एवं मेमनों के जन्म एवं 2 माह की आयु पर शारीरिक भार में सुधार देखा गया। इसी प्रकार पड़ती भूमि पर मेमनों की चराई कराने से 104 ग्राम प्रतिदिन की तुलना में पूरक खिलाई पर पाले गए मेमनों में 140 से 160 ग्राम प्रतिदिन प्रति मेमना वृद्धि दर पाई गई।

अंगीकृत गाँवों की भेड़ों के रेवड़ में कुल मृत्युदर 5.44 प्रतिशत पाई गई जिसके मुख्य कारण निमोनिया, कमजोरी, दस्त एवं पेट में अफारा पाए गए। प्रक्षेत्र की रेवड़ों में मध्य मानसून के पश्चात एक बार कृमिनाशक दवाई पिलाने का जठरांत्र कृमियों की रोकथाम पर प्रभाव देखा गया। अंगीकृत गाँवों में 6 स्वास्थ्य शिविर आयोजित किए गए जिसमें विभिन्न बीमारियों से संबंधित 1871 पशुओं का उपचार कर 246 किसानों को लाभ पहुँचाया गया।

मागरा एवं बीकानेरी चोकला ऊन तथा नायलॉन के मिश्रण से 9'x 6' आकार के तीन गलीचे तैयार किए गए। ये गलीचे हाथ की गठौन एवं जटिल डिजायन से तैयार किए गए तथा ग्रामीणों को प्रदर्शन हेतु रखे गए। मैसर्स फ़ैल्ट एण्ड नॉन-वूवेन टेक्नीकल इन्डस्ट्रीज, जयपुर, मैसर्स मुकुन्द लाल मोती लाल कम्पनी, बीकानेर, मैसर्स ट्रान्सपैक-सिलोक्स, वड़ोदरा, केन्द्रीय ऊन विकास मण्डल, जोधपुर एवं जम्मू-कश्मीर भेड़ एवं ऊन उत्पाद विकास बोर्ड, श्रीनगर को विभिन्न मामलों में परामर्श सेवाएँ प्रदान की गईं।

केन्द्रीय भेड़ एवं ऊन अनुसंधान संस्थान की खरगोश इकाई से कुल 837 खरगोश बेचे गए एवं अजमेर, कोटा, जयपुर, टोंक, झुन्झुनू, सीकर, पाली, हरियाणा एवं पंजाब में स्थित 26 खरगोश इकाईयों का सर्वेक्षण किया गया। प्रक्षेत्र इकाईयों के दूध पीते हुए, बढ़वार वाले एवं वयस्क खरगोशों का समग्र शारीरिक भार क्रमशः 462 ग्राम, 1.62 एवं 2.74 किग्रा. तथा जन्म के समय लिटर आकार एवं भार क्रमशः 5.90 एवं 298 ग्राम पाया गया।

एस.एम.एस. अलर्ट सेवा: सही समय एवं सही प्रकार से सूचना के प्रसार हेतु इस नई विधि का विकास किया गया तथा यह 1 जनवरी, 2011 से प्रारम्भ की गई है। इसमें संस्थान द्वारा पंजीकृत भेड़ पालकों को प्रत्येक सप्ताह भेड़ पालन के प्रयोग में ली जाने वाली उन्नत पद्धति से संबंधित सूचना एस.एम.एस. द्वारा भेजी जाती है।

भेड़ उत्पादन एवं ऊन प्रसंस्करण की विकसित तकनीकों के प्रसार हेतु 10 प्रदर्शनियाँ आयोजित की गईं। संस्थान द्वारा नई तकनीकों एवं विकसित ज्ञान को किसानों तक पहुँचाने हेतु भेड़ एवं किसान मेला, प्रक्षेत्र दिवस, किसानों से सम्पर्क, वन महोत्सव आयोजित किए गए। संस्थान के बारे में उपलब्धियों, तकनीकों एवं अन्य गतिविधियों पर दो वीडियो फिल्म बनाई गईं।

Executive Summary

The Central Sheep and Wool Research Institute, Avikanagar is one of the animal science institutes of Indian Council of Agricultural Research, New Delhi. The Institute was established in 1962 to conduct applied and basic research on all aspects of sheep and rabbit production, health and product utilization. The meetings of Research Advisory Committee (RAC), Institute Management Committee (IMC) and Quinquennial Review Team (QRT) were held periodically to review the research programmes, supervise the administration and other activities and recommend suitable changes in research, administration and technical portfolio of the Institute. The Institute has sanctioned post of 91 scientific, 154 technical and 87 administrative staff. To accomplish the research programme of the Institute, Rs. 400.00 lakh under plan and Rs. 2008.00 lakh under non-plan was allocated during the year 2010-11. The Institute has generated revenue of Rs. 100.64 lakhs through sale of farm produce, technologies, live animals, animal produce (wool, meat and milk), training and consultancy services during the year 2010-11.

The Institute has made considerable progress in the genetic improvement of native sheep (Chokla, Malpura, Magra and Marwari) breeds, development of three breed cross prolific sheep, nutrition and feeding of grower lambs and restructuring of carcasses of spent ewes, development of agro-forestry system, accelerated lambing system, genome analysis of sheep breeds, genetic improvement of resistance to *Haemonchus contortus*, epidemiology of diseases, carpet, technical textiles and apparels from indigenous wool, value added products and development of transferable, commerciable and patentable technologies.

The body weight of 26.56 and 33.56 kg at 6 and 12 month of age, respectively were achieved in Avikalin sheep. Greasy fleece yield of 1034 and 975 g in first and second six monthly clips was achieved with fibre diameter and medullation of 32.44 μ and 37.50 %, respectively. Fifty nine breeding rams of Avikalin were sold to progressive farmers of Karnataka state for improvement of local sheep. In Malpura sheep, body weights of 25.74 and 31.90 kg were achieved at 6 and 12 months of age, respectively. A total of 79 rams sold to the farmers for the genetic improvement of their sheep. In GMM X Patanwadi (Three breed cross), body weight of 31.82 and 39.35 kg and in reciprocal cross of Patanwadi X GMM, 20.42 and 29.14 kg at 6 and 12 months of age, respectively were achieved. This year Kendrapada, a prolific sheep with relatively higher body weights than Garole purchased from native tract of Orissa. In Chokla sheep, body weights of 25.09 and 30.11 kg at 6 and 12 months of age, respectively were achieved. Annual wool yield of 2.436 kg achieved with fibre diameter, staple length and medullation of 35.39 μ , 7.10 cm and 38.50%, respectively. A total of 41 breeding rams were sold to Ram Rearing Project sponsored by CWDB, Jodhpur for distribution in the native tract. The body weight of 20.07 and 31.87 kg in Marwari sheep and 22.96 and 31.41 kg in Magra sheep were achieved at 6 and 12 month of age, respectively. In Marwari sheep, 10 adult rams and 99 male hoggets were sold in the breeding tract of Marwari sheep and Andhra Pradesh. In addition, 92 adult and 64 hogget females were sold for establishment of Marwari unit at Sheep Breeding Farm,

Fathepur (Sikar). In Magra sheep, 77 rams and 30 male hogget were sold for genetic improvement of sheep in farmer's flock. Bharat Merino sheep for fine wool production under cold climate of SRRC, Maanavanur attained body weights of 20.73 and 34.86 kg at 6 and 12 month of age, respectively and produced annually 2.00kg clean fleece yield in males and 1.65 kg in females. In Angora rabbits, fibre yields of 167, 170, 154, 149 and 155 g, for 1st to 5th clip, respectively with staple length, fibre diameter and guard hair of 6.26 cm, 12.84 μ and 4.99%, respectively were recorded. In White Giant and Soviet Giant rabbits, body weights of 1.962 and 1.916 kg achieved at SRRC, Mannavanur. A total of 1182 breeding rabbits supplied to 64 clients of Karnataka, Tamil Nadu, Kerala and Puducherry states.

Prosopis juliflora is one of the important feed resources in the country. Dried leaves and pods of *P. juliflora* were explored and utilized in feeding of sheep. It was established that dried leaves and pods can be used up to the level of 10-20 and 40-50%, respectively in the ration of sheep without any deleterious effect. In nutritional manipulation of lambs for improving mutton production, 4% rumen protected fat with vitamin E increased body weights and wool yield of lambs. Similarly, 0.3% sulphur as Na₂SO₄ in ration of sheep increased wool yield and fibre diameter and decrease hairy and medullation percent. Large numbers of local cultivar, top feed, spice straw, herb and other crop residue were evaluated for formulating feed and reducing enteric methane emissions.

The semen in liquid form upto 24 hr at 4-8°C did not affect the protein profile of sperm membrane and can be suitably preserved for artificial insemination. Lambing percent of 64.4 was achieved with short term preserved semen. In improving reproductive efficiency of sheep, 3 lamb crops in 2 years were achieved in 57.2 and 72.7% ewes within the target period of 243 and 636 days. Under multiple stresses (thermal, nutritional and walking stress) studies on sheep, thermal stress decreased the plasma testosterone and increased plasma total protein, cholesterol, inorganic phosphorus and magnesium concentrations.

In the Institute flocks, planned health practices were followed and no specific outbreak of disease was recorded during the year. Among non-specific diseases pneumonia, septicaemia, enteritis and impaction were major causes of mortality. The breed-wise EADR indicated minimum value in Patanwadi (0.090) followed by Patanwadi crosses (0.203), Malpura (0.228), GMM/MGM (0.274), Chokla (0.281), Garole X Malpura (0.318) Avikalin (0.399) and Garole (0.768) sheep. Annual expenditure during the year per sheep, goat and rabbit on health measures was Rs. 45.03, 41.29 and 7.09, respectively. The PCR protocols were standardized for diagnosis of Johne's disease, ovine pulmonary adenomatosis and caseous lymphadenitis. The overall annual loss due to gastrointestinal nematodes was estimated as Rs. 125.78 and Rs. 94.29 per adult and yearling sheep, respectively. The strategic control (single drench schedule) of GIN in sheep was able to prevent the loss up to the extent of 45-59%. The feeding of both high and moderate protein diet to growing lambs significantly improved the ability to withstand the pathogenic effects of *Haemonchus contortus* infection.

In research programme of Textile Manufacture and Textile Chemistry, a total of 728 blankets, 185 shawls, 3 carpets and 119 namda were manufactured and evaluated for quality attributes. Nylon blended blankets improved feel, strength and colour fastness properties, however pure wool blankets had lower abrasion loss and higher thermal insulation. The handloom and powerloom blankets had similar thermal resistance properties. Shawl prepared from Angora hair with Bharat Marino wool upto 60: 40 proportions increased bending length, frictional force, abrasion loss, thermal insulation properties. The carpet made from Magra (September clip) wool improved resiliency as well as compressibility compared to Bikaneri chokla. The carpet made from Bikaneri Chokla wool improved compressibility but lower resiliency.

In biotechnological approaches for enhancing mutton production by introgression of *Fec B* gene, Kendrapara sheep from their native tract were purchased and screened for prolific gene. In the Kendrapada flock, around 84% of carrier sheep with *Fec B* gene were found. For identification of fibre of different animal species to avoid adulteration of quality fibre like pashmina, DNA were isolated from wool, pashmina and angora fibre and PCR condition for wool and pashmina fibre were optimized by species specific PCR primers. In research programme on genetic resistance of sheep to *Haemonchus contortus*, on the basis of sire-wise mean intensity of infection (post-drench), the sires were ranked and progenies were selected for susceptible (S) or resistant (R) line. In Malpura and Avikalin progenies, the mean intensity of infection was 3-10 times higher in S-line compared to R-line. The animals of R-line were maintained without any anthelmintic intervention.

Fodder production for livestock is crucial in water deficient zones of arid and semiarid regions. Agro-forestry system, conservation and management of natural resources and establishment of pasture on sloppy lands for maximizing forage production was developed and evaluated.

Carcass of lambs and cull ewes maintained on feed containing 4% rumen protected fat showed improvement in pre-slaughter weight and lean meat yield but not in the meat quality. Nugget, salami, sausage and kofta were prepared and evaluated for consumer acceptability. Total of 124.35 kg meat products were prepared and sold to consumers. Total of 292 (202 sheep, 34 goats and 56 rabbits) animals slaughtered and carcass was evaluated.

In transfer of technology programme, intergrated approach was adopted for improving productivity of sheep in field flocks. Body weight of 3.43, 13.61, 20.22, 26.06 and 29.55 kg in Malpura and 3.56, 13.65, 21.36, 27.50 and 30.19 kg in Kheri were recorded at birth, 3, 6, 9 and 12 months of age. In field flock, lambing rate of 65.9% was achieved in acyclic ewes using intra-vaginal progesterone impregnated sponges and PMSG (100 IU) followed by artificial insemination with short term preserved chilled semen.

Field demonstrations were laid at farmer's field on improved varieties of fodder crops, chemical fertilizers and biofertilizers. Besides demonstration, 150 fodder and fruit tree saplings were planted on community land to popularize the fodder tree as a measure to ensure availability and quality fodder during scarcity period.

Supplementation of concentrate mixture in ewes during late gestation and early lactation improved body weights of lambs at birth and 2 month and milk yield, similarly supplementation in lambs improved growth rate to 140 to 160g as compared to 104g on grazing alone.

The overall mortality was 5.44% and predominant causes were pneumonia, debility, enteritis and tympany in sheep flock of adopted villages. The practice of single strategic drench with appropriate anthelmintic after mid monsoon effectively managed the GI nematodes in field flocks. Six health camps were organized in adopted villages and 1871 cases were treated for different ailments and 246 farmers benefited from health camps.

Three carpets of 9'X6' size were prepared from Magra and Bikaneri Chokla wool in blends with nylon. These carpets were hand knotted with intricate designs and demonstrations were laid for the villagers. Consultancy services on various issues were provided to J & K Sheep and Wool Product Development Board, Srinagar, CWDB, Jodhpur, M/s Transpek-Silox, Vadodara, M/s Mukundlal Motilal Company, Bikaner, M/s Felt and Non-woven Technical Industries, Jaipur.

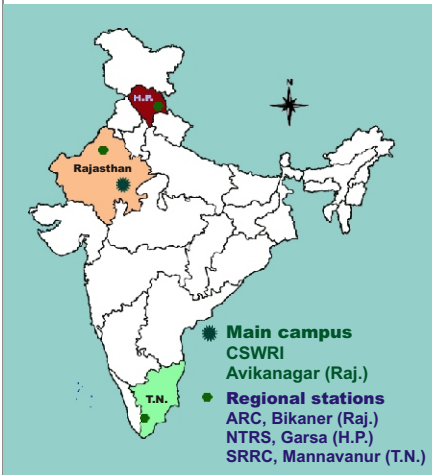
A total 837 rabbits were sold during the period from CSWRI Unit and survey was made in 26 rabbit units at Ajmer, Kota, Jaipur, Tonk, Jhunjhunu, Sikar, Pali, Haryana and Punjab. The overall body weights of weaners, growers and adults in field units were 462g, 1.62 kg and 2.74 kg and litter size and weight at birth were 5.90 and 298 g, respectively.

A new approach "SMS-Alert service" was developed and started from January 1, 2011 for timely and systematic dissemination of information. From institute one SMS was sent to registered sheep breeders on sheep practices to be followed in that particular week.

To disseminate technologies on improved sheep production and wool processing, ten exhibitions were organized. Sheep and Farmer Mela, Field day, Farmer interaction, Van Mahautsav were organized to create aware among farmers about new technology and knowledge developed by the Institute. Two videos were developed on institute profile, achievements, technologies and other activities.



Administrative block of CSWRI



Main campus and regional stations of CSWRI

About the Institute

The Central Sheep and Wool Research Institute is a premier Institute of Indian Council of Agricultural Research (ICAR) engaged in research and extension activities on sheep and rabbits. It was established in 1962 at Malpura in Rajasthan. Now campus is popular by the name of Avikanagar. The campus is spread over an area of 1510 hectare. It has three Regional Research Centres in different climatic zones of the country to develop region specific technologies. North Temperate Regional Station (NTRS) was established in 1963 in temperate region at Garsa, Kullu in Himachal Pradesh. The Southern Regional Research Centre (SRRC) was established in 1965 in sub temperate region at Mannavanur in Tamil Nadu. Arid Region Campus (ARC) was established in 1974 at Bikaner in arid region of Rajasthan. The Institute and its sub-stations have been working for enhancing the productivity of sheep and rabbit by applying scientific methods and developing new technologies.

The Institute has developed new strains of Avikalin for carpet wool production and Bharat Merino sheep for fine wool production in temperate climate. The scientific breeding, feeding and management practices were developed for improving the production traits of Malpura, Marwari, Magra and Chokla sheep. A prolific sheep from crossing of Malpura, Garole and Patanwadi breeds has been developed and its performance evaluation is ongoing under semi-arid climate. Some of the important technologies developed by the Institute are: Intensive lamb production for mutton, complete feed block for scarcity feeding, artificial insemination, embryo transfer technology, indigenous sponges for estrus synchronization, area specific mineral mixture, cost effective worm management program, disease data information system for organized sheep and goat farms and wool hair blended woollen products and meat and meat products.

Mandate

Basic and applied research on sheep and rabbit production, health, utilization, training and transfer of technologies to the beneficiaries

Objectives

1. To undertake basic and applied research on all aspects of sheep and rabbit production.
2. To develop, update and standardize meat, fibre and pelt technologies.
3. To impart trainings on sheep and rabbit production and utilization.
4. To transfer improved technologies on sheep and rabbit production to farmers, rural artisans and development workers.
5. To provide referral and consultancy services on production and products technology of sheep and rabbits.

Budget

Particulars	2009-10	2010-11
Sanctioned Budget		
Non-Plan	1904.26	2008.00
Plan	270.00	400.00
Total	2174.26	2408.00
Total Expenditure		
Non-Plan	1904.26	2008.00
Plan	270.00	400.00
Total	2174.26	2408.00

Resource Generation

A total of Rs 100.64 lakh has been generated toward revenue head through sale of animals, meat, wool, milk, consultancy services, training and other activities.

Manpower (As on 31.03.2011)

The sanctioned, filled and vacant position of scientist, technical, administrative and supporting staff in the institute and its regional stations has been depicted in table given below.

Categories	Sanctioned	Filled	Vacant
Director	1	1	-
Principal Scientist	9	7	2
Senior Scientist	20	7	13
Scientist	61	41	20
Total	91	56	35
Technical	145	119	26
Administrative	82	64	18
Supporting	171	111	60
Total	398	294	104
Grand Total	489	530	139

Library



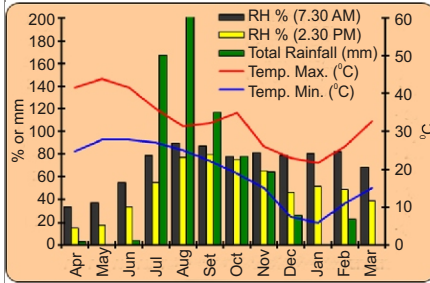
Reading room of CSWRI library

The library of CSWRI is a special library and it is well known for its rich information resources in the field of sheep, goats and rabbits and their product utilization. Collection of books, journals, periodicals etc being maintained in Veterinary Sciences and Agricultural Sciences especially on Wool Science and Forage Agronomy. Library is well equipped with CD ROM Server providing access to available bibliography databases through Institute LAN at the desktop of the scientist. On line facility of the Indian/ Foreign Journals are being provided by CeRA/ICAR, New Delhi through e-journal consortia under NAIP programme. Their access has been facilitated through Internet connectivity in full text including DDR servers.

At present, library has 10478 Books, 10627 Journals and 112 M.Sc / Ph.D Thesis. To keep pace with recent development, library added 149 Books

and subscribed/procured 7 Foreign Journals, 60 Indian Journals and 22 free/gratis Journals. Library is maintaining the bibliographic CD databases and raised it to 82 sets including CAB database, AGRIS, WTA CD etc.

Meteorological data (April 2010- March 2011)



Monthly meteorological data at CSWRI Avikanagar

Months	Temperature (°C)		Rainfall (mm)	Rainy days	Av. wind velocity (km/hr)	Av. sun shine (hr)	Humidity (%)		Av. evaporation (mm)
	Max	Min					7.30AM	2.30PM	
Apr	41.67	24.65	3.00	1	5.50	2.35	33.23	14.83	13.1
May	43.85	27.86	0.00	0	7.10	9.36	37.39	17.40	16.6
Jun	41.51	27.78	4.20	1	8.40	9.40	54.73	33.70	14.1
Jul	35.97	26.96	167.3	9	5.30	5.65	78.68	54.48	6.5
Aug	31.42	24.93	373.2	11	2.20	4.56	89.58	77.23	3.2
Sep	32.16	22.30	116.6	4	2.90	6.09	86.87	80.00	3.6
Oct	34.93	18.86	78.00	1	4.90	9.09	77.87	75.23	5.7
Nov	26.15	15.18	64.6	5	1.70	5.77	81.70	65.40	2.7
Dec	22.88	7.49	26.0	2	2.00	8.75	78.61	46.03	2.6
Jan	21.71	5.91	0.00	0	2.10	8.58	80.23	51.87	2.6
Feb	26.00	10.96	22.6	2	2.80	9.39	81.89	48.96	3.8
Mar	32.65	15.17	0.00	0	3.40	9.51	68.29	38.35	6.6

Projects

Dual type Avikalin sheep for meat and wool production

L.L.L. Prince, A.L. Arora, S.S. Misra (From 16.7.10), Ashish Chopra (From 27.1.11), Chandan Paswan (Upto 27.9.10), C.P. Swarnkar, M.K. Srivastava (Upto 25.5.10), O.P. Koli (From 1.6.10 to 10.1.11) and S.L. Ahari (From 27.1.11)

Genetic improvement of Malpura sheep for mutton production

S.S. Misra (From 17.7.10), A.L. Arora, Ved Prakash, C.P. Swarnkar, R.S. Bhat, M.K. Srivastava (Up to 25.5.10) and O.P. Koli (From 1.6.10)

Improving prolificacy in sheep for mutton production

Sub-project: Improving prolificacy in Malpura sheep through Garole Inheritance and enhancing milk production using Patanwadi sheep

A.L. Arora, L.L.L. Prince, S.S. Misra (From 16.7.10), Ved Prakash, Chandan Paswan (Upto 25.9.10), C.P. Swarnkar, Jyoti Kumar, Ashish Chopra (From 27.1.11), O.P. Koli and J.K. Sharma

Sub project: Improving prolificacy in Malpura sheep through Kendrapada inheritance

L.L.L. Prince, A.L. Arora, S.S. Misra (From 27.1.11), Ved Prakash (From 27.1.11), Chandan Paswan (Upto 27.9.10), C.P. Swarnkar, Ashish Chopra (From 27.1.11), Rajiv Kumar (Upto 23.2.11) and O.P. Koli

Evaluation and improvement of Chokla sheep for carpet wool (Network Project)

L.L.L. Prince, A.L. Arora, Chandan Paswan (Upto 27.9.10), Ved Prakash, Ashish Chopra (From 27.1.11), G.G. Sonawane, O.P. Koli (Upto 30.5.10) and Vinay Kumar (From 1.6.10)

Improvement of Magra sheep for meat and carpet wool production under farm conditions (ARC, Bikaner)

H.K. Narula, R.K. Sawal, K.C. Sharma, P.R. Sharma, Vimal Mehrotra and M. Ayub

Improvement of Marwari sheep for carpet wool production through selection (ARC, Bikaner) Network Project

H.K. Narula, P.R. Sharma, M. Ayub and Vimal Mehrotra

Improvement of synthetic sheep breeds for meat and wool production under sub-temperate climate (NTRS, Garsa)

S.K. Niranjana, S.R. Sharma, S. Saha and J.B. Phogat (From 1.2.11)

Demonstration unit of Bharat Merino sheep (SRRC, Mannavanur)

N. Swain (Upto 28.2.11), A.S. Rajendiran, S. Rajapandi, K. Narayanan (Upto 12.5.10)

Genetic improvement of Angora rabbit for wool production in sub-temperate climatic conditions (NTRS, Garsa)

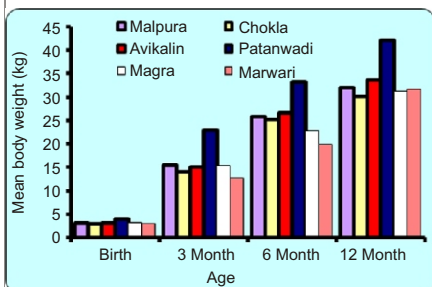
S.K. Niranjana, S.R. Sharma and S. Saha

Genetic improvement of Sirohi goats for meat and milk production (AICRP)

A.L. Arora, S.S. Misra (From 17.7.10), Chandan Paswan (Upto 22.8.10), Ashish Chopra (From 27.1.11), Fateh Singh, Sureshkumar (Upto 16.8.10) and S.S.R. Naqvi



Flock of Avikalin sheep



Growth performance of sheep



Flock of Malpura sheep



GMM x Patanwadi ewe

Dual type Avikalin sheep for meat and wool production

The overall least square means for body weight at birth, 3, 6 and 12 months age were 3.03, 15.07, 26.56 and 33.56 kg, respectively. Overall least square means for I and II six monthly greasy fleece yield (GFY) were 1034 and 975 g, respectively. Adult six monthly GFY was 752 g. In adult sheep, overall fibre diameter and medullation was 32.44 μ and 37.50 %, respectively. The overall fiber diameter, medullation and staple length in hogget sheep was 32.76 μ , 38.77 % and 6.43 cm, respectively. The tugging rate was 93.7 % while lambing rate on ewe's available and tugged basis was 84.4 and 90.1 %, respectively. Survivability at 0-3, 3-12 months and adult stage was 90.5, 96.4 and 95.3 %, respectively with overall value of 95.7 %. Fifty nine breeding rams of Avikalin were sold to progressive farmers for improvement of local sheep.

Genetic improvement of Malpura sheep for mutton production

The overall least square means for body weight at birth, 3, 6 and 12 months age were 3.08, 15.58, 25.74 and 31.90 kg, respectively. ADG in body weight of lambs during pre- and post-weaning phases were 138.53 and 114.78 g, respectively. The least square means for first six monthly, adult six monthly and adult annual GFY were 619, 400 and 802 g, respectively. The tugging rate was 93.64 %, while lambing rate on ewe's available and tugged basis was 85.75 and 91.69 %, respectively. The survivability at 0-3, 3-12 months and adult stage was 95.01, 97.41 and 96.40 %, respectively with overall value of 96.23 %. A total of 79 rams sold to the farmers for genetic improvement of their sheep.

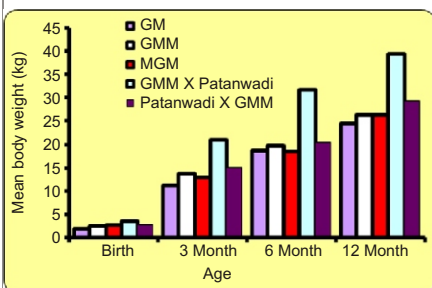
Prolific sheep for mutton production

Improving prolificacy in Malpura sheep through Garole inheritance and enhancing milk production using Patanwadi sheep

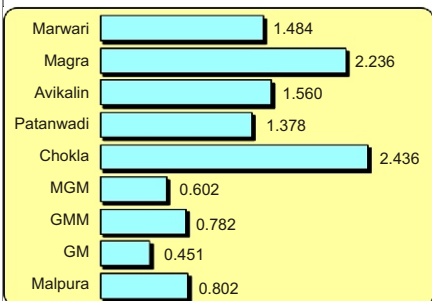
The overall least square means for body weight at birth, 3, 6 and 12 months age were 1.94, 11.30, 18.57 and 24.48 kg in Garole x Malpura (GM); 2.54, 13.65, 19.60 and 26.39 kg in GM x Malpura (GMM); 2.62, 12.93, 18.54 and 26.33 kg in Malpura x GM (MGM); 3.98, 22.81, 33.31 and 42.16 kg in Patanwadi; 3.51, 20.87, 31.82 and 39.35 kg in GMM x Patanwadi and 2.68, 14.83, 20.42 and 29.14 kg in Patanwadi x GMM, respectively. The overall means for first six monthly GFY in GM, GMM, MGM, Patanwadi, GMM x Patanwadi and Patanwadi x GMM were 373, 430, 392, 711, 737 and 500 g, respectively. The overall means for adult annual GFY were 451, 782, 602 and 1378 g in GM, GMM, MGM and Patanwadi, respectively. Annual tugging rate ranged from 87.91 (GM) to 97.87 % (Patanwadi). Lambing rate on ewe's available basis varied from 79.72 (GM) to 95.74 (Patanwadi) and on tugged basis varied from 92.22 (GMM) to 97.83 % (Patanwadi). Highest litter size of 1.68 was recorded in GM. The overall survivability in GM, GMM and MGM was 95.79, 95.45 and 97.47 %, respectively. Survivability of GMM x Patanwadi, Patanwadi x GMM at all the stages except 0-3 month was 100 %.



Kendrapada ewe



Growth performance of prolific sheep



Annual GFY (kg) of sheep



Flock of Chokla sheep

Improving prolificacy in Malpura sheep through Kendrapada inheritance

A total of 78 Kendrapada sheep were purchased in November 2010 from its native tract. *Fec B* gene was detected in 84 % of purchased flock of Kendrapada sheep. The average body weight of lambs at birth and 3 month were 1.26 and 7.13 kg, respectively. The average adult body weights of adult sheep increased from 15.97 (January) to 17.17 kg (March). Adult survivability in the flock was 83.33 %.

Overall least square means for body weight (kg) of native and synthetic sheep

Genotype	Birth	Weaning	6 month	12 month
Malpura	3.08	15.58	25.74	31.90
Garole X Malpura	1.94	11.30	18.57	24.48
GM X Malpura	2.54	13.65	19.60	26.39
Malpura X GM	2.62	12.93	18.54	26.33
Patanwadi	3.98	22.81	33.31	42.16
GMM X Patanwadi	3.51	20.87	31.82	39.35
Patanwadi X GMM	2.68	14.83	20.42	29.14
Chokla	2.97	14.01	25.09	30.11
Avikalin	3.03	15.07	26.56	33.56
Magra	3.24	15.40	22.96	31.41
Marwari	3.00	12.88	20.07	31.87

Overall least square means greasy fleece yield (kg) of native and synthetic sheep

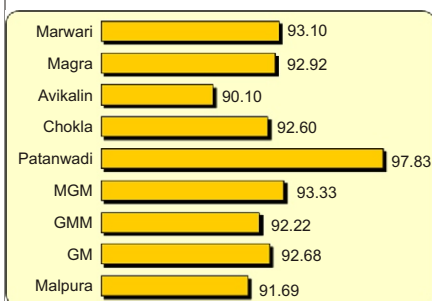
Genotype	I six monthly GFY	Adult annual GFY
Malpura	0.619	0.802
Garole X Malpura	0.373	0.451
GM X Malpura	0.430	0.782
Malpura X GM	0.392	0.602
Patanwadi	0.711	1.378
GMM X Patanwadi	0.737	-
Patanwadi X GMM	0.500	-
Chokla	1.314	2.436
Avikalin	1.034	1.560
Magra	0.599	2.236
Marwari	0.566	1.484

Evaluation and improvement of Chokla sheep for carpet wool

The overall least square means of body weight at birth, 3, 6 and 12 months age were 2.97, 14.01, 25.09 and 30.11 kg, respectively. The least square means of GFY for first six monthly, adult six monthly and adult annual was 1.314, 1.149 and 2.436 kg, respectively. Lambing rate on ewe's available and tugged basis was 90.7 and 92.6 %, respectively. The overall fibre diameter, staple length and medullation was 33.49 μ , 7.53 cm and 41.04 % in yearling males and 35.39 μ , 7.10 cm and 38.50 % in adults, respectively. Selection differential of the rams selected were 5.23 kg for body weight at six months and 184 g for first six monthly GFY. A total of 41 breeding rams were sold to Ram Rearing Project (CWDB) for distribution in their native tract.



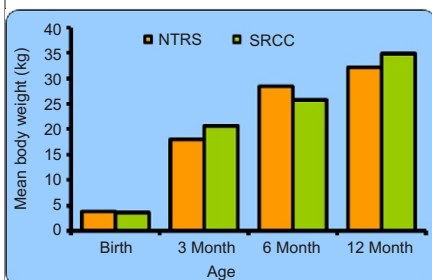
Flock of Magra sheep



Annual lambing rate (%) in sheep



Flock of Marwari sheep



Growth performance of sheep in temperate regions

Improvement of Magra sheep for meat and carpet wool production

The overall least square means for body weight at birth, 3, 6 and 12 months age were 3.24, 15.40, 22.96 and 31.41 kg, respectively. The least square means of GFY for adult annual, lamb's I, II and III clips were 2235, 509, 843 and 673 g, respectively. The overall least square means for fibre diameter, hetro fibre, hairy fibre, medullation, staple length and crimp were 33.21 μ , 30.57 %, 8.48 %, 39.27 %, 5.85 cm and 0.89 / cm, respectively. The tuppung rate was 98.42 % while lambing rate on ewe's available and tuppung basis was 91.40 and 92.92 %, respectively. The overall survivability, culling and sale were 97.09, 9.68 and 19.86 %, respectively. A total of 77 ram and 30 male hogget were sold to farmers and other agencies for genetic improvement of sheep.

Reproductive performance of native and synthetic sheep

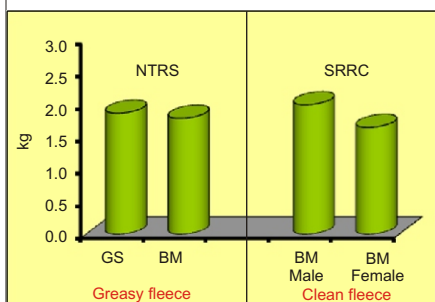
Genotype	Tuppung (%)	Lambing (%)		Multiple births (%)
		Available basis	Tuppung basis	
Malpura	93.64	85.75	91.69	-
Garole X Malpura	87.91	79.72	92.68	58.77
GM X Malpura	92.78	86.45	92.22	38.55
Malpura X GM	89.59	83.58	93.33	42.86
Patanwadi	97.87	95.74	97.83	22.22
Chokla	97.92	90.70	92.60	-
Avikalin	93.70	84.40	90.10	7.03
Magra	98.42	91.40	92.92	-
Marwari	97.85	91.08	93.10	3.66

Improvement of Marwari sheep for carpet wool production through selection

The overall least square means for body weight at birth, 3, 6 and 12 months age were 3.00, 12.88, 20.07 and 31.87 kg, respectively. The least square means of GFY for adult spring, autumn, annual were 820, 616 and 1484 g, respectively and for lamb's I and II clips were 565 and 783 g, respectively. The least square means of fibre diameter, hetro and hairy fibre, medullation, staple length and crimp were 36.41 μ , 39.95 %, 16.41 %, 55.86 %, 5.17 cm and 0.63 / cm, respectively. The tuppung rate was 97.85 % and lambing rate on ewe's available and bred basis was 91.08 and 93.10 %, respectively. The overall survivability, culling and sale were 97.39, 11.41 and 19.21 %, respectively. A total of 10 adult rams, 99 male hoggets, 92 adult ewes and 64 hogget females sold to various agencies and farmers for genetic improvement.

Synthetic sheep for meat and wool under sub-temperate climate

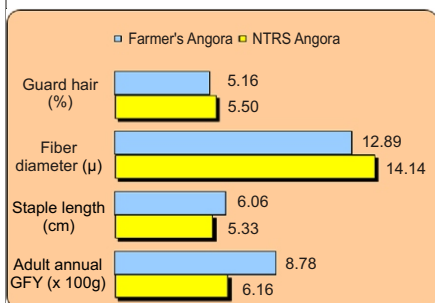
The overall body weight at birth, 3, 6 and 12 months of age were 3.71, 17.93, 28.35 and 32.23 kg, respectively. During the autumn 2010, tuppung and lambing rates on ewe's available basis was 92.4 and 82.0 %. The overall GFY for lambs at 6 month of age was 1.06 kg. The overall GFY in adult Gaddi Synthetic (GS) and Bharat Merino (BM) was 1.87 and 1.79 kg, respectively. The staple length, fibre diameter and medullaion were 4.39 cm, 19.67 and 0.73 % for crossbreds, respectively.



Annual adult wool yield from sheep in temperate regions



Angora rabbit



Comparative wool yield and wool quality from Angora rabbit

Average body weight gains of adult female flock on migration at highland pasture was exceptionally higher (10.36 kg) in intercrosses than GS and BM. Highest body weight of 42.2 kg in adult flock was recorded in last month (September) of migration at highland pasture while young females gained 15.7 kg during the migration. In comparative study of young animals under migration with stationary flock, better growth and wool production traits were recorded under migration.

Bharat Merino sheep

The overall mean body weight of BM at birth, 3, 6 and 12 months was 3.57, 20.73, 25.74 and 34.86 kg, respectively. Annual clean fleece yield among rams and ewes was 2.00 and 1.65 kg, respectively with clean fleece yield of 90%. The annual tuppung rate was 82.50 % and lambing rate on the basis of ewe bred was 81.82 %. The survivability between 0-3, 3-6, 6-12 months and adults was 96.21, 97.24, 100 and 98.21 %, respectively with an overall survivability of 97.81 %.

Angora rabbit for wool production in sub-temperate climate

The doe weight for German Angora (GA) at service (DWS) and kindling (DWK) were 3.35 and 3.46 kg, respectively. The litter size at birth (LSB) and weaning (LSW) were 5.09 and 4.58, respectively and litter weight at birth (LWB) were 285.5 g. The overall body weight for GA at 42, 84, 126 and 168 days of age were 0.62, 1.30, 1.88 and 2.30 kg, respectively. Annual wool yield was significantly higher in GA (803 g) than Russian Angora (RA) and British Angora (BA). Wool yield in five clips were 167, 170, 154, 149 and 155 g, respectively. The overall wool yield of GA progenies in I, II and III clips were 17.9, 69.4 and 116.9 g, respectively. The overall estimates for staple length, fibre diameter and guard hair in GA were 6.26 cm, 12.84 μ and 4.99 %, respectively. The kit survivability for GA breed was 86.4 %.

The wool yield of young and adult Angora rabbits at NTRS farm was significantly higher than farmer's flock. Similar patterns were observed for growth and reproduction traits except LSB and LSW. For wool quality parameters, staple length was significantly higher in farm Angora, whereas fibre diameter and guard hair percent was lower than farmer's flock. A total of 253 Angora rabbits (99 males+154 females) were supplied as germplasm to the farmers and NGOs of Himachal Pradesh, Uttarakhand and Delhi.

Comparison of different parameters of Angora rabbits between Farmer's and NTRS, Garsa

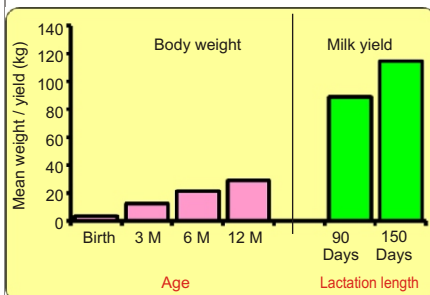
Attributes	Farmer's Angora	NTRS Angora
Production parameters		
Progeny I clip (g)	8.58	23.13
Progeny II clip (g)	48.30	88.09
Adult annual wool yield (g)	615.58	877.55
Wool quality parameters		
Staple length (cm)	5.33	6.06
Fibre diameter (μ)	14.14	12.89
Guard hair (%)	5.50	5.16



Flock of Sirohi goats

Genetic improvement of Sirohi goats for meat and milk production

The overall least square means for body weight at birth, 3, 6 and 12 months of age were 3.32, 12.68, 21.13 and 28.80 kg, respectively. The average daily gain during 0-3 and 3-12 months of age was 103 and 55 g, respectively. The milk yield of does was 89.14 kg for 90 days, 114.70 kg for 150 days and lactation length was 172.28 days. The tugging rate was 91.30 %. The breeding efficiency was 77.94 and 85.48 % on the basis of doe's available and tugged, respectively. The kidding rate was 82.00 and 89.92 % on the basis of doe's available and tugged, respectively.



Growth performance and milk yield in Sirohi goat

The mortality rate in 0-3, 3-6, 6-12 months of age and adults were 3.24, 0.84, 6.90 and 2.58 %, respectively. A total of 147 goats (63 males and 84 females) were sold to the farmers and development agencies of Rajasthan, Haryana and Uttarakhand.

Projects

Assessment of plane of nutrition and energy expenditure of grazing sheep in critical physiological stages and seasons to augment its productivity

S.K. Sankhyan, A.K. Shinde, R.S. Bhatt, N.M. Soren and S.A. Karim

Identification, evaluation, improvement and utilization of newer feed resources for sheep

Sub-project: Exploration of *Prosopis juliflora* as newer / alternative feed resources for sheep

O.H. Chaturvedi, A. Sahoo and M. Asgar

Development of feeding system for improving quantity and quality of mutton and wool production

Sub-project: Development of microbial feed additives to manipulate lambs growth

R.S. Bhatt, N.M. Soren, P.K. Jain and S.A. Karim

Sub-project: Exploitation of genetic potential of growth of native animals by challenge feeding

R.S. Bhatt, N.M. Soren, P.K. Jain and S.A. Karim

Sub-project: Evolving feeding system for higher wool production

N.M. Soren, O.H. Chaturvedi, M. Asgar and S.A. Karim

Nutrient input output relationships in sheep on pasture under arid ecology (ARC, Bikaner)

R.K. Sawal

Nutritional studies for formulating economical feeding programme for sheep and rabbit reared in north temperate region of India (NTRS, Garsa)

S. Saha and S.R. Sharma

AICRP on improvement of feed resources and nutrient utilization in raising animal production

A.K. Shinde, S.K. Sankhyan and A. Sahoo

NAFBSRA on increasing nutrient availability from roughage based rations through enhancing rumen efficiency or reducing enteric methane production by use of secondary plant metabolites (ARC, Bikaner)

R.C. Jakhmola

NAFBSRA on increasing nutrient availability from roughage based rations through enhancing rumen efficiency or reducing enteric methane production by use of secondary plant metabolites (CSWRI, Avikanagar)

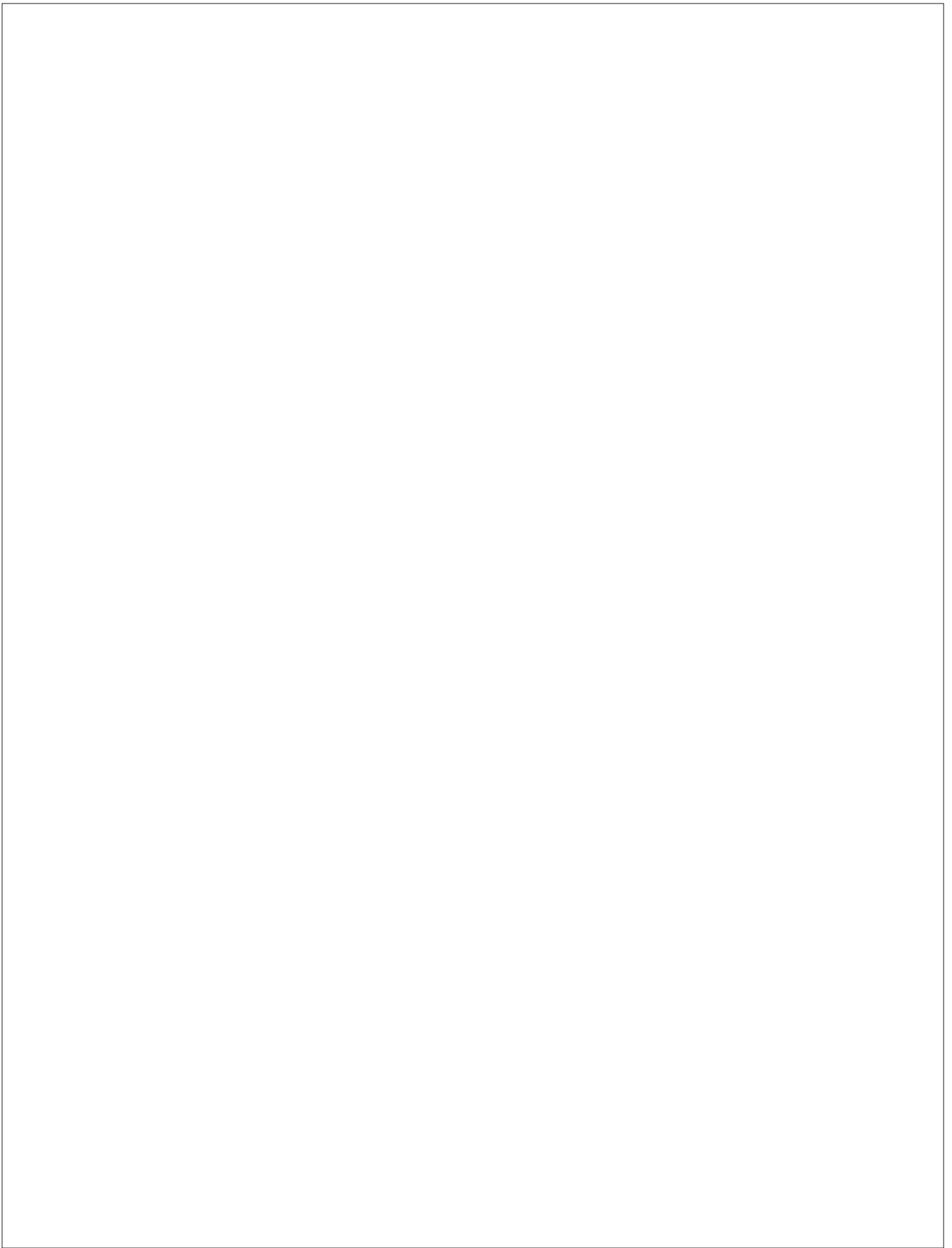
A. Sahoo and N.M. Soren

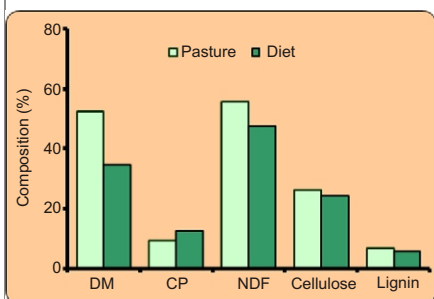
Network/Outreach project on estimation of methane emission under different feeding systems and development of mitigation strategies

R.S. Bhatt and N.M. Soren

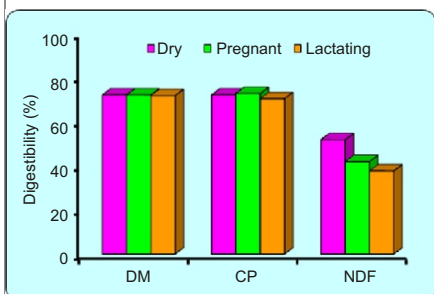
Network programme on veterinary type culture-rumen microbes

A. Sahoo, N.M. Soren and A.S. Meena





Composition of pasture and diet samples



Digestibility estimates in ewes at different physiological stages



Leaves and pods of *Prosopis juliflora*

- ▶ **Dried leaves can replace concentrate mixture, cluster bean and cenchrus straw up to 10-20 %**
- ▶ **Dried pods can replace concentrate mixture, cluster bean straw and cenchrus grass up to 40-50%**

Plane of nutrition of grazing sheep in physiological stages and seasons

The biomass yield of community grazing land was 6.2 q DM/ha. Biomass sample comprised of Chidichawla, Bekariya, Doodhi, Congress grass and Doob. Contribution of Congress grass and Doob was higher than other species. The biomass samples contained 52.55 DM, 9.37CP, 55.57 NDF, 26.22 cellulose and 6.80 % lignin.

Doodhi (32.6 %), Bekaria (19.4 %), Chidichawla (15.71 %) and Congress grass (12.15 %) were major constituents of diet of sheep on community land. DM content ranged from 33-39 % in most of vegetation except Aak (24.81 %) and CP content ranged from 11-14 % and lignin 4-7 %. Diet samples contained 34.78 DM, 12.77 CP, 47.64 NDF, 24.16 cellulose and 5.83 % lignin. The diet contained 26.62 % higher CP than biomass samples.

The DM (g/kgW^{0.75}), DCP (g/kgW^{0.75}) and ME (MJ/kgW^{0.75}) intakes in dry, pregnant and lactating ewes was 96.10, 8.85 and 0.50; 89.40, 8.23 and 0.46 and 78.95, 7.07 and 0.41 / day, respectively. Digestibility of DM, CP and acid detergent fibre (ADF) in dry ewes were 72.28, 72.30 and 51.96 %, respectively, whereas corresponding values in pregnant and lactating ewes were 72.24, 72.51 and 42.01 and 71.99, 70.59 and 37.78 %, respectively.

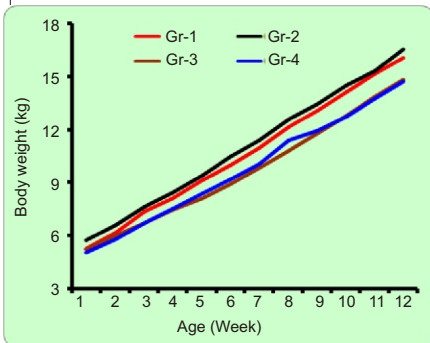
Identification, evaluation, improvement and utilization of newer feed resources

***Prosopis juliflora* (Vilayati babool) as newer/alternative feed resources**

Potential gas production was highest in case of conventional concentrate mixture followed by pods and leaves. Replacement of concentrate mixture with pods from 10 to 50% levels did not have substantial effect on potential gas production. It reduced significantly when replaced with >20 % leaves. Relative degradation rate (d) was higher in leaves followed by concentrate mixture and pods. However, replacement of conventional concentrate mixture with leaves or pods upto 10, 20, 30, 40 and 50 % levels did not alter the degradation rate.

Gas production (GP) was highest when concentrate mixture was used as substrate and reduced to a constant level when pods replaced concentrate mixture up to 50 %. However, GP reduced significantly when leaves replaced concentrate mixture beyond 10 % level. TDMD and TOMD were higher in case of diets containing concentrate mixture and pods than diet containing concentrate mixture and leaves.

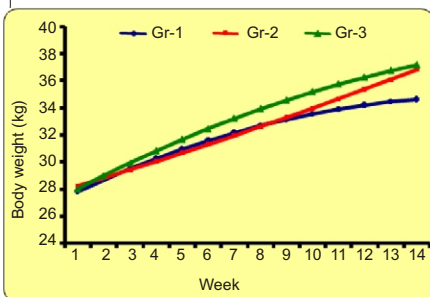
Replacement of conventional concentrate mixture with pods increased rumen acetate production and decreased butyrate production. Acetate: propionate ratio also increased with the increasing level of concentrate replacement with pods up to 30 %. Replacement of concentrate mixture with leaves beyond 20 % level reduced rumen acetate, butyrate and TVFA production significantly and beyond 30 % level decreased acetate: propionate ratio. Dried leaves can replace concentrate



Effect of microbial feed additives on body weight gain in lambs



Preparation of rumen protected fat



Weekly body weight changes in cull ewes

mixture, guar and cenchrus straw up to 10-20 % while, dried pods can replace concentrate mixture, guar and cenchrus straw up to 40-50 %. The total alkaloid in green dried leaves ranged from 0.43-0.77 %.

Development of feeding system for improving quantity and quality of mutton and wool production

Development of microbial feed additives to manipulate lamb growth

Lambs were fed concentrate mixture containing 19 % protein along with *Alianthus excelsa* leaves as roughage. The lambs of Gr-1, 2, 3 and 4 were drenched with liquid culture of *Lactobacillus acidophilus* (3.6×10^9 cells / ml) @ 0.0, 1.0, 1.5 and 2.0 ml / kg body weight, respectively.

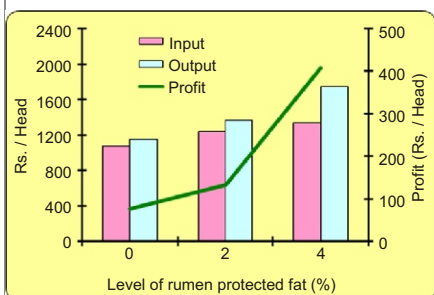
The lambs in Gr-2 gained (1.7 %) more weight than the control (Gr-1), while lambs in Gr-3 and Gr-4 showed lower weight gains. The concentrate intake was higher in control group than probiotics fed groups, while roughage intake was higher in probiotics fed groups than the control. The DM intake was higher in control and Gr-2 and lower in Gr-3 and Gr-4. Feed conversion efficiency was similar in all the groups. Weekly faecal *E. coli* count was also lower in probiotics fed groups than the control.

Exploitation of genetic potential of growth of native animal by challenge feeding

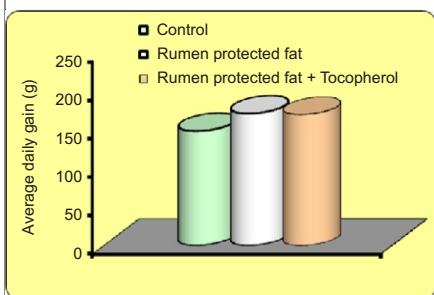
Realimentation in cull ewes by supplementing rumen protected fats: Cull ewes (> 6 year old) with body weight of 29.2 kg were divided into 3 groups and fed concentrate and roughage *ad-libitum* in cafeteria system. The ewes in Gr-1 were fed standard concentrate and gram straw. The concentrate in Gr-2 and Gr-3 was supplemented with 2 and 4 % rumen protected fat (calcium salt of fatty acids made from rice bran oil), respectively.

The ADG was maximum in Gr-3 (80 g) followed by Gr-2 (75 g) and minimum in Gr-1 (57 g). Plane of nutrition data revealed higher concentrate and total DM intake, lower roughage - concentrate ratio, higher organic matter (OM) intake, ME intake with rumen protected fat supplementation. The digestibility of DM, OM, CP, ether extract and fibre fractions was increased with rumen protected fat supplementation. Balance of nitrogen was also improved with fat supplementation.

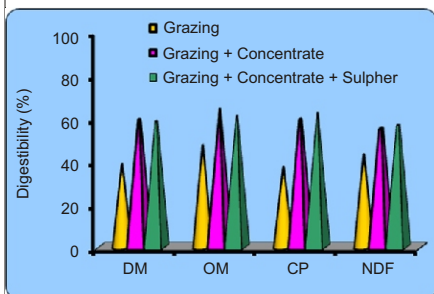
Rumen metabolite data revealed improvement in pH value with fat supplementation. No effect on total VFA, total nitrogen and TCA-ppt-N was observed, however rumen ammonia values were increased with rumen protected fat supplementation. The population of spirotrichs and total protozoal count was increased with rumen protected fat supplementation. Rumen ammonia values decreased at 4 hr post feeding with concentrate feeding in control and also decreased with rumen with protected fat supplementation. Blood biochemical data revealed increased cholesterol and decreased NEFA values with rumen protected fat supplementation.



Economics of rumen protected fat supplementation in cull ewes



Effect of rumen protected fat and vitamin E on weight gain in lambs



Effect of sulphur on nutrient digestibility in sheep

The carcass attributes data revealed higher pre-slaughter weight in Gr-2 and Gr-3 compared to Gr-1. Dressing yield was highest (52.5 %) in Gr-3. Loin eye area, improved and bone percent decreased with rumen protected fat supplementation. The CP content and ether extract level in *Longissimus dorsi* muscle was improved with fat supplementation.

The economic analysis revealed that total input per sheep in Gr-1, Gr-2 and Gr-3 accrued during 90 days was Rs. 1076, 1234 and 1339, income was Rs. 1152, 1368 and 1746 and profit was Rs. 76, 134 and 407, respectively.

Comparative performance of lambs fed rumen protected fat with vitamin E : Malpura lambs (28 days old) in Gr-1 (control) were offered standard lamb ration, dry Pala / Khejri leaves and green Ardu / Neem leaves. The lambs of Gr-2 were supplemented with 4 % rumen protected fat (RPF) and Gr-3 were supplemented both RPF and 40 mg α -tocopherol. Pre-weaning performance revealed increased body weight in Gr-2 and Gr-3 compared to Gr-1. During post-weaning, similar trend was continued and on 180 days of age, the body weight of 33.0 kg in Gr-2, 32.5 kg in Gr-3 and 28.6 kg in Gr-1 were attained. The wool yield was increased with supplementation of fat alone and also in combination with vitamin E.

Effect of protein levels and sulphur supplementation on wool production and quality

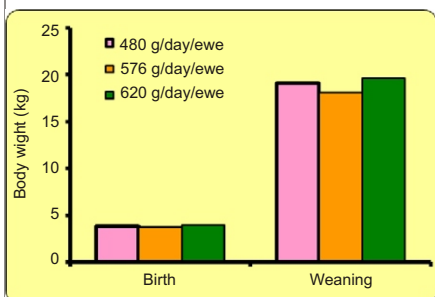
Chokla sheep were maintained on grazing (Gr-1), grazing with concentrate mixture containing 15.98 % CP (Gr-2) and grazing with concentrate mixture containing 15.95 % CP + 0.3% sulphur (Gr-3). The intake of DM, OM, CP and NDF was lower in Gr-1 than Gr-2 and Gr-3 while ADF intake was similar in all the groups. Digestibility of DM, OM, CP and NDF in Gr-1, Gr-2 and Gr-3 was 38.85, 59.36 and 58.50 %; 47.26, 64.57 and 61.13; 37.10, 59.55 and 62.55 % and 43.04, 55.00 and 56.63 %, respectively.

At 4 hr, pH of rumen liquor was higher in Gr-1, followed by Gr-2 and lower in Gr-3. The concentration of total N and NH_3 -N was similar in all the groups. TCA-ppt-N was significantly higher in Gr-3 than both Gr-1 and Gr-2. Urinary excretion of allantoin, uric acid and xanthine+hypoxanthine was 5.47, 6.26 and 6.47; 2.12, 2.43 and 2.53 and 0.80, 1.16 and 0.94 mmol/d, in Gr-1, Gr-2 and Gr-3, respectively. The excretion of xanthine+hypoxanthine was higher in Gr-2 than Gr-1 and Gr-3. The microbial nitrogen synthesis (MNS) showed similar trend in all groups. The efficiency of MN synthesis (g N) both in term of DOMI (kg) or DOMR (kg) was higher in Gr-1 than Gr-2 and Gr-3. The concentration of serum total protein, albumin, globulin, A:G ratio, urea and cholesterol was similar among the groups. Activity of serum enzymes SGOT was higher in Gr-2 and Gr-3 while activity of SGPT and ALP was similar in all the groups.

Delayed type hypersensitivity (DTH) response to intra-dermal inoculation of phyto-haemagglutinin exhibited maximum response (24 hr) in Gr-2 and Gr-3. Total wool yield (g) over a period of six months was significantly lower in Gr-1 than other groups. The staple length of wool fibre was significantly higher in Gr-2 than Gr-1 and Gr-3. The fibre diameter was lower in Gr-1 than other groups. Hetero, hairy and medullation percent of the wool fibre was similar in all the groups.

Nutrient input output relationships in sheep on pasture under arid ecology

Plant population and DM availability improved with the increase in precipitation in arid region. CP content was improved during July-August but decreased at later months of the year. Number of bites of sheep decreased with increase in the pasture availability during winter and spring. Among perennial grasses *Lasiurus indicus* was preferred more during summer, *Cenchrus* spp and *Ochthochloa compressa* during winter, *Panicum turgidum* during spring and *Aristida adscensionis* during all seasons. Green/dry phyllocades of *Calligonum pollygonides*, leaves of *Prosopis cineraria*, *Zizyphus nummularia* and *Aerva* species were preferred during winter and spring. Annuals such as *Tribulus*, *Indigofera* and *Boerhavia* spp were preferred during summer and monsoon due to their higher availability in grazing land. Wool production was higher in sheep supplemented with concentrate mixture.



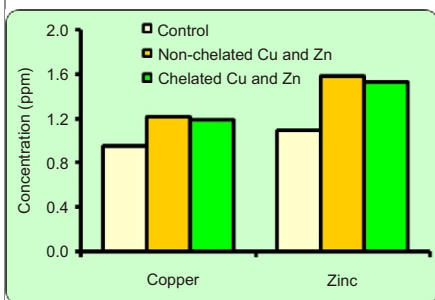
Effect of concentrate supplementation to pregnant ewes on growth of lambs

Economical feeding programme for sheep and rabbit in north temperate region

Nutritional manipulation in pregnant ewes: A total of 36 pregnant crossbred ewes were equally distributed in three groups. The concentrate mixture was supplemented from 2 months pregnancy to weaning of lambs at the rate of 480, 576 and 620 g /day/ewe in Gr-1, Gr-2 and Gr-3, respectively. Mean weight of lambs in Gr-1, Gr-2 and Gr-3 at birth were 3.82, 3.77 and 3.90 kg and at weaning were 19.14, 18.05 and 19.63 kg, respectively.

Milk yield and its composition under concentrate supplementation: The rate of concentrate supplementation from 2 months of pregnancy to weaning of lambs in Gr-1, Gr-2 and Gr-3 was 480, 576 and 620 g / day /ewe, respectively. The highest daily milk yield was recorded as 985.90 and 1079.30 g in II week of lactation in Gr-1 and Gr-2, respectively and 972.63 g in III week in Gr-3. Total milk yield during the entire lactation period was 60.52, 66.31 and 64.29 kg in Gr-1, Gr-2 and Gr-3, respectively.

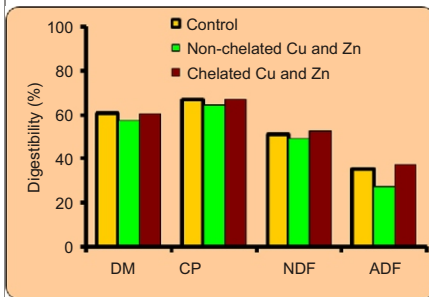
lambs under Intensive and semi-intensive management: Lambs in intensive system at 3 and 6 month of age attained body weights of 18.68 and 24.83 kg with ADG of 188 g and mean six monthly GFY of 1.107 kg. On the other hand, lambs in semi-intensive system attained body weight of 18.65, 24.83 kg with ADG of 68 g and GFY of 0.901 kg.



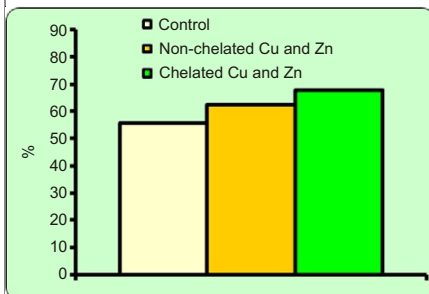
Effect of chelated Cu and Zn on serum concentration

Chelated mineral for improving male reproduction (AICRP)

Cu and Zn content of cenchrus grass, concentrate mixture without Cu and Zn (Gr-1), concentrate mixture with inorganic source of Cu and Zn (Gr-2) and concentrate mixture with copper- and zinc- methionine (Gr-3) were 15.64, 16.12 ppm; 16.87, 34.67 ppm; 37.15, 48.56 ppm and 26.19 and 39.58 ppm, respectively. In Gr-1, Gr-2 and Gr-3, the average values for serum Ca, P, Mg, Cu, Zn and Mn were 11.38, 11.74, 11.96 mg%; 2.99, 3.12 and 3.14 mg%; 2.44, 2.54 and 2.77 mg%; 0.95, 1.29 and 1.19 ppm; 1.09, 1.58 and 1.53 ppm and 0.89, 0.95 and 1.03 ppm, respectively. Cu and Zn



Effect of chelated Cu and Zn on digestibility of nutrients in ram



Effect of chelated Cu and Zn on sperm motility

- ▶ ***Medicago sativa* roots and *Sapindus rarak* pulp seem to be promising in altering rumen fermentation**

concentration of serum increased with supplementation of chelated and non-chelated minerals. In Gr-1, Gr-2 and Gr-3, the average values for glucose, total protein, albumin, globulin, urea and cholesterol were 46.40, 47.59 and 46.02 mg%; 7.75, 8.21 and 8.36 g%; 2.70, 2.82 and 2.85 g%, 4.69, 5.04 and 5.13 g%; 33.31, 34.53, 34.40 mg% and 71.07, 74.10 and 71.03 mg%, respectively.

In Malpura ram, daily DM, DCP and ME intake were 1142, 1145 and 1145 g; 102, 98 and 103 g and 6.91, 6.93 and 6.93 MJ, respectively in Gr-1, Gr-2 and Gr-3. DM, CP, NDF and ADF digestibility of feed was 60.62, 66.82, 51.00 and 35.29 % in Gr-1, 57.51, 64.38, 49.03 and 27.14 % in Gr-2 and 60.04, 67.19, 52.75 and 37.28 % in Gr-3, respectively.

Semen volume increased from 0.71 ml (Gr-1) to 0.75 ml (Gr-2) and 0.76 ml (Gr-3). Similarly, mass motility increased from 3.97 % (Gr-1) to 4.40 % (Gr-3). Sperm motility increased from 55.74 % (Gr-1) to 62.48 % (Gr-2) and 67.66 % (Gr-3). Rapid motile sperm increased from 47.98 % (Gr-1) to 56.38 % (Gr-2) however, no effect of supplementation of copper and zinc methionine on rapid motile sperm was recorded.

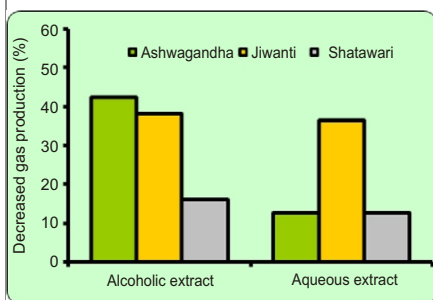
Increasing nutrient availability from roughage based rations through enhancing rumen efficiency or reducing enteric methane production by use of secondary plant metabolites

Effect of inclusion of *Medicago sativa* roots (LR), *Sapindus rarak* pulp (RP), *Acacia concina* pods (SP) and *Acacia nilotica* pods (BP) on fermentation of complete feeds: Four complete feed (CF) mixtures were prepared, two with moderately high (13%) CP with variable roughage: concentrate (R: C). CF-1 and CF-2 had R: C of 40:60 and 60:40, respectively. Another two CF had moderate CP level (10%) with R: C of 75:25. CF-3 had nearly 20% grain while CF-4 had ~ 2% grain. To each of these feed mixtures, four plant parts *Medicago sativa* roots (LR), *Sapindus rarak* pulp (RP), *Acacia concina* pods (SP) and *Acacia nilotica* pods (BP) were included at 0.5, 1.0, 2.0 and 5.0 % levels.

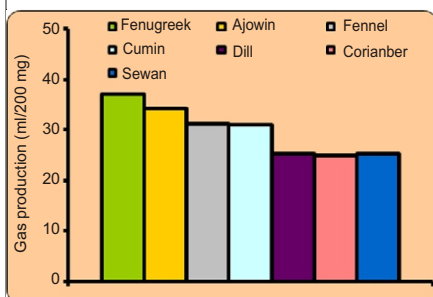
Inclusion of LR, RP, SP and BP had little effects on fermentation of CF-1 but decreased protozoa count after inclusion of LR. Maximum (53%) decrease was observed when LR was included at 5% level to CF-2. Inclusion of RP also affected fermentation of all feed mixtures in a way that number of protozoa reduced drastically at higher level of inclusion of RP. The decrease of 75% was noticed when RP was added to CF-2. SP inclusion influenced fermentation to the larger extent when its concentration was 5% in DM. Inclusion of BP did not alter fermentation including that of protozoa count of CF-2, CF-3 and CF-4. LR and RP seem to be promising agents for altering rumen fermentation.

Effect of inclusion of vegetable oils on fermentation of complete feeds: Two types of complete feed mixtures (CFR-60 and CFR-75) were prepared. CFR-60 had R: C of 60:40 with 13 % CP while CFR-75 had R: C of 75:25 with 10% CP. Four vegetable oils mustard (MO), coconut (CO), eucalyptus (EO) and linseed (LO) were evaluated. Oils were added to fermentation mixture containing buffered rumen liquor with either CFR-60

or CFR-75 in 5 graded levels ($\mu\text{l/ml}$) 0, 0.5, 1.0, 1.5 and 2.0. Inclusion of MO altered fermentation negatively when its concentration in fermentation medium exceeded 1.5 $\mu\text{l/ml}$. As a result significantly less gas was produced during fermentation of both feeds that had MO concentration of 1.5 or 2.0 $\mu\text{l/ml}$ than that of those contained 0.5 or 1.0 $\mu\text{l/ml}$ MO. This in turn affected ME, SCFA and TDDM content in similar way. The MBP did not influence by inclusion of MO in CFR-60, however inclusion of MO increased MBP with increasing level of MO in CFR-75. Inclusion of other oil sources CO, EO and LO tend to decrease GP, ME, SCFA, TDDM and MBP. The effect was more pronounced when CO level was 1.0 $\mu\text{l/ml}$ or higher. EO and LO decrease fermentation in a manner even at 0.5 $\mu\text{l/m}$ concentration, there was a significant decrease in GP, ME, SCFA, TDDM and MBP.



Effect of herbal extracts on fermentation of complete feeds



In vitro gas production in rumen (24 hr incubation)

- ▶ Ajwain straw is more anti-methanogenic compared to other straws/ forages
- ▶ All spice straws except Cumin had lower $t_{1/2}$ value and facilitate substrate degradation with maximum microbial protein synthesis

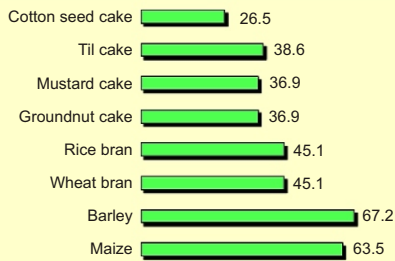
Effect of inclusion of herbal extracts on fermentation of complete feeds: Aqueous or alcoholic extracts of Ashwagandha (*Withania somnifera*), Jiwanti (*Leptadenia reticulata*) and Shatawari (*Asparagus racemosus*) were added (@ 1 ml / 50ml) to complete feeds CFR-60 or CFR-75. Alcoholic extract of Ashwagandha, Jiwanti and Satavari decreased GP significantly by 42.3, 38.1 and 16 %, respectively. The water extracts of these herbs also caused reduction in GP to the extent of 12.7, 36.4 and 12.7 %, respectively. The affects of inclusion of extracts to complete feed had similar effect on its ME or SCFA contents. TDDM content of feed did not vary significantly by inclusion of either extracts of herbs, except inclusion of alcoholic extract of Ashwagandha which decreased TDDM significantly.

Increasing nutrient availability from roughage based rations through enhancing rumen efficiency or reducing enteric methane production by use of secondary plant metabolites (CSWRI, Avikanagar)

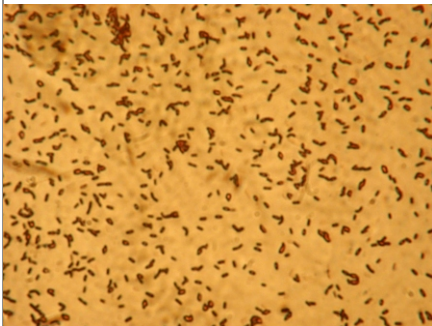
The kinetics parameters were studied by *in vitro* ruminal incubation for 96 hr. The 24 hr gas production (ml/200 mg) was highest in Fenugreek (37.0), followed by Ajowin (34.2), Fennel (31.2), Cumin (31.0), Dill (25.2), Sewan (25.2) and Coriander (25.0). All the test forages showed similar increase in gas production during the next incubation hours except Sewan (45.0), with the higher values in Fenugreek (46.9) and Ajowin (46.0).

Accordingly the potential production (ml) was highest in Fenugreek (42.4), followed by Sewan (40.8), Ajowin (40.5) and lowest in Dill (29.1). The gas production rate constant was highest in Fennel (0.067), followed by Coriander (0.062), Dill (0.060) and lowest in Sewan (0.020). But the maximum gas production rate at the point of inflection (μ_m) showed highest value for Fenugreek (2.512) followed by Fennel (2.445), Ajowin (2.240), Coriander (1.838), Dill (1.745), Cumin (1.726) and Sewan (0.825). The $t_{1/2}$ was highest for sewan (24.75 hr) and lowest in fennel (7.51 hr).

The methane production (ml/200 mg) was assessed from volatile fatty acids production. Tree leaves showed lower values (5.95 to 6.14) compared to spices straws (8.42 to 11.41) and that of Sewan grass and Wheat straw was 9.19 and 9.54, respectively. The percent methane production was lowest from Ajowin (36.14) and highest from Wheat straw (40.39).



In vitro gas production (ml)
after 96 hr of incubation



Gram negative cocobacilli
isolated from rumen

Methane emission under different feeding systems and development of mitigation strategies

In vitro gas production of commonly available grains, byproducts, oil cakes like maize, barley, wheat bran, rice bran, groundnut cake, mustard cake, til cake, cotton seed cake, adult ration-1, adult ration-2 and rabbit feed at 96 hr was 63.5, 67.2, 45.1, 45.1, 36.9, 36.9, 38.6, 26.5, 38.7, 71.5, 46.2, 36.2 ml and the $t_{1/2}$ (hr) was highest for maize and adult ration-2 and lowest for til cake and rice bran. The potential gas production among tree leaves was higher in Dhok, Siras, and Sitaphal and lower in Khejri, Bargad and Safeda leaves. The $t_{1/2}$ was higher for Jamun, Khejri and Sagwan and lower for Mango, desi Babool and Amla. Guar straw produced higher volume of gas whereas the Cumin straw produced lower gas during 96 hr of incubation, while $t_{1/2}$ was longer for Wheat and Jowar straw and shorter for Guar and Saunf straw. Among the cultivated crops herbage, volume of gas ranged from 25.3 (Sugarcane) to 57.5 ml (Maize). The $t_{1/2}$ ranged from 6.54 (Til) to 19.21 hr (Sugarcane). Total gas production by incubating Pala leaves at 96 hr was 32.7 ml and the $t_{1/2}$ varied from 7.93 (Dhatara) to 16.47 hr (Arnia).

Among the common creepers higher volume of gas was produced in Ghav bel and Pardesikakoda, moderate in Green beldi, Tinda leaf and Lauki while lower volume in Surket, Kartumbabel and Chirpota. The $t_{1/2}$ ranged from 6.33 (Green beldi) to 18.30 hr (Kakoda). Baru, Doob, Cenchorus and Kajleo grasses produced higher volume of gas while Bekaria, Chidichawla, Safed Bekria and Sewan grass produced lower volumes and the $t_{1/2}$ ranged from 8.68 (Kunijara) to 27.90 hr (Bekaria).

Veterinary Type Culture Collection Rumen Microbes

The rumen liquor was collected from 8 grazing sheep (R1 to R8). The pure cultures were tested on the basis of morphology of colonies, 8 different bacterial mono cultures were separated and preserved at -20°C . All the isolates are gram-ve but varied morphologically from cocci to bacillus or coco-bacillus. The motile isolates were R1, R2, R5, R7 and R8. The gas and H_2S production was positive for all the isolates except R6 and R7. The sugar utilization revealed cellobiose negative for R7 and R8. In all other isolates, positive sugar utilization for cellobiose and glucose resulted in drop of pH and increase of absorbance indicated the growth of organisms in the media. Catalase test was negative for R1 and R3. Gelatin liquification test was negative for R4, R6 and R7. The anaerobiosis test revealed that all the isolates were obligatory except R1 which was facultative.

Projects

Ram semen preservation and utilization

Anil Joshi (Upto 4.3.11), Davendra Kumar, R.K. Paul and S.M.K. Naqvi

Sub-project: Production and evaluation of ram semen

Anil Joshi (Upto 4.3.11), Davendra Kumar and S.M.K. Naqvi

Sub-project: Ram semen preservation and evaluation

Davendra Kumar, Anil Joshi (Upto 4.3.11) and S.M.K. Naqvi

Sub-project: Isolation and characterization of membrane proteins of cryopreserved ram spermatozoa

R.K. Paul, Anil Joshi (Upto 4.3.11) and Davendra Kumar

Sub-project: Fertility trial with frozen-thawed ram semen

S.M.K. Naqvi, Davendra Kumar and Anil Joshi (Upto 4.3.11)

Improving reproductive efficiency of sheep for augmenting production

S.M.K. Naqvi, Anil Joshi (Upto 4.3.11), Sajjan Singh (Upto 21.10.10), K. Narayanan (From 17.5.10 to 30.3.11), S.R. Pareek (Upto 31.8.10), V.K. Saxena (From 23.4.10) and Aminudeen (Upto 22.6.10)

Sub-project: Effect of nutrition supplementation on ovulation rate in sheep

S.M.K. Naqvi, Aminudeen (Upto 22.6.10) and V.K. Saxena (From 23.4.10)

Sub-project: Study on reproductive potential of Malpura sheep

S.M.K. Naqvi, Anil Joshi (Upto 4.3.11) and S.R. Pareek

Sub-project: Improvement of reproductive performance of Patanwadi sheep and production of 3 lambs in 2 years

S.M.K. Naqvi and S.R. Pareek

Sub-project: Effect of systemic administration of synthetic kisspeptin peptide on the pulsatile release of plasma LH and FSH level in malpura ewes

V.K. Saxena (From 23.4.10), K. Narayanan (From 17.5.10 to 30.3.11) and S.M.K. Naqvi

Studies on multiple stresses on reproduction and production of sheep

V.P. Maurya, V. Sejian, Davendra Kumar and S.M.K. Naqvi,

Sub-project: Effect of thermal stress on the biochemical and hormonal profile of Malpura rams

V.P. Maurya, V. Sejian and S.M.K. Naqvi

Sub-project: Effect of multiple stresses (thermal, nutritional and walking stress) on the productive and reproductive efficiency of Malpura ewes

V. Sejian, V.P. Maurya and S.M.K. Naqvi

Sub-project: Effect of cold stress on performance adaptability on growing lambs and their dams

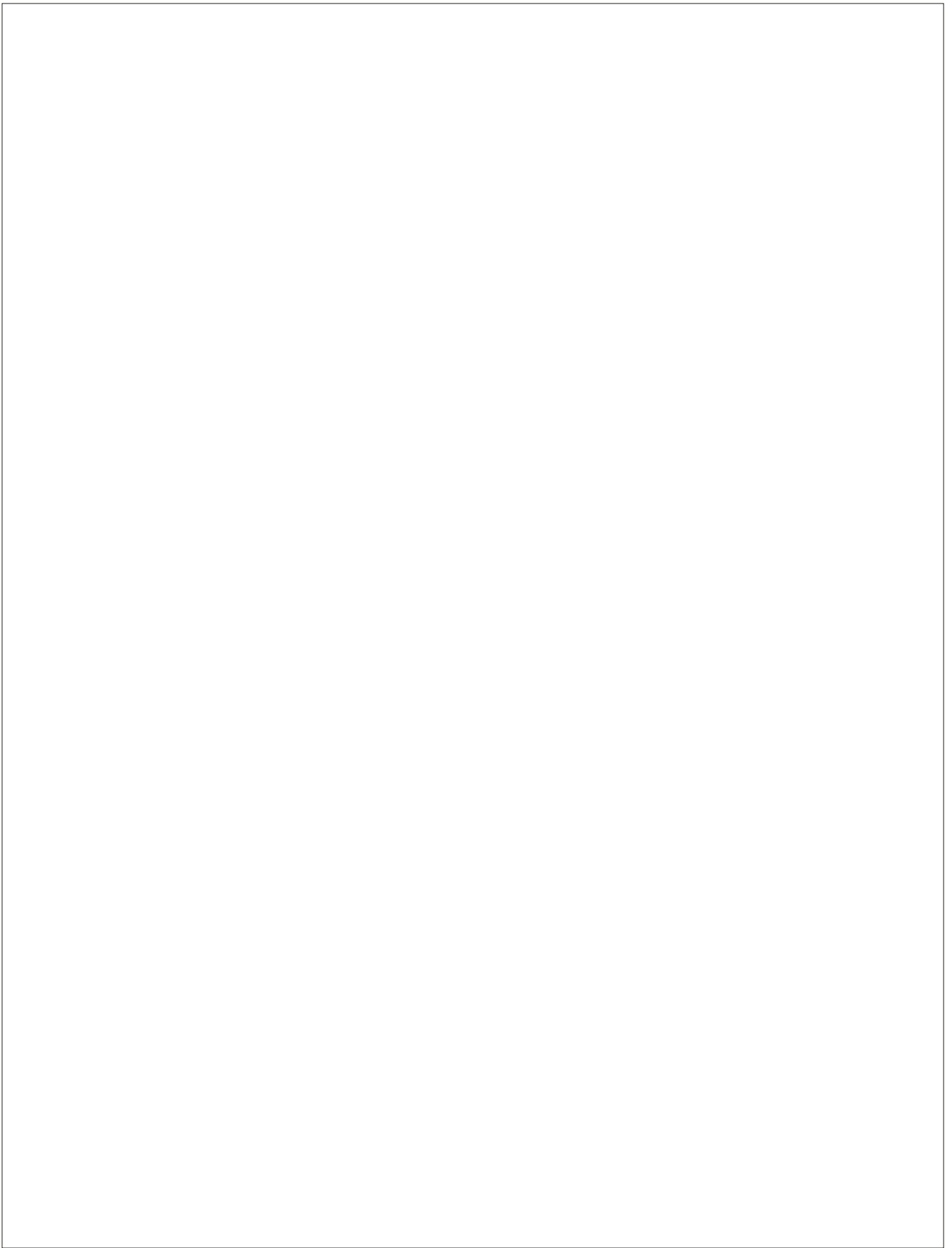
V. Sejian, V.P. Maurya and S.M.K. Naqvi

Sub-project: Effect of combined stress (thermal + nutritional) on physiological, biochemical, endocrine profile, sexual behaviour and semen quality of adult Malpura rams

V.P. Maurya, V. Sejian, Davendra Kumar and S.M.K. Naqvi

Network project on adaptation and facilitation of livestock to impending climatic changes through shelter management

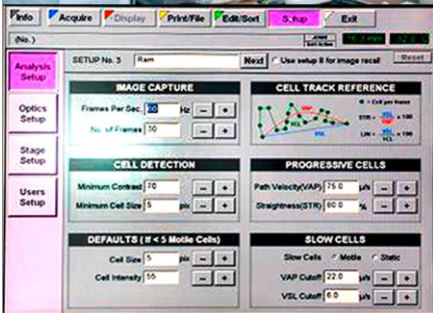
V.P. Maurya, V. Sejian and S.M.K. Naqvi



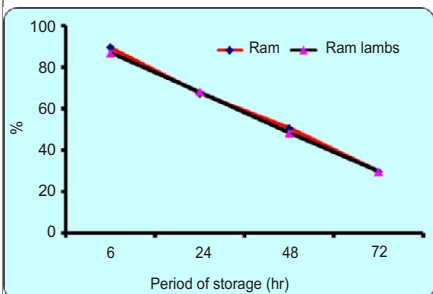


Ram semen preservation and utilization

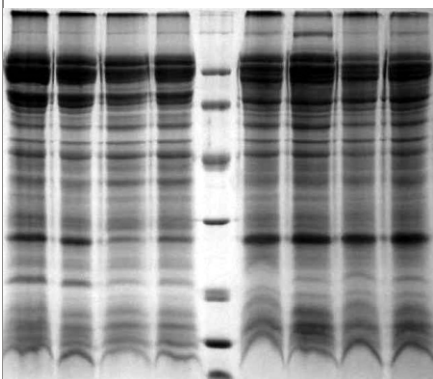
Semen production and analysis of Patanwadi rams: The means for ejaculate volume (ml), mass motility (0-5 scale), sperm motility (%), rapid motile sperm (%), linearity (%), straightness (%), elongation (%), curvilinear velocity ($\mu\text{m}/\text{sec}$), average path velocity ($\mu\text{m}/\text{sec}$), straight line velocity ($\mu\text{m}/\text{sec}$), amplitude of lateral head displacement (μm), beat frequency (Hz) and area of sperm head (μm^2) were 0.98, 4.67, 85.3, 79.2, 54.5, 78.8, 47.9, 253.8, 167.3, 135.7, 7.79, 18.82 and 4.83, respectively. The results indicated that Patanwadi rams produced good quality semen during breeding season in semi-arid tropical climate.



CASA analysis of semen



Effect of short-term preservation on rapid motile sperm

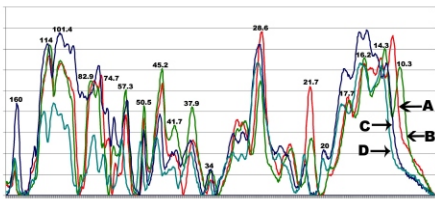


SDS-PAGE profile of membrane proteins from cryopreserved sperm

Short-term preservation of old and young Patanwadi ram semen: The overall means ejaculate volume (ml) and mass motility (0-5 scale) were 1.02 and 4.58 in old (4 year old) and 0.81 and 4.44 in young (18-24 month old) rams, respectively. The age of animals had no significant effect on any of the semen parameters except area of the sperm head during short-term preservation which was higher in young rams (4.8 vs 4.5 μm^2) compared to old rams. Preservation of semen had a significant ($p < 0.05$) effect on sperm motility, different sub population of motile sperm and sperm velocities, which leads to progressive declined with the storage period. During storage the magnitude of decline in motility was less prominent at 24 hr compared to 0 hr while it was pronounced on rapid motile sperm. The rapid motile sperm in old ram semen were 89.4, 67.3, 50.5 and 29.7 % at 0, 24, 48 and 72 hr of storage, respectively. The corresponding values for young rams were 86.8, 68.1, 48.2 and 29.7 %, respectively. In old ram semen, the effect of storage was significant ($p < 0.05$) on linearity, straightness, elongation and area of sperm head but it was non-significant on amplitude of lateral head and beat frequency. In young rams, the effect of storage was significant ($p < 0.05$) on linearity and straightness, which decreased during first 24 hr of storage after that the changes were non-significant. The results indicated Patanwadi old and young ram semen can be preserved in liquid form up to 24 hr.

Isolation and characterization of membrane proteins of cryopreserved ram spermatozoa

Functional and ultrastructural changes associated with short-term semen preservation: Live sperm count, normal acrosome percent, mean acrosome score, per cent motility decreased significantly ($p < 0.05$) beyond 24 hr of storage. The sperm membrane protein yield was not affected by the period of preservation up to 72 hr at 4-8 °C. The detergent (Triton X-100) levels (0.5 and 1%) had no effect on polypeptide pattern in the sperm membrane extracts. However, the density of many bands was higher with 1% compared to 0.5% Triton X-100. A total of 26 bands were found ranging from 160.5 to 10.3 Kda. Out of these, 13 bands (114.0, 101.4, 74.7, 70, 45.2, 29.6, 28.6, 26.7, 17.7, 16.2, 15, and 14.3 Kda) were major and 13 bands (160.5, 136.2, 130.6, 82.9, 57.3, 50.5, 41.7, 37.9, 34, 31.9, 23.6, 21.7 and 20 Kda) were minor. The band pattern up to the 48 hr of storage was similar except 74.7 Kda band, which was absent from 48 hr onwards. Densitometric analysis of the bands revealed that the average density of the bands after the 24 hr of storage were almost similar to those at 0 hr. After



Densitometric tracing of the SDS-PAGE of extracted membrane polypeptides from 0 (A), 24 (B), 48 (C) and 72 hr (D) stored semen samples. The numbers above the peaks indicate the mol. wt. in kda

the 48 hr of storage, the density of 8 bands (160.5, 130.6, 101.4, 82.9, 31.9, 26.7, 20 and 15 Kda) was increased and that of 4 other bands (50.5, 45.2, 28.6 and 21.7 Kda) was decreased while the 74.7 Kda band remained undetected. After the 72 hr of storage, the density of 13 bands (130.6, 114, 101.4, 70, 57.3, 50.5, 45.2, 41.7, 28.6, 21.7, 15, 14.3 and 10.3 Kda) was decreased sizably. The results indicated that preservation of semen at 4-8°C did not affect the protein profile of sperm membrane up to 24 hr, thereafter some changes occurred.

Fertility trial with frozen-thawed ram semen

The lambing rate of 64.4% was achieved with insemination of short-term preserved semen of young ram's per-os for two cycles in Malpura ewes exhibiting natural estrus.

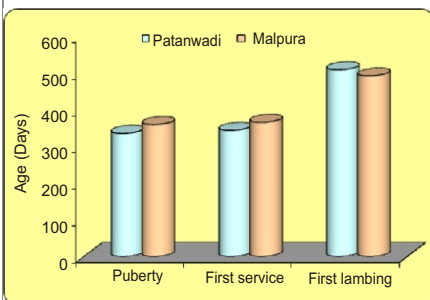
Improving reproductive efficiency of sheep for augmenting production

Acacia pods supplementation on ovulation rate in sheep

The effect of dietary supplementation of *Acacia nilotica* pods was studied in Malpura adult ewes. Ewes in Gr-1 were given *Cenchrus ciliaris* and *Acacia nilotica* pods *ad libitum* and concentrate mixture (2.0 % of body weight), while in Gr-2 were provided only *Cenchrus ciliaris* (*ad-libitum*) and concentrate mixture for a period of 45 days. All the ewes in both the groups exhibited the estrus. The conception and lambing rates in Gr-1 and Gr-2 were 100.0 and 72.3 %, respectively.

Reproductive potential of Malpura sheep

Patanwadi females attained puberty at an early age (335 days) as compared to Malpura (359 days). All the ewes exhibited first estrus within 12 months of age. Age and body weights at first service in Malpura and Patanwadi ewes were 365 and 343 days and 31.7 and 31.7 kg, respectively. The age at first lambing in Malpura and Patanwadi ewes was 508 and 491 days, respectively.



Reproductive performance of Patanwadi and Malpura ewes

Reproductive performance and production of 3 lambs in 2 years

The study on improvement of reproductive efficiency in Patanwadi sheep for production of 3 lambs in 2 years achieved second and third lambing in 57.2 and 72.7 % ewes within target of 243 and 636 days, respectively.

Systemic administration of synthetic kisspeptin peptide on the pulsatile release of plasma LH and FSH level

Solid phase peptide synthesis was done on the rinkamide resin of the 10 mer version of kisspeptin peptide which consists of sequence as Tyr62-Asn63-Trp64-Asn65-Ser66-Phe67-Gly68-Leu69-Arg70-Tyr71NH2. Peptide was cleaved out of the resin using the cleavage mixture (Trifluoro acetic acid-82.5%, Thioanisole-5%, Ethanedithiol-5%, Water-10%, Phenol-5%). Kisspeptin peptide was purified by RP-HPLC using a gradient

of 65-90 %, C-18 column in binary gradient module consisting of 5 % acetonitrile in water and a limiting organic solvent. The peptide was recovered directly after lyophilization. The yield of peptide was promisingly high and it showed good purity with retention time at about 23-24 min in RP-HPLC. Circular dichroism spectroscopy of the peptide was conducted in nuclease free water and Trifluoro ethanol (TFE) to find out the adopted secondary structures by the peptides defining the propensity of peptide and its native conformation with respect to structure inducing effect of TFE.

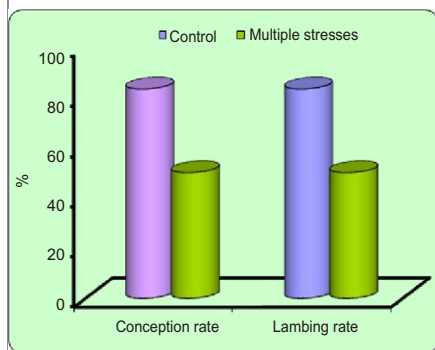
Studies on multiple stresses on reproduction and production of sheep

Thermal stress on the biochemical and hormonal profile

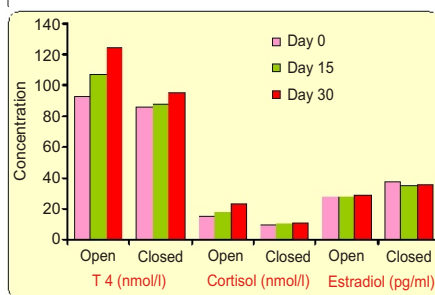
A study on Malpura rams in climatic chamber at 42°C and 54 % RH showed that thermal stress significantly decreased the plasma testosterone and increased plasma total protein, cholesterol, inorganic phosphorus and magnesium concentrations.

Effect of multiple stresses (thermal, nutritional and walking stress) on the productive and reproductive efficiency of Malpura ewes

A study on Malpura ewes allocated to Gr-1 (control) and Gr-2 (multiple stresses-30% feed allowance of control and walking distance of 14 km/day) indicated that final body weight differed significantly between the groups. Respiration rate differed significantly between the groups during afternoon. The sweating rate did not differ significantly between groups. The estrus incidence and duration differed significantly between the groups only during first estrus cycle. Conception rate was lower in Gr-2 (50.0 %) compared to Gr-1 (83.3%), similar trend was obtained for lambing rate. The birth weight of lambs did not differ significantly between groups. Among the haemato-biochemical parameters, Hb and PCV increased significantly while plasma glucose, estradiol, T₃ and T₄ decreased significantly in Gr-2 compared to Gr-1. Total plasma protein and plasma cholesterol also differed significantly between the groups. Plasma progesterone showed a reverse trend to that of estradiol.



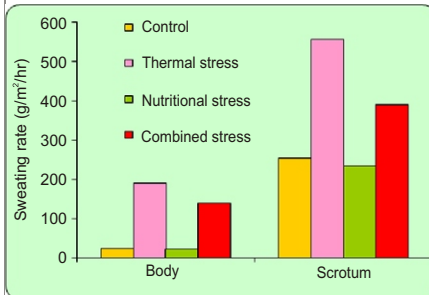
Effect of multiple stresses on reproductive performance of Malpura ewes



Effect of cold stress on hormonal profile in sheep

Cold stress on performance adaptability of lambs and their dams

The body weight differed significantly between Gr-1 (open shed, exposed to cold) and Gr-2 (closed shed, protected from cold). Both dam and lamb showed significant reduction in body weights in Gr-1 during the peak winter (December). ADG was significantly reduced in Gr-1 compared to Gr-2. Respiration rate, pulse rate and rectal temperature did not differ among the groups during morning while in the afternoon differed significantly. Hb, PCV, plasma cortisol, T₃ and T₄ increased significantly in Gr-1 compared to Gr-2. There was a significant reduction in plasma estradiol concentration in Gr-1 compared to Gr-2. Plasma progesterone showed reverse trend to that of estradiol concentration.



Effect of combined stress on sweating rate in Malpura rams

Effect of combined stress (thermal + nutritional) on physiological, biochemical, endocrine profile, sexual behaviour and semen quality

The effect of combined stresses was studied in adult Malpura rams in Gr-1 (control) and Gr-2 (thermal stress) provided *ad libitum* feeding while Gr-3 (nutritional stress) and Gr-4 (combined stress) provided with restricted feed (30% of feed allowance of Gr-1). Rams of Gr-2 and Gr-4 were kept in climatic chamber at 42 °C for 6 hr a day (between 10:00 to 16:00 hr) to induce thermal stress. Body weight and heart girth were highest in Gr-1 followed by Gr-2, Gr-3 and Gr-4. Respiration rate, pulse rate and rectal temperature were higher in Gr-2 and Gr-4 compared to other groups. The body weight ranged from 38.9 (Gr-4) to 50.4 kg (Gr-1). The BCS showed similar trend as that of body weights. Feed intake was higher in Gr-1 followed by Gr-2, 3 and 4. Water intake was highest in Gr-2 and lowest in Gr-3. Hb and PCV reduced significantly in Gr-2 and Gr-4 compared to Gr-1 and Gr-3. The plasma glucose concentration was highest in Gr-1 and lowest in Gr-4. Reaction time, time taken for first ejaculation and latency period was significantly highest in Gr-4 and lowest in Gr-1. Reaction time for II ejaculation and number of mounts for II ejaculation also had similar trend. Semen volume did not differ significantly. The mass motility was significantly higher in Gr-1 and Gr-3 compared to Gr-2 and Gr-4. The percent motility was significantly higher in Gr-1 compared to Gr-2 and Gr-4.

Adaptation and facilitation of livestock to impending climatic changes through shelter management

- ▶ Ambient temperature had severe impact on physiological, nutritional and haemato-biochemical parameters of sheep

In hot semi-arid climate, Hb concentration was lowest during summer season. PCV % remained highest during winter and lowest during rainy season. The plasma T_3 and T_4 concentrations were higher during winter (November - January) and lower in summer (April - June). The highest plasma cortisol concentration was recorded in summer while the lowest in spring season (February-March). In ewes, body weight, respiration rate, rectal temperature, skin temperature, sweating rate, feed intake, water intake, Hb, PCV, and glucose did not differ between Gr-1 (shed) and Gr-2 (climatic chamber) up to 35°C thereafter from 40 to 45°C differed significantly ($p < 0.05$) between the groups.

Projects

Epidemiological investigation on economically important diseases of sheep, goat and rabbit

B.N. Tripathi, D. Singh, S.K. Dixit, F.A. Khan, C.P. Swarnkar, G.G. Sonawane, Jyoti Kumar, Fateh Singh and S.L. Sisodia

Sub-project: Development of diagnostics and immunoprophylactics for control and prevention of paratuberculosis (Johne's disease) in sheep and goats

B.N. Tripathi, G.G. Sonawane, Jyoti Kumar, Fateh Singh and Rajeev Kumar (Upto 23.2.11)

Sub-project: Etiopathology, diagnosis and treatment of pneumonia in sheep

S.K. Dixit, B.N. Tripathi, G.G. Sonawane, Jyoti Kumar, Fateh Singh and Rajeev Kumar (Upto 23.2.11)

Sub-project: Role of nutrient supplementation in improving resilience and resistance of growing lambs against gastrointestinal nematode infections

F.A. Khan, A.Sahoo, G.G.Sonawane and S.A. Karim

Epidemiological investigations on economically important diseases of sheep and rabbits in sub- temperate condition (NTRS Garsa)

S.R. Sharma and S.K. Niranjana

All India network programme on gastro-intestinal parasitism

D. Singh, C.P. Swarnkar and F.A. Khan

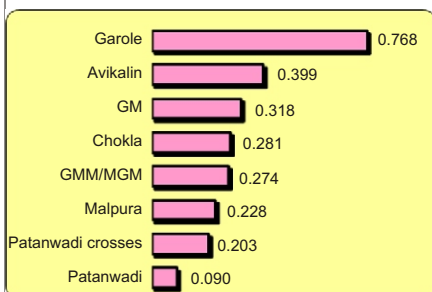
All India network project on blue tongue disease

B.N. Tripathi, G.G. Sonawane and Fateh Singh

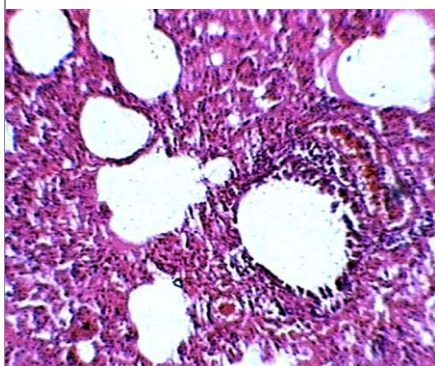
Veterinary type culture

B.N. Tripathi, G.G. Sonawane, Fateh Singh and Jyoti Kumar

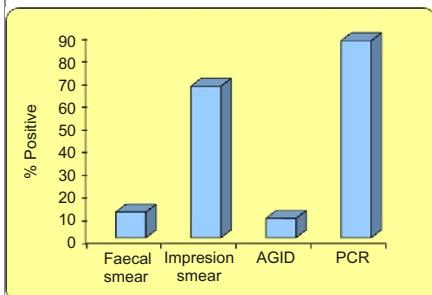
Epidemiological investigation on economically important diseases of sheep, goat and rabbit



Breed-wise annual mortality rate (EADR) in sheep at Avikanagar



Bronchopneumonia in sheep



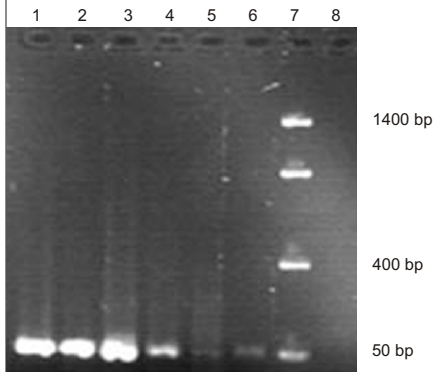
Comparative positivity for JD in sheep on different tests

Mortality profile: The annual equivalent average death rates (EADR) per 1000 animal days at risk in sheep, goat and rabbit were 0.293, 0.184 and 2.221, respectively. The EADR was comparatively low (0.252) in native breeds followed by 0.329 in genotypes having Garole inheritance and maximum (0.399) in crossbred (Avikalini). In sheep flocks, the major non-specific reasons for mortality were pneumonia, septicaemia, enteritis and impaction. Among specific causes, JD and neonatal inanition were major diseases accounted for 3.13 and 2.19 % of total deaths, respectively. The breed-wise EADR was minimum in Patanwadi sheep (0.090) followed by Patanwadi crosses (0.203), Malpura (0.228), GMM / MGM (0.274), Chokla (0.281), Garole x Malpura (0.318) Avikalini (0.399) and Garole (0.768). Age-wise analysis revealed highest EADR in suckling (1.174) followed by weaner (0.344), adult (0.158) and hogget (0.077). The monthly mortality ranged from 0.28 % (June) to 1.80 % (December). In goats, the major cases of deaths were tympany, enteritis and pneumonia. The enteritis and gastroenteritis accounted for 71.3 % of total mortality in rabbit. The overall expenditure (per head / annum) on health management for sheep, goat and rabbit was Rs. 45.03, 41.29 and 7.09, respectively.

Disease investigation: Three outbreaks of diseases in sheep (Tonk, Chittorgarh and Bikaner) were investigated and possible preventive measures were suggested to avoid mortality losses. A total of 216 tissue samples from 38 animals with various affections were processed for histological interpretation and diagnosis. A virulent form of foot rot was recorded in goats while disease was in mild form in sheep. *Corynebacterium pseudotuberculosis* was isolated and characterized from suspected cases of caseous lymphadenitis. Pure bacterial isolates of *E. coli*, *Salmonella spp* and others were obtained from tissue samples affected with enteritis and septicaemia. A total of 139 culture and direct smears were stained and examined by direct microscopy as an aid to diagnosis. None of 51 serum sample from Kendrapada sheep was positive for brucellosis. In addition, out of 289 (sheep and goat) serum samples (Alwar and Tonk districts), tested by RBPT, 22 were found positive. Need based examination of faecal samples exhibited prevalence of strongyle, *Trichuris*, *Strongyloides* eggs and *Eimeria* oocysts in sheep to the tune of 74.47, 1.06, 10.64 and 53.19 %, respectively. In samples from rabbit, the overall positivity for *Eimeria* oocysts was 74.47 %. On *in-vitro* egg hatch assay, benzimidazole resistance was detected in *Haemonchus contortus* from Kendrapada sheep.

Development of diagnostics and immunoprophylactics for control and prevention of paratuberculosis (Johne's disease) in sheep and goats

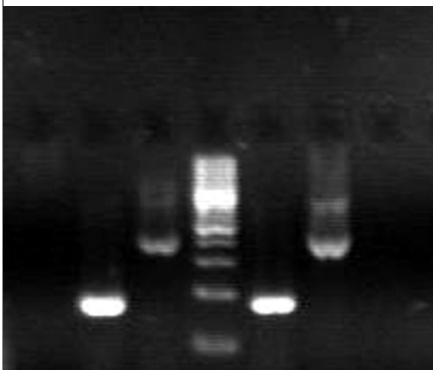
The number of samples found positive for *Mycobacterium avium* subsp *paratuberculosis* (MAP) on examination of faecal smears were 51 out of 521 Chokla, 13 out of 61 GMM and MGM and 2 out of 3 Malpura sheep. On tissue smear examination (ICV and MLN), out of 39 suspected cases (based on PM lesions), 24 were positive for JD. Out of 117 serum samples tested by AGID, 10 were found positive for JD. An absorbed ELISA for



PCR amplification of 251 gene.
Lane 1: positive control; lane 2-6: test
samples; lane 7: 50 bp ladder;
lane 8: negative control



Cross section of lung affected with OPA



PCR amplification of OPAU3 gene,
176 bp product (50 bp ladder)

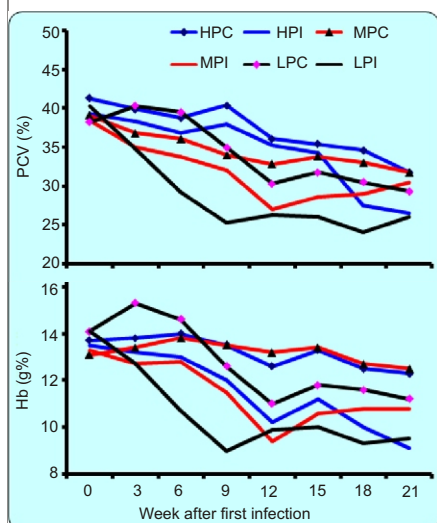
detection of *M. a. paratuberculosis* (MAP) antibody was standardized and 546 serum samples from Chokla sheep were tested. At 70, 80, 90 and 100 % cut off, the positivity was 21.0, 16.5, 14.3 and 11.4 %, respectively. Genomic DNA from 54 samples (40 blood and 14 tissues) were extracted. The PCR protocols targeting IS900, ISMav2 and 251 genes were standardized on positive samples and subsequently applied on test samples (40 blood samples). Three samples each yielded positive amplifications with ISMav2 and 251 genes. Tissues of 15 JD suspected cases collected at necropsy were subjected to 251 gene PCR, of which 13 were detected positive for MAP genome. A total of 94 faecal samples were subjected to culture on the HEYM with and without mycobactin J after appropriate decontamination. All the culture tubes have been kept in the BOD incubator and being examined at weekly intervals for any bacterial growth.

Etiopathology, diagnosis and treatment of pneumonia in sheep

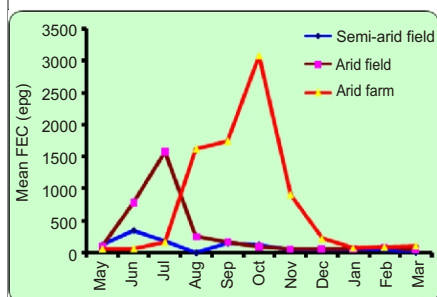
In order to find effective treatment of various grades of pneumonia, three different regimens were evaluated at the level of real beneficiaries. Adult animals having URI were successfully treated with T-I (a combination of ampicillin and cloxacillin @ 10 mg/kg bw and acetaminophen @ 10 mg/kg bw 8 hrly i/m for 4-5 days along with ancillary therapy) but those revealing heavy congestion in dorso-diaphragmatic region in lung parenchyma along with moist rales did not respond favourably. One affected animal required support of bronchodilators (etophyllin and theophyllin) and blood ionizer. A group of 5 lambs treated with T-II, (aminoglycosides, amikacin sulphate @ 7.5 mg/kg bw i/m 12 hrly and acetaminophen @ 10 mg/kg i/m 8 hly) responded well and animals recovered fully.

The other group of pyretic URI cases treated with (ampicillin+cloxacillin 10 mg/kg bw, etophyllin and theophyllin, 0.75 ml/head/day and salbutamol @ 2.5 mg/kg bw) responded well as seen in reduction of illness days from 5-7 days to 3-5 days but there were two relapsed/ re-exposed cases during watch period and therefore, need to be clinically evaluated on more number of animals. Another 5 animals treated with T-III (ampicillin+cloxacillin 10 mg/kg bw, etophyllin and theophyllin, 0.75 ml/ head/ day, salbutamol 2.5 mg/kg bw and amikacin sulphate @ 7.5 mg/kg bw, a loading dose and 5 mg/kg bw subsequent doses 12 hrly) yielded a very good response. These animals recovered in 6-7 days without any sign of further relapse upto 4 weeks.

On post-mortem examination a total of 130 sheep, 4 goats and 2 rabbits were diagnosed for pulmonary affections. Histopathology of 18 pneumonic cases revealed lesions of bronchopneumonia (7), suppurative pneumonia (2), interstitial pneumonia with foci of secondary bacterial complication (7) and acute pulmonary congestion and oedema (2). Out of 30 lung samples, 14 yielded 31 pure bacterial isolates (11 Gram+ve and 20 Gram-ve). Out of 20 Gram-ve bacterial isolates, 11 were identified as various serotypes of *E. coli* and one *Proteus* sp. along with unidentified isolates. Three out of 13 sheep lungs were found to be positive for the retrovirus of ovine pulmonary adenomatosis (OPA) by U3 gene PCR.



Effect of protein supplementation on PCV and Hb in lambs infected with GIN



Intensity of strongyle infection in sheep flocks of Rajasthan

Role of nutrient supplementation in improving resilience and resistance of growing lambs against gastrointestinal nematode infections

The study was performed in artificially infected Chokla male weaners under stall feeding on diets comprised of compound feed (Roughage: Concentrate 40:60) and feeding was restricted to 3.0 % of the body weight. Clinical signs of haemonchosis (anaemia, hypoproteinaemia, hypoalbuminaemia and reduced survival) became evident maximum in low protein diet group and minimum in high protein diet group. Live weight gain was not affected by infection in both high and moderate protein diet group. The study revealed that feeding both high and moderate protein diet to growing lambs significantly improved the ability to withstand the pathogenic effects of *Haemonchus contortus* infection. The lambs fed with high protein diet performed well despite higher worm burden.

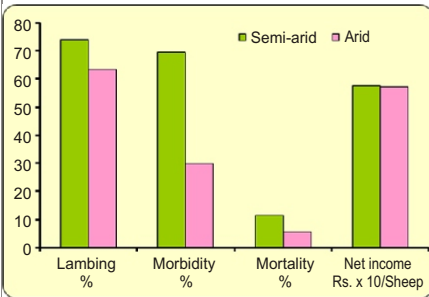
All India network programme on gastrointestinal parasitism

Preparation of bioclimatographs: This year, the period suitable for propagation of *H. contortus* and *Trichostrongylus* spp was from mid - June to late - September and from October to March, respectively in semi-arid Rajasthan and from mid - June to mid September (*H. contortus*) and October to March (*Trichostrongylus* spp) in arid Rajasthan.

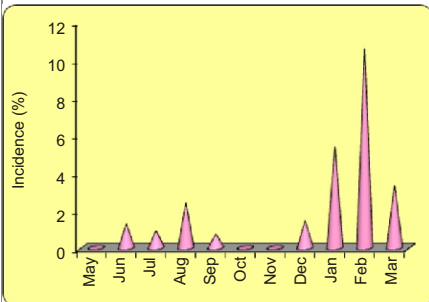
Impact assessment of modified worm management programme (MWMP) in sheep flocks:

The results from 10078 samples revealed that the proposed programme (single targeted drench during mid to late monsoon) successfully controlled the parasitism in terms of incidence and intensity of infection and production parameters as compared to conventional 2-3 drench regime. Among field flocks the mean monthly intensity of strongyle infection varied from 12.06 (March) to 676.00 epg (August) in semi-arid region and from 20.83 (February) to 1905.00 epg (August) in arid region. Farm flocks managed by TST approach showed minimum intensity (58.16 epg) in May which increases with onset of monsoon and reached to peak (3075.00 epg) in the month of October and declined thereafter. The possible reasons for spontaneous decline in intensity of infection from November onwards were decrease in stocking density due to en-mass culling of sheep and availability of good plane of nutrition in addition to climatic factors.

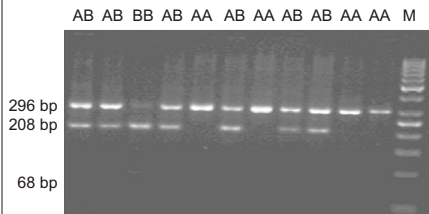
The rise in incidence during June in both the agroclimatic conditions suggested possible role of resumption of development in hypobiotic larvae. The annual incidence of *Trichuris* and *Moneizia* spp remained < 3.0 %. The incidence of *Strongyloides papillosus* was higher in farm flocks. In spite of flukicide drench, the annual incidence of *Amphistomes* remained higher in semi-arid region compared to arid region. The prevalence of *Fasciola gigantica* and *Schistosoma indicum* was sporadic in semi-arid and arid region, respectively. The annual incidence of *Eimeria* spp remained around 25.0 % and remained moderately higher in field flocks during monsoon. On coproculture, *H. contortus* was predominant parasite followed by *Oesophagostomum* and *Trichostrongylus* spp. Infectivity of pasture was noticed during monsoon and post monsoon season.



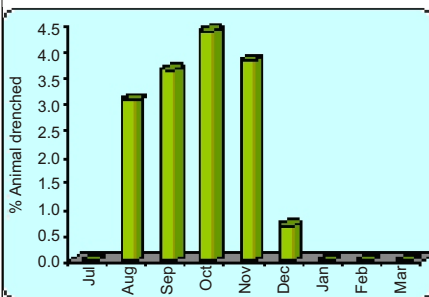
Performance of field flocks kept under MWMP



Monthly incidence of amphistomes in semi-arid Rajasthan



RE pattern of Ovar-DRB 1 gene with SacI (M: 50 bp ladder)



Impact of TST on number of anthelmintic drenches in sheep flock

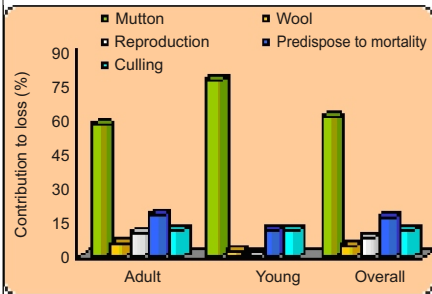
Production economics of worm management programme: The lambing rate ranged from 63.21 (arid) to 73.77% (semi-arid) in field flocks kept under MWMP. The annual percent morbidity and mortality in field flocks varied from 29.91 (arid) to 69.37 and from 5.54 (arid) to 11.21 (semi-arid), respectively. The annual disposal rate ranged from 20.15 (arid) to 25.29 % (semi-arid). The total annual expenditure/sheep varied from Rs. 207.19 (semi-arid) to Rs. 345.80 (arid) and the net annual income/sheep ranged from Rs. 575.50 (semi-arid) to Rs. 617.14 (arid).

Evaluation of flukicide intervention in sheep flocks of semi-arid Rajasthan: The flukicide drench was made in March, 2010 and the incidence ranged from nil (June, October, November) to 10.53 % (February) with annual incidence to the tune of 2.37 %. This year the incidence rate peaked early (during January-February) compared to previous years (June-August) .

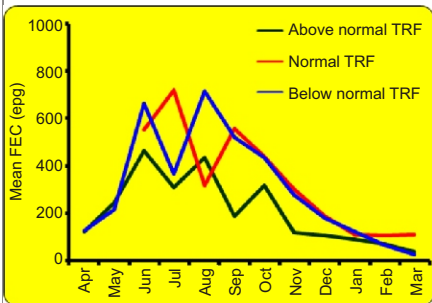
Performance testing of simulation and forecasting programme (FROGIN): The performance of the programme was evaluated in both agroclimatic zones of Rajasthan involving farm and field flocks. The anthelmintic and grazing management was implemented as per prediction made by FROGIN.

Observations on the effect of Garole inheritance on faecal egg counts in sheep: Five restriction enzymes viz; *SacI*, *SacII*, *NciI*, *Hin1I* and *BstNI* were used to observe polymorphism in Ovar-DRB1 gene. With *SacI* there was significant difference in genotypic frequencies among level of Garole inheritance. Frequency of 'A' allele is 0.89, 0.71, 0.58 and 0.64 in Garole, GM, GMM and Malpura, respectively. There is significant reduction in the frequency of A allele with the reduction in the inheritance of Garole. With *Hin1I* the frequency of 'B' allele is 0.64, 0.61, 0.38 and 0.40 in Garole, GM, GMM and Malpura, respectively. There is significant reduction in the frequency of B allele with the reduction in the inheritance of Garole. With *SacII* RE, the frequency of A allele is 0.94, 0.76, 0.86 and 0.82 in Garole, GM, GMM and Malpura, respectively. Garole had significantly higher frequency of A allele than its crosses and Malpura. Though *NciI* and *BstNI* also produced similar genotypes but there was no difference in genotypic frequency among different breeds.

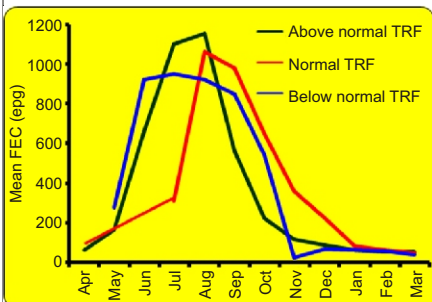
Evaluation of targeted selective treatment (TST) in sheep against Haemonchus contortus: On the basis of screening using eye color chart, the proportion of animals in flocks exhibiting clinical anaemia ranged from nil (January to March) to 4.59% (November). The mean FECs in visually anaemic and un-drenched animals ranged from nil (December) to 13681.0 epg (October). In un-drenched and visually anaemic sheep haematological profile exhibited that mean Hb, PCV, TEC, MCH, MCHC and MCV ranged from 5.20 (October) to 6.20 g% (December), 14.48 (October) to 24.75 % (July), 2.33 (September) to 3.10 million/mm³ (December), 19.56 (August) to 31.11 µg (July), 26.51 (July) to 38.74 % (October) and from 63.46 (August) to 118.55 µ³ (July), respectively. Based on color chart for anaemia, a total of 15.50 % of the animals were drenched particularly during wormy season.



Component of losses due to GIN in sheep



Intensity of strongyle infection in sheep semi-arid Rajasthan

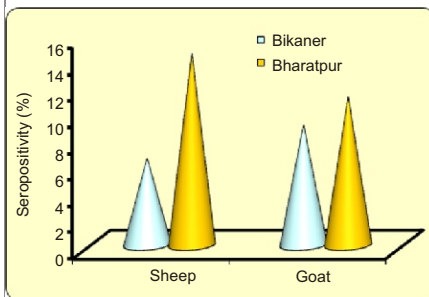


Intensity of strongyle infection in sheep arid Rajasthan

Assessment of economic losses due to GI parasitism: The estimations were made for production losses as well as for impact evaluation of different treatment schemes in sheep flocks by the method of partial farm budgeting. Based on sheep population in Rajasthan, the estimated annual losses due to GI parasites were Rs. 973.715 million in adult and Rs. 217.993 million in yearling sheep. The cost-benefit analysis for strategic control of GIN (single drench schedule) resulted in prevention of losses to the tune of 45.53 % in female and 59.00 % in male sheep. The short term studies with limited numbers of animals could not give consistent results on economic losses. The economic evaluation of various schemes revealed better economic impact of TST followed by TT approach compared to conventional drench schedule.

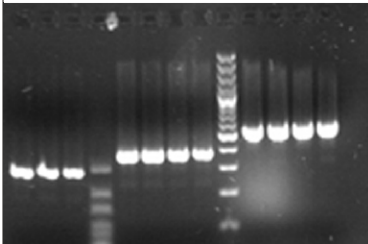
Studies on impact of drought on epidemiology of G.I. parasitism: The period of 7 years (April, 04 to March, 11) was divided into 3 groups depending on amount of annual rainfall as i) above normal TRF ii) normal TRF and iii) below normal TRF. In semi-arid Rajasthan, there was no evident effect of annual TRF on incidence of strongyle worms during the period from April to June. However, significantly higher incidence rate was observed from August to November in the years when annual TRF was below normal. However in arid region, no evident effect of annual TRF was noticed on incidence of strongyle worms throughout the year. In semi-arid region, the magnitude of monthly incidence of *Trichostrongylus* spp remained almost similar in all three categories of annual TRF. On the other hand, monthly incidence of *S. papillosus* was relatively higher during occurrence of normal annual TRF. In arid region, incidence of *Trichostrongylus* spp was slightly higher during the years with low TRF and no major variation was observed in incidence of *S. papillosus*. Monthly incidence of *Moneizia* spp remained relatively higher during the period of normal or below annual TRF in semi-arid region. In arid region incidence of *Moneizia* remained marginally higher during period of normal annual TRF and lowest during the period of low annual TRF. The incidence of *Eimeria* spp remained higher during the period of normal TRF in semi-arid region and during period of low TRF in arid region. In semi-arid Rajasthan, the annual incidence of *Amphistomes* spp found to be inversely related with amount of total annual rainfall. However, the length of infection found to be prolonged during the occurrence of TRF above the normal. The incidence of *Fasciola gigantica* and *Schistosoma* spp infection remained quit low and no definitive pattern was observed. In semi-arid Rajasthan, the monthly intensity of strongyle infection found to be not affected by categories of annual TRF, however it remained marginally lower during periods of rainfall higher than normal. In arid region there was extension of duration with relatively higher intensity of infection in the years with low annual TRF.

Training to all collaborating centers on epidemiology and forecasting system: During the year 4 persons were imparted 7 days practical training on management and analysis of meteorological and epidemiological data, preparation of bioclimatographs and mathematical modeling for forecasting of *H. contortus* infection.



Incidence of BT

1 2 3 4 5 6 7 8 9 10 11 12 13 14



PCR amplification of DNA from *Corynebacterium pseudotuberculosis* (goat isolates). Lane 1-3 : ABC gene; lane 4: Ultra ladder; lane 5-8: NADP gene; lane 9: 100 bp ladder; lane 10-13: PIP gene and lane 14: negative control

All India network project on bluetongue disease

This year no outbreak of BT (Bluetongue Disease) was recorded in farm and field flocks. The farmers were educated about the disease by showing clinical pictures. The serum samples were maintained in serum bank. The total collection of serum samples of sheep and goat in the bank is 11846 (sheep-8274, goat-3572). During the period, 1493 serum samples from sheep and goats were collected from field flocks (Bikaner, Bharatpur, Jhunjhunu, Chittogarh, Alwar and Dhaulpur) and 546 sheep from farm flocks. Out of these samples, 472 samples were tested by ELISA and 9.41% of 308 sheep and 10.3% of 164 goats were found positive for bluetongue antibody. Two new trappers for the collection of *Culicoides* vectors were fabricated. A total of 32 collections of suspected *Culicoides* were made and 25 samples were examined by ZSI, Kolkata however, none of the samples was found positive.

Veterinary type culture

Twenty nine isolates of *E. coli* and *Salmonella* following morphological and biochemical characterization were submitted to CRI, Kasauli for further typing. After serotyping, one salmonella isolate was confirmed as *Salmonella typhimurium* serotype 4,12:i:1,2. Of 16 *E. coli* isolates, 4 belonged to serogroup O66, 2 each to serogroups O60 and O95 and 1 each to serogroups O14, O20, O62, O71, O84, O87, O102 and O147. Faecal and tissue samples from Johne's disease affected sheep were subjected to bacterial culture for *Mycobacterium avium* subsp. *paratuberculosis*. Attempts are being made to revive bovine, ovine and caprine isolates of *M. avium* subsp. *paratuberculosis* available with the nodal officer. Cases of caseous lymphadenitis caused by *Corynebacterium pseudotuberculosis* in goats and sheep were investigated. Following primary isolation and identification, molecular characterization targeting three genes viz. ABC transporter NADP and PIP genes was completed. These 3 genes were amplified and amplicons were sequenced commercially. All three genes from sheep and goat isolates showed high degree of homology with the published sequences available in the gene data base. A case of gangrenous mastitis in Patanwadi sheep associated with *Clostridium* sp. was investigated. Specific primers for molecular detection of *Dichelobacter nodosus* and *Fusobacterium necrophorum* from foot rot cases of goat have been designed.

Projects

Development of carpet pile, technical textiles and apparels utilizing indigenous wool blends

Sub-project: Processing of wools and its blend for carpet pile, technical textiles home textiles and garments

D.B. Shakyawar, N.P. Gupta (Upto 31.1.11), L. Ammayappan (Upto 4.1.11), A.S.M. Raja and Ajay Kumar (From 26.7.10)

Sub-project: Improvement in performance characteristics of wool and woollen products using different chemical treatments

L. Ammayappan (Upto 4.1.11), A.S.M. Raja and D.B. Shakyawar

Sub-project: Development of decision-making software for woollen products

D.B. Shakyawar and N.P. Gupta (Upto 31.1.11)

Sub-project: Development of eco-friendly natural dyes for woollen products with antimicrobial and anti moth properties

A.S.M. Raja, L. Ammayappan (Upto 4.1.11), N.P. Gupta (Upto 31.1.11) and Ajay Kumar (From 26.7.10)

NAIP on a value chain on enhanced productivity and profitability of Pashmina fibre

D.B. Shakyawar, A.S.M. Raja, Ajay Kumar (From 26.7.10) and L. Ammayappan (Upto 4.1.11)

Development of upgraded utilization techniques for wool produced in southern peninsular region of the country

D.B. Shakyawar, A.S.M. Raja and Ajay Kumar (From 26.7.10)

**Textile Manufacturing and
Textile Chemistry**

Development of carpet pile, technical textiles and apparels utilizing indigenous wool blends

Processing of wools and its blend for carpet pile, technical textiles, home textiles and garments

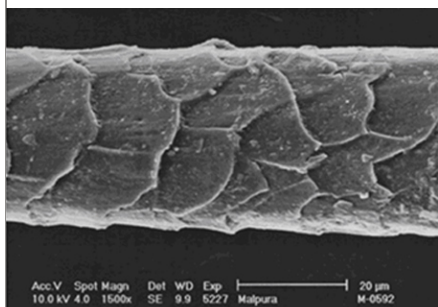
The mean fibre diameter of Avikalin wool ranged between 32 to 35 μ with 37 to 55 % medullation and 6.3 cm staple length. The mean fibre diameter of Chokla ranged between 32 to 36 μ , medullation 30 to 54% and staple length 7.0 to 8.3 cm. Different types of wool, Angora hair and Pashmina were characterized using scanning electron microscope (SEM).

A total of 3192 kg of wool was processed in woollen spinning system into 3-4 Nm yarn for making blanket and carpet. Yarn (2419 kg) for blanket from different wool mix and yarn (216 kg) for carpet from Utharada / Magra wool in blends with nylon was spun in woollen spinning system. Yarn was dyed with metal complex / acid dyes. A total of 728 blankets and 185 shawls, 3 carpets, 119 namda and 6 carpet samples were manufactured. Blankets (90) were also dyed with reactive and acid dyes in bright shades. Nylon blended blankets were better in feel, strength and colour fastness properties, however pure wool blankets had lower abrasion loss and higher thermal insulation. There was no significant difference between handloom and powerloom blankets in terms of their thermal resistance properties.

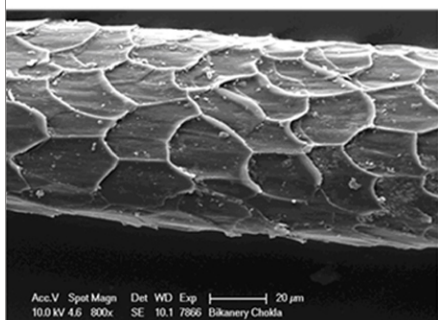
Bharat Merino and Gaddi Synthetic wool was successfully spun up to 42 Nm and Chokla up to 22 Nm in khadi system. Angora hair blending with Bharat Marino wool up to 60: 40 proportions was spun into yarn of 48 to 50 Nm and found suitable for shawl manufacturing. The performance properties (bending length, frictional force, abrasion loss, thermal insulation) of shawl prepared from RH: BM blends increased with the increase in the proportion of rabbit hair. The carpet made from Magra (September) clip showed higher resiliency as well as compressibility compared to Bikaneri Chokla wool. The carpet made from Bikaneri Chokla wool showed higher compressibility but lower resiliency due to the presence of higher proportion of hairy fibres.

Improvement in performance characteristics of wool and woollen products using different chemical treatments

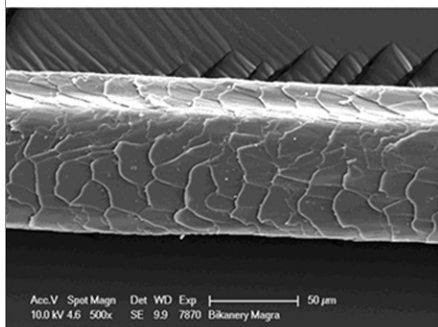
Fine wool required five bowls scouring process for spinning into yarn of finer counts. Canary colour wool was dyed to bright colours using acid and reactive compared to metal-complex dyes. Dyeing recipe was standardized for nine shades using metal complex dyes. Application of micro and nano-silicone finishing agent on woollen shawl was standardized and there was no significant difference in terms of softness of shawl. The finishing process for pure Angora hair: Bharat Merino wool (60:40) shawl was optimized for better softness with reduced pilling tendency. The Translit IN provided 15-20 % higher whiteness to the wool compared to hydrose when treated with 0.6 % sulphuric acid at 40-50 °C for 20 minutes.



SEM of Malpura wool fibre



SEM of Bikaneri Chokla wool fibre



SEM of Magra wool fibre

Development of decision-making software for woollen products

The database for shawl and blanket properties was created and analyzed statistically. The software developed for predicting carpet performance was verified for validity using data of hand knotted carpet from Magra wool.

Development of eco-friendly natural dyes for woollen products with antimicrobial and anti moth properties

The process for extracting of natural dyes from saffron flower, onion peel off, henna, tulip tree leaves and cochineal and dyeing on wool yarn was standardized. Angora hair: Bharat Merino wool blended shawls were dyed with natural dyes with good fastness properties. Saffron flower extract dyed without mordant showed zone of inhibition for the growth of *Staphylococcus aureus* while onion dyed did not show antimicrobial activity. Wool dyed with silver oak extract was least attacked by moth followed by henna and madder dye materials. Wool dyed with saffron and onion materials were severely attacked by moth. Cochineal showed different tautomeric forms in different pH which gave shades from purple to red with different mordants.

SHADE CARDS

Onion Natural Dye

Dyeing/ Mordanting	At pH 5		At pH 8-9	
	Dyed Sample	Washing Fastness	Dyed Sample	Washing Fastness
Onion only				
Aluminium sulphate				
Stannous chloride				
Ferrous sulphate				
Citric Acid				

Saffron Flower Natural Dye

Dyeing/ Mordanting	At pH 5		At pH 8-9	
	Dyed Sample	Washing Fastness	Dyed Sample	Washing Fastness
Dye only				
Aluminium sulphate				
Stannous chloride				
Ferrous sulphate				
Citric Acid				

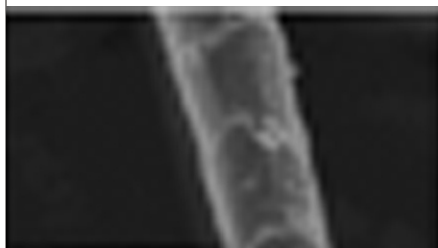
Silver oak, Myrobalan and Madder

Dyeing/ Mordanting	Silver oak	Myrobalan	Madder
	Dyed Sample	Dyed Sample	Dyed Sample
Onion only			
Aluminium sulphate			
Stannous chloride			
Ferrous sulphate			
Citric Acid			

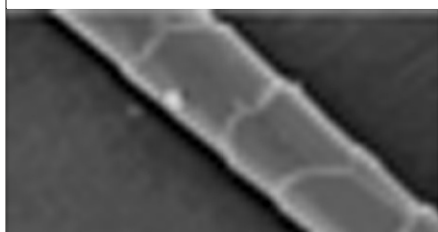
Henna, Tulip tree, Walnut and Pomegranate

Dyeing/ Mordanting	Henna	Tulip	Walnut	Pomegranate
	Dyed Sample	Dyed Sample	Dyed Sample	Dyed Sample
Dye				
Aluminium sulphate				
Stannous chloride				
Ferrous sulphate				
Citric Acid				

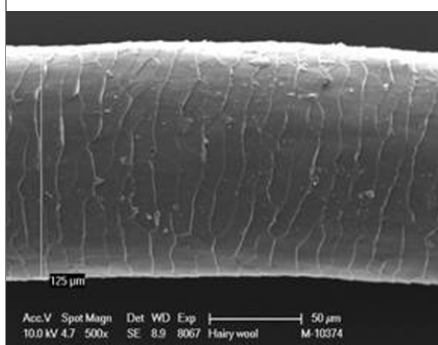
A value chain on enhanced productivity and profitability of Pashmina fibre



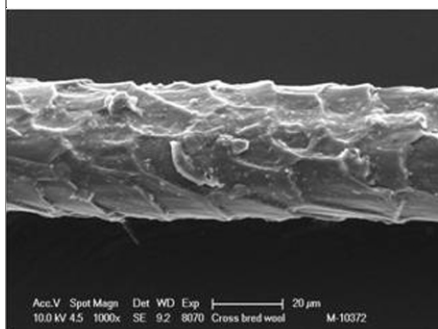
SEM of Pashmina wool fibre



SEM of Cashmere wool fibre



SEM of wool fibre from local sheep



SEM of wool fibre from crossbred sheep

Pashmina fibre was characterized using scanning electron microscope. A protocol was standardized for isolation of DNA from raw and processed Pashmina as well as other animal fibre. Modified dehairing cum carding machine was fabricated and dehairing trial on Pashmina was undertaken, which removed guard hair up to 95% in 3 passages without affecting quality of fibres. Pashmina wool was blended with Nylon-6 in the ratio of 50:50 and yarn of 50 Nm was prepared on modified cotton card and worsted spinning system. Weaving of blended yarn was carried out on improved light weight handloom with higher loom speed. It enhanced the productivity up to 30-40 % due to lower breakage e.g. warp and weft. The chemical finishing technique for removal of nylon from shawl was standardized to produce pure Pashmina shawl.

Extraction and application of colorant from saffron flower waste, onion skin were optimized. The dyeing of Pashmina shawl at pH 5 and 80°C for 1 hr with different mordant ($\text{Al}_2(\text{SO}_4)_3$, SnCl_2 , citric acid, FeSO_4) provided wide range of shade of colours with higher fastness properties. Antimicrobial study of dyed Pashmina shawl showed that myrobolone and silver oak had anti-microbial activity against *M. coccus*, *S. aureus*, *P. auriginosa* and *E. coli*.

Development of upgraded utilization techniques for wool produced in southern peninsular region of the country

Survey was conducted in Kolar and Chintamani districts (Karnataka) to ascertain the wool availability in southern part of the country. The wool produced in southern region had 55 µ fibre diameter and 65% medullation. With the introduction of Bharat Merino rams, the wool quality improved to medium-fine grade (32 µ fibre diameter and 54 % medullation) suitable for good quality technical felts for defence / railways. Morphological characterization of collected wool was studied using SEM. The coarse wool had shorter scale height as compared to crossbred wool however, both wool had same scale frequency. Both local and crossbred wool were procured from Kolar Sheep Breeders Association and scoured using non-ionic detergent with sodium carbonate in three bowl scouring machine. Handmade felts were made by mixing the southern wool and spinning waste generated at wool processing plant. The developed felts were value added through dyeing with synthetic and natural dyes.

Projects

Integrated approaches for improvement in productivity of sheep and rabbit under field condition through transferable technologies

Sub-project: Improvement in sheep production through breeding and genetic manipulation
A.L. Arora, Ved Prakash (Upto 26.1.11) and A. Chopra (From 27.1.11)

Sub-project: Improvement of sheep production in farmer's flock through physiological and reproductive techniques

Sajjan Singh (Upto 21.10.10) and S.M.K. Naqvi

Sub-project: Demonstration of fodder production technologies for improvement in sheep and rabbit production under field condition

L.R. Meena, J.S. Mann (Upto 31.1.11), S.C. Sharma and Roop Chand

Sub-project: Improvement in sheep production through improved feeding practices

O.H. Chaturvedi, A. Sahoo, R.S. Bhatt and S.A. Karim

Sub-project: Improvement in sheep production through health technology

C.P. Swarnkar, B.N. Tripathi, Vinay Kumar (Upto 31.5.10) and S.L. Sisodia (From 31.5.10 to 31.3.11)

Sub-project: Improvement in wool utilization through indigenous wool products developed by local artisans

N.P. Gupta (Upto 31.1.11), D.B. Shakyawar, A.S.M. Raja and Ajay Kumar (From 26.7.10)

Sub-project: Improvement in broiler rabbits through demonstration and training

Rajeev Gulyani, Vinay Kumar and J.S. Mann (Upto 31.1.11)

Sub-project: Improvement in socio-economic condition of sheep farmers through extension education and technical literacy programme

J.S. Mann (Upto 31.1.11), D. Sethi (From 30.7.10) Raj Kumar, L.R. Meena, R. Gulyani, D.C. Gupta, B.L. Sharma, R.L. Bairwa and O.P. Pande

Sub-project: Radio farm school on sheep, goat and rabbit production

Debabrata Sethi, J.S. Mann (Upto 31.1.11), R. Gulyani, D.C. Gupta, L.R. Meena, Raj Kumar and R.L. Bairwa

Sub-project: Development of need based interactive small ruminant information system

Debabrata Sethi, R. Gulyani, D.C. Gupta and Raj Kumar

Marketing of small ruminants in Rajasthan

D.C. Gupta, D. Sethi and Raj Kumar

Integrated approach for improvement in productivity of sheep under field conditions through transfer of technologies in arid region

R.K. Sawal, K.C. Sharma, H.K. Narula and M. Ayub

Integrated approach for improving productivity of Broiler/ Angora rabbit and sheep under field conditions through transferable technologies

J.B. Phogat (From 01.2.11), S.R. Sharma, S. Saha and S.K. Niranjana

Transfer of technology for improvement in sheep, rabbits and wool production

N. Swain (Upto 28.2.11), A.S. Rajendiran, S. Rajapandi and K. Narayanan (Upto 12.5.10)

Performance evaluation of broiler rabbits under farm and field condition

A.S. Rajendiran, N. Swain (Upto 28.2.11), S. Rajapandi and K. Narayanan (Upto 12.5.10)

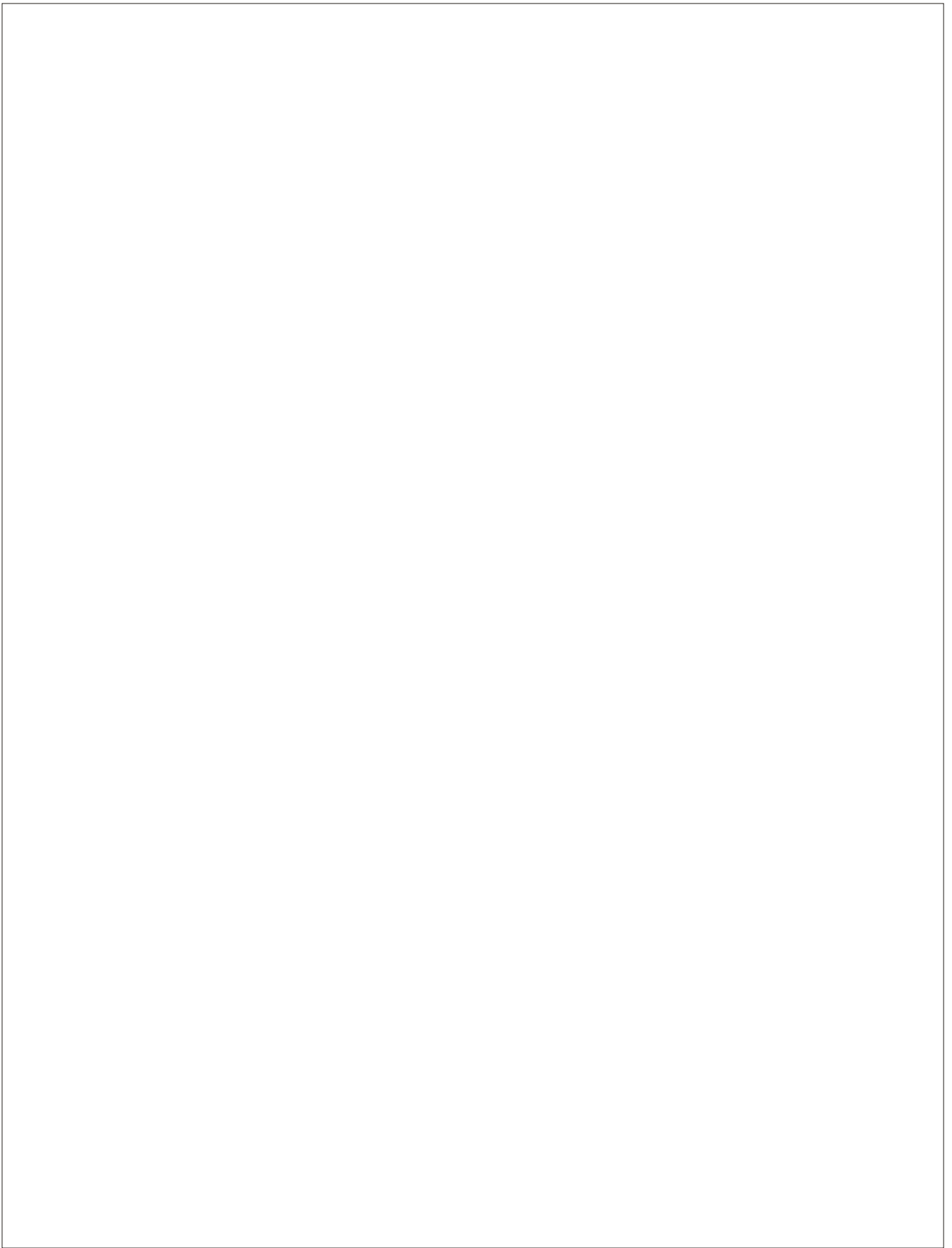
Sheep and wool improvement scheme (Malpura rams)

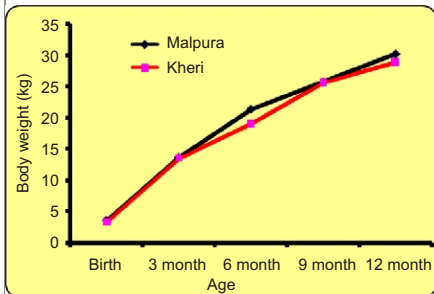
S.A. Karim, R. Gulyani, D.B. Sakhyavar, D. Sethi, Raj Kumar, A. Chopra, C.P. Swarnkar, D.C. Gupta, O.H. Chaturvedi, L.R. Meena and R.L. Bairwa

Ram raising unit for Chokla rams

S.A. Karim, R. Gulyani, D. Sethi, Raj Kumar, L.L.L. Prince, L.R. Meena, Ajay Kumar, C.P. Swarnkar and O.H. Chaturvedi

**Transfer of Technology and
Social Science**





Growth performance of sheep in field



Intra-vaginal progesterone impregnated sponges in sheep

Integrated approaches for improvement in productivity of sheep and rabbit under field condition through transferable technologies

Improvement in sheep production through breeding and genetic manipulation

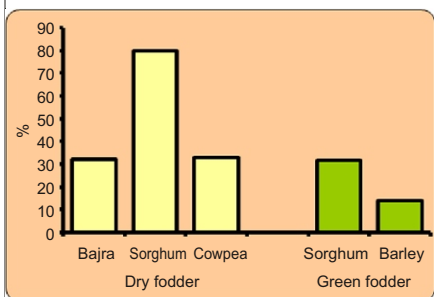
A total of 7109 sheep in 118 flocks were covered in Bhipur, Malpura, Swaria and Chawandia centres of TOT. The body weight of Malpura sheep at birth, 3, 6, 9 and 12 month of age were 3.56, 13.65, 21.36, 27.50 and 30.19 kg and Kheri were 3.33, 13.57, 19.09, 25.70 and 28.92 kg, respectively. Average greasy fleece yield at first 6 month and adult clip was 460 and 613 g, respectively.

Improvement of sheep production in farmer's flock through physiological and reproductive techniques

Oestrus was induced and synchronized in 44 acyclic ewes using intra-vaginal progesterone impregnated sponges and PMSG (100 IU). All the treated ewes exhibited oestrus within 2 days of sponge withdrawal. Chilled Patanwadi semen diluted 1:1 in EYMG with > 80 % progressive motility and sperm concentration was used for fixed time AI (twice at 36 and 48 hrs of sponge withdrawal). The overall lambing rate of 65.9 % was achieved.

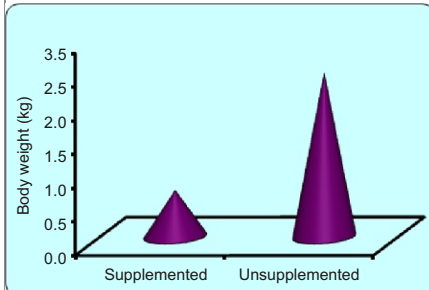
Demonstration of fodder production technologies for improving sheep and rabbit production under field condition

A total of 88 field demonstrations were laid at farmer's field on improved varieties of fodder crops, use of chemical fertilizers and biofertilizers in fodder crops. Fodder and fruit tree saplings (150) were planted on community land to popularize the silvipasture system as a measure to ensure availability of fodder especially during scarcity period. The overall survival of planted tree species after 6 months of sapling was 87.89 %.

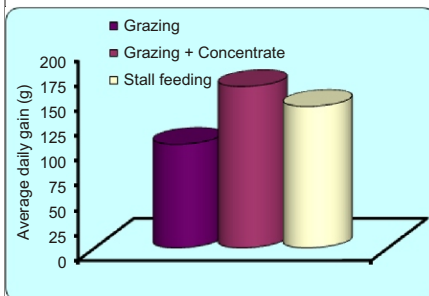


Relative increase in fodder yield with improved varieties over local

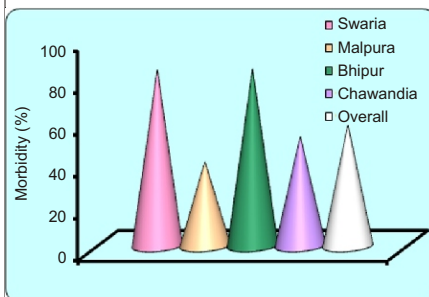
Improved fodder bajra variety 'Rajka bajra' produced higher green and dry fodder yield than local variety. The dry fodder yield was increased by 32.07 % over local variety. During kharif and summer seasons, demonstrations (15) on improved sorghum varieties viz., MP Chari and SSG 593 were laid on farmer's field. Green and dry fodder yield increased by 31.52 and 79.92 % in improved varieties than local. Improved cowpea variety EC 4216 produced higher dry fodder than local variety. The increase in dry fodder and seed yield were 32.86 and 40.63 % respectively over the local variety. During kharif season, 6 demonstrations on improved varieties of guar viz., Guar Durga and RGC936 were carried out on farmer's field. Green fodder (307.14 q /ha) and stover (64.49 q /ha) yield were higher with Guar Durga as compared to other varieties. The seed and stover yields of SML 668 variety of green gram were increased by 46.15 and 17.58 %, respectively than local variety. The green fodder and straw yields were increased by 13.81 and 13.97 %, respectively with RD 2035 comparison to RD 2552 variety of barley. The green and dry fodder yield were higher with Baramassi variety of lucerne than Anand varieties, however both the improved variety produced higher green and dry fodder yield over local variety.



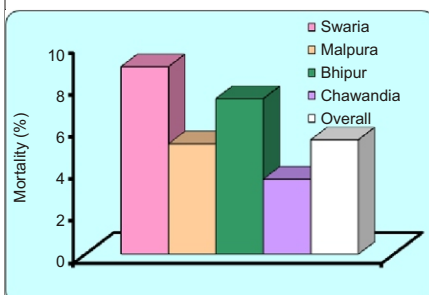
Loss of weight in ewes at lambing



Average daily gain in lambs



Annual morbidity rate in field flocks



Annual mortality rate in field flocks

Application of nitrogen and phosphorus (@ 90: 60 kg) produced highest green fodder and straw yield of barley in comparison to other treatment combinations. The increase in green and dry fodder was 40.60 and 55.11 % over no fertilizer application.

Improvement in sheep production through improved feeding practices

Concentrate supplementation during late gestation and early lactation: A demonstration was made on concentrate supplementation in 51 Malpura and Kheri ewes during late gestation and early lactation. The ewes in Gr-1 were supplemented concentrate mixture (350g daily) from late gestation to early lactation while ewes in Gr-2 were maintained on grazing only. The body weights of ewes in Gr-1 and Gr-2 at parturition were 35.22 and 33.92 kg, respectively. The mean birth weight of lambs born from ewes in Gr-1 was 0.59 kg higher compared to lambs born from ewes in Gr-2. The body weight of lambs at 60 days of age was higher in Gr-1 as compared to Gr-2. Milk yield of ewes was higher by 150 to 200 g in Gr-1 as compared to Gr-2.

Concentrate supplementation in lambs of farmer's flock: A total of 140 Malpura and Kheri (15-30 days old) lambs in equal numbers were maintained on Grazing (Gr-1), Grazing + concentrate feeding (Gr-2) and Stall feeding (Gr-3). The initial mean body weight of lambs in Gr-1, Gr-2 and Gr-3 were 5.58, 4.83 and 4.98 kg and final mean body weight at 135 day of age were 17.0, 22.6 and 20.6 kg with average daily gain of 104, 162 and 142 g, respectively.

Improvement in sheep production through health technology

Morbidity and mortality profile in sheep flocks of TOT area: The overall morbidity in TOT flocks was 57.50 % and ranged from 39.94 to 84.18 % in different villages under TOT programmes. The predominant conditions responsible for morbidity were pneumonia, enteritis, wound, debility, simple indigestion, lameness and conjunctivitis. The overall mortality in TOT flocks was 5.44 %, ranging from 3.57 to 8.92 %. The predominant causes responsible for mortality were pneumonia, debility, enteritis and tympany.

Rationalization of deworming practices in TOT flocks: The annual incidence for strongyle infection was 59.66 %. The seasonal incidence ranged from 33.47 (winter) to 70.31 % (monsoon). The implementation of a single strategic drench with appropriate anthelmintic after mid monsoon managed the GIN in field flocks. Other GI nematodes recorded at low level were *Strongyloides papillosus* (3.54 %) and *Trichuris* (1.50 %). The seasonal incidence of *Moneizia* spp varied from 0.82 % (winter) to 4.50 % (summer) with an annual incidence of 4.50 %. Among flukes, *Amphistomes* were predominant and their incidence was common during summer and monsoon (13.51 and 6.60 %, respectively) with an annual positivity of 6.33 %. The annual incidence of *Eimeria* oocysts was 41.52 % with maximum incidence during winter (60.82 %) followed by summer (36.94 %) and monsoon (29.51%).



Health camp in TOT village

Health camps: Six health camps were organized in TOT villages and 1871 cases (1490 sheep, 329 goats and 52 large ruminants) were treated for different ailments. The number of farmers benefitted from health camps was 246.

Sero-prevalence of brucellosis in sheep flocks: A total of 46 serum samples from field flocks were tested for brucellosis by RBPT and one sample was found positive (2.17 %).

Improvement in wool utilization through indigenous wool products developed by local artisans

Production of carpet: Carpet wool from Utarda region of Bikaner was procured for comparison with Magra wool. Wool was converted into 4 Nm yarn. The yarn was dyed with metal complex dyes into 9 different shades. The yarn was used for preparing hand knotted carpet with intricate designs at Mor and Moondiya villages. Three carpets of 9'X6' size were prepared from Magra and Bikaneri Chokla wool in blends with nylon.

Consultation and other services: Consultancy services were provided to J & K Sheep and Wool Product Development Board, Srinagar for revival of industries, CWDB, Jodhpur for evaluation of projects, M/s Transpek-Silox, Vadodara for bleaching of wool, M/s Mukundlal Motilal Company, Bikaner for bulk evaluation and other physical properties of wool yarn, M/s Felt and Non-woven Technical Industries, Jaipur for setting of scouring and carbonization plant.

Improvement in broiler rabbits through demonstration and training

Institute unit: Among males, British Brown rabbits (3.10 kg) were heavier than Soviet Chinchilla (3.09 kg), White Giant and New Zealand White (3.03 kg), Grey Giant (2.82 kg) and Dutch (2.41 kg). Among females, WG (3.29 kg) were heavier than BB (3.26 kg), SC (3.19 kg), NZW (3.18 kg), GG (3.02 kg) and Dutch (2.60 kg). The overall male (2.91 kg) and female (3.09 kg) adult body weight ranged between 2.30 to 3.47 kg.

Field units: A total of 837 rabbits were sold during the period. Twenty six rabbit units were surveyed at Ajmer (1), Kota (3), Jaipur (9), Tonk (4), Jhunjhunnu (4), Sikar (2), Pali (1), Haryana (1) and Punjab (1). The total rabbit population in these units was 1713, comprising of 400 kits, 311 weaners, 270 growers and 732 adults. The overall body weights among weaners, growers and adults were 462 g, 1.62 kg and 2.74 kg, respectively. Among litter traits, the overall LSB and LWB were 5.90 and 298 g, respectively.

Extension education and technical literacy

Participation in exhibition: To disseminate improved sheep production and wool and meat processing technologies, 10 exhibitions were organized at Bharat Nirman Jan Suchna Abhiyan Bhandarez (Dausa), Field day at Avikanagar, Kisan Mela at IVRI, Izatnagar, International Pushkar Mela, Kisan Mela, Directorate of Rapeseed Mustard Research, Bharatpur, Krishi



Field unit of rabbit farm at exhibition



Kishan mela, exhibition, field days and ghosti

Expo, Jaipur, Krishi Vigyan Mela, Vansthali, Bhed evam Kisan Mela (Avikanagar), Masala Kisan Mela, NRCSS, Tabiji and Krishi Mela, Tonk.

Bhed evam Kisan Mela: A grand sheep and Kisan Mela was organized on 5 March, 2011 at Avikanagar. About 1000 farmers from various parts of the country participated and about 500 sheep, 100 goats and 100 rabbits were brought by them for participation.

Field/Institute visits organized: A total of 13 exposure visits were organized for 426 participants covering farmers and students.

Field Day, Kisan Gosthi, Van Mahotsav: Field day was organized at micro-watershed development cum demonstration unit of the Institute. Two Kisan Gosthis were organized in the adopted villages. Two Van-Mahotsavs were organized, one in the Institute and another in the Soda village.

Interactive meetings attended: Scientist from the Institute attended monthly Inter-media Coordination Committee meetings, organized by Press Information Bureau, Jaipur and inter-departmental coordination meeting organized by NGO- CECOEDCON at Malpura.

Audio visuals developed: Two video films were developed on institute's profile, achievements, technologies and other activities.

Radio farm school on sheep, goat and rabbit production

The topics for radio farm school on sheep and goat production were decided in consultation with scientists of the Institute. Scripts were developed for radio talks. Survey was conducted for listenership status and information source use-pattern along with the information need of the small ruminant farmers of the project area.

Development of need based interactive small ruminant information system

Literature was collected for different components of the information system and survey schedule was developed for information need assessment of the sheep and goat breeders. A new approach developed for timely and systematic dissemination of information through SMS-alert service. SMS-alert service started from January 1, 2011 and every week one SMS was sent to registered sheep breeders. The SMS contained advice regarding sheep practices to be followed in that particular week. SMS- alert was used for publicity of Kisan Mela etc.

Marketing of small ruminants in Rajasthan

A total of 200 small ruminant (SR) farmers belonging to 15 villages from Bikaner and Loonkaransar tehsil of Bikaner district were surveyed to identify the marketing channels of SR in arid region. The prime marketing channels were SR farmers - primary traders - traders in the mega market - butchers - consumers, SR farmers - primary traders - butchers - consumers, SR farmers - butchers - consumers and SR farmers - farmers. There is only

Small ruminants marketing channels in arid Rajasthan

- ▶ Farmer - Primary trader - Trader - Butcher - Consumer
- ▶ Farmer - Primary trader - Butcher - Consumer
- ▶ Farmer - Butcher - Consumer
- ▶ Farmer - Farmers

one meat market in Bikaner city where, the local primary traders sell small ruminants (mostly goats) to butchers. Butchers of Jaipur and Ajmer city were also surveyed, on an average butcher purchased 17 sheep and 26 goats in a week at the rate of Rs 1658 and Rs 1681, respectively. On an average sheep and goat produced 8.6 kg meat and sold at the rate of Rs. 160 to Rs. 200 / kg. Weekly average gross income realized per sheep and goat was Rs. 1904 and Rs. 1978, respectively. Weekly expenditure borne by the butcher was Rs. 1053. More than 77 % of consumers demanded 'halal' meat. Meat demand was highest on Sunday (68.3 kg) and butcher's average weekly sale of meat was 310 kg. The major constraints reported by the butchers were lack of credit facility followed organized meat market and hygienic slaughter houses.

Integrated approach for improvement in productivity of sheep under field conditions through transfer of technologies in arid region (ARC Bikaner)

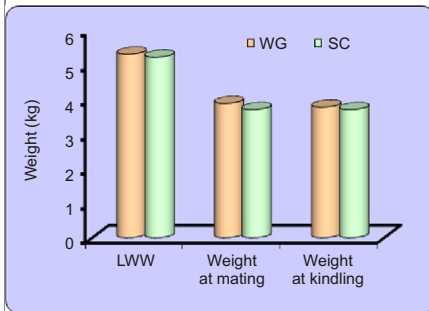
Farmers were educated for improved sheep husbandry practices through off-campus camps. Sheep and goats (16 flocks) were examined for health disorders and faecal samples were collected for implementing effective control measures for endo-parasites. A total of 450 animals were sold for breed improvement in the field. Khejri and Mopane saplings were planted in community grazing area for improving fodder production. Biomass availability of grazing land was assessed and it was found that biomass yield and quality improved substantially after rain in monsoon. Farmers were made aware about supplementary feeding and selection of breeding ram. The technologies developed by the centre were displayed through exhibition on various occasions.

Integrated approach for improving productivity of Broiler/ Angora rabbit and sheep under field conditions through transferable technologies (NTRS Garsa)

Four training programmes on sheep and Angora farming were organized. Twenty units of Angora rabbits (12 in Mandi and 8 in Kullu) each comprising of 8 females and 4 males were established. One day training cum farm demonstration programme was organized on sheep and rabbit husbandry for Primary Animal Husbandry Workers under Mid Himalayan Watershed Programme coordinated by HPKV, Palampur. A total of 250 Angora rabbits and 56 sheep of superior germplasm were supplied to farmers for improvement of their stock.

Transfer of technology for improvement in sheep, rabbits and wool production (SRRRC Mannavanur)

A total of 1182 breeding rabbits supplied to 64 clients of Tamil Nadu, Kerala, Puducherry and Karnataka. A total of 96 Bharat Merino sheep supplied to 24 clients of Tamil Nadu and Karnataka. Technical guidance was provided to enhance the sheep and rabbit production under commercial production through personal visits. Training Manual (Tamil Version) on commercial rabbit production was updated for training programme of the farmers.



Performance of broiler rabbit

Performance evaluation of Broiler rabbits in farm and field conditions (SRRM Mannavanur)

A total of 1647 kits were born. Mean weights at 6 and 12 weeks were 0.892 and 1.962 kg in White Giant (WG) and 0.879 and 1.916 kg in Soviet Chinchila (SC), respectively. Litter size at birth (LSB) ranged from 6.99 (WG) to 7.07 (SC) while litter size at weaning (LSW) ranged from 5.98 (WG) to 5.99 (SC). Litter weight at birth (LWB) varied from 349.9 (WG) to 354.6 g (SC) while litter weight at weaning (LWW) varied from 5.301 (WG) to 5.214 kg (SC). Mean weights at mating and kindling were 3.787 kg in WG and 3.700 kg in SC and 3.771 kg in WG and 3.700 kg in SC, respectively. The kindling rate was 65.50 % in WG and 73.37 % in SC. The overall survivability of rabbits including kits was 93.50 %.

Sheep and wool improvement scheme (Malpura rams)

Under the project, 17 villages, 123 breeders and 8000 sheep were covered during the period. Five health camps were organized to create awareness on health care practices and treatment of sick animals. Vaccination and deworming of all the registered flocks were done. A total of 69 Malpura rams were raised at farm unit for distribution to registered sheep breeders.

Ram raising unit for Chokla rams

Forty four Chokla rams were raised at farm unit for distribution to farmers in native tract of Chokla.

Projects

Genome analysis of sheep breeds by molecular methods

L.L.L. Prince, Rajiv Kumar (Upto 23.2.11), Rajni Kumari, Amar Singh Meena (From 23.4.10), Basanti Jyotsana (From 18.9.10) and Ved Prakash

Sub-project: Identification and molecular analysis of fecundity gene in prolific and non-prolific sheep

L.L.L. Prince, Rajiv Kumar (Upto 23.2.11), Rajni Kumari, Amar Singh Meena (From 23.4.10) and Basanti Jyotsana (From 18.9.10)

Sub-project: Study on gene polymorphism in wool related traits and fiber identification by molecular methods

Rajiv Kumar (Upto 23.2.11), L.L.L. Prince, Rajni Kumari, Amar Singh Meena (From 23.4.10) and Ved Prakash

Sub-project: Study on genes affecting the mutton production by molecular methods

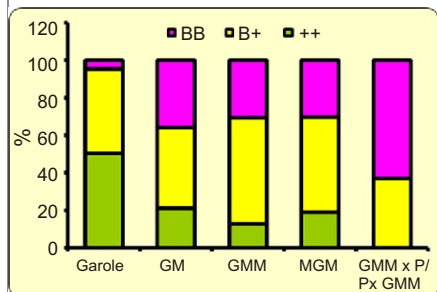
Rajni Kumari, Rajiv Kumar (Upto 23.2.11), L.L.L. Prince, Amar Singh Meena (From 23.4.10), and Basanti Jyotsana (From 18.9.10)

Sub project: Study on genes affecting reproduction in sheep by molecular methods

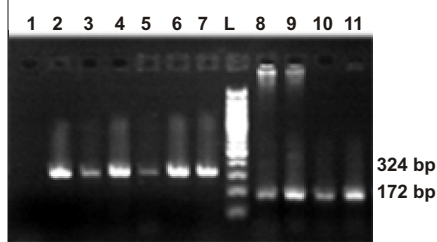
Amar Singh Meena (From 23.4.10), Rajni Kumar, Rajiv Kumar (Upto 23.2.11), L.L.L. Prince, Ved Prakash and Basanti Jyotsana (From 18.9.10)

Genetic improvement of resistance to *Haemonchus contortus* in sheep

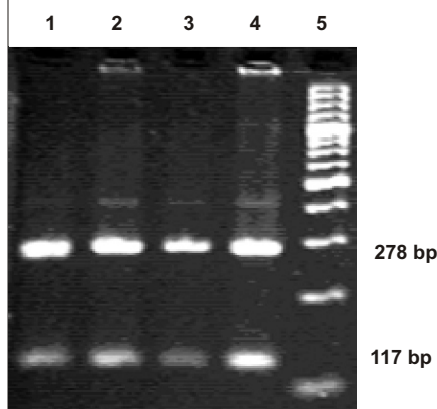
D. Singh, C.P. Swarnkar, L.L.L. Prince, F.A. Khan (Upto 30.11.10), C. Paswan (Upto 27.9.10) and A.L. Arora



Frequency distribution of Fec B gene in prolific sheep breeds



Fibre identification by PCR. Lane 1: negative control; lane 2-7: Pashmina, lane L: 100 bp ladder, lane 8-11: sheep wool



Faql restriction products of Callipyge gene. Lane 1-4: AA genotype; lane 5: 100 bp ladder

Genome analysis of sheep breeds by molecular methods

Identification and molecular analysis of fecundity gene

Out of 42 Garole sheep, 21, 19 and 2 sheep were genotyped as BB, B+ and ++, respectively for Fec B gene. In GM sheep, BB, B+ and ++ genotypes Fec B mutation was detected in 34, 69 and 58 sheep, respectively. Among GMM, 19, 85 and 46 and in MGM, 10, 27 and 16 were BB, B+ and ++, respectively. Out of 54 three breed cross lambs (GMM x Patanwadi / Patanwadi x GMM), 20 and 34 were B+ and ++ for Fec B. A total of 84 % Kendrapada sheep were found carriers for Fec B gene.

Gene polymorphism in wool related traits and fibre identification

Eleven breeds of sheep from different geographical regions were studied for KRT1.2 polymorphism and 3 genotypes reported. Six breeds of sheep screened for KAP1.3 polymorphism. For fibre identification, DNA isolation protocol and species specific PCR conditions were standardized.

Genes affecting the mutton production

Growth hormone (GH) gene: Polymorphism of GH gene at locus A1575G and A781G was studied for nine sheep breeds belonging to different agro-ecological regions of India. The study analyzed random blood samples of the 645 sheep by PCR-RFLP technique. The allelic frequency differences for both alleles across the Indian breeds were statistically non-significant. Further, study was done to establish an association of genotypes with growth traits at different ages in Avikalin and Malpura breeds. The study revealed that the effect of the genotype was not significant on body weight at different ages in Avikalin and Malpura breeds.

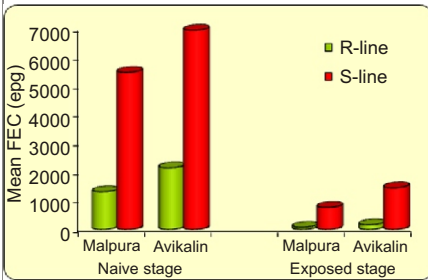
Callipyge gene: Ten samples each of Avikalin, Bharat Merino, Nellore, Chokla and Malpura breeds were studied for genetic polymorphism of Callipyge gene. The polymorphism of CLPG gene was detected in 426 bp PCR product by restriction endonuclease Faql. All the samples of sheep were found monomorphic for CLPG gene as only wild allele A was detected. The mutant allele G was not detected.

Genes affecting reproduction in sheep

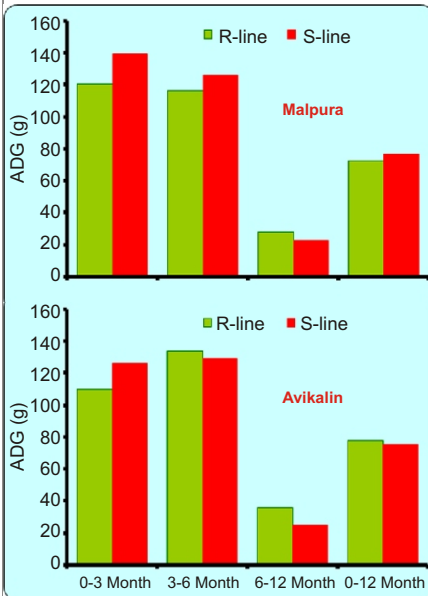
Five breeds were studied for aromatase gene (Cyp 19) polymorphism. The genotyping AB was dominant in studied population of sheep breeds. PCR-RFLP conditions of melatonin receptor 1A (MTNR1A) gene were optimized and polymorphism in MTNR1A gene at locus C606T and G612A was studied using Rsa1 and MnlI restriction enzymes.

Genetic improvement of resistance to Haemonchus contortus in sheep

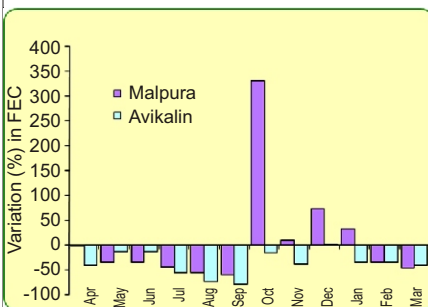
Monitoring the level of infection in naïve and exposed animals under natural conditions: A total of 316 lambs (190 Malpura and 126 Avikalin) belonging to 33 sires of Malpura and 21 sires of Avikalin breed were



Intensity of strongyle infection in selected progenies



Average daily gain in body weight in divergent lines



Monthly magnitude of variation for mean FEC in R-line over S-line

evaluated for gastrointestinal nematode (GIN) under natural challenge of infection from July to November, 2010 at monthly interval. Sire-wise pre-drench mean FEC during the month of September ranged from 566 to 9191 epg in Malpura and from 1233 to 9125 epg in Avikalin. Following termination of primary infection, all the animals were allowed to graze on naturally contaminated pasture and sire-wise mean FEC in exposed hoggets (November) ranged from nil to 520 epg in Malpura and from 100 to 758 epg in Avikalin.

Selection of divergent lines w.r.t. susceptibility to GIN: On the basis of sirewise mean FEC (post-drench) the sires were ranked and progenies were selected for susceptible (S) or resistant (R) line. In Malpura breed for selected progenies the mean FECs were more than 4.5-10.0 times higher in S-line compared to R-line. Like-wise in Avikalin breed for selected progenies the mean FECs remained around 3-10 times higher in S-line compared to R-line.

Within breed variation (Heritability estimates): The FEC data for all the progenies born during 2004 to 2010 were pooled for estimation of heritability and sire variation in FEC was taken as random effect while sex and year effects were taken as fixed effect. The overall h^2 estimates for log transformed FEC in naïve animals were 0.104 and 0.141 for Malpura and Avikalin, respectively. In exposed animals the h^2 estimates for log transformed FEC were 0.081 and 0.043 for Malpura and Avikalin, respectively.

Performance of selected lines: No significant variation was observed in monthly body weights and annual GFY of adult sheep belonging to R- and S-line in both the breeds. The overall annual tugging and lambing on tugged basis was 91.1 and 84.3 % in R-line and 93.2 and 85.4 % in S-line, respectively. Based on observations from 2004-10, it was found that average annual mortality ranged from 6.33 (R-line) to 7.03 % (S-line) and average culling / sale varied from 6.12 (R-line) to 7.72 % (S-line). The data on growth performance of animals selected during 2010 revealed non significant difference at all stages in both the lines except in birth weight of Avikalin where progenies in S-line had significantly higher birth weight compared to progenies in R-line. The average daily gain (ADG) from birth to 12 month of age ranged from 72.52 to 76.85 g (R-line) and from 75.32 to 78.22 g (S-line) in Malpura and Avikalin, respectively. The annual GFY in selected progenies ranged non-significantly from 1.283 kg (R-line) to 1.318 kg (S-line) in Malpura and from 1.900 kg (R-line) to 1.900 kg (S-line) in Avikalin.

Intensity of GIN in selected lines: In Malpura breed, the monthly mean FECs remained lower (2.79% in April to 60.53% in September) in R-line compared to S-line, however relatively higher FECs during October to January in R-line could be attributed to effect of anthelmintic (closantel) drench in S-line during September. Similarly in Avikalin breed, the monthly mean FECs remained 12.81% (Jun) to 79.31% (Sep) lower in R-line compared to S-line. In spite of no anthelmintic intervention in the R-line the FEC never reached the threshold level (> 2000 epg) during the year suggesting that these animals could be maintained without anthelmintic

drench. On the contrary in animals of S-line the peak of infection was noticed in the month of July (passing the threshold limit) that require anthelmintic intervention.

Observations for animals born from selected animals: In both the breeds it has been observed that progenies having inheritance of R-line possess comparatively lower FEC than those having inheritance of S-line. The ADG (0-12 month) and annual GFY remained slightly higher in progenies born from S-sire compared to those from R-sire.

Polymorphism of Ovar-DRB1 gene in selected lines: Though Ovar-DRB1 is highly polymorphic in both the lines but no association could be traced out between the frequencies of RE pattern.

Projects

Establishment of agro-forestry system for maximization of forage production

Sub-project: Effect of solar reflectance and CO₂ concentration on crop productivity under ardu based agro-forestry system in semi-arid region

J.S. Mann (Upto 31.1.11) and S.C. Sharma

Conservation and management of natural resources through agronomical manipulations

Sub-Project: Development of silvi-pasture system through agronomical manipulation for improving productivity of sloppy degraded land in semi - arid conditions

S.C. Sharma, J.S. Mann (Upto 31.1.11) and Roop Chand

Development of agro - horti pastures system sustainable to semi - arid conditions

Sub-project: Rejuvenation of old ber orchard for hortipasture system development in semi arid condition

L.R. Meena, J.S. Mann (Upto 31.1.11), S.C. Sharma and Roop Chand

Feed and fodder resource development for small ruminants in arid region

Sub-Project: Evaluation of different rejuvenation techniques of old sewan (*Lasiurus indicus*) grasslands with organic and inorganic sources of nutrients in hot arid region

K.C. Sharma

Sub-project: Effect of irrigation scheduling on the sewan (*Lasiurus indicus*) grass seed productivity and its viability

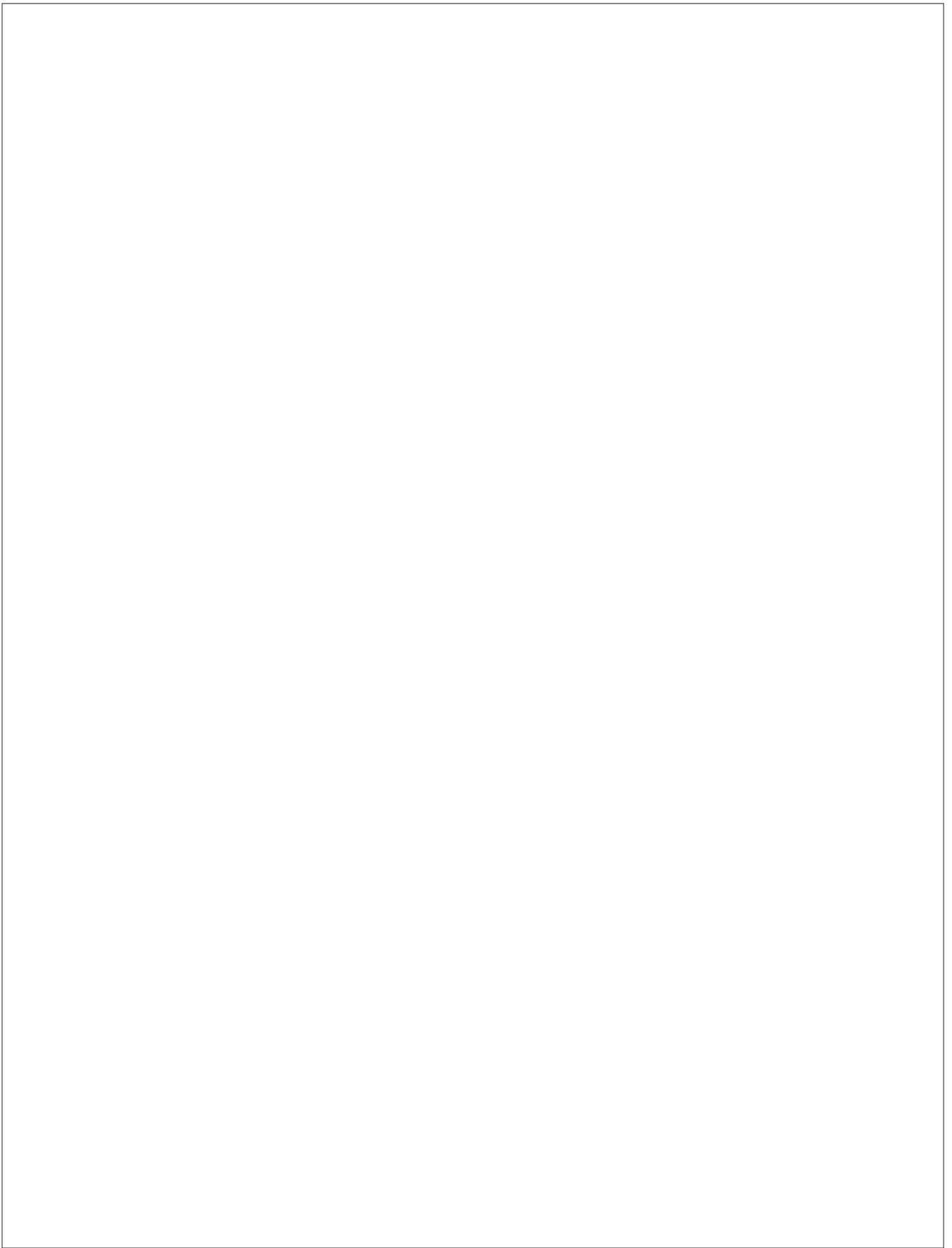
K.C. Sharma

Sub-project: Integrated nutrient management in oat (*Avena sativa*) and lucerne (*Medicago sativa*) in hot arid region

K.C. Sharma

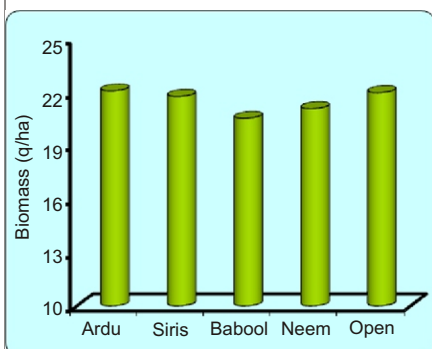
Sub-project: Fodder production potential of fodder pearl millet (*Pennisetum glaucum*) and cluster bean (*Cyamopsis tetragonoloba*) in intercropping system under different planting pattern during summer in hot arid region

K.C. Sharma

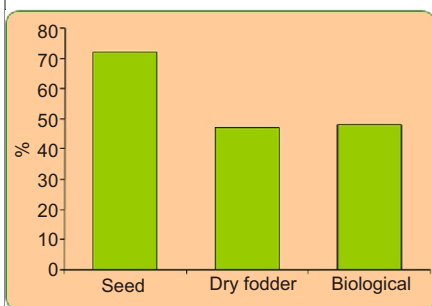




Three-tier agroforestry at bloom stage (Bajra+Moong+Cenchrus)



Average productivity of different crops in association of fodder trees



Relative increase in yields from cenchrus with V-ditch over without V-ditch contour bund



Established cenchrus pasture with V-ditch contour bunds

Establishment of agroforestry system for maximization of forage production

Effect of solar reflectance and CO₂ concentration on crop productivity under ardu based agroforestry system in semi-arid region

The growth parameters viz., fresh and dry weights per plant at 15 - 60 days after sowing (DAS), plant height at 15 - 45 DAS and harvest stage were at par in all the type of land use systems (open field, two-tier and three-tier agroforestry). These parameters were recorded relatively higher in two- and three-tier systems in comparison to open field.

Tree-crop interaction in agroforestry system in relation to reflectance and CO₂ concentration and its effect on productivity of crop

The fresh and dry weights, plant height, crop growth rate (CGR) and relative growth rate (RGR) were not affected by fodder tree association at various stages of crop growth except fresh and dry weights at 60 DAS and RGR at 45 to 60 DAS in agroforestry system. The average fresh and dry weights / plant at 60 DAS was at maximum in association of ardu and significantly higher compared to neem and babool association and at par with sirus association and open field condition.

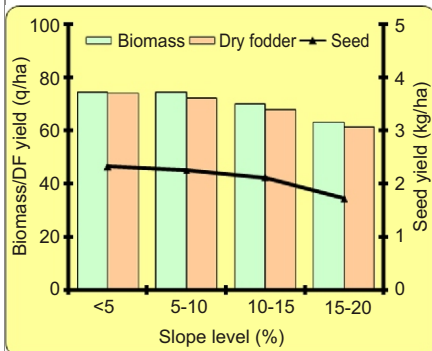
Conservation and management of natural resources through agronomical manipulation

Development of silvi-pasture system through agronomical manipulation for improving productivity of sloppy degraded land in semi - arid conditions

Three year old pasture: The cenchrus height, dry matter accumulation/clump, plant population/ha, tillers/clump, spike length, dry fodder, seed and biological yields were recorded significantly higher with V-ditch contour bund in comparison to without V-ditch contour bund. The seed, dry fodder and biological yields were higher by 72.2, 47.1 and 48.22%, respectively with V-ditch contour bund to that of without V-ditch contour bund.

Old pasture (IV year): At micro-watershed area, effects of position and place of cenchrus planting were studied in 4 year old pasture. The results indicated that except cenchrus height and spike length at harvest, all the other parameters (plant height and DMA/clump at 15, 30 and 45 DAS, plant population/ha, tillers/clump, dry fodder, seed and biological yields/ ha) were not affected by different place of cenchrus planting when cenchrus pasture was established with V-ditch contour bunds, however, these parameters were relatively higher at lower sites of sloppy lands. The growth parameters and yields were significantly higher at below V-ditch contour bund in comparison to above V-ditch contour bund. The biomass production was higher by 33.16% below V-ditch compared to above V-ditch contour bund.

Pasture at varying slope: The land slope significantly influenced cenchrus height at 30 and 45 DAS and harvest stage, DMA/clump at 15, 30 and 45



Cenchrus production at different slopes at micro-watershed



Cenchrus grass and *Dolichos lablab* at bench terrace

DAS, tillers/ clump, moisture content at 15 cm soil depth during July to October, dry fodder, seed and biological yield. These parameters were recorded maximum up to <5 % slope and as slope increased, these parameters reduced progressively up to 20 % slope. The difference in biomass production between 5 and 20 % land slope was 21.38 %. The place of cenchrus planting at upper, middle and lower sides of sloppy land brought considerable variations in growth parameters. Cenchrus height at 15 DAS, plant population/ha, spike length and moisture content during July were not influenced by place of cenchrus planting in sloppy land. Position of cenchrus above and below V-ditch contour bunds also significantly influenced pasture height at 30 and 45 DAS and harvest, DMA/clump at 30 and 45 DAS, spike length, dry fodder and biomass yields, soil moisture content (15 cm soil depth) during August to October. However, plant height and DMA/clump at 15 DAS, plant population/ha at harvest, tillers/clump, seed yield and moisture content during July remained unaffected due to above and below V-ditch position of cenchrus planting. Below V-ditch contour, biomass production of cenchrus was 11.93 % higher compared to above V-ditch contour bund position.

Terrace Study: At steep slope area, terrace was built and cenchrus were grown along with annual and perennial legumes (*Dolichos lablab*, cluster bean and cowpea). The remarkable variations were not observed in growth character and yield of cenchrus at top to bottom terrace. Among legumes, the highest biomass production was recorded in *Dolichos lablab* followed by cowpea.

Improvement of poor quality well water by use of amendments for maximization of food and fodder production in semi-arid regions

The application of 10 t/ha gypsum in soil and green manure significantly improved soil health and water quality. There was significant reduction in pH of soil and water, increase in organic carbon and slight reduction in bulk density.

Development of agro-horti-pasture system suitable to semi-arid conditions

Rejuvenation of old established ber orchard for development of horti-pasture system in semi-arid region

All the growth and yield attributes were higher in *C. setigerus* than *C. ciliaris* but spike length was higher in *C. ciliaris* as compared to *C. setigerus*. Integrated nutrient management significantly influenced growth and yield attributes of grass species. Growth parameters were higher with application of sheep manure (@ 5 t/ha along with 20+20+10 kg NPK/ha) in grass species and 10 kg sheep manure in conjunction with 250g urea + 375g SSP + 375g MOP/plant in ber plant. Green and dry fodder as well as seed yield was higher in *C. setigerus* than *C. ciliaris*. Seed yield in grass species was higher with the fertilizer application however fruit yield was not increased significantly with grass species. Fertilizer application in ber plants significantly increased ber fruit yield compared to no use of fertilizer.



Ber based hortipasture system

Evaluation of production potential of different fodder crops under ber based hortipasture system

Green and dry fodder yield was highest in 2:2 row ratios of cenchrus and cowpea. The yield of individual crop sown as sole was higher than inter-cropping system. Cenchrus + dolichos intercropping system (2:2) was considered next to intercropping of cenchrus + cowpea (2:2) followed by cenchrus + guar in 2:2 rows. The lower green and dry fodder yield was recorded in sole cenchrus (146.8 and 47.71 q /ha) as compared to other sole legume sown crops. The land equivalent ratio (LER) for all sole crops was >1. LER was 1.65 in cowpea and cenchrus sown in paired row ratio of 2:2. LER was slightly increased with increase in row proportion of legumes than cenchrus.

Performance of crops in agro-horti pasture

Crop growth and physiological parameters, dry fodder, seed and biological yield of cenchrus and sewan grasses were not remarkably differed under fruit tree association and open field conditions.

Development of agro-techniques for higher biomass yield of feed and fodder resource for small ruminants in hot arid region

Seeding and planting methods of sewan (*Lasiurus indicus*) grass

Transplanting of nursery seedlings showed its superiority with significantly higher green (12.23 and 13.56 t/ha) and dry matter (4.52 and 5.10 t/ha) yield followed by soaked seed sowing method with green fodder yield (9.67 and 11.56 t/ha) and dry matter yield (3.58 and 4.35 t/ha). Lowest grass yield was recorded under dry seed sowing in mud and germinated seed sowing methods due to lower plant stand and poor growth attributes. Growing of grass in bunches under seed pellet sowing method reduced the values of growth attributes and recorded lower grass yield as compared to seedling transplantation and soaked seed method of sowing. Seedling transplantation method recorded highest values of net returns (Rs. 3558/ha) and B:C ratio (1.22) followed by soaked seed sowing method (Rs. 2713/ha and 1.20).

Forage crops and grasses under agro forestry systems

Agri-silviculture model for hot arid region

- ▶ Cluster bean out-yielded moth beans
- ▶ Higher fodder yield with sewan grass than cenchrus
- ▶ Maximum net return and B: C ration with khejri tree, cluster bean crop and sewan grass

Remunerative agri-silviculture model for hot arid region: The experiment consisted of 12 treatment combinations viz., 3 multi purpose tree species khejri (*Prosopis cineraria*), ardu (*Ailanthus excelsa*) and rohida (*Tecomella undulata*) as main plot treatment and 4 crops and grasses clusterbean (*Cyamopsis tetragonoloba*), moth bean (*Vigna aconitifolia*), sewan (*Lasiurus indicus*) and cenchrus (*Cenchrus ciliaris*) as sub plot treatments. There was substantial improvement in the growth attributes of all tree species and none of tree species had significant effect on the grain, straw and fodder productivity of crops and grasses. The crop of cluster bean significantly out-yielded moth bean in both the years. Similarly, sewan grass gave significantly higher green fodder (120.7 and 167.4 q/ha) and dry matter (46.8 and 60.2 q/ha) yields in both the years, respectively over

Cluster bean or moth bean can be grown in association of multipurpose tree species (khejri, ardu and rohida) as agri-silviculture model for realizing higher and remunerative productivity under hot arid region of Rajasthan

- ▶ Pearl millet + cluster bean - lucerne sequence with ber plantation under agri-horticulture system for higher fodder productivity in hyper arid ecosystem of Rajasthan
- ▶ The system can be more beneficial for commercial production of ber plantation

- ▶ Interaction effect of date of sowing and N on green fodder and dry matter yield was found significant
- ▶ Sewan grass should be sown in 1st week of July along with application of 40 kg N/ha in two splits (at sowing + 4 week crop stage) and 5 ton sheep manure/ha in hot arid region of Rajasthan

cenchrus grass. Tree component did not affect cluster bean yield equivalent (CYE) values significantly but grain crops due to their better market prices of products showed their superiority and recorded greater values of CYE (cluster bean 13.11 and moth bean 12.80 q/ha) than grasses. These values were statistically at par but significantly greater than the values observed with grasses (sewan 8.56 and cenchrus 6.23 q/ha). Sewan grass registered significantly higher values of CEY over cenchrus grass. Among tree species khejri plantation recorded maximum net returns (Rs. 11697/ha) and B:C ratio (1.78) compared with other tree species. Among crops and grasses, cluster bean recorded maximum values of net returns (Rs.16837/ha) and B:C ratio (2.05) followed by moth bean (Rs. 15925/ha and 1.99). Grasses were less remunerative than grain crops. However, sewan grass gave greater values of net returns (Rs. 8585/ha) and B:C ratio (1.67) than cenchrus (Rs.3230/ha and 1.26).

Production potential of fodder cropping sequences in with or without ber plantation

Green fodder production under ber based agri-horticulture system:

All the growth attributes were maximum in pearl millet + cluster bean either succeeded by oats or lucerne and these values were substantially higher than ber sole, except stem girth during January, 2010, where stem girth improvement differed significantly. In case of total fodder yield of cropping sequences (annual), pearl millet + cluster bean - lucerne sequence recorded the maximum green fodder (96.2 t/ha) and dry matter (20.85 t/ha) yield followed by pearl millet - lucerne (GFY 93.6 t/ha). Annual green fodder and dry matter yield was significantly lower under ber plantation compared to without ber plantation except annual green fodder yield during 2010-11, where differences were non-significant. Sorghum equivalent yield (green fodder) was calculated on the basis of prevalent market prices of different fodder species (outputs) and results showed that the SFEY (124.7 t/ha) recorded with pearl millet + cluster bean - lucerne sequence was statistically at par with pearl millet - lucerne but significantly higher over rest of the cropping sequences. The difference in SFEY values recorded under with ber (89.0 t/ha) or without ber plantation (92.9 t/ha) were non - significant. Economic evaluation showed that without ber plantation treatment registered higher net returns (Rs. 49923/ha) and B:C ratio (2.14) compared with ber plantation (Rs. 46014 and 2.05) due to production of higher fodder yields and no yield of ber plantation under with ber plantation. Among cropping sequences, pearl millet + cluster bean - lucerne sequence recorded maximum values of net returns (Rs. 79841/ha) and B: C ratio (2.78) followed by pearl millet - lucerne (Rs. 75350/ha and 2.69).

Sowing time and nitrogen levels on the productivity of sewan grass

The maximum values of growth attributes viz., plant height (130.2 cm), number of plants/m² (9.57), number of tillers/tussock (129.2) and tussock diameter (71.8 cm) were recorded at sowing date of 4th July. It increased green fodder (172.2 q/ha) and dry matter (59.9 q/ha) yield over the sowing date in first week of August or September. In case of nitrogen application, growth and productivity increased up to the highest level of nitrogen (@ 60 kg/ha) but significant response was observed only up to the level of

40 kg N/ha. Maximum green fodder (98.6 q/ha) and dry matter (35.4 q/ha) yield were recorded at 60 kg N/ha and these were higher by 0.61 and 1.14, 8.35 and 12.0 and 43.9 and 60.2 % over 40, 20 and 0 kg N/ha, respectively. Interaction effect of date of sowing and nitrogen on green fodder and dry matter yield was found significant. Economic evaluation showed that first date of sowing (4th July) recorded maximum net returns (Rs.14278/ha) and B: C ratio (2.47) compared to delay date of sowing. Nitrogen levels, net returns and B: C ratio increased with increase in N dose up to the level of 40 kg N/ha (Rs. 4737.0/ha) and B: C ratio (1.51) and thereafter values slightly decreased.

Row spacing and nitrogen levels on the productivity of sewan grass

Although, number of tillers/tussock and tussock diameter at canopy level were maximum at wider spacing of 75 cm apart rows but maximum green fodder (153.7 q/ha) and dry matter (51.3 q/ha) yields were observed at closer spacing of 25 cm apart rows. The magnitude of increase in green fodder and dry matter yield was 2.06 and 11.6 and 1.38 and 11.3 % over 50 and 75 cm row spacings, respectively. Each increase in nitrogen level substantially increased the green fodder and dry matter yields of sewan grasses up to 60 kg N/ha but it was significant only up to the level of 40 kg N/ha. Thereafter, improvement in sewan grass fodder yield was non- significant. The highest green fodder (177.5 q/ha) and dry matter (59.2 q/ha) yields with 60 kg N/ha were higher by 1.95 and 2.0 %, 34.9 and 33.3 % and 67.1 and 66.3 % over 40, 20, and 0 kg N/ha, respectively. Interaction of row spacing and nitrogen was found non-significant. The maximum net returns (Rs. 10558/ha) and B:C ratio (2.09) were recorded under 50 cm row spacing followed by 25 cm spacing apart rows (Rs. 10522/ha and 2.05). In case of nitrogen application, although maximum value of net returns (13647/ha) were obtained with 60 kg N/ha but B: C ratio was the highest (1.37) under 40 kg N/ha.

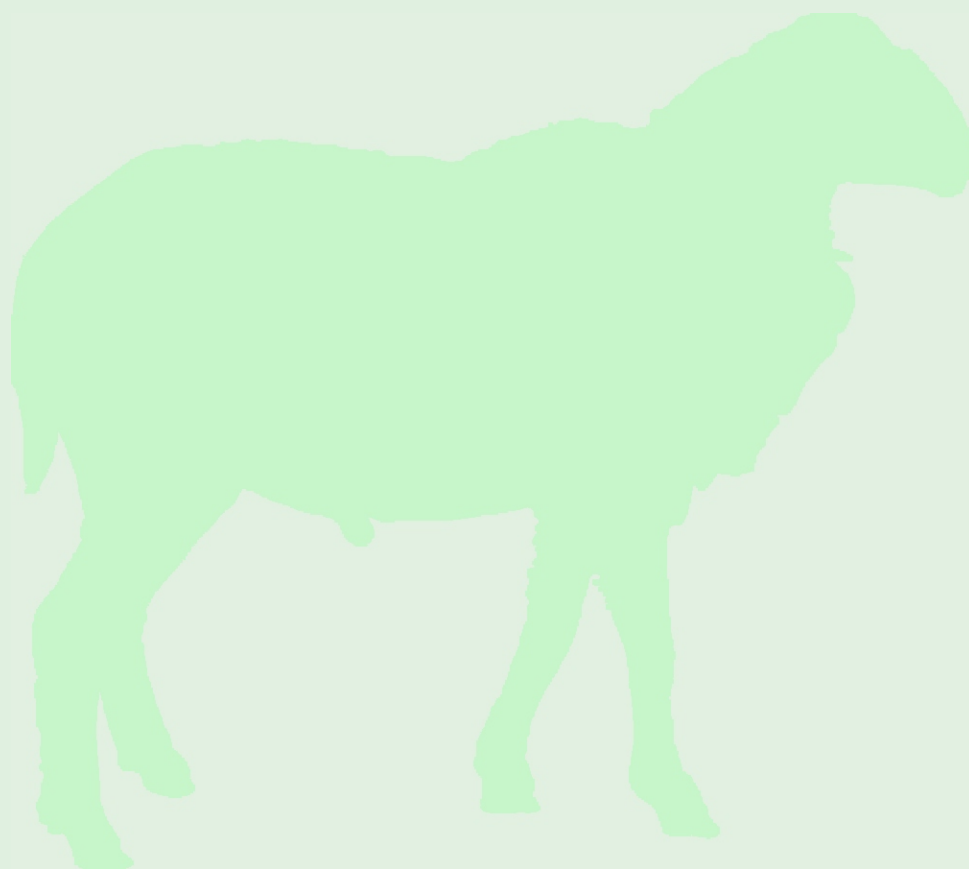
In hot arid Rajasthan, sewan grass may be sown at 50 cm apart rows and it should be fertilized with 40 kg N/ha along with 5 ton sheep manure/ha for higher and economical sewan fodder production

Projects**Carcass evaluation of sheep, goats and rabbits**

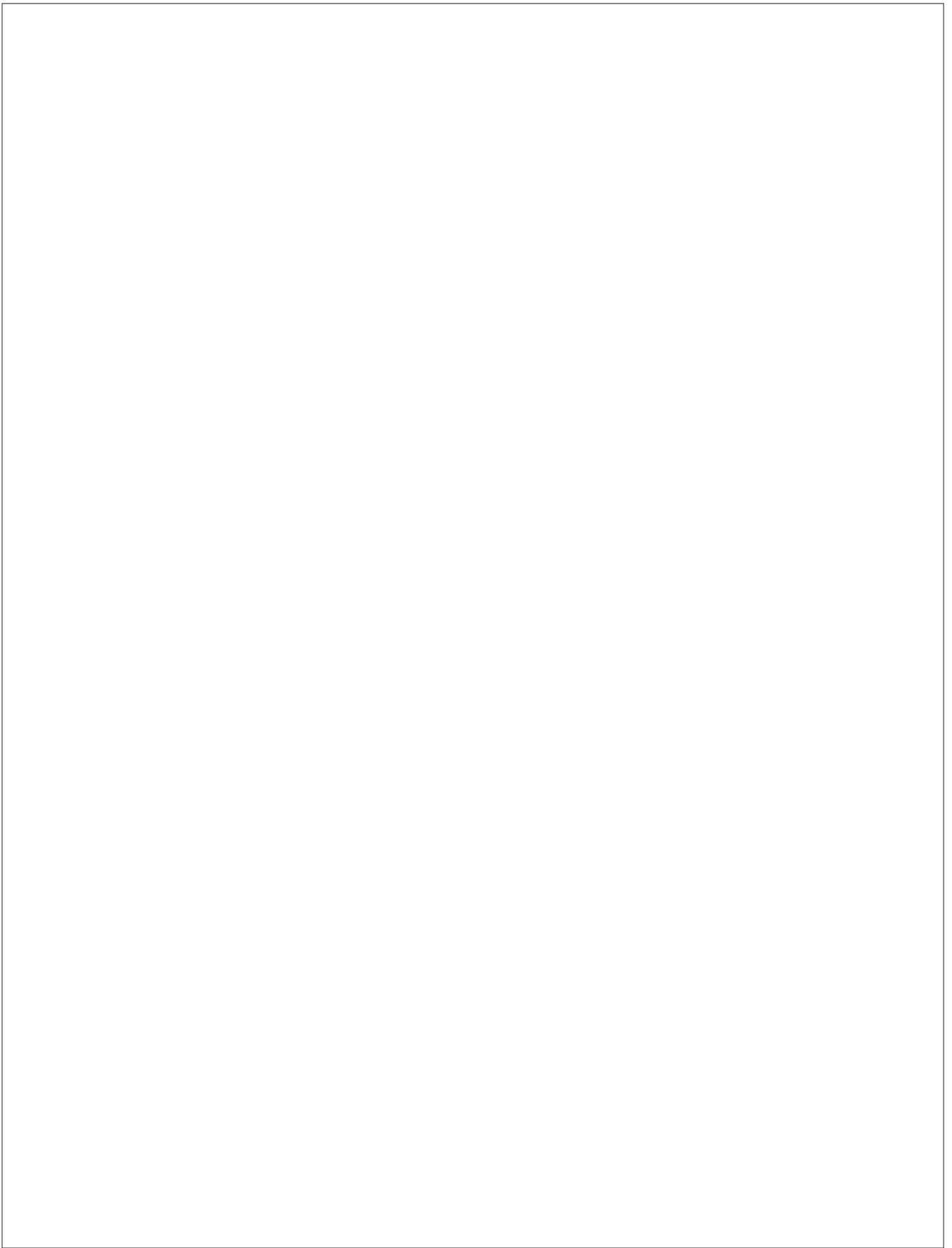
S. Suresh Kumar (Upto 19.8.10), Y.P. Gadekar (From 27.8.10), A.K. Shinde, S.A. Karim and M. Nasimuddin

Technology development for utilization of animal products/ by products for further processing of value added items

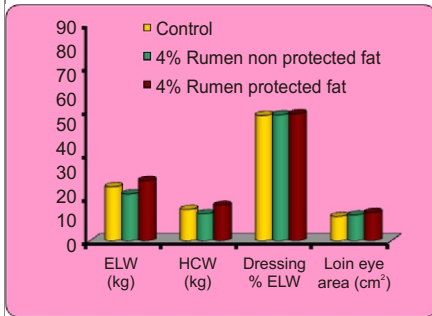
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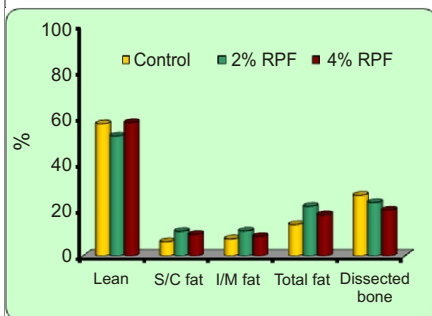
Meat Science and Pelt Technology



Carcass evaluation of sheep, goats and rabbits



Effect of rumen protected fat on carcass traits of lambs

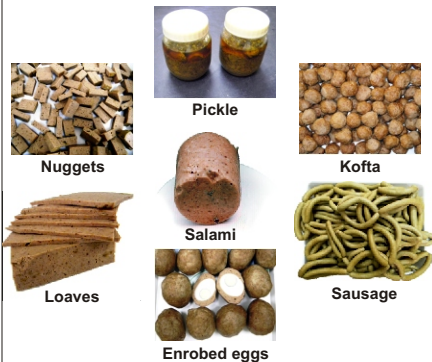


Effect of rumen protected fat on carcass traits of cull ewes

Carcasses of lambs supplemented with rumen protected fat: Lambs were supplemented with 0 % (Gr-1), 4 % rumen non-protected fat (Gr-2) and 4 % rumen protected fat (Gr-3) from the age of 28 to 180 days. Average pre-slaughter weight for Gr-1, Gr-2 and Gr-3 were 27.08, 23.32 and 30.74 kg and hot carcass weights (HCW) were 14.50, 12.51 and 16.38 kg, respectively. The lamb provided dressing yield of 57-58 % on empty live weight (ELW). The different commercial cuts viz., leg, loin, rack, neck and shoulder and breast and shank on an average contained 53-55 % lean, 19-22 % fat and 22-23 % bone. Caul fat and kidney fats were 680 and 410 g in Gr-1, 700 and 200 g in Gr-2, 970 and 390 g in Gr-3. The average lean, subcutaneous, inter muscular and bone per cent were 53.24, 11.09, 10.57 and 22.93 in Gr-1, 53.41, 9.90, 9.17 and 23.26 in Gr-2 and 54.75, 10.13, 9.67 and 22.29 in Gr-3, respectively. The cooking losses and water holding capacity was higher in Gr-3 while shear-force values were higher in Gr-1. The study suggested that supplementation of 4% rumen protected fat in lamb's diet improved pre-slaughter weight, lean yield but did not improve meat quality significantly.

Carcass evaluation of cull ewe fed with different levels of rumen protected fat during pre slaughter fattening: Cull ewes (>6 years old) were fed 0 (Gr-1), 2 % (Gr-2) and 4 % (Gr-3) rumen protected fat with *ad libitum* roughage and concentrate in cafeteria system for 90 days before slaughter. Pre-slaughter and hot carcass weights of ewe at the end of 90 days for Gr-1, Gr-2 and Gr-3 were 32.60, 15.71; 38.33, 18.40 and 37.05, 19.40 kg, respectively. Dressing yield (on ELW) in Gr-1, 2 and 3 was 55.16, 56.28 and 59.37 %, respectively. The different primal cuts viz., leg, loin, rack, neck and shoulder and breast and fore shank for Gr-1, Gr-2 and Gr-3 contained 57.45, 52.11 and 58.01 % lean; 13.62, 21.55 and 17.92 % fat and 26.41, 23.21 and 19.91 % bone, respectively. The loin eye area was 11.94 in Gr-1, 15.56 in Gr-2 and 15.72 cm² in Gr-3. The cooking losses and water holding capacity were 35.76 and 83.36 in Gr-1, 30.67 and 88.39 in Gr-2 and 31.10 and 86.48 % in Gr-3, respectively. The shear force values of mutton for Gr-1, Gr-2 and Gr-3 were 3.66, 5.03 and 3.63 kg/cm², respectively. The study suggested that supplementation of rumen protected fat at 4 % level in cull ewe's diet increased pre-slaughter weights and carcass yield but did not improve meat quality.

Carcass characteristics of new developed strain: Five males (18 months old) of newly developed strain A (GMM x Patanwadi) were slaughtered to study their carcass traits. Average pre-slaughter weight, dressing on ELW, loin eye area, caul fat and kidney fat was 43.69 kg, 53.65 %, 16.49 cm², 0.28 kg and 0.14 kg, respectively. Average lean, fat and bone content in carcass were 56.87, 9.04 and 29.59 %, respectively. Meat: bone and lean: fat ratio was 1.94 and 7.06, respectively. Water holding capacity was 25.28% while cooking losses and drip losses were 15.37 and 6.76 %, respectively. Shear force value as measure of tenderness was 4.14 kg/cm².

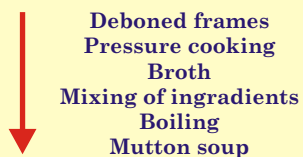


Value added meat products

Mutton pickle formulation

Ingredients	Quantity
Deboned meat	1.0 kg
Salt	30 g
Spice mix	30 g
Turmeric powder	10 g
Vinegar	200 ml
Citric acid	4 g
Vegetable oil	250 ml
Mustard seeds	10 g
Condiment paste	25 g

Preparation of mutton soup



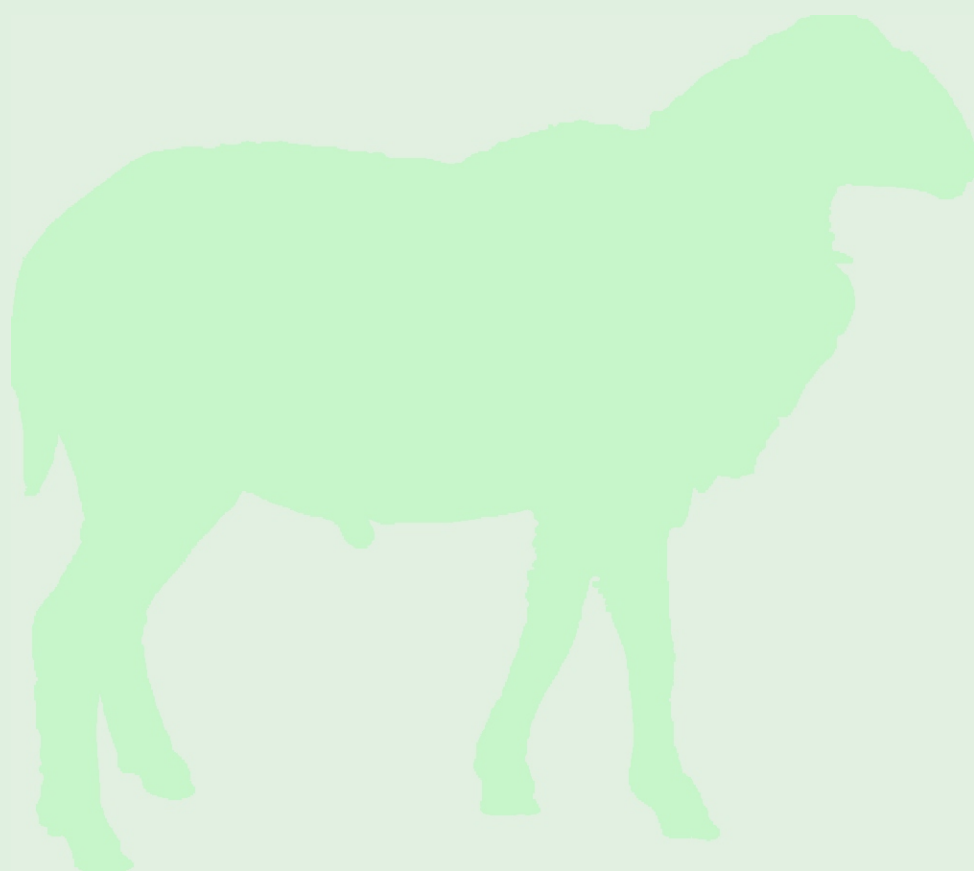
Technology development for utilization of animal products / by - products for further processing of value added items

Nugget, salami, sausage and kofta meat products were prepared and evaluated for consumer acceptability. A total of 124.35 kg of meat products were prepared and sold to consumers in the Institute and an amount of Rs.15544 was realized. In addition, new meat products like mutton soup, mutton pickle and enrobed eggs were developed. A total of 202 sheep, 34 goats and 56 rabbits were slaughtered and the fresh meat was sold after carcass evaluation. An amount of Rs. 286103 from sale of mutton, Rs. 38693 from sale of chevon and Rs. 7868 from sale of rabbit meat was realized. A total of Rs. 348208 was realized through sale of fresh meat and meat products.

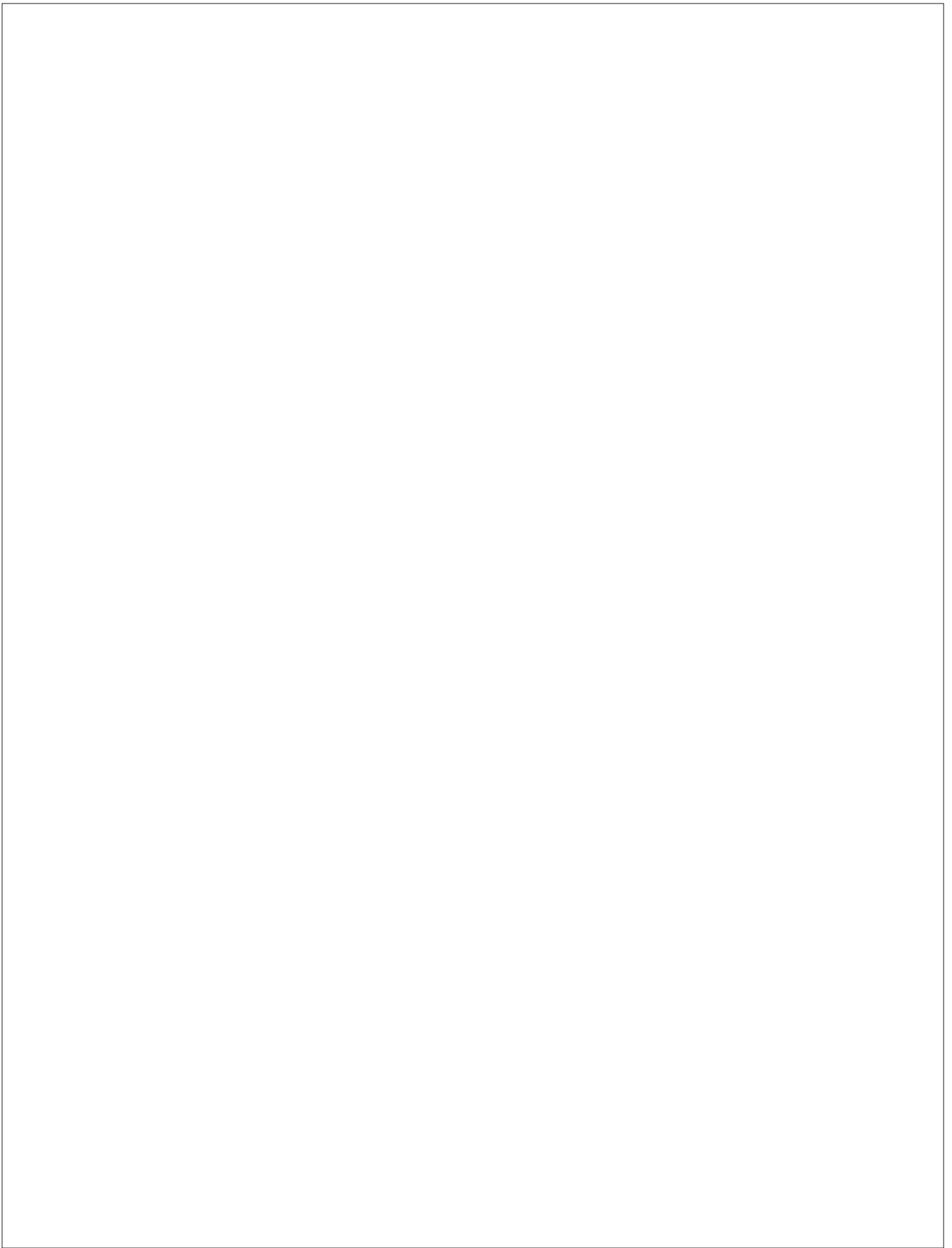
Mutton pickle: Mutton pickle is a traditional shelf stable meat product of India. It's preparation consisted of deboning of meat, making meat chunks of 1.5-2.0 cm, addition of turmeric and half of the quantity of vinegar. It was kept for 2-3 hrs in refrigerator. The excess fluid was drained out and meat chunks were cooked in pressure cooker for 10-15 min. Spices and condiments were fried followed by addition of cooked meat pieces. It was allowed to cool on its own and remaining half of the vinegar was added. The pickle was filled in sterile PET jars and kept at room temperature for maturation for 7 days.

Mutton soup: After separation of meat from bones, the bones with leftover small quantity of meat were used to extract juice for preparation of mutton soup. The deboned frames were pressure cooked to obtain the broth. The ingredients were comprised of broth (50%), water (50%), salt (0.77%), spice mix (0.25%), corn flour (1.25%), monosodium glutamate (0.05%), citric acid (0.09%) and condiment paste (2.25%).

Enrobed Eggs: Value added mutton product was made using chicken eggs. The eggs were boiled in the water. After separation of egg shell, around 50-60 g of mutton emulsion was coated over the egg and cooked in water.



सतसर्वात्





हिन्दी सप्ताह के उद्घाटन समारोह पर दीप प्रज्वलन



हिन्दी सप्ताह के समापन समारोह पर सम्बोधन

केन्द्रीय भेड़ एवं ऊन अनुसंधान संस्थान, अविकानगर में राजभाषा प्रकोष्ठ कार्यरत है। इस प्रकोष्ठ का मुख्य कार्य संस्थान मुख्यालय अविकानगर एवं इसके अधीन तीन उपकेन्द्रों (अ) मरू क्षेत्रीय परिसर, बीकानेर (राजस्थान), (ब) उत्तरी शीतोष्ण क्षेत्रीय केन्द्र, गड़सा (हिमाचल प्रदेश) एवं (स) दक्षिणी क्षेत्रीय अनुसंधान केन्द्र, मन्नावनूर (तमिलनाडू) में कार्यरत वैज्ञानिकों, तकनीकी एवं प्रशासनिक अधिकारियों एवं कर्मचारियों को सरकारी कार्य में अधिक से अधिक राजभाषा हिन्दी का प्रयोग करने के लिए प्रोत्साहित करना है। हिन्दी प्रकोष्ठ द्वारा भारत सरकार के गृह मंत्रालय के अधीन कार्यरत राजभाषा विभाग एवं भारतीय कृषि अनुसंधान परिषद, नई दिल्ली से समय-समय पर प्राप्त निर्देशों की अनुपालना सुनिश्चित की जाती है। यह प्रकोष्ठ परिषद से प्राप्त निर्देशों के अनुसार संस्थान मुख्यालय अविकानगर में कार्यरत विभिन्न विभागों एवं अनुभागों तथा उप केन्द्रों से प्राप्त प्रत्येक तिमाही के अन्त में हिन्दी की तिमाही प्रगति प्रतिवेदन को संकलित करके परिषद को प्रेषित करता है। परिषद के निर्देशानुसार संस्थान राजभाषा कार्यान्वयन समिति की बैठक प्रत्येक तिमाही में आयोजित की जाती है जिसमें कार्यान्वयन समिति के सभी सदस्यों को भारत सरकार से प्राप्त वार्षिक कार्यक्रम में निर्धारित लक्ष्यों पर विस्तृत रूप से चर्चा एवं अर्जित लक्ष्यों की समीक्षा की जाती है। बैठक में प्रत्येक विभाग एवं अनुभाग द्वारा प्रेषित तिमाही हिन्दी प्रगति प्रतिवेदन की समीक्षा की जाती है तथा जिन विभागों एवं अनुभागों द्वारा परिषद के निर्देशानुसार निर्धारित लक्ष्यों को प्राप्त नहीं किया जाता है, उन्हें उचित निर्देश जारी किए जाते हैं। संस्थान में दैनिक उपयोग में आने वाले आवेदन प्रपत्रों, प्रोफार्मा, प्रशिक्षण सामग्री एवं लोकप्रिय आलेखों का अनुवाद कार्य भी प्रकोष्ठ का एक प्रमुख कार्य है। वैज्ञानिक, तकनीकी एवं प्रशासनिक अधिकारियों एवं अन्य कर्मचारियों द्वारा प्रयोग में लिए जाने वाले प्रोफार्मा को द्वि-भाषी तैयार कर उन्हें प्रयोग में लाने हेतु संस्थान की वेबसाइट पर डाला गया है। संस्थान द्वारा प्रकाशित त्रैमासिक प्रकाशन प्रसार-पत्र के प्रकाशन में प्रकोष्ठ भाषायी सहयोग प्रदान करता है।

भारत सरकार एवं परिषद से प्राप्त निर्देशानुसार हिन्दी में तिमाही कार्यशालाओं का भी आयोजन किया जा रहा है जिसमें विषय विशेषज्ञों तथा हिन्दी के विद्वानों के व्याख्यान आयोजित किए जाते हैं ताकि वैज्ञानिकों द्वारा अनुसंधान से सम्बन्धित लोकप्रिय पम्फलेट तथा तकनीकी बुलेटिन हिन्दी में तैयार कर उनका प्रकाशन कराया जा सके। इसी प्रकार प्रशासनिक एवं तकनीकी श्रेणी के अधिकारियों एवं कर्मचारियों के लिए भी हिन्दी में तिमाही कार्यशाला आयोजित की जाती है ताकि हिन्दी में सरकारी कार्य करने में आ रही झिझक को दूर किया जा सके। इन कार्यशालाओं में वैज्ञानिकों, अधिकारियों एवं कर्मचारियों को बढ़-चढ़ कर हिस्सा लेने के लिए प्रोत्साहित किया जाता है। वर्ष के दौरान "यूनिकोड" कार्यक्रम पर वैज्ञानिकों, तकनीकी एवं प्रशासनिक श्रेणी के अधिकारियों एवं कर्मचारियों के लिए तीन कार्यशालाएँ आयोजित की गईं। भारत

सरकार एवं परिषद द्वारा अधिकारियों एवं कर्मचारियों के लिए हिन्दी से सम्बन्धित लागू की गई प्रोत्साहन योजनाओं की विस्तृत जानकारी समय-समय पर प्रदान की जाती है तथा उनमें भाग लने के लिए भी प्रोत्साहित किया जाता है।

संस्थान द्वारा वर्ष 2010-2011 के दौरान हिन्दी सप्ताह का सफल आयोजन किया गया जिसके अन्तर्गत संस्थान में कार्यरत वैज्ञानिकों, अधिकारियों एवं कर्मचारियों के लिए विभिन्न प्रतियोगिताएँ जैसे— शोध पत्र प्रदर्शन, हिन्दी टिप्पण, वैज्ञानिकों, प्रशासनिक एवं तकनीकी अधिकारियों एवं कर्मचारियों तथा चतुर्थ श्रेणी के कर्मचारियों के लिए निबन्ध प्रतियोगिता, हिन्दीतर भाषी वैज्ञानिकों, अधिकारियों एवं कर्मचारियों के श्रुतिलेख एवं हिन्दी पठन प्रतियोगिता, सामान्य ज्ञान प्रतियोगिता एवं स्व-रचित कविता पाठ आदि आयोजित की गईं। इन प्रतियोगिताओं के विजेताओं एवं उप-विजेताओं को पुरस्कृत भी किया गया।



हिन्दी सप्ताह के दौरान शोध पत्र प्रदर्शन का अवलोकन

संस्थान के उप-केन्द्र मरू क्षेत्रीय परिसर, बीकानेर (राजस्थान) में भी हिन्दी सप्ताह का आयोजन किया गया। उद्घाटन समारोह के मुख्य अतिथि ने केन्द्र पर हो रहे राजभाषा कार्य की सराहना करते हुए उपस्थित केन्द्र के वैज्ञानिकों, अधिकारियों एवं कर्मचारियों को अपना अधिक से अधिक कार्य हिन्दी में करने का आह्वान किया। संस्थान के अन्य उप केन्द्रों जैसे उत्तरी शीतोष्ण क्षेत्रीय केन्द्र, गडसा (हिमाचल प्रदेश) एवं दक्षिणी क्षेत्रीय अनुसंधान केन्द्र, मन्नावनूर (तमिलनाडू) पर भी हिन्दी दिवस का आयोजन किया गया। तीनों उप केन्द्रों पर इस दौरान विभिन्न प्रतियोगिताएँ आयोजित की गईं तथा विजेताओं एवं उप-विजेताओं को पुरस्कृत भी किया गया।

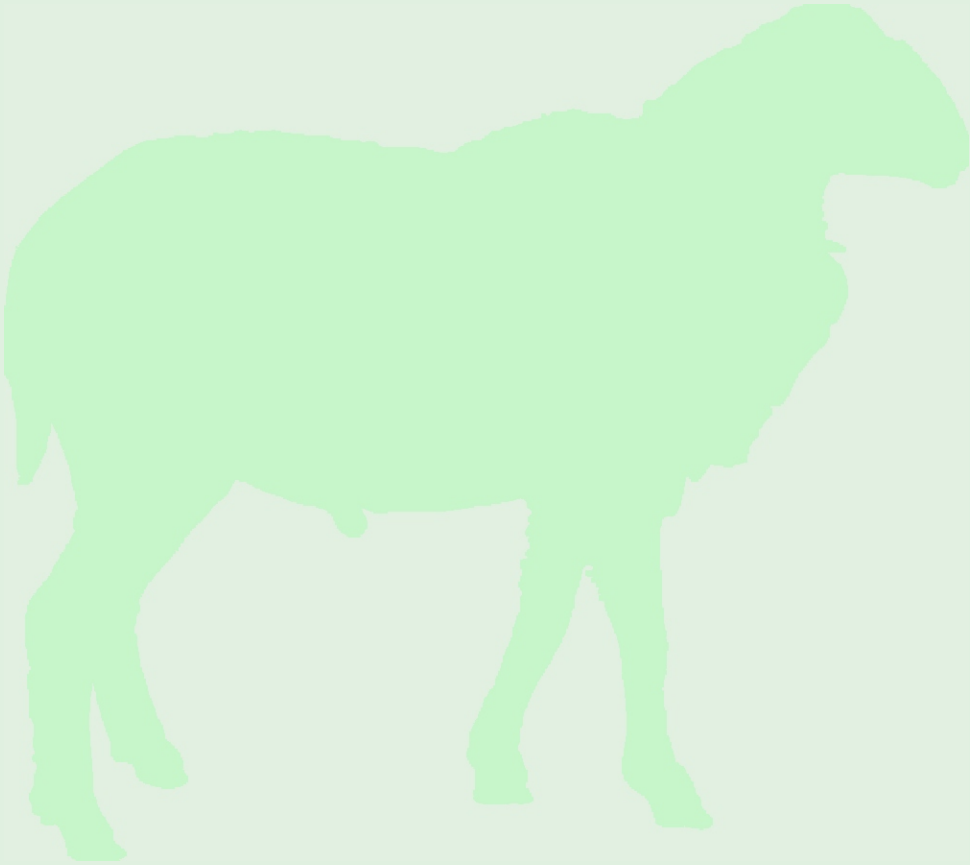


हिन्दी सप्ताह के दौरान शोध पत्र प्रदर्शन का अवलोकन

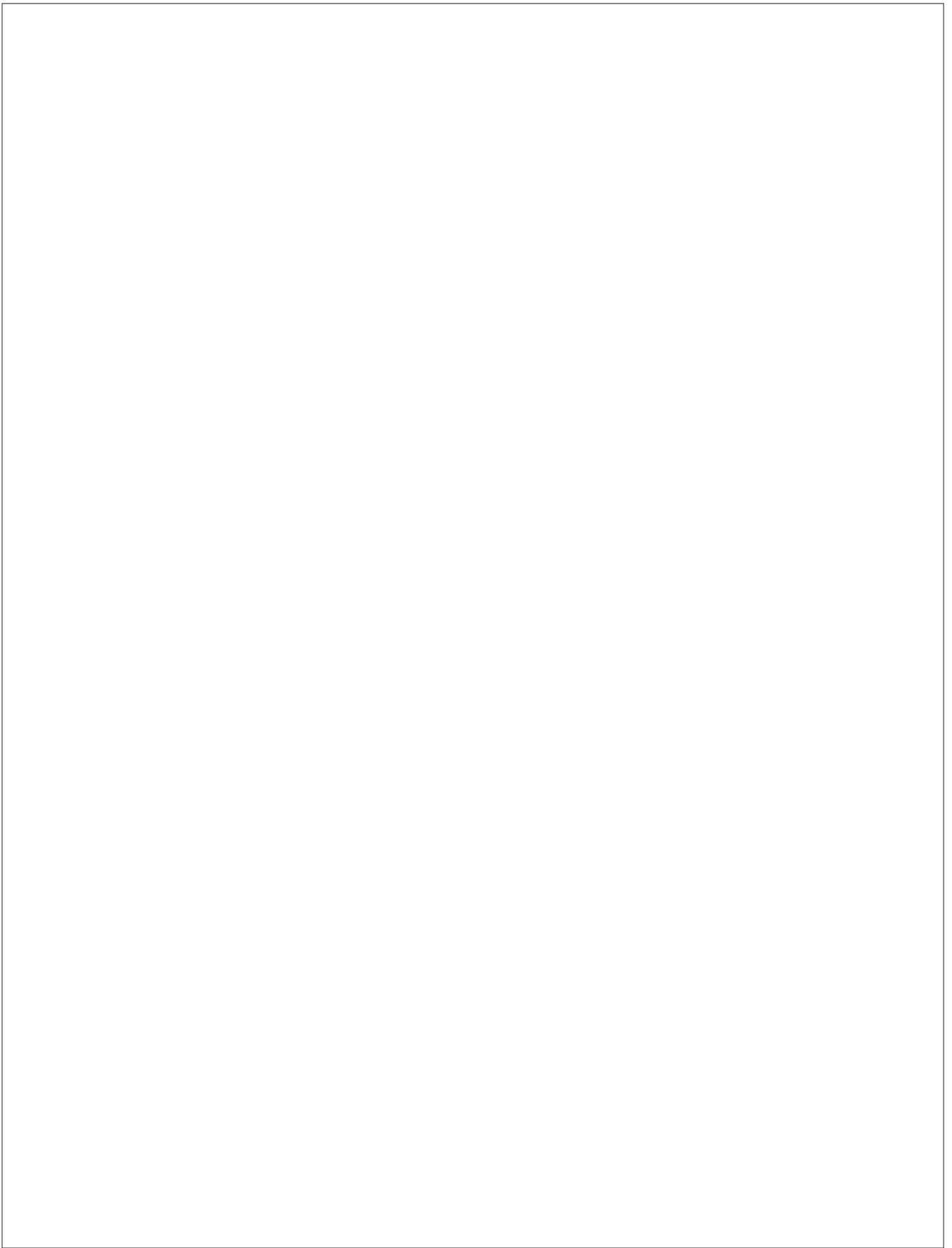
संस्थान द्वारा वर्ष के दौरान निम्नलिखित पत्रिका, तकनीकी बुलेटिन एवं पम्फलेट का प्रकाशन किया गया:

- ✱ वार्षिक हिन्दी पत्रिका अविपुंज
- ✱ सूक्ष्म ध्वनि तरंग (अल्ट्रासोनोग्राफी): भेड़ों में शीघ्र गर्भ परीक्षण की एक सरल व सटीक तकनीक – तकनीकी बुलेटिन
- ✱ ऊसर भूमि पर चारा फसलों में जिप्सम डालें, अधिक चारा उगाएँ –पम्फलेट
- ✱ चारा फसलों का वैज्ञानिक विधि से संरक्षण एवं भण्डारण –पम्फलेट
- ✱ चारा फसलों में जीवाणु खाद अपनाएँ, अधिक लाभ कमाएँ –पम्फलेट

उपरोक्त सभी प्रकाशनों का विमोचन संस्थान द्वारा दिनांक 05.03.2011 को आयोजित भेड़ मेला एवं किसान गोष्ठी के दौरान किया गया।



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TRAINING MANUALS**Artificial insemination and embryo transfer technology in sheep**

Editors: S.M.K. Naqvi, D. Kumar, K. Narayanan, A. Joshi, V.P. Maurya, V. Sejian, R.K. Paul and V.K. Saxena, CSWRI, Avikanagar, pp 1-89.

TRAINING ATTENDED

A.S.M. Raja, attended training programme on Remote sensing and GIS for characterization of cold arid habitats at National Remote Sensing Centre, (ISRO), Hyderabad, 31 January - 11 February, 2011.

Amar Singh Meena participated in winter school training on Basics of recombinant technology and bioinformatics tools at CCS, HAU, Hisar, 10 - 30 November, 2010.

Aniruddh Kumar Pareek attended training programme on drafting interpretation of patent specification and claims organized by National Institute of Intellectual Property Management (NIIPM), Nagpur, 16 - 17 September, 2010.

Aniruddh Kumar Pareek attended training programme on technology diplomacy organized by Consumer Unity and Trust Society and DST at Jaipur, 31 May - 04 June, 2010.

D.B. Shakyawar attended International training programme on Advances in cashmere wool processing and quality evaluation, Deakin University, Australia, 23 November - 7 December, 2010.

D. Kumar attended International training on Animal production and health at the Egyptian International Centre for Agriculture (EICA), Dokki, Giza, Cairo, Egypt, organized by the Ministry of Agriculture and Land Reclamation of the Arab Republic of Egypt, 1 October - 15 December, 2010.

D. Sethi attended training on Introduction to GIS and its applications at National Remote Sensing Centre, Hyderabad, 22 March - 16 April, 2011.

K. Narayanan attended training on Advances in the application of veterinary diagnostic theriogenology organized by GADVASU, Ludhiana, 16 February - 8 March, 2011.

L. Ammayappan attended International training program on nanotechnology in RUTGERS University, New Jersey, USA, 30 March-26 June, 2010.

L. Leslie Leo Prince participated in training programme on Data analysis using SAS at MPUAT, Udaipur, 14-19 February, 2011.

L. Ammayappan attended National training on production, processing and utilization of Pashmina fibre at CSKHPKV, Palampur, 1-7 December, 2010.

R.K. Paul undergone a 21-days training on Recent advances in endocrine control of livestock production and reproduction organized by CAFT, Division of Physiology and Climatology, IVRI, Izatnagar, 25 February - 17 March, 2011.

Rajni Kumari participated in summer school training on Basics of recombinant technology and DNA diagnostics at CCS, HAU, Hisar, 14 July - 4 August, 2010.

V. K. Saxena attended training program on Basic techniques in solid phase peptide synthesis and application of synthetic peptides in animal disease diagnosis and research at IVRI, Izatnagar, 22 September - 12 October, 2010.

V. Sejian attended International training program under carbon trading/carbon sequestration/climate change in animal science at Carbon Management and Sequestration Centre, School of Environment and Natural Resources, The Ohio State University, Columbu, Ohio, USA, 4 April - 3 July, 2010.

PATENTS

Maurya, V.P., Sejian, V., Naqvi, S.M.K. and Karim, S.A. 2010. Low cost, indigenous cradle for safe restraining of sheep. (2113/Del/2010).

S.M.K. Naqvi, Sajjan Singh and Davendra Kumar. 2010. Low cost, indigenous vaginal sponges for estrus control in buffaloes. (2114/Del/2010).

AWARDS / RECOGNITION RECEIVED

S.M.K. Naqvi, Principal Scientist and Head, Division of Physiology and Biochemistry was conferred with SAPI fellowship award by Society of Animal Physiologists of India on the occasion of the International Conference on Physiological Capacity Building in Livestock under Changing Climate Scenario, Izatnagar, 11-13 November, 2010, for his outstanding contribution in small ruminant physiology.

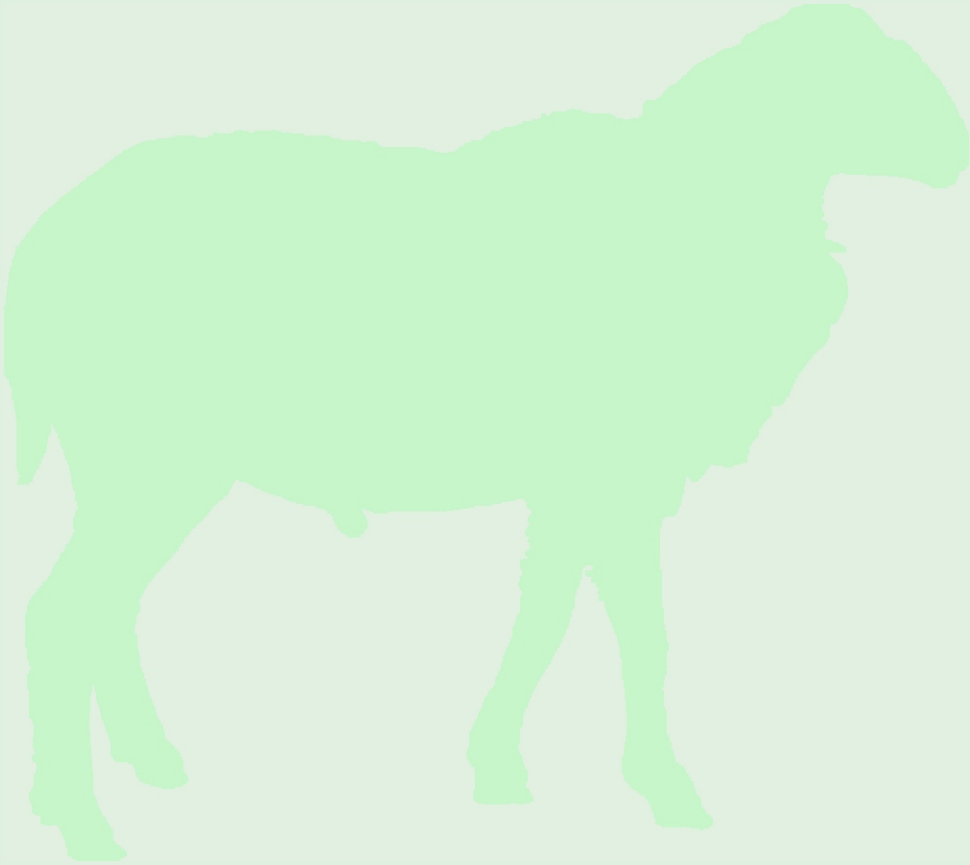
रजनी कुमारी, राजीव कुमार, अमर सिंह मीणा एवं एल.एल.एल. प्रिन्स 2010. पशुओं के लिए वृद्धि हार्मोन जीन बहुरूपता – एक चयन चिन्हक. हिन्दी दिवस वैज्ञानिक शोध पत्र प्रदर्शनी के दौरान प्रथम स्थान प्राप्त किया।



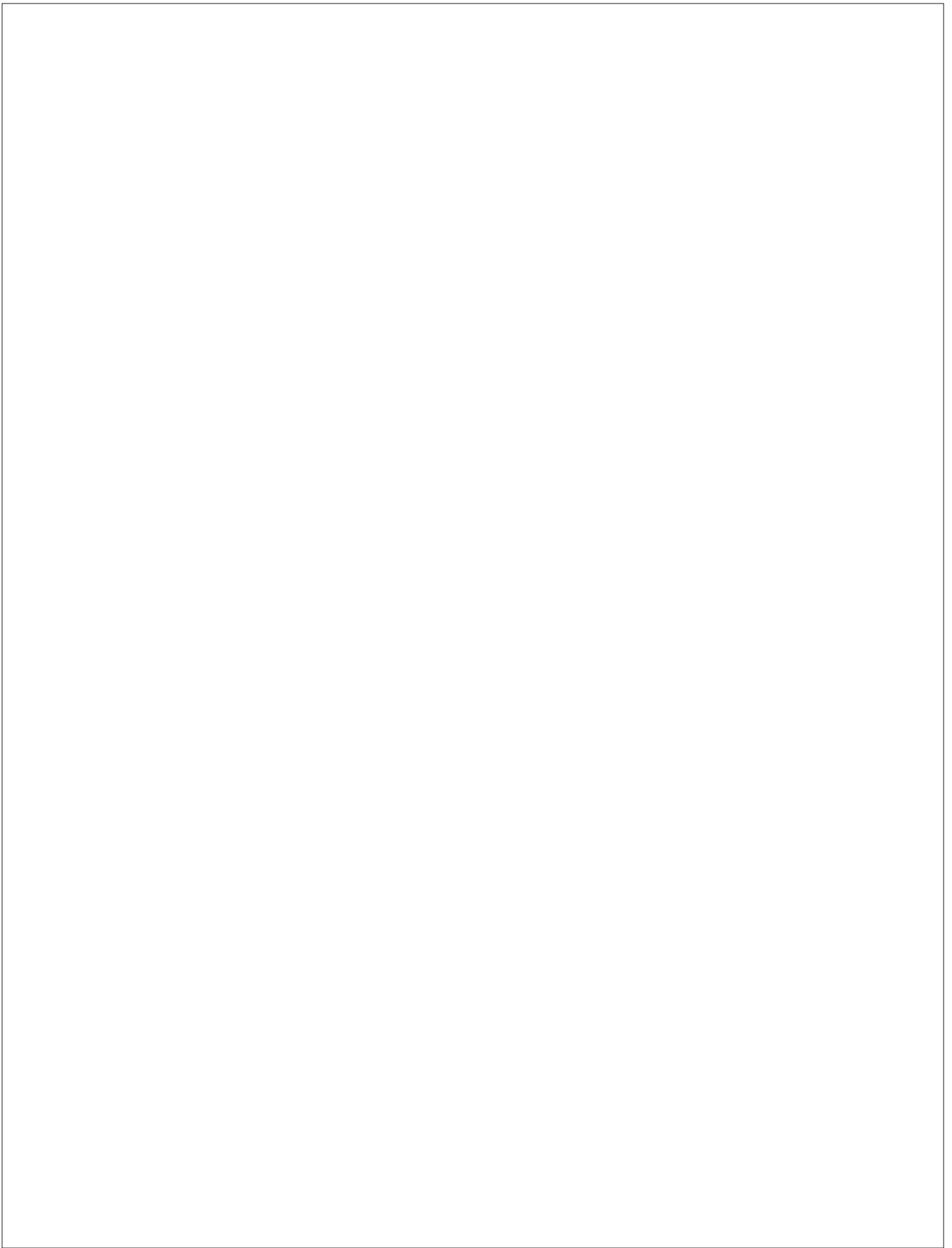
**Dr. S.M.K. Naqvi,
receiving SAPI fellowship award**

विजय प्रकाश मौर्य., वी. सेजियन एवं एस.एम.के. नकवी 2010. शारीरिक अवस्था माप का भ्रूण विकास व भेड़ की प्रसव व्यवहार पर प्रभाव. हिन्दी दिवस वैज्ञानिक शोध पत्र प्रदर्शनी के दौरान द्वितीय स्थान प्राप्त किया ।

वेद प्रकाश, राजीव कुमार, एस.एस. मिश्रा, एल.एल.एल. प्रिस, चंदन पासवान एवं ए.एल. अरोडा 2010. फैंक-बी जीन के समावेश से शारीरिक भार एवं मादा उत्पादन क्षमता पर पड़ने वाले प्रभाव का तुलनात्मक विश्लेषण. हिन्दी दिवस वैज्ञानिक शोध पत्र प्रदर्शनी के दौरान तृतीय स्थान प्राप्त किया ।



**Training Programmes, Meetings
Organised and Sports Events**





Training for Veterinary Officers



Training for PI / Co-PI / RA



Training for Farmers

TRAINING PROGRAMME AND HUMAN RESOURCE DEVELOPMENT

A total of 55 scientists and other staff were sponsored for attending and presenting papers in seminars / symposia / workshops, while 15 scientists/technical/ administrative officers were sponsored for short courses / training programmes/ winter-summer schools to upgrade their skills.

Following 22 training programmes were organized at CSWRI Avikanagar. In these programmes, 186 farmers, 23 officers and 32 students were trained.

Title	Period	Total Participants
AI and ETT in sheep	15.1.11 to 29.1.11	9 Veterinary Officers of J&K
	30.1.11 to 13.2.11	10 Para vets of J&K
Management of Epidemiological data and development of forecasting module for Gastrointestinal Nematodiasis	31.1.11 to 6.2.11	4 PI/Co-PI/RA from Pantnagar, Gangtok and Jabalpur (AINW programme on GIP)
Advances in Sheep Production	10.5.10 to 12.5.10	32 farmers from Ajmer
	29.9.10 to 1.10.10	11 farmers from Lapodia, Dudu, Jaipur
	20.1.21 to 22.1.11	32 farmers from Kota
	07.3.11 to 11.3.11	47 farmers from Udaipur
	22.3.11 to 26.3.11	20 farmers from Tonk
Advances in Sheep Production and Wool Technology	13.5.10 to 15.5.10	22 farmers from Kalahandi (Orissa)
Rabbit Production	29.11.10 to 04.12.10	22 farmers from Jhunjhunu

In addition 55 B.V.Sc. and A.H. students from Apollo College of Veterinary Medicine, Jaipur underwent internship training in 6 batches during the period from 5.8.10 to 15.1.11.

RESEARCH ADVISORY COMMITTEE MEETING

The meeting of the Research Advisory Committee (RAC) was held during 5-6 April, 2011 at CSWRI main campus under the chairmanship of Dr. R.M. Acharya, Former Deputy Director General (Animal Science), Indian Council of Agricultural Research (ICAR), New Delhi. The members present in the meeting were Dr. S.A. Karim, Director, CSWR, Avikanagar, Dr. S.C. Gupta,

ADG (AP&B), ICAR, New Delhi, Dr. B.C. Patnayak, Former Director, CSWRI, Avikanagar, Dr. Khub Singh, Former Director, NIANP, Bangalore, Dr. N. Kandasamy, Former Dean, Veterinary College and Research Institute, Namakkal, Dr. P.K. Sanyal, Professor and Head, College of Veterinary Sci. and AH, Durg, Chattisgarh, Mr. Kamal Kishore, Former Scientist, CSWRI, Avikanagar and Dr. A.K. Shinde, Member Secretary CSWRI, Avikanagar.



RAC Meeting at CSWRI, Avikanagar

Director, CSWRI welcomed the Chairman and Members of RAC and gave a brief review of the achievements of the Institute during the year 2010-11. He also informed the committee about the new initiative taken for functioning of wool processing plant and improving productivity of sheep flocks maintained under breeding and other related programs.

The Chairman, Dr. R.M. Acharya appraised the house about the importance of the RAC meetings and suggested for implementation of recommendation of RAC in right earnest. The emphasis should be on increasing the sheep productivity by improving reproductive efficiency (fecundity, prolificacy and number of lambs and total weight harvested in life time) and survivability. He initiated the discussion with priorities for sheep production in the country. Mutton has now replaced wool as the most important commodity followed by wool in sheep husbandry and similar trend has been noticed all over the world. Migration is a predominant system of sheep rearing in hot semi-arid, arid and cold hilly regions of the country. In both the region, migration has a positive impact on sheep production and socio-economic condition and livelihood security of poor farmers. The migration patterns with climate changes scenario shows that migration in western arid and semi-arid regions of India now widely fluctuates with prevailing more frequent drought conditions. The current status of sheep production on migration needs to be studied by CSWRI. It was suggested that the problem faced by shepherd *en route* migration may be identified. The survey of migratory flocks should be carried out in hot arid and semi-arid dry region and north temperate location including breeding, health, shelter, nutrition, feed supplements, marketing of wool and live animals followed by shepherd *en route* migration and problem faced by them. The current migration strategies and their effectiveness and short and long term change in the practices is required which should be continuously monitored. Market intelligence both for live animals/meat animals, wool and other commodities need be evaluated for trends in demand and supply of meat and wool for different utilities and market price in different parts of the country. In most of the sheep dominating states, population trends are almost static except sizable increase in Andhra Pradesh, the reason may be identified.

INSTITUTE RESEARCH COMMITTEE MEETING

The Annual Institute Research Committee Meeting was held during April 18-20, 2011 under the Chairmanship of Dr S.A. Karim, Director of the Institute. At the onset of meeting, he welcomed representative of Animal Science Division, ICAR, Heads of the Division, In-charges and Scientists of main campus and regional stations. He informed the house that this is last year of XI plan and all the targets fixed for the project should be completed and RPF III be submitted in next Annual IRC meeting. The equipment



IRC Meeting at CSWRI, Avikanagar

earmarked for XI plan be prioritized and purchased during the year. Each scientist should publish at least two papers in a year, new scientist should pursue for publication of research papers on priority. It was informed by the Chairman with constant pursuance scientists of Institute have brought external funded projects from DST, DBT, NAIP and CWDB, which has supported the Plan requirement of the Institute in critical financial crunch period. It was also informed that Council is in favour of closing of SRRC, Mannavanur, due to lack of focused program and inadequate scientist placement at the station therefore it was decided that new work and programme will be withheld. Chokla and Malpura rams are ready for disposal to CWDB sponsored schemes. The elite rams of Chokla and Malpura may be disseminated to stakeholder on priority. Kendrapada has been procured from native tract and acclimatizing to semi-arid climate of the location. Kendrapada will be used in three breed cross programme of prolific sheep. It has been emphasized that new shed under CWDB sponsored scheme will be constructed at sector no 12 to accommodate the animals.

Dr Vineet Bhasin, Principal Scientist (AG&B), Animal Science Division, ICAR, New Delhi attended the IRC meeting of the Institute as an observer of the Council. He informed the house that as per Council directive, individual scientist can be PI in one project and Co-PI in two research projects. Moreover, the externally funded projects should be taken as per the mandate of the Institute.

Dr A.K. Shinde, Principal Scientist and In-charge, PME acted as member secretary and recorded the proceeding of meetings.

INSTITUTE JOINT STAFF COUNCIL MEETING

The meeting of the Institute Joint Staff Council Meetings was held on 18 January 2010 at CSWRI, Avikanagar main campus under the chairmanship of Dr. S.A. Karim. The following members were present in the meeting: Dr. A.L. Arora, PS, Dr. S.M.K. Naqvi, PS, Dr. V.P. Maurya, Senior Scientist, Sh B.D. Phansal, SAO, Sh Nuruddin, Assistant, Sh Ram Avtar Sharma, Senior Stenographer, Sh S.R. Meena, TO, Sh Vijay Pal Singh, TO, Sh M.P. Jain, Sh Sultan / Bhure Khan, SSGr-II and Sh Sita Ram Mali, SSGr-I. Chairman welcomed all the members of joint council. All the agenda items of earlier meetings were discussed. Various issues pertaining to welfare of staff members and development of common facilities for smooth functioning of Institute were discussed.

INSTITUTE MANAGEMENT COMMITTEE MEETING

The meeting of Institute Management Committee meeting was held at CSWRI, Avikanagar on September 15, 2010 under the chairmanship of Dr. S.A. Karim. Members present in the meeting were: Dr. S.B.S. Yadav, Dr. B.K. Singh, Dr. S.M.K. Naqvi, Dr. A.L. Arora, Dr. A.K. Shinde and Sh K.L. Meena. A brief description of multi dimensional progress / achievement and scientific activities of the Institute was narrated before the IMC members by the Chairman. Important research achievement of the institute and new initiative taken by the Institute were narrated to IMC



IMC Meeting at CSWRI, Avikanagar

members. The IMC members appreciated the work being undertaken by the Institute in research, development and training.

INSTITUTE TECHNOLOGY MANAGEMENT COMMITTEE MEETING

A meeting of Institute Technology Management Committee (ITMC) was held on August 19, 2010 for discussing patent applications. Dr. J.S. Bhatia from Apollo College of Veterinary Medicine, Jaipur was present as Subject Matter Expert. Patent applications filed were 1. Low cost, indigenous cradle for safe restraining of sheep for pregnancy diagnosis by V.P. Maurya, V. Sejian, S.M.K. Naqvi and S.A. Karim and 2. Low cost, indigenous vaginal sponges for estrous control in buffalo by S.M.K. Naqvi, Sajjan Singh and Davendra Kumar. The other request for examination of patent applications filed were 1. Production of fermented probiotic feed, production protocol, fermentation conditions, drying, storage and uses thereof by M.K. Tripathi and S.A. Karim and 2. Fermentation vessel for conducting gas production studies (*in vitro*): Fabrication, protocol and uses by R.C. Jakhmola, S.K.S. Raghuvansi, Narendra Singh and M.K. Tripathi.

MID-TERM REVIEW MEETING OF NETWORK PROJECT ON SHEEP IMPROVEMENT AND MEGA SHEEP SEED PROJECT

Mid-Term Review Meeting of Network Project on Sheep Improvement (NWPSI) was held on 12-13 January, 2011 at CSWRI Guest House, Jaipur. Dr. A.L.Arora, Head (AG&B) welcomed the participants and gave a brief overview of the agenda for this review meeting and also highlighted the activities of the all ten units accomplished during the period 2010-11. Dr. S.A. Karim, Director, CSWRI highlighted the status of sheep husbandry in climate change scenario, permanent state of migration and change of breeding and marketing practices. Dr. S.C. Gupta, ADG (AP&B) emphasized the need to take the view of farmers in sheep production programmes. If the programme is not profitable to farmers then it will not be acceptable to them. He suggested the participants to adopt bottom up approach and should give more emphasis on farmers' need based programmes for flock improvement. Progress made by the ten units under NWPSI and four units under was reviewed and suitable suggestions and recommendations were provided.

The Mid-Term Review Meeting of Mega Sheep Seed Project was also held on these days and progress made in the four units and inputs for the formulation of XII plan was discussed and suitable suggestions and recommendations were made.



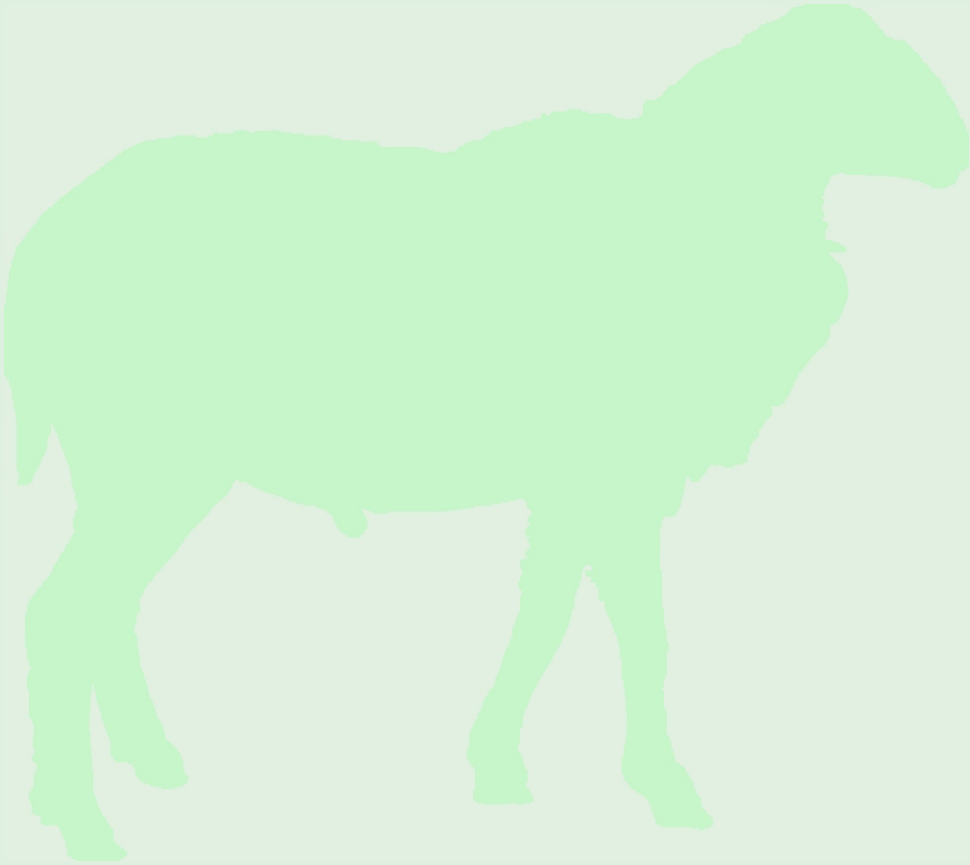
Review Meeting at Jaipur



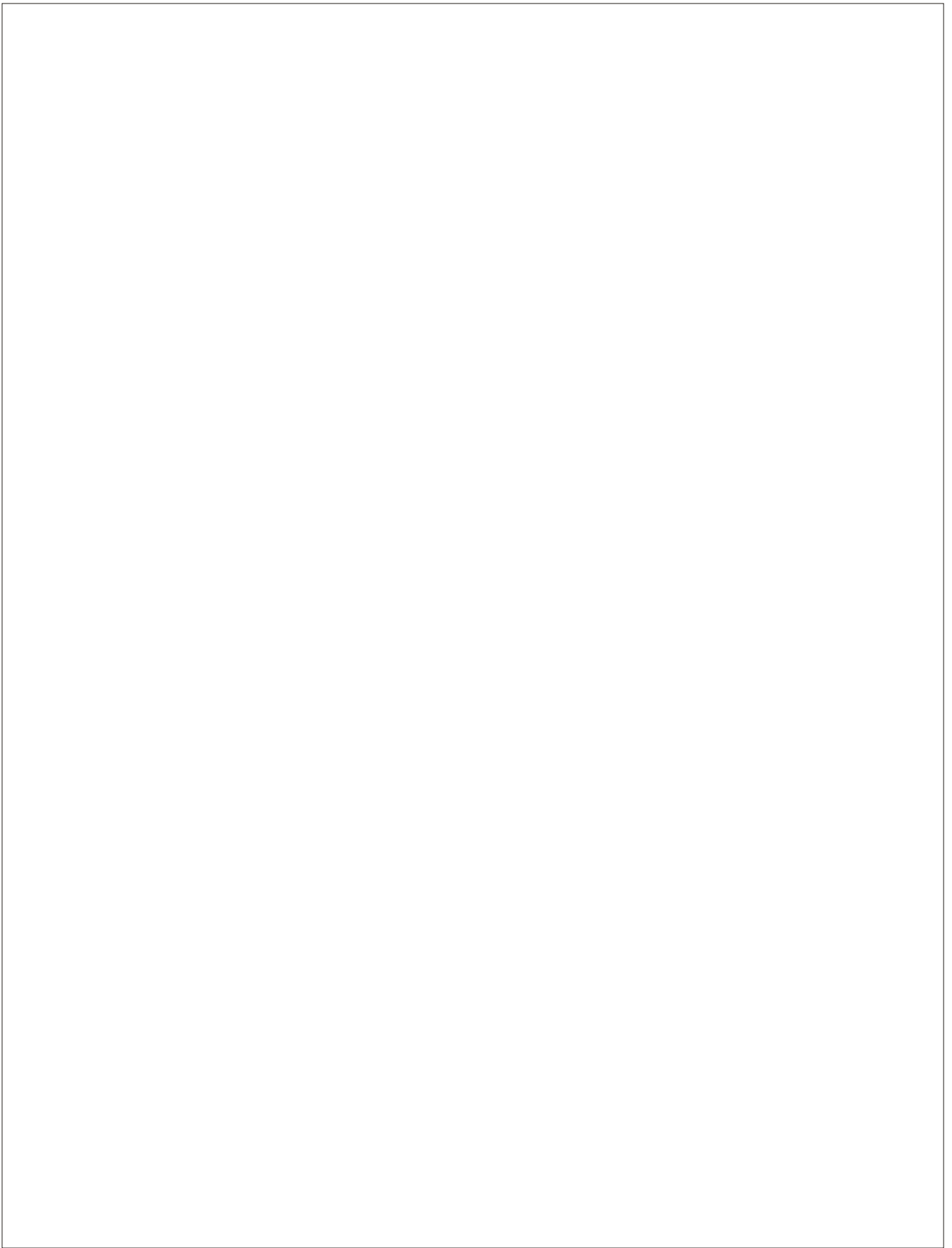
Participation in ICAR West Zone Tournament at IGFRJ Jhansi

SPORTS

Institute participated in ICAR West Zone Tournament held at IGFRJ Jhansi from 15-19 February, 2011. A total of 48 players were participated in Kabaddi, Volleyball (Shooting and Smashing), Basket ball, Table Tennis and Badminton as team events and all types of athletic events like races and throws etc. under individual events. Institute won first prize in Basket Ball and Kabaddi and Second prize (Runner up) in Badminton and Volleyball shooting events.



**Institute Research Projects and
Outside Projects**



MAIN CAMPUS

1. Dual type Avikalin sheep for meat and wool production
2. Genetic improvement of Malpura sheep for mutton production
3. Improving prolificacy in sheep for mutton production
4. Assessment of plane of nutrition and energy expenditure of grazing sheep in critical physiological stages and seasons to augment its productivity
5. Identification, evaluation, improvement and utilization of newer feed resources for sheep
6. Development of feeding system for improving quantity and quality of mutton and wool production
7. Ram semen preservation and utilization
8. Improving reproductive efficiency of sheep for augmenting production
9. Studies on multiple stresses on reproduction and production of sheep
10. Epidemiological investigation on economically important diseases of sheep, goats and rabbits
11. Development of carpet pile, technical textile and apparels utilizing indigenous wool blends
12. Integrated approaches for improvement in productivity of sheep and rabbit under field condition through transferable technologies
13. Marketing of small ruminants in Rajasthan
14. Genome analysis of sheep breeds by molecular methods
15. Genetic improvement of resistance to *Haemonchus contortus* in sheep
16. Establishment of agro-forestry system for maximization of forage production
17. Conservation and management of natural resources through agronomical manipulations
18. Development of agro-horti pastures system sustainable to semi arid conditions
19. Carcass evaluation of sheep, goats and rabbits
20. Technology development for utilization of animal products/ byproducts for further processing of value added items

ARID REGION CAMPUS, BIKANER

1. Improvement of Magra breed of sheep for meat and carpet wool production under farm condition
2. Feed and fodder resource development for small ruminants in arid region
3. Developing feeding system for improving sheep production under hot arid region

4. Assessment of reproductive efficiency of sheep in arid region
5. Integrated approach for improvement in productivity of sheep under field conditions through transfer of technologies

NORTH TEMPERATE REGIONAL STATION, GARSA

1. Improvement of synthetic sheep breeds for meat and wool production under sub temperate climate
2. Genetic improvement of Angora rabbits for wool production in sub-temperate climatic conditions
3. Epidemiological investigations on economically important diseases of sheep and rabbits in sub- temperate condition
4. Nutritional studies for formulating economical feeding programme for sheep and rabbit reared in north temperate region of India
5. Integrated approach for improving productivity of Broiler/ Angora rabbit and sheep under field conditions through transferable technologies

SOUTHERN REGIONAL RESEARCH CENTRE, MANNAVANUR

1. Demonstration unit of Bharat Merino sheep
2. Transfer of technology for improvement in sheep, rabbits and wool production
3. Performance evaluation of broiler and angora rabbits in field conditions

AICRP AND NETWORK PROJECTS

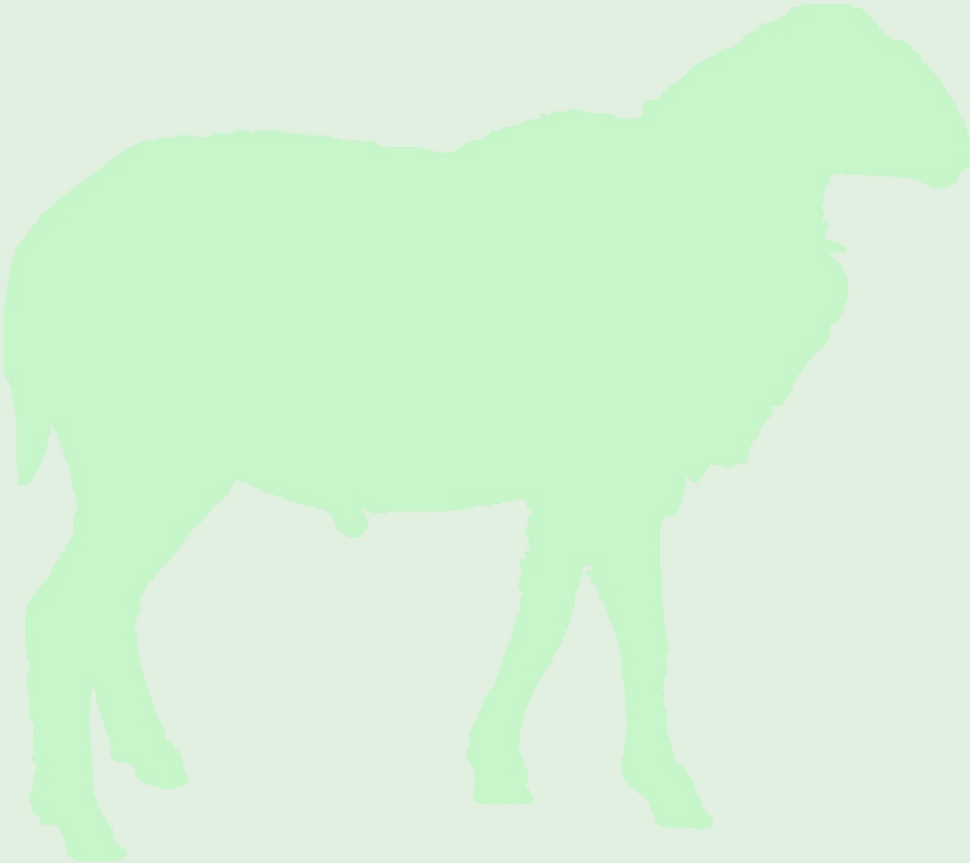
1. AICRP on improvement of feed resources and nutrient utilization in raising animal production
2. Network / outreach project on estimation of methane emission under different feeding systems and development of mitigation strategies
3. Network programme on veterinary type culture-rumen microbes
4. Network project on adaptation and facilitation of livestock to impending climatic changes through shelter management
5. All India Network programme on gastro-intestinal parasitism
6. All India Network project on blue tongue disease
7. Network programme veterinary type culture
8. Evaluation and improvement of Chokla sheep for carpet wool
9. Genetic improvement of Sirohi goats for meat and milk production
10. Assessing resilience of small ruminant production under changing climate condition in semiarid zone (NICRA)
11. Network project on amelioration of temperate / alpine pastures for livelihood support to pastoral communities

NATIONAL AGRICULTURAL INNOVATIVE PROJECTS

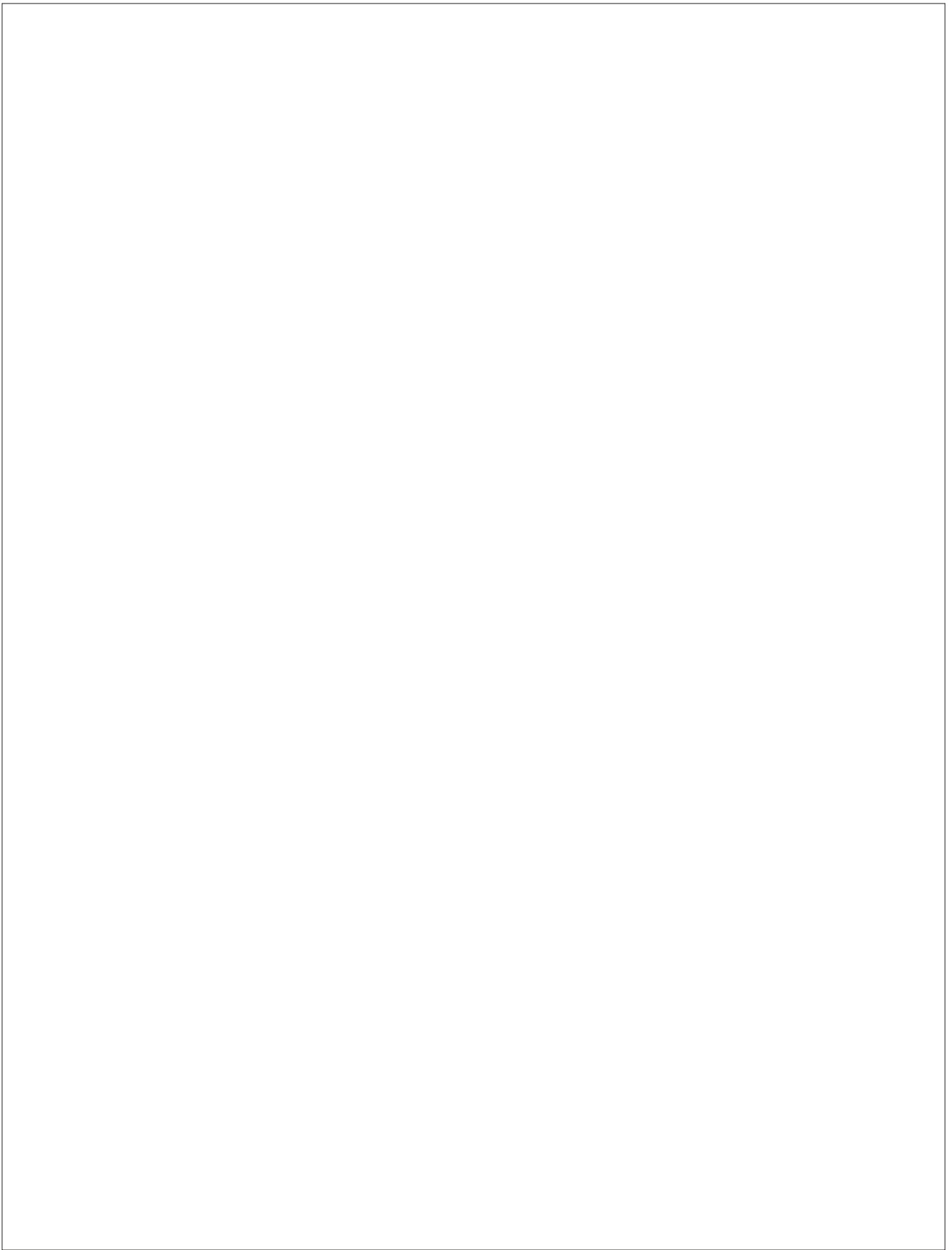
1. NAFBSRA Increasing nutrient availability from roughage based rations through enhancing rumen efficiency or reducing enteric methane production by use of secondary plant metabolites (ARC, Bikaner)
2. NAFBSRA Increasing nutrient availability from roughage based rations through enhancing rumen efficiency or reducing enteric methane production by use of secondary plant metabolites (CSWRI, Avikanagar)
3. NFBSFARA Deciphering the mechanism of aberrant maternal recognition of pregnancy (MRP) events in sheep and buffalo under heat and nutritional stress
4. NAIP on a value chain on enhanced productivity and profitability of Pashmina fibre
5. Intellectual property management and transfer/commercialization of agriculture technology scheme (up scaling of existing component i.e. intellectual property right (IPR) under ICAR headquarter scheme on management on information services)

IICP / CWDB / OTHER PROJECTS

1. Ram raising unit for Chokla rams under IWIDP
2. Ram raising unit for Malpura rams under IWIDP
3. Ram rearing farm for Magra Sheep (ARC, Bikaner)
4. Implementation of Angora development program (NTRS, Garsa)
5. R&D Project on Angora rabbit breeding, health, nutrition and reproduction aspects
6. Strengthening of Angora rabbit germ-plasm centre (NTRS, Garsa)
7. Implementation of sheep and wool improvement Scheme (SWIS) for 0.50 lakhs sheep at Kolar districts of Karnataka and Kodai hills of Tamil Nadu
8. Ram rearing farm for Bharat Merino rams (SRRC, Mannavanur)
9. R&D work on development and up-gradation utilization techniques for the wool proceed in South peninsular region of the country
10. Molecular identification and characterization of melatonin receptor in sheep in relation to reproductive seasonality (DBT)



Faculty and Staff



Dr S.A. Karim**Director****Animal Genetics and Breeding Division**

Dr A.L. Arora	Principal Scientist and Head
Dr L.L.L. Prince	Senior Scientist
Dr S.S. Misra	Senior Scientist
Dr G.R. Gowane	Scientist (On study leave)
Dr Ved Prakash	Scientist
Dr Ashish Chopra	Scientist
Dr Chandan Paswan	Scientist (On study leave)
Mr Nemi Chand Gupta	Technical Officer (T-5)
Mr A.K. Prasad	Technical Officer (T-5)

Animal Nutrition Division

Dr A. Sahoo	Principal Scientist and Head
Dr A.K. Shinde	Principal Scientist
Dr S.K. Sankhyan	Principal Scientist
Dr R. S. Bhatt	Principal Scientist
Dr O.H. Chaturvedi	Senior Scientist
Dr N. M. Soren	Scientist
Mr P.K. Jain	Technical Officer (T-5)
Mr Mohd Asgar	Technical Officer (T-5)

Physiology and Biochemistry Division

Dr S.M.K. Naqvi	Principal Scientist and Head
Dr V.P. Maurya	Senior Scientist
Dr Davendra Kumar	Scientist, SS
Dr V. Sejian	Scientist
Dr Rajni Kumar Paul	Scientist
Dr Vijay Kumar Saxena	Scientist
Er C.V.K.N. Rao	Instrument Engineer (T-9)
Mr N.L. Gautam	Technical Officer (T-5)
Mr K.C. Sharma	Technical Officer (T-5)
Mr Kailash Chand Sharma	Technical Officer (T-5)

Animal Health Division

Dr B.N. Tripathi	Principal Scientist and Head
Dr Dharendra Singh	Principal Scientist

Dr S.K. Dixit	Senior Scientist
Dr F.A. Khan	Senior Scientist
Dr C.P. Swarnkar	Scientist (SG)
Dr G.G. Sonawane	Scientist
Dr Vinodhkumar O.R.	Scientist (On study leave)
Dr Jyoti Kumar	Scientist
Dr Fateh Singh	Scientist
Dr S.L. Sisodia	Veterinary Officer (T-6)
Mr Gulab Chand	Technical Officer (T-6)

Textile Manufacturing and Textile Chemistry Division

Dr D.B. Shakyawar	Principal Scientist and Incharge
Mr Ajay Kumar	Scientist
Dr A.S.M. Raja	Scientist
Mr Nehru Lal Meena	Technical Officer (T-5)

Transfer of Technology and Social Science Division

Dr Rajiv Gulyani	Principal Scientist and Incharge
Dr D.C. Gupta	Principal Scientist
Dr L.R. Meena	Senior Scientist
Dr Debabrata Sethi	Scientist
Dr Raj Kumar	Scientist
Mr Babu Lal Sharma	Technical Officer (T-7/8)
Mr Ratan Lal Bairwa	Technical Officer (T-6)
Mr Allahnoor Khan	Technical Officer (T-5)
Mr R.K. Meena	Technical Officer (T-5)
Mr O.P. Pandey	Technical Officer (T-5)

Meat Science and Pelt Technology Section

Dr A. K. Shinde	Principal Scientist and Incharge
Dr Y.P. Gadekar	Scientist
Mr M. Nasimuddin	Technical Officer (T-5)

Grassland and Forage Agronomy Section

Dr S.C. Sharma	Senior Scientist and Incharge
Mr Roop Chand	Scientist
Mr R.P. Chaturvedi	Technical Officer (T-5)

Animal Biotechnology Section

Dr L.L.L. Prince	Senior Scientist and Incharge
Mr Satish Kumar	Scientist (On study leave)
Dr Rajeev Kumar	Scientist (On study leave)
Dr Rajni Kumari	Scientist
Mr Amar Singh Meena	Scientist
Dr Basanti Jyotsana	Scientist

Fibre Physics Section

Dr D.B. Shakyawar	Principal Scientist and Incharge
Dr A.K. Surya	Technical Officer (T-6)
Mr R.C. Mathur	Technical Officer (T-5)
Mr Aziz Ahmed	Technical Officer (T-5)

Prioritization, Monitoring and Evaluation

Dr A.K. Shinde	Principal Scientist and Incharge
Mr B.L. Bairwa	Technical Officer (T-5)

Livestock Farm Section

Dr A.K. Shinde	Principal Scientist and Incharge
Dr Om Prakash Koli	Technical Officer (T-7/8)
Dr Vinay Kumar	Veterinary Officer (T-7/8)
Mr Nanag Ram	Technical Officer (T-5)
Mr S.S.R. Naqvi	Technical Officer (T-5)
Mr Ram Rai Meena	Technical Officer (T-5)
Mr J.K. Sharma	Technical officer (T-5)
Mr Ram Kumar Koli	Technical Officer (T-5)
Mr S.L. Ahari	Technical Officer (T-5)

Farm Section

Mr Shyam Singh	Farm Supdt (T-7/8) and Incharge
Mr R.B. Sharma	Technical Officer (T-5)

Network Programme on Sheep Improvement Cell

Dr A.L. Arora	Principal Scientist
Dr L.L.L. Prince	Senior Scientist

Mega Seed Project Cell

Dr A.L. Arora	Principal Scientist
Dr S.S. Misra	Senior Scientist

ARIS Cell

Dr S.K. Sankhyan	Principal Scientist and Incharge
Mr M.L. Jangid	Technical Officer (T-6)
Mr M.R. Solanki	Technical Officer (T-5)

Administration

Mr K.L.Meena	Chief Administrative Officer
Mr Ravindra Singh	Assistant Administrative Officer
Mr Lalu Ram Koli	Assistant Administrative Officer
Mr R.A. Sahoo	Assistant Administrative Officer

Estate Section

Mr C.R. Gadhwal	Technical Officer (T-6)
Mr K.K. Prasad	Technical Officer (T-5)

Instrument and Electrical Unit

Mr G. S. Saxena	Technical Officer (T-6) and Incharge
Mr Anoop Verma	Technical Officer (T-5)
Mr D.K. Shivnani	Technical Officer (T-5)

Workshop and Vehicle Section

Mr G.S. Saxena	Technical Officer (T-6) and Incharge
Mr Vijay Pal Singh	Technical Officer (T-5)

Security Section

Mr Rukmesh Jakhar	Security Officer
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Human Dispensary

Dr A. Sahoo	Principal Scientist and Incharge
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Horticulture Section

Mr Sita Ram Meena	Technical Officer (T-6) and Incharge
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Library Section

Mr R.A. Verma	Technical Officer (T-6) and Incharge
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Human Resource Development Section

Dr Rajeev Gulyani	Principal Scientist and Incharge
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Hindi Cell

Mr M.L. Gupta	Asst Director (OL) and Incharge
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Right to Information Cell

Mr M.L. Gupta	Public Information Officer
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Institute Technology Management Unit

Dr F.A. Khan	Senior Scientist and Incharge
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Public Relation Cell

Dr S.C. Sharma	Senior Scientist and Incharge
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Dr D. Sethi	Scientist
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Mr M.L. Gupta	Assistant Director (OL)
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NAIP Cell

Dr B.N. Tripathi	Principal Scientist and In charge
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Dr C.P. Swarnkar	Scientist (SG)
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Arid Region Campus, Bikaner

Dr R.C. Jakhmola	Principal Scientist and Head
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Dr R.K. Sawal	Principal Scientist
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Dr K.C. Sharma	Senior Scientist
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Dr H.K. Narula	Senior Scientist
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Dr M.M. Harsh	Scientist
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Dr Mohd Ayub	Technical Officer (T-9)
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Dr P.R. Sharma	Technical Officer (T-9)
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Mr Vimal Malhotra	Technical Officer (T-6)
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Mr R.P. Sharma	Technical Officer (T-5)
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Mr T.C. Kachhawa	Technical Officer (T-5)
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Mr S.C. Gupta	Technical Officer (T-5)
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Mr S.R. Chaudhary	Technical Officer (T-5)
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Mr Shankar Lal	Technical Officer (T-5)
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Northern Temperate Research Station, Garsa

Dr J.B. Phogat	Head
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Dr S.R. Sharma	Senior Scientist
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Dr Sidhartha Saha	Scientist
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Mr Kishore Singh	Technical Officer (T-6)
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Mr A. Mahajan	Technical Officer (T-5)
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Mr Paine Ram	Technical Officer (T-5)
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Mr Manoj Kumar Sharma	Technical Officer (T-5)
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Mr T.N. Sharma Technical Officer (T-5)

Mr Durga Singh Technical Officer (T-5)

Southern Regional Research Centre, Mannavanur

Dr A.S. Rajendiran Senior Scientist and In charge

Mr S. Rajapandy Technical Officer (T-5)

Mr M. Lorduraj Technical Officer (T-5)

JOINED

1. Dr. Vijay Kumar Saxena, Scientist (Biochemistry) on 23.04.10
2. Shri Amar Singh Meena, Scientist (Animal Biotechnology) on 23.04.10
3. Dr. Raj Kumar, Scientist (Vety. Extn. Education) on 23.04.10
4. Dr. Siddratha Sarthy Misra, Senior Scientist (AG&B) on 05.07.10
5. Dr. Gadekar Yogesh Prabhakar, Scientist (LPT) on 05.07.10
6. Dr. S. Chandrasekar, Scientist (Animal Biotechnology) on 27.08.10
7. Dr. (Mrs.) Basanti Jyotsana, Scientist (Animal Bioechnology) on 17.09.10
8. Dr. Jagat Bir Phogat, Head, NTRS, Garsa on 01.02.11

RETIRED

1. Sh. Chittar S/o Sh. Chhoga, Skilled Support Staff on 30.04.10
2. Sh. Prahalad Sharma S/o Sh. Mool Chand Sharma, SSS on 30.04.11
3. Sh. Jagdish S/o Sh. Chatra, Skilled Support Staff on 31.05.10
4. Sh. P.C.Verma, T-6 (Technical Officer) on 30.06.10
5. Sh. S.R.Partani, T-5 (Technical Officer) on 31.07.10
6. Sh. R.K.Sharma, Assistant on 31.07.10
7. Sh. Prabhand Chand S/o Sh. Hazari Lal, Skilled Support Staff on 31.07.10
8. Sh. Panchu S/o Sh. Bhoora, Skilled Support Staff on 31.07.10
9. Dr. Aminu Deen, Principal Scientist (AR) compulsory retired on 13.07.10
10. Sh. S.R.Pareek, T-6 (Technical Officer) on 31.08.10
11. Sh. Datta Ram, T-4 (Farm Technician) on 31.08.10
12. Sh. Suraj Mal Nai, Skilled Support Staff on 31.08.10
13. Sh. Durga Lal S/o Nand Ram Meena, Skilled Support Staff on 30.09.10
14. Dr. J.S.Mann, Principal Scientist (Agronomy) on 31.01.11
15. Sh. N.P.Gupta, Principal Scientist (Textile Manufacture) on 31.01.11
16. Sh. R.P.Verma, Assistant Administrative Officer on 31.01.11
17. Dr. N.Swain, Principal Scientist (LPM) on 28.02.11
18. Sh. Mool Chand Sharma, Skilled Support Staff on 28.02.11
19. Sh. K.S. Maurya, T-5 (Technical Officer) on 31.03.11
20. Sh. Kalu S/o Sh. Nanda, Skilled Support Staff on 31.03.11

TRANSFERRED

1. Dr. M.K.Srivastava, T-9 (AFM) on 25.05.10
2. Dr. S.Suresh Kumar, Scientist on 19.08.10
3. Sh. B.D.Phansal, Senior Administrative Officer on 09.09.10
4. Dr. S.Chandrasekar, Scientist (Animal Biotechnology) on 27.09.10
5. Dr. Sajjan Singh, Senior Scientist (AR) on 21.10.10
6. Dr. L. Ammayappan, Scientist (Textile Chemistry) on 04.01.11
7. Dr. K.Narayanan, Scientist (AR&G) on 30.03.11

OBITUARY

1. Sh. Bhagirath T-5 (Technical Officer) expired on 10.06.10
2. Sh. Ram Narayan Meena, T-2 (Tractor Driver) expired on 22.09.10
3. Dr. Anil Joshi, Principal Scientist (Biochemistry) expired on 04.03.11

LIST OF ABBREVIATIONS

ADF	Acid Detergent Fibre	FEC	Faecal Egg Count
ADG	Average Daily Gain	FROGIN	Forecasting for Rajasthan on Ovine Gastrointestinal Nematodosis
A:G	Albumin: Globulin	FSH	Follicle Stimulating Hormone
AI	Artificial Insemination	GA	German Angora
AICRP	All India Coordinated Research Project	GFY	Greasy Fleece Yield / Green Fodder Yield
ALP	Alkaline Phosphatase	GG	Gray Giant
ARC	Arid Region Campus	GH	Growth Hormone
B:C	Benefit : Cost	GI	Gastrointestinal
BA	British Angora	GIN	Gastrointestinal Nematode
BB	Black Brown	GM	Garole X Malpura
BM	Bharat Merino	GMM	GM X Malpura
BOD	Biologically Oxygen Demand	GP	Gas Production
BTD	Blue Tongue Disease	GS	Gaddi Synthetic
Ca	Calcium	h ²	Heritability
CF	Complete Feed	Hb	Haemoglobin
CGR	Crop Growth Rate	HCW	Hot Carcass Weight
CO	Coconut	HEYM	Herrold's Egg Yolk Media
CP	Crude Protein	ICAR	Indian Council of Agricultural Research
CRI	Central Research Institute	ICV	Ilieocacal Valve
CSWRI	Central Sheep and Wool Research Institute	IMC	Institute Management Committee
Cu	Copper	IPR	Intellectual Property Right
CWDB	Central Wool Development Board	ITMC	Institute Technology Management Committee
CYE	Cluster bean Yield Equivalent	IU	International Unit
DAS	Days After Sowing	IWIDP	Integrated Wool Improvement and Development Programme
DBT	Department of Biotechnology	JD	Johne's Disease
DCPI	Digestible Crude Protein Intake	LAN	Local Area Network
DM	Dry Matter	LER	Land Equivalent Ratio
DMA	Dry Matter Accumulation	LH	Leuteolizing Hormone
DMI	Dry Matter Intake	LO	Linseed
DNA	Deoxyribo Nucleic Acid	LSB	Litter Size at Birth
DOMI	Digestible Organic Matter Intake	LSW	Litter Size at Weaning
DOMR	Digestible Organic Matter in Rumen	LWB	Litter Weight at Birth
DST	Department of Science and Technology	LWW	Litter Weight at Weaning
DTH	Delayed Type Hypersensitivity	MAP	<i>Mycobacterium avium</i> subsp <i>paratuberculosis</i>
DWK	Doe Weight at Kindling	MBP	Microbial Protein
DWS	Doe Weight at Service	MCH	Mean Corpuscular Haemoglobin
EADR	Equivalent Average Death Rate	MCHC	Mean Corpuscular Haemoglobin Concentration
ELISA	Enzyme Linked Immunosorbent Assay	MCV	Mean Corpuscular Volume
ELW	Empty Live Weight		
EO	Eucalyptus		
EYMG	Egg Yolk Mcillvaine Glucose		

ME	Metabolizable Energy	RGR	Relative Growth Rate
MEI	Metabolizable Energy Intake	RH	Rabbit Hair
Mg	Magnesium	RPF	Rumen Protected Fat
MGM	Malpura X GM	RP-HPLC	Reverse Phase High Pressure Liquid Chromatography
MLN	Mediastinal Lymph Node	R-line	Resistant - line
Mn	Manganese	SC	Soviet Chinchilla
MNS	Microbial Nitrogen Synthesis	SCFA	Short Chain Fatty Acid
MO	Mustard	SEM	Scanning Electron Microscopy
MWMP	Modified Worm Management Programme	SFEY	Sorghum Fodder Equivalent Yield
NAFBSRA	National Fund for Basic and Strategic Research in Agriculture	SGOT	Serum Glutamic Oxaloacetic Transaminase
NAIP	National Agricultural Innovative Project	SGPT	Serum Glutamic Pyruvic Transaminase
NDF	Neutral Detergent Fibre	S-line	Susceptible - line
NEFA	Non Esterified Fatty Acid	SR	Small Ruminants
NICRA	National Initiative on Climate Resilient Agriculture	SRRC	Southern Regional Research Centre
NPK	Nitrogen Phosphorus and Potash	$t_{1/2}$	Half Life
NTRS	North Temperate Regional Station	T_3	Tri-iodothyronine
NWPSI	Network Project on Sheep Improvement	T_4	Tetra-iodothyronine
NZW	New Zealand White	TCA-ppt-N	Tri Chloro Acetic Acid Precipitated Nitrogen
OM	Organic Matter	TDDM	Total Digestible Dry Matter
OPA	Ovine Pulmonary Adenomatosis	TDMD	Total Dry Matter Digestibility
P	Phosphorus	TEC	Total Erythrocytic Counts
PCR	Polymerase Chain Reaction	TFE	TriFluoro Ethanol
PCV	Packed Cell Volume	TOMD	Total Organic Matter Digestibility
PM	Post Mortem	TOT	Transfer of Technology
PPM	Parts Per Million	TRF	Total Rain Fall
QRT	Quinquinal Review Team	TST	Targeted Selective Treatment
R: C	Roughage: Concentrate	TT	Targeted Treatment
RA	Russian Angora	TVFA	Total Volatile Fatty Acid
RAC	Research Advisory Committee	WG	White Giant
RBPT	Rose Bengal Plate Agglutination Test	Zn	Zinc
RE	Restriction Enzyme	ZSI	Zoological Survey of India
RFLP	Restricted Fragment Length Polymorphism		