



# वार्षिक प्रतिवेदन ANNUAL REPORT 2018-19



भाकृअनुप-राष्ट्रीय पशु आनुवंशिक संसाधन ब्यूरो

करनाल-132001 (हरियाणा) भारत

ICAR-National Bureau of Animal Genetic Resources

Karnal-132001 (Haryana) INDIA

*With Best Compliments*

*Director, ICAR-NBAGR*



# N B A G R



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2018 - 19



रा.प.आ.सं.ब्यूरो

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करनाल - 132001 (हरियाणा) भारत

**ICAR-National Bureau of Animal Genetic Resources**

Karnal - 132001 (Haryana) India



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## *From Director's Desk ...*

Dr. MS Swaminathan once said “If conservation of natural resources goes wrong, nothing else will go right”. From this perspective, it is my proud privilege to be associated with an institute that is striving to characterize and conserve the mega biodiversity of animal genetic resources (AnGR) of India. Since its inception in 1984, the institute has had a glorious history of identifying the genetic potential of our livestock diversity and generating awareness about the need to conserve these resources for posterity. Therefore, with immense pride, I put forth to our readers the “Annual Report (2018-19)” of ICAR-NBAGR which chronicles the achievements of the Bureau in the area of identification, evaluation, characterization, conservation and utilization of livestock and poultry biodiversity of the country.

The past one year witnessed registration of fifteen new breeds of indigenous livestock and poultry (two of cattle, three buffalo, six goats, and one each of sheep, pig, donkey and chicken) taking the total tally of registered livestock breeds to 184. Work was initiated on phenotypic characterization of a number of cattle populations from different parts of India namely, Mangadh dahodi, Jhari, Kuttampuzha and Vilwadiri cattle. Survey work was also carried out to explore and characterize indigenous cattle populations of Madhya Pradesh, Jharkhand, Haryana, Punjab and North-West Rajasthan. Among small ruminants, Macherla Brown sheep and native goats of Telangana State were explored during this period. Genotypic characterization of Mangadh dahodi cattle and Telanga goats was also completed using microsatellite markers.

Conservation of AnGR is an important mandate of the institute. In this regard, the Gene Bank of the Bureau was strengthened with semen doses from cattle, buffalo



and goat breeds. Additionally, somatic cell lines of Kharai Camel, Nagaland Mithun, Ladakhi Yak, Ladakhi and Kutchi Donkey were generated and cryopreserved. Significant progress was seen in attempts to conserve Ankaleswar chicken (under Network project) and Kadaknath chicken and Assam local pig & goat (under TSP) in their habitat. Under an IRC approved project on evaluation of livestock policies and programmes for management of AnGR in Haryana and Punjab states, major issues confronting our farmers were identified to be non-availability of genetically superior germplasm and inadequate marketing facilities for livestock and their products. I am sure the recommendations that emerge from this work would help to provide meaningful solutions to these problems.

The biotechnological research in the last one year revolved around generation of comprehensive milk transcriptome from three lactation stages of Murrah buffalo, skeletal muscle transcriptome profiling of Bandur (Mandya) sheep, identification and cataloguing of genome wide SNPs in Indian cattle breeds from different agro-climatic regions using genotyping-by-

sequencing (GBS) and exploring the genetic basis of local adaptation of Indian native cattle breeds utilizing cattle HD chip. NASF project on exploring the potential effects of A1A2 milk on health yielded some significant findings and recorded crucial histological changes in some selected tissues of mice fed with A1A1, A2A2 and A1A2 based milk diets. An SNP database on "SNPs in Indigenous Animal Genetic Resources" was a significant achievement of the period under report. The scientific endeavors of our faculty are being pursued in the form of 22 research projects that are currently running in the institute.

Services provided to different government agencies for screening of chromosomal defects and genetic diseases deserve a special appreciation. I am very pleased with the active participation of the scientists in various extension modules of the bureau such as Mera Gaon Mera Gaurav program and Mahila Kisan Diwas. Such platforms are ideal opportunities to showcase the activities of the institute and generate awareness about the importance of Indian agriculture sector in general and AnGR in particular. Celebrations such as Foundation Day, Biodiversity day, Republic Day, Independence Day, Vigilance Week, International yoga day, Rashtriya Swachhta Abhiyan and Hindi Pakhwada kept the staff of the Bureau enthused with zeal and vigour.

I seize this opportunity to compliment my colleagues for their recognition through various research publications and awards. I also extend my best wishes to those who were promoted in the last one year. Encouragement and appreciation from the distinguished personalities and visitors who come to NBAGR is enough for us to maintain the momentum and also ushers in more energy to achieve our efforts to justify the mandate of the Bureau.

I convey my heartfelt thanks to Dr T. Mohapatra, Secretary (DARE) & DG, ICAR, Dr J.K. Jena, DDGs (AS), Dr R S Gandhi, ADG (AP&B) and Dr Vineet Bhasin, PS for their constant support and guidance. I appreciate all the scientists, technical, administrative officers and other staff members as well as research scholars of the bureau for their contribution in the progress of the institute. At the same time, I congratulate the editorial team for compiling the bureau's achievements in the shape of this document and publishing it in time.

I am sure our readers enjoy the current edition of Annual Report of ICAR-NBAGR which provides a glimpse of achievements made during 2018-19. Suggestions for improvement are always welcome on Director's desk.

*Jai Hind!*



(RK Vih)

## निदेशक की कलम से ...

डॉ. एमएस स्वामीनाथन ने एक बार कहा था कि "यदि प्राकृतिक संसाधनों का संरक्षण गलत होगा, तो कुछ भी सही नहीं होगा"। इस दृष्टिकोण से, यह एक ऐसे संस्थान के साथ जुड़ने का मेरा सौभाग्य है जो भारत के पशु आनुवंशिक संसाधनों की विशाल जैव विविधता की विशेषता और संरक्षण करने के लिए प्रयासरत है। 1984 में अपनी स्थापना के बाद से, संस्थान का हमारी पशुधन विविधता की आनुवंशिक क्षमता की पहचान करने और भविष्य के लिए इन संसाधनों के संरक्षण की आवश्यकता के बारे में जागरूकता पैदा करने का एक गौरवपूर्ण इतिहास रहा है। इसलिए, मैं गर्व के साथ आईसीएआर-एनबीएजीआर की "वार्षिक रिपोर्ट (2018-19)" को अपने पाठकों के सामने रख रहा हूँ, जो कि पशुधन और मुर्गीपालन की पहचान, मूल्यांकन, लक्षणीकरण, संरक्षण और उपयोग के क्षेत्र में ब्यूरो की उपलब्धियों की समीक्षा करता है।

इस वर्ष के दौरान नस्ल पंजीकरण समिति के अनुमोदन से पालतू पशुओं एवं कुक्कुटों की 15 नई नस्लें, जिनमें : गोवंश की दो, भैंस की तीन, बकरी की छः, एवं भेंड़, शूकर, गधे एवं मुर्गी की एक-एक नस्ल पंजीकृत की गयी हैं। इन नस्लों को लेकर अब कुल पंजीकृत स्वदेशी नस्लों की संख्या 184 तक पहुंच गई है। भारत के विभिन्न हिस्सों से मानगढ़ दाहोदी, झारी, कुट्टमपुझा और विलवादिरी गोवंशियों की आबादी के प्रारूपिक लक्षण वर्णन पर परियोजना शुरू की गयी। मध्य प्रदेश, झारखंड, हरियाणा, पंजाब और उत्तर-पश्चिम राजस्थान की स्वदेशी गोवंश की आबादी का पता लगाने और उन्हें चिह्नित करने के लिए सर्वेक्षण कार्य भी किया गया। छोटे जुगाली करने वाले पशुओं में, माचेरला ब्राउन भेड़ और तेलंगाना राज्य की देशी बकरियों को इस अवधि के दौरान सर्वेक्षण किया गया। मानगढ़ दाहोदी गोवंशी और

तेलंगाना बकरियों के जीनोटाइपिक लक्षण वर्णन को भी माइक्रोसेटेलाइट मार्करों का उपयोग करके पूरा किया गया।

पशु आनुवंशिक संसाधनों का संरक्षण संस्थान का एक महत्वपूर्ण अधिदेश है। इस संबंध में ब्यूरो के जीन बैंक में गोवंश, भैंस और बकरी की विभिन्न नस्लों के वीर्य प्रशीतन संरक्षण हेतु रखा गया। इसके अतिरिक्त, खड़ाई ऊँट, नागालैंड मिथुन, लद्दाखी याक, लद्दाखी और कच्छी गधा की दैहिक सेल लाइनों को प्रशीतन किया गया। अंकलेश्वर मुर्गी (नेटवर्क प्रोजेक्ट के तहत) और कड़कनाथ मुर्गी और असम के स्थानीय सुअर और बकरी (टीएसपी के तहत) को उनके गृहक्षेत्र में संरक्षित करने के प्रयासों में महत्वपूर्ण प्रगति देखी गई। हरियाणा और पंजाब में पशु आनुवंशिक संसाधन के प्रबंधन के लिए पशुधन नीतियों और कार्यक्रमों के मूल्यांकन के लिए परियोजना जारी है। पशुपालन की गतिविधियों पर प्रभावली आधारित जानकारी किसानों / पशुधन रखने वालों और अन्य हितधारकों से एकत्र की गई। मुझे यकीन है कि इस परियोजना से निकलने वाली सिफारिशें इन समस्याओं का सार्थक समाधान प्रदान करने में मदद करेंगी।

पिछले वर्ष जैव प्रौद्योगिकी अनुसंधान: मुराह भैंस के तीन पीढ़ियों के व्यापक दूध ट्रांस्क्रिप्टोम के अध्ययन, मांड्या भेंड़ के मांस की गुणवत्ता, कृषि जलवायु में भारतीय गोवंशी नस्लों में जीनोम सम्बन्धी एसएनपी की पहचान और सूचीकरण से संबंधित रहा है। जीनोटाइपिंग-बाय-सीक्वेंसिंग (जीबीएस) का उपयोग करने वाले



क्षेत्र और गोवंश एचडी चिप जीनोटाइपिंग का उपयोग करने वाले भारतीय देशी गोवंश नस्लों के स्थानीय अनुकूलन के आनुवंशिक आधार की खोज भी की गयी। स्वास्थ्य पर ए1ए2 दूध के संभावित प्रभावों की खोज पर एनएसएफ परियोजना ने कुछ महत्वपूर्ण निष्कर्ष मिले हैं और ए1ए1, ए2ए2 और ए1ए2 आधारित दूध आहारों के साथ खिलाए गए चूहों के कुछ चयनित ऊतकों में महत्वपूर्ण ऊतकीय परिवर्तन दर्ज किए गए। "स्वदेशी पशु आनुवंशिक संसाधनों में एसएनपी" पर एक एसएनपी डेटाबेस रिपोर्ट इस अवधि की एक महत्वपूर्ण उपलब्धि है। हमारे संस्थान के वैज्ञानिक प्रयासों को 22 अनुसंधान परियोजनाओं के माध्यम से आगे बढ़ाया जा रहा है।

गुणसूत्र दोष और आनुवांशिक बीमारियों की जांच के लिए विभिन्न सरकारी एजेंसियों को प्रदान की जाने वाली सेवा विशेष प्रशंसा की पात्र हैं। मैं ब्यूरो के वैज्ञानिकों की विभिन्न आदर्श कार्यक्रमों जैसे कि मेरा गाँव मेरा गौरव कार्यक्रम और महिला किसान दिवस में सक्रिय भागीदारी रहती है। इस तरह के मंच संस्थान की गतिविधियों को प्रदर्शित करने और विशेष रूप से भारतीय कृषि क्षेत्र के महत्व और विशेष रूप से पशु आनुवंशिक संसाधनों के बारे में जागरूकता पैदा करने के लिए आदर्श है। संस्थान का स्थापना दिवस, अंतर्राष्ट्रीय जैव विविधता दिवस, गणतंत्र दिवस, स्वतंत्रता दिवस, सतर्कता सप्ताह, अंतर्राष्ट्रीय योग दिवस, राष्ट्रीय अभियान अभियान और हिंदी पखवाड़ा जैसे समारोहों में ब्यूरो के अधिकारी एवं कर्मचारी उत्साह एवं जोश से भाग लेते हैं।

मैं अपने सहयोगियों को विभिन्न शोध प्रकाशनों और पुरस्कारों के माध्यम से उनकी उपलब्धियों एवं विशिष्ट

पहचान के लिए बधाई देता हूँ। मैं उन लोगों को भी शुभकामनाएं देता हूँ जिन्हें पिछले वर्ष पदोन्नत किया गया। एनबीएजीआर में आने वाले प्रतिष्ठित आगंतुकों से प्राप्त प्रोत्साहन और प्रशंसा हमारे लिए गौरवपूर्ण है और यह ब्यूरो के अधिदेश को प्राप्त करने के लिए हमें और अधिक ऊर्जा एवं प्रोत्साहन मिलता है।

मैं, डॉ. टी. महापात्र, सचिव (डेयर) एवं महानिदेशक, भा.कृ.अनु.प., डॉ. जे. के. जेना, उप-महानिदेशक (पशु विज्ञान), डॉ. आर एस गांधी, सहायक-महानिदेशक (ए पी एंड बी) एवं डॉ. विनीत भसीन, प्रधान वैज्ञानिक कृषि भवन, नई दिल्ली को उनके निरंतर समर्थन तथा मार्गदर्शन के लिए अपना हार्दिक धन्यवाद ज्ञापित करता हूँ। मैं, संस्थान के सभी वैज्ञानिकों, तकनीकी, प्रशासनिक अधिकारियों और अन्य स्टाफ सदस्यों के साथ-साथ ब्यूरो में कार्यरत शोधकर्ताओं का संस्थान की प्रगति में उनके योगदान के लिए उनकी सराहना करता हूँ। साथ ही साथ, संपादक मण्डल को ब्यूरो की उपलब्धियों को इस वार्षिक प्रतिवेदन के आकार में संकलित करने और इसे समय पर प्रकाशित करने के लिए बधाई देता हूँ।

मुझे यकीन है कि हमारे पाठक आईसीएआर-एनबीएजीआर की वार्षिक प्रतिवेदन के इस वर्तमान संस्करण जो संस्थान की वर्ष 2018-19 के दौरान मिली उपलब्धियों की झलक प्रदान करता है, का आनंद लेंगे। सुधार के लिए सुझाव का संस्थान हमेशा स्वागत करता है।

जय हिन्द !

  
(रमेश कुमार विज)



- ICAR-National Bureau of Animal Genetic Resources, Karnal is the nodal institute working for the benefit and upliftment of indigenous livestock and poultry breeds in the country. It has a broader mandate of 1) Identification, evaluation, characterization, conservation and utilization of livestock and poultry genetic resources of the country; and 2) coordination and capacity building in animal genetic resources management and policy issues. Three Divisions - 1) Animal Genetic Resources 2) Animal Genetics, and 3) Animal Biotechnology have been created in 2013 to achieve the institute's mandate. In addition, two units namely- Livestock Information & Management and Network Project have also been functioning to support the Institute's activities.
- Total expenditure under different heads (Capital, Revenue and Pension & retirement benefits) was Rs. 1701.48 Lakhs against the total receipt of Rs. 1717.05 Lakhs during financial year of 2018-19. Under Network project, total expenditure was Rs. 107.15 Lakhs, against Receipt of Rs. 107.33 Lakhs. Rs. 54.06 Lakhs was received as revenue during 2018-19.
- Fifteen new breeds of indigenous livestock and poultry – two of cattle, three buffalo, six goats, and one each of sheep, pig, donkey and chicken – were registered by Breed registration committee. Five breeds were from NE region of the country. After including these newly registered breeds, total number of indigenous breeds now in the country is 184, which include 43 for cattle, 16 buffalo, 34 goat, 43 sheep, 7 horses & ponies, 9 camel, 8 pig, 2 donkey, 1 yak, 19 chicken, 1 duck and 1 for geese.
- Survey for characterization of Mangadh dahodi cattle was undertaken in Gujarat. The animals are primarily reared for agricultural operations and to some extent for milk production. These cattle are reared in low input production system of management. The animals of Mangadh dahodi cattle are small sized. Coat colour is mostly white, while few are whitish grey or grey in colour. Daily milk yield ranges from 1.5 to 4.5 kg.
- Jhari cattle population of Telangana was characterized during the period under report. Jhari name was originated from the name of a village from Asifabad district. Herd size ranged from 4 to 10 but some farmers had big herds up to 300 cattle. Jhari cattle are grey and white in colour. Grey is predominate in males and white in females. Body is small to medium, compact and cylindrical in shape. Face is the major character for differentiating with other cattle population i.e. longer and convex type. The other differentiating characters are horns, which are longer and thin at the base as compare to Ongole or its grades. The daily milk yield ranged from 1.0 to 3.0 kg and lactation length varies from 90 to 150 days. Bullocks were also used for transportation and load carrying. It was observed that Jhari cattle are physically distinct from the other cattle populations of the region like Kamma, Vandharvi and Thurupu.
- Phenotypic characterization of Kuttampuzha and Vilwadiri cattle populations of Kerala was started. Both Kuttampuzha and Vilwadiri cows are small in size. Kutampuzha cattle are also called as Periyar cattle because of its distribution in the villages on both sides of Periyar River. The coat colour of

Kuttampuzha cattle varies from grey -18.35%, balck-21.25% brownish black-40.15% and mixuture-19.25% whereas for Vilwadi cattle dark tan – 30.5%, black – 26.5%, grey – 11.0%, brownish tan – 5.65% and mixed – 26.35 % with straight forehead and curved horns. These cattle populations produced about 1.2 to 2.5 litres of milk per day under the extensive system of rearing and are aggressive in behaviour.

- A pilot survey was carried out to explore and characterize the homogenous population(s) of native cattle populations of Madhya Pradesh. Gwalior and Chambal Division (Bhind, Morena, Sheopur, Gwalior and Datia districts) of Madhya Pradesh have the white and grey type cattle, as mixed populations distributed across the region. These cattle mostly reared for milk purpose and produce 2-7 Kg milk/ day. A unique cattle population was explored in Sheopur district that was different from the existing registered cattle breeds. Locally known as “Bawri” (also known as Garri) is being raised by Gurjars for milk under extensive system in ravine areas.
- Survey was conducted to characterise Indigenous cattle populations of Haryana, Punjab and North-West Rajasthan. The farmers who migrated from Lunkarnasar area of Rajasthan maintained indigenous cattle including Rathi x Sahiwal, Rathi, Sahiwal and also crosses of exotic breeds viz. HF and Jersey in very low proportion. Such farmers maintained large cattle herds under extensive to semi-intensive system of management. Cattle’s keeping is their primary occupation and source of livelihood. Some of the farmers also reported reverting back to maintenance of indigenous cattle.

For the resource poor farmers the indigenous cattle (Rathi and Sahiwal) are certainly a better choice.

- A project was started on phenotypic characterization and evaluation of Macherla Brown sheep population of Andhra Pradesh. Macherla Brown is mutton type local sheep inhabiting in the villages adjacent to Krishna River in Guntur, Krishna, Prakasham districts of AP and Nalgonda of Telangana. It is medium to large in size with coat color mainly white with black or brown patches on different parts of the body. The convex head, leafy ears and long hairs on thighs are other distinct predominant traits. The tail is very small and thin. The average adult body weight of males and females animals were  $57.27 \pm 1.42$  and  $45.03 \pm 0.56$  kg, respectively which varies from 41 to 69 kg in males and 32 to 60 kg in females.
- Preliminary survey was conducted to characterise local cattle and goat populations of Mahakaushal region of Madhya Pradesh and Jharkhand. In palamu (Jharkhand) region one cattle and one goat population was identified and found to be uniform and candidates for characterization. In MP local cattle and buffalo population of Mahakaushal region was also uniform and different from known breeds.
- Survey was started to characterise native goats of Telangana State locally known as Mahbubnagari or Palamoor goat. Goats with coat colour black, white, and brown, with or without spots, splashes, with or without facial stripes existed in the flock. In Nallamala forest area majority of goats were of black/ brown and white splashes on their coat. Animals in Adilabad, Asifabaad, Bhupapally

- districts were mostly (60-70%) black. Goats are kept under semi-extensive management. Genomic DNA of 31 Mahbubnagar goats genotyped for the reported SNPs in the candidate genes for prolificacy (GDF9, BMP15 and BMP1B), however, did not support their association with prolificacy trait.
- Project is in progress to evaluate the livestock policies and programmes for management of AnGR in Haryana and Punjab states. Major problem so far identified with interaction of farmers and VO/other technocrats are non-availability of genetically superior germplasm, marketing of livestock as well as livestock products, quality feed on reasonable rates, veterinary services at the door of farmers, problems in getting finance and insurance claims etc. Due to poor price of milk, farmers are reducing the herd size. Piggery is growing at a faster rate in last five years in the state of Punjab due to better marketing. In poultry, the market is controlled by Businessmen at Delhi and mostly based on demand and supply basis rather than cost of production basis.
  - Institute is running a project for developing a model of sustainable improvement vis-à-vis conservation of indigenous cows in Guashalas. During the year a total of 16 calving (2 Sahiwal and 14 Haryana) were happened in Jundla Gaushala. During the year Controlled Internal Drug Release (CIDAR) treatment was applied to 13 Haryana and 2 Sahiwal cows with the help of State Animal Husbandry Department Karnal. A total of 62 (7 Sahiwal (6 F + 1 M) and 55 Haryana (30 F + 25M)) calves were born in the project since its inception. In Sahiwal, monthly daily milk yield ranged from  $4.5 \pm 1.5$  kg to  $7.25 \pm 1.25$  kg. In Haryana, monthly daily milk yield ranged from  $1.55 \pm 0.324$  to  $4.81 \pm 0.56$  kg.
  - Germplasm repository at National Gene Bank, ICAR-NBAGR is being strengthened by preserving diversified form of germplasm (semen, embryos, DNA, epididymal sperms and somatic cells). Total 17900 semen doses of one each of cattle, buffalo and goat breeds and 555 somatic cell doses of Laddakhi donkey and 384 of Laddakhi yak were added for cryopreservation.
  - A study was conducted to investigate the time course effects of milk with different genotypes (A1A1, A2A2 & A1A2) with respect to A1/A2 allele of beta casein on the liver, kidney and pancreas of C57BL/6 mice. The mice were divided into four groups (three experimental groups and one control group) and were fed with milk powder based diet. Histological examination of the liver from mice fed with A1A1 genotype milk based diet revealed fatty changes and cellular swelling at all the three time points (3, 6 and 9 months) of trial. In other two groups, the fatty changes were not observed even after 9 month of feeding. However, in A1A2 group, cellular swelling was observed after 6 months of feeding that persisted till 9 months of trial as well. The present study has helped to record the crucial histological changes on some selected tissues of mice fed with A1A1, A2A2 and A1A2 based milk diets.
  - Under CRP on Agrobiodiversity (Conservation of Animal Genetic Resources) methods have been standardized for establishment and characterization of cell lines from different species which can be used as genetic material to restore precious

germplasm, if need so arises. Somatic cell lines of Kharai Camel, Nagaland Mithun, Ladakhi Yak, Ladakhi and Kutchi Donkey were generated and deposited with National Gene Bank at NBAGR.

- Genotypic characterization of Mangadh dahodi cattle of Gujarat was completed. Genotypic characterization at 24 microsatellite loci revealed 11.62 numbers of observed alleles and 5.37 of effective number alleles. Average observed and expected heterozygosity values were 0.755 and 0.759 respectively.
- By genetic diversity analysis of Telangana goats 145 alleles were detected in black goat. The mean observed number and effective number of alleles across all the loci was  $6.59 \pm 0.57$ ;  $3.33 \pm 0.37$  and  $7.27 \pm 0.63$ ;  $3.33 \pm 0.39$  for black and splashed populations, respectively. Difference in the observed and expected number of alleles in both the populations suggested presence of several low frequency alleles in these populations. Analysis indicated that these two groups of goat lack homogeneity at phenotypic as well as genetic level.
- Under a project on understanding genetic basis of white markings and their impact on haematological and physiological parameters, data on animals classified into under, over and typical white markings generated. Significantly higher neutrophils count was recorded in under white animals. Polymorphism analysis in candidate genes KIT, MITF and MC1R, responsible for coat colour identified four SNPs and indels in the upstream region of MITF and KIT genes, potentially associated with their expression.
- In silico experiments were designed to explore genetic basis of local adaptation of Indian native cattle breeds utilizing cattle HD chip genotyping data on seven native cattle breeds - Haryana, Tharparkar Gir, Sahiwal, Kangyam, Ongle and Vechur. Mean values of the 22 different bioclimatic predictors was calculated in different agroclimatic regions of seven different native breeds.
- In Sahiwal cattle, a total 450431 and 25821 genome wide SNPs were identified with reference to *Bos taurus* and *Bos indicus* genomes respectively and 8266 genome wide SSRs were identified in the Sahiwal cattle. The novel SNPs with reference to *Bos taurus* were 14908 and 150231 with *Bos indicus* genomes respectively. Total 22762 SNPs were mapped to production trait QTLs while 42314 SNPs were mapped to QTLs associated with reproduction traits. In Murrah buffaloes, a total of 130688 high quality SNPs along with 35110 INDELS; 219856 high quality SNPs along with 15201 INDELS were identified using Murrah and Water buffalo genome, respectively. All the SNPs identified in the study were structurally and functionally annotated. Further the SNPs located in the candidate genes affecting Milk production (Milk yield, Milk Fat Percentage), Fertility, and other major genes were also annotated. In another study, samples of Indian yaks belonging to Arunachali yak, Himachali yak, Ladakhi yak and Sikkimi yak were used for the identification of genome wide SNPs and INDELS with cattle and buffalo as outgroup. The genetic distance calculated using genome wide SNPs in the Indian yaks revealed that Ladakhi and Sikkimi yak populations are found to be distinct.



- In order to understand the interplay of different genes and pathways involved in lactation, a comprehensive milk transcriptome profiling from three lactation stages of Murrah buffalo was performed by RNA sequencing. The top 20 genes, with highest expression were analyzed for major biological pathways involved in each stage of lactation. As a result, 216 DE genes between early-mid, 157 between early-late and 219 between mid-late lactation stages were identified. The differential expression of randomly selected genes like *CSN2*, *FABP3*, *LALBA*, *LPIN1*, *PAEP*, *RPS9* and *RPS23* was validated by quantitative PCR (qPCR). *ACTB* and *GAPDH* were used as the reference genes as they showed least variation in expression across the different stages in terms of RPKM (RNAseq data) and Ct values (qPCR). The highly connected genes identified in study are mainly implicated in immune response, cell growth and angiogenesis. Cell proliferation and growth of the mammary gland continues in the early and mid stage of lactation, while the immune cells may help in maintaining the health of the udder. Further studies are required to verify the impact of the hub genes on the relevant pathways.
- Skeletal Muscle transcriptome profiling of Bandur (Mandya) sheep was completed. The miRNAs from the skeletal muscles of Bandur sheep breed study were identified and characterized. Bandur is a consumer favoured mutton type sheep of India, mainly distributed in Mandya district of Karnataka. A total of 499 novel miRNAs were discovered in Bandur sheep. The miRNAs identified in study were enriched for functions namely cell proliferation, cell differentiation, osteogenesis, lipid metabolism, muscle development, adipocyte differentiation, stress response etc. Potential gene targets for the identified miRNAs were predicted. Most relevant target genes predicted in our study included *MYO5A*, *SIN3B*, *HSPB1* and *NR2F2*. This study is a stepping stone in understanding the role of miRNAs in molecular pathways relevant to muscle traits.
- In-silico analysis was carried out to identify genes representing  $\mu$ -opioid receptors (MOR) in mice and human genome. Different splice variants of MORs were fished out from a much larger pool of sequences available in NCBI databases. The structure of BCMs, mu, kappa and delta receptors was predicted and molecular docking studies were performed. The studies showed that both in human and mice, BCMs have highest affinity for MOR and least affinity for kappa 1 opioid receptor. The order of betacasomorphin affinity for opioid receptors was:  $\mu > \delta > \kappa$ .
- Relative of antioxidant levels were evaluated in native livestock – Ladakhi cattle, Ladakhi yak, Ladakhi donkey, double hump camel and Zanskar ponies of Leh-Ladakh region under National Fellow project. FRAP values were significantly ( $p \leq 0.05$ ) higher in Ladakhi yak and Zanskar ponies compared to other species of high altitude region. The DPPH was lowest in Zanskar ponies ( $48.16 \pm 2.66$ ) as compared to other species. The GSH level was highest in double hump camel followed by Ladakhi yak, Zanskar ponies, Ladakhi donkey and Ladakhi cattle. The antioxidant capacity in terms of FRAP, and reduced glutathione (GSH) level was estimated in six different breeds of cattle viz., Ladakhi cows (LAC), Gir (GIC), Tharparkar (TAC),

- Sahiwal (SAC), Karan Fries (KFC), Holstein Friesian (HFC) and Murrah buffaloes (MUB). FRAP values were significantly ( $p < 0.05$ ) higher in high altitude adapted LAC ( $3.74 \pm 0.26$ ) as compared to cattle breeds from tropical regions. The result also showed significant ( $p < 0.05$ ) increase in DDPH radical scavenging activity during hot summer and humid seasons in comparison to spring season in all the cattle breeds and Murrah buffaloes.
- In order to identify and catalogue genome wide SNPs in Indian cattle breeds from different agroclimatic regions, genotyping-by-sequencing (GBS) data was generated in 13 native and 2 exotic cattle breeds. A total of 82, 878 SNPs were identified with an average SNP-to-SNP distance of 30 kb across the bovine genome. A large proportion of SNPs identified in native cattle were novel and could be used in future as indicine specific genomic resource. Comparative transcriptome changes in PBMCs of Sahiwal cows, Holstein Friesian cows and Murrah buffaloes during summer and winter stress were analysed to understand the transcriptomic variations between peak summer (THI > 85) and winter (THI < 72) period. There was relatively a greater transcriptional response during the summer season in all three breeds. In Sahiwal cows PBMCs, a total of 453 genes were differentially expressed of which 275 genes were up-regulated and 178 genes were down-regulated. In Murrah buffaloes, a total of 1345 genes were found to be differentially expressed, of which 578 genes were up-regulated and 767 genes were down-regulated.
  - CRISPR-Cas9 based knockout of  $\text{Na}^+/\text{K}^+$  ATPase alpha isoform gene (*ATP1A1*) in cattle fibroblast to understand its role in heat stress response was studied. The results showed that the cytotoxicity in  $\text{Na}^+\text{K}^+\text{ATP1A1}$  knockout cells increased immediately after exposure to heat stress to 40% at 2h of recovery and reached to 72% at 4h and 78% at 8h as compared to unstressed CRISPR-edited cells. The depolarization of mitochondrial membrane was higher in  $\text{NaK}^+\text{ATP1A1}$  mutant heat stressed cells compared to normal heat stressed cells, indicating its role in maintaining the membrane potential under stress conditions. Also, the results highlight the potential role of *ATP1A1* played under heat stress.
  - A SNP database on “SNPs in Indigenous Animal Genetic Resources” was also created containing the information about the SNPs identified in Yak, cattle and buffalo along with their annotation details.
  - Institute also provides the genetic defect/disease testing services to the different government agencies. Total 344 bulls/males were screened for chromosomal defects. Cytogenetic screening of 165 cattle males, 236 buffalo males and one horse and mare each was conducted. Two bulls were found to carry abnormal karyotypes. A total of 20 bulls of cattle (18) and buffalo (2) were screened for DNA testing for genetic diseases for BLAD, Citrullinemia Factor XI deficiency and DUMPS (HF and HF crosses only).
  - Under Network project, phenotypic and genotypic characterization of new livestock and poultry is going on. Conservation of Ankaleswar chicken (under Network

project) and conservation of Kadaknath and Assam local pig and goat (under TSP) is in progress in their habitat.

- A total of 7 research projects were completed during last year. At present 22 research projects including five externally funded and one National Fellow projects are running in the institute.
- Total 48 research papers were published in National and International Journals of high impact factor. Twenty four technical/popular articles were published. 2 books / monograph / tech. bulletin and training manual were also published by the institute.
- One Model Training Course was conducted for SAHD officers. Two training programmes were organized for upscaling the skill of administrative, technical and supporting staff of ICAR institutes.
- Scientists of the Bureau participated in Mera Gaon Mera Gaurav and visited various villages and created awareness among farmers on their doorsteps and field. Exhibitions on AnGR were organized at various places to showcase institute's activities and sensitize farmers about the benefits of indigenous animals.
- Institute also celebrated different occasions like Foundation Day of Bureau, Biodiversity day, Republic Day and Independence Day, Jai Kisan Jai Vigyan, Rashtriya Swachhta Abhiyan, Vigilance Week, International

yoga day, Agricultural Education Day, Hindi Pakhwada in its premises.

- The Institute Research Committee (IRC) and Research Advisory Committee (RAC) meetings were held on time and the progress of research projects was reviewed.
- A contingent of 27 staff members of ICAR-NBAGR participated in the ICAR (North Zone) games / Basket Ball and fetched trophies in cycle race.
- A number of distinguished persons including DG, DDG (AS), ICAR visited the institute and interacts with bureau staff.
- Scientists were deputed for training programmes within the country and attended the workshops, symposia and conferences and presented their research work.
- NBAGR scientists are included in PG faculty of Animal Genetics & Breeding, Animal Biotechnology and Animal Biochemistry disciplines of ICAR-National Dairy Research Institute and teaching various courses in these divisions. The scientists are regularly guiding the students of different institutes and universities, including ICAR-NDRI for masters and PhD degrees.
- At present, 26 scientific, 15 technical, 17 administrative and 4 skilled staff persons are working at the Institute. Three scientists and four technical staff received their promotions to the next higher grade.

- भाकृअनुप- राष्ट्रीय पशु आनुवंशिक संसाधन ब्यूरो, पालतू पशुओं और कुक्कुट विशेष रूप से स्वदेशी नस्लों के प्रोत्साहन और उत्थान के लिए काम कर रहा एक अग्रणी संस्थान है। संस्थान का अधिदेश है: 1) देश के पशुधन और कुक्कुट आनुवंशिक संसाधनों की पहचान, मूल्यांकन, लक्षणीकरण, संरक्षण एवं उनका सतत् उपयोग; तथा 2) पशु आनुवंशिक संसाधन प्रबंधन और नीतिगत मुद्दों में समन्वय और क्षमता निर्माण। संस्थान के अधिदेश को प्राप्त करने के लिए संस्थान में तीन विभाग- 1) पशु आनुवंशिक संसाधन 2) पशु आनुवंशिकी, और 3) पशु जैव प्रौद्योगिकी बनाये गए हैं; इसके अलावा, दो इकाइयां- पशुधन सूचना और प्रबंधन और नेटवर्क परियोजना भी कार्य कर रही हैं।
- वित्तीय वर्ष 2018-19 के दौरान विभिन्न मदों (पूंजी, राजस्व और पेंशन और सेवानिवृत्ति लाभ) के तहत रु.1701.48 लाख की कुल प्राप्ति में रु.1717.05 लाख का कुल व्यय हुआ। नेटवर्क परियोजना के तहत, रु.107.15 लाख की कुल प्राप्ति से रु.107.33 लाख का कुल व्यय हुआ। इसके अलावा वित्तीय वर्ष 2018-19 में रु. 54.06 लाख राजस्व के रूप में प्राप्त किये गए।
- इस वर्ष के दौरान नस्ल पंजीकरण समिति के अनुमोदन से पालतू पशुओं एवं कुक्कुटों की 15 नई नस्लें, जिनमें : गोवंश की दो, भैंस की तीन, बकरी की छः, एवं भेंड़, शूकर, गधे एवं मुर्गी की एक-एक नस्ल पंजीकृत की गयी। जिसमें से पांच नस्लें देश के पूर्वोत्तर क्षेत्र से थीं। इन नस्लों को लेकर अब कुल पंजीकृत स्वदेशी नस्लों की संख्या 184 तक पहुंच गई है, जिसमें गोवंश की 43, भैंस 16, बकरी 34, भेंड़ 43, घोड़े एवं पोनी की 7, ऊँट की 9, शूकर की 8, गधे की 2, याक की 1, मुर्गी की 19 एवं हंस एवं बत्तख की एक-एक नस्लें शामिल हैं।
- गुजरात की मानगढ़ दहोदी गाय का लक्षणीकरण किया गया। यह गाय मुख्यरूप से कृषि कार्य एवं कुछ मात्रा में दूध पाने के लिए पाली जाती है। यह प्रबंधन की कम लागत प्रणाली के तहत पाली जाती

है। मानगढ़ दहोदी गाय, छोटे कद की होती है। ये मुख्यतः सफ़ेद रंग की होती हैं, लेकिन कुछ गायें भूरी-सफ़ेद या भूरे रंग की भी पायी जाती हैं। इनका दैनिक दुग्ध उत्पादन 1.5 से 4.5 किग्रा. तक होता है।

- इस वर्ष के दौरान तेलंगाना राज्य की झारी गाय समूह का लक्षणीकरण एवं उनके उत्पादन का अध्ययन किया गया। “झारी” नाम असीफाबाद जिले के एक ग्राम के नाम पर पड़ा है जो कि इसका मूल स्थान है। औसत समूह का आकार 4 से 10 तक होता है, लेकिन कुछ पशु पालक 300 तक भी गायें पालते हैं। झारी गायें भूरे एवं सफ़ेद रंग की होती हैं। भूरा रंग नर में एवं सफ़ेद मादा में मुख्य रूप से पाया जाता है। ये छोटे से मध्यम आकार की होती हैं। तथा इनका शरीर सुगठित एवं आकार वर्तुलाकार होता है। इनका चेहरा लम्बा एवं अवतल होता है जोकि इसे अन्य नस्लों से भिन्न करता है। अन्य विभेदक लक्षण सींग की लम्बाई है जोकि आकार में क्षेत्र की अन्य नस्ल ओंगोल एवं इसके ग्रेड की अपेक्षा लम्बी एवं मूलाधार पर पतली होती होती हैं। प्रतिदिन का दुग्ध उत्पादन 1.0 से 3.0 किग्रा. होता है एवं दुग्ध काल 90 से 150 दिनों का होता है। इनके बैल भारवाही कार्यों में भी प्रयोग में लाये जाते हैं। अध्ययन यह दर्शाता है कि झारी गोवंशी क्षेत्र की अन्य समूहों यथा कम्मा, वन्धार्वी एवं थुरुपु से प्रारूपिक रूप से भिन्न है।
- केरल में पायी जानी वाली कुट्मपूझा एवं विल्वाद्री गायों के दो नए समूहों का मूल्यांकन एवं अध्ययन इस वर्ष शुरू किया गया। दोनों समूहों की गायें आकार में छोटी होती हैं। कुट्मपूझा गायों को पेरियार के नाम से भी जाना जाता है, क्योंकि ये गायें पेरियार नदी के दोनों तरफ वितरित हैं। कुट्मपूझा गायों के शरीर का रंग भूरा (18.35%), काला (21.25%), भूरापन लिए हुए काला (26.5%) या मिश्रित (19.25%) होता है जबकि विल्वाद्री गायों का रंग गहरा लाल-भूरा (30.5%), काला (26.5%), भूरा (11.0%), हल्का भूरा-लाल (5.65%) एवं मिश्रित (26.35%) होता है तथा इनका माथा सीधा



एवं सींग मुड़े हुए होते हैं। कम लागत प्रणाली में भी इनका दुग्ध उत्पादन 1.2 से 2.5 ली. प्रतिदिन होता है तथा ये स्वभाव से उग्र होती हैं।

- एक अग्रगामी सर्वेक्षण मध्य प्रदेश की गायों के मूल्यांकन एवं लक्षणीकरण के लिए भी किया गया। ग्वालियर एवं चम्बल संभाग (भिंड, मुरैना, शेओपुर एवं दतिया जिले) की गायें सफ़ेद एवं भूरे रंग की मिश्रित गायों का समूह हैं जोकि पूरे संभाग में वितरित हैं। ये गायें मुख्यतः दूध के लिए पाली जाती हैं तथा इनका दुग्ध उत्पादन प्रतिदिन लगभग 2 से 7 किग्रा. तक होता है। शेओपुर जिले में “बावरी” नाम की अलग गायों का समूह पाया जाता है जोकि पंजीकृत नस्लों से भिन्न हैं, इसे इस इलाके में गारी के नाम से भी जाना जाता है। इन गायों को गुज्जरो द्वारा दुग्ध उत्पादन हेतु इस इलाके के बीहड़ों में कम लागत प्रणाली के तहत पाला जाता है।
- हरियाणा, पंजाब एवं उत्तर –पश्चिम राजस्थान में पाए जाने वाले गोवंशी समूहों के मूल्यांकन एवं लक्षणीकरण के लिए भी सर्वेक्षण किया गया। राजस्थान के लूनकरनसर क्षेत्र के वे पशुपालक जोकि निष्क्रमण पर रहते हैं वे देशी गायें राठी, साहिवाल, राठी X साहिवाल एवं विदेशी नस्लों होल्सटीन फ्रीजियन एवं जर्सी के संकर रखते हैं, जिसमें विदेशी नस्लों का भाग कम होता है। ये पशुपालक गायों के बड़े समूहों को अर्ध – सघन एवं विरल (एक्स्टेंसिव) पद्धति में पालते हैं। गाय पालन इनका मुख्य एवं जीवन यापन का साधन है। कुछ पशुपालक जोकि विदेशी-संकर गायों का पालन करते थे अब पुनः देशी गायों के पालन कि तरफ लौट रहे हैं। साधन सहित पशुपालकों के लिए देशी नस्लों (राठी, साहिवाल) निश्चित ही एक अच्छा विकल्प है।
- आंध्रप्रदेश प्रदेश की मचरेल्ला ब्राउन भेंड़ के मूल्यांकन एवं लक्षणीकरण के लिए एक परियोजना इस वर्ष से शुरू की गयी है। मचरेल्ला ब्राउन भेंड़ मॉस उत्पादन हेतु कृष्णा नदी के आस-पास आंध्रप्रदेश के गुंटूर, कृष्णा, प्रकाशम् जिलों एवं तेलंगाना राज्य के

नालगोंडा जिले एवं इसके आस –पास पायी जाती है। यह मध्यम से बड़े आकार की भेंड़ है जिसके शरीर का रंग मुख्यतः सफ़ेद होता है जिसपर शरीर के विभिन्न हिस्सों पर विभिन्न आकर एवं प्रकार के काले, भूरे, भूरे-लाल रंग के धब्बे पाए जाते हैं। इसके अन्य मुख्य विभेदक लक्षण: अवतल चेहरा, लटकते हुए कान एवं पिछले पैर पर बड़े – बड़े बालों के गुच्छों का पाया जाना है। इनकी पूँछ बहुत ही छोटी एवं पतली होती है। इनके वयस्क नर एवं मादा का औसत शरीर भार क्रमशः 57.27±1.42 एवं 45.03±0.56 किग्रा. होता है, जोकि नर में 41 से 69 एवं मादा में 32 से 60 किग्रा. तक विस्तारित होता है।

- मध्य प्रदेश के महाकौशल क्षेत्र एवं झारखण्ड की स्थानीय देशी गायों एवं बकरियों के लक्षणीकरण के लिए एक प्रारंभिक सर्वेक्षण किया गया। पलामू क्षेत्र (झारखण्ड) में गाय एवं एक बकरी के समूह की पहचान की गयी है जोकि एकसार हैं एवं लक्षणीकरण हेतु अहर्ता रखते हैं। मध्य प्रदेश के महाकौशल क्षेत्र में पायी जाने वाली देशी गायें एवं भैसैं भी ज्ञात नस्लों से भिन्न हैं एवं एकसार हैं।
- तेलंगाना राज्य में पायी जाने वाली स्थानीय महबूबनगरी एवं पालामूर बकरियों के लक्षणीकरण हेतु एक परियोजना शुरू की गयी। इनका रंग काला, सफ़ेद एवं भूरा होता है जिसपर विभिन्न रंग के धब्बे हो भी सकते हैं। कुछ बकरियों के चेहरे पर धारियां भी पायी जाती हैं। नाल्लामाला जंगल क्षेत्र की बकरियां मुख्यतः काली/भूरी एवं सफ़ेद रंग के धब्बे लिए होती हैं। अदीलाबाद, असिफाबाद, भुपल्ली जिलों की अधिकतर (60–70%) बकरियां काले रंग की होती हैं। इनको अर्ध-सघन पद्धति के तहत पाला जाता है। महबूबनगरी बकरियों के डी एन ए का विश्लेषण भी बहु –प्रजनकता जीन (जीडीएफ9; बीएमपी15, बीएमपीआर1बी) के लिए किया गया लेकिन इसमें कोई सम्बन्ध नहीं पाया गया।
- हरियाणा और पंजाब में पशु आनुवंशिक संसाधन के प्रबंधन के लिए पशुधन नीतियों और कार्यक्रमों

के मूल्यांकन के लिए परियोजना जारी है। पशुपालन की गतिविधियों पर प्रश्रावली आधारित जानकारी किसानों / पशुधन रखने वालों और अन्य हितधारकों से एकल की गई। आनुवंशिक रूप से उन्नत नर की अनुपलब्धता, पशुओं एवं इनके उत्पादों का विपणन, मुनासिब दाम पर चारे-दाने की अनुपलब्धता, पशुपालकों के घर पर पशु चिकित्सा सुविधा का न मिलना, पूंजी एवं बीमा आदि का समय पर भुगतान न होना आदि मुख्य समस्याएं पशुपालकों एवं अन्य सम्बंधित लोगों द्वारा बताई गयीं। दूध के कम मूल्य के कारण पशुपालक अपने समूह का आकर सीमित कर रहे हैं। पिछले पांच वर्षों के दौरान पंजाब राज्य में अच्छी विपणन व्यवस्था के कारण शूकर पालन के व्यवसाय में काफी तरक्की हुई है। मुर्गीपालन मुख्यतः दिल्ली स्थित व्यापारियों द्वारा नियंत्रित है जोकि उत्पादन लागत आधारित न होकर मांग एवं आपूर्ति आधारित है, जिससे मुर्गी पालकों को उचित मूल्य नहीं मिल पाता।

- संस्थान गौशालाओं में स्वदेशी गायों के संरक्षण के साथ-साथ सतत सुधार के मॉडल के विकास के लिए एक परियोजना चला रहा है। इस वर्ष जुंडला गोशाला में कुल 16 बच्चे पैदा हुए जिसमें 2 साहिवाल एवं 14 हरियाणा के थे। इस वर्ष गायों के सुधार हेतु हरियाणा की 13 एवं साहिवाल की 2 गायों में, हरियाणा-राज्य पशुपालन विभाग द्वारा सीडाआर का प्रयोग भी किया गया है। इस परियोजना में अबतक कुल 62 (साहिवाल के 7 एवं हरियाणा के 55) गायों के बच्चे पैदा हो चुके हैं। साहिवाल में दैनिक दुग्ध उत्पादन 4.5 से 7.25 किय्रा. तक जबकि हरियाणा में 1.55 से 4.81 किय्रा. तक प्राप्त हुआ।
- नेशनल जीन बैंक, एनबीएजीआर में जर्मप्लाज्म रिपॉजिटरी को जर्मप्लाज्म (वीर्य, भ्रूण, डीएनए, एपिडीडिमल शुक्राणु और दैहिक कोशिकाओं) के विविध रूप को संरक्षित करके मजबूत किया जा रहा है। मवेशियों, भैंस और बकरी की नस्ल के कुल 17900 वीर्य की खुराक और लद्दाखी गधे की 555

दैहिक कोशिका खुराक और 384 लद्दाखी याक को क्रायोप्रेजर्वेशन के लिए रखा गया।

- बीटा कैसिइन के ए1/ए2 एलील के संबंध में विभिन्न जीनोटाइप्स (ए1ए1, ए2ए2, ए1ए2) के साथ दूध के प्रभाव की जांच करने के लिए एक अध्ययन किया गया था। चूहों को चार समूहों (तीन प्रयोगात्मक समूहों और एक नियंत्रण समूह) में विभाजित किया गया था और दूध पाउडर आधारित आहार के साथ खिलाया गया था। ए1ए1 जीनोटाइप दूध आधारित आहार के साथ खिलाए गए चूहों के जिगर की हिस्टोलॉजिकल परीक्षा में परीक्षण के सभी समय (3, 6 और 9 महीने) पर फैटी परिवर्तन और सेलुलर सूजन का पता चला। अन्य दो समूहों में, खिलाने के 9 महीने बाद भी वसायुक्त परिवर्तन नहीं देखा गया। हालांकि, ए1ए2 समूह में, खिलाने के 6 महीने बाद सेलुलर सूजन देखी गई थी जो कि 9 महीने के परीक्षण तक भी बनी रही। वर्तमान अध्ययन से ए1ए1, ए2ए2 और ए1ए2 आधारित दूध आहार के साथ खिलाए गए चूहों के कुछ चयनित ऊतकों पर महत्वपूर्ण ऊतकीय परिवर्तनों को रिकॉर्ड करने में मदद मिली।
- कृषि जैव विविधता पर सीआरपी परियोजना के तहत पशु आनुवंशिक संसाधनों का संरक्षण तरीकों को विभिन्न प्रजातियों से सेल लाइनों की स्थापना और लक्षण वर्णन के लिए मानकीकृत किया गया है, जिनका उपयोग आवश्यकता अनुसार कीमती जर्मप्लाज्म को पुनर्स्थापित करने के लिए आनुवंशिक सामग्री के रूप में किया जा सकता है। खरई ऊंट, नागालैंड मिथुन, लद्दाखी याक, लद्दाखी और कच्छी गधा की दैहिक सेल लाइनों को नेशनल जीन बैंक में जमा किया गया।
- गुजरात के मनगढ़ दाहोदी मवेशियों का जीनोटाइपिक लक्षण वर्णन पूरा किया गया। 24 माइक्रोसैटेलाइट चिन्हकों में जीनोटाइपिक लक्षण वर्णन से देखी गई व प्रभावी एलील्स की संख्या क्रमशः 11.62 और 5.37 थी। औसत देखे गए और अपेक्षित विषमयुग्मता मूल्य क्रमशः 0.755 और 0.759 थे।

- तेलंगाना बकरियों की आनुवंशिक विविधता विश्लेषण में काली बकरी में 145 एलील का पता लगाया गया। काले और धब्बे युक्त बकरियों में औसतन एलील्स की देखी गई संख्या और प्रभावी संख्या क्रमशः 6.59 व 3.33 और 7.27 व 3.33 थी। दोनों आबादी में एलील्स की देखी गई और अपेक्षित संख्या में अंतर इन आबादी में कई कम आवृत्ति वाले एलील की उपस्थिति का सुझाव देती है। विश्लेषण ने संकेत दिया कि बकरी के इन दो समूहों में बाह्य व आनुवंशिक स्तर पर समरूपता का अभाव है।
- नीली रावी भैंसों में श्वेत चिन्हों के आनुवांशिक आधार को समझने और हेमेटोलॉजिकल और फिजियोलॉजिकल मापदंडों पर उनके प्रभाव को परखने के लिए एक परियोजना के तहत कम, अधिक और विशिष्ट सफेद चिन्हों वाले जानवरों को वर्गीकृत किया गया। सीबीसी के द्वारा उल्लेखनीय रूप से उच्च न्यूट्रोफिल गणना, कम सफेद जानवरों में दर्ज की गई। इसके अलावा श्वेत चिन्हों के लिए जिम्मेदार KIT, MITF और MC1R जीनों में पॉलीमॉर्फिज़्म विश्लेषण के द्वारा, MITF और KIT जीन के अपस्ट्रीम प्रमोटर क्षेत्र में चार एसएनपी और इंडल्स की पहचान की गयी, जो कि संभवतः उनकी अभिव्यक्ति के साथ जुड़े हो सकते हैं।
- भारतीय देशी गोवंशियों के स्थानीय अनुकूलन के आनुवंशिक आधार का पता लगाने के लिए इन सिलिको प्रयोगों द्वारा सात देशी मवेशियों की नस्लों-हरियाणा, थारपारकर गिर, साहीवाल, कंग्यम, ओंगोल और वेचुर पर मवेशी सघन चिप जीनोटाइपिंग डेटा का उपयोग किया गया। 22 अलग-अलग जैव रासायनिक भविष्यवक्ताओं के मध्यमान मूल्यों की गणना सात अलग-अलग देशी नस्लों के विभिन्न कृषि-संबंधी क्षेत्रों में की गई।
- साहीवाल मवेशियों में, कुल 450431 और 25821 जीनोम एसएनपी और 8266 जीनोम एसएसआर की पहचान की गई। बोस टॉरस के संदर्भ में नए एसएनपी क्रमशः 14908 और बोस इंडिकस के संदर्भ में

150231 थे। कुल 22762 एसएनपी को उत्पादन सम्बन्धित क्यू.टी.एल. जबकि 42314 एसएनपी को प्रजनन सम्बन्धित क्यू.टी.एल. में मैप किया गया। मुर्दाह भैंसों में, 35110 इन्डेल के साथ कुल 130688 तथा 15201 इन्डेल के साथ 219856 उच्च गुणवत्ता वाले एसएनपी की पहचान क्रमशः मुर्दाह और जलीय भैंस जीनोम का उपयोग करके की गई। अध्ययन में पहचाने गए सभी एसएनपी संरचनात्मक और कार्यात्मक रूप से एनोटेट थे। इसके अलावा दूध उत्पादन (दुग्ध उत्पादन, मिल्क फैट प्रतिशत), प्रजनन क्षमता और अन्य प्रमुख जीनों को प्रभावित करने वाले उम्मीदवार जीनों में स्थित एसएनपी को भी एनोटेट किया गया। एक अन्य अध्ययन में, अरुणाचली याक, हिमाचली याक, लद्दाखी याक और सिक्किमी याक से संबंधित भारतीय याक के नमूनों का उपयोग समूह के रूप में मवेशी और भैंस के साथ जीनोम विस्तृत एसएनपी और इन्डेल की पहचान के लिए किया गया था। भारतीय याक में जीनोम विस्तृत एसएनपी का उपयोग करके आनुवंशिक दूरी से पता चला है कि लद्दाखी और सिक्किमी याक आबादी अलग पाई जाती है।

- दुग्धकाल में शामिल विभिन्न जीनों और मार्गों के परस्पर क्रिया को समझने के लिए, आरएनए अनुक्रमण द्वारा मुर्दाह भैंस के तीन स्तनपान चरणों से एक व्यापक दूध ट्रांस्क्रिप्टोम रूपरेखा का प्रदर्शन किया गया। उच्चतम अभिव्यक्ति के शीर्ष 20 जीन के साथ दुग्धकाल के प्रत्येक चरण में शामिल प्रमुख जैविक मार्गों के लिए विश्लेषण किया गया था। परिणामस्वरूप, प्रारंभिक-मध्य, के बीच 216 डीई जीन, प्रारंभिक-देर के बीच 157 और मध्य-देर दुग्धकाल चरणों के बीच 219 की पहचान की गई। CSN2, FABP3, LALBA, LPIN1, PAEP, RPS9 और RPS23 चुने गए जीन की अंतर अभिव्यक्ति को मातात्मक पीसीआर द्वारा मान्य किया गया। ACTB और GAPDH को संदर्भ जीन के रूप में उपयोग किया गया था क्योंकि उन्होंने RPKM और Ct मान के संदर्भ में विभिन्न चरणों में अभिव्यक्ति

में कम से कम भिन्नता दिखाई। अध्ययन में पहचाने गए अत्यधिक जीन मुख्य रूप से प्रतिरक्षा प्रतिक्रिया, कोशिका वृद्धि और एंजियोजेनेसिस से जुड़े हुए हैं। स्तन ग्रंथि की कोशिका प्रसार और वृद्धि दुग्धकाल के प्रारंभिक और मध्य चरण में जारी है, जबकि प्रतिरक्षा कोशिकाएं उदर के स्वास्थ्य को बनाए रखने में मदद कर सकती हैं। प्रासंगिक मार्गों पर हब जीन के प्रभाव को सत्यापित करने के लिए आगे के अध्ययन की आवश्यकता है।

- बंडूर (मंड्या) नस्ल भेड़ की मांसपेशी की ट्रांसक्रिप्टोम प्रोफाइलिंग पूरी हो गई। इसकी मांसपेशियों से माइक्रो-आरएनए की पहचान एवं अध्ययन किया गया। बंडूर एक उपभोक्ता पसंदीदा मटन (मांस) प्रकार की भेड़ है, जो मुख्य रूप से कर्नाटक के मंड्या जिले में पाई जाती है। बंडूर भेड़ में कुल 499 नवीन माइक्रो-आरएनए की खोज की गई। अध्ययन में पहचाने गए माइक्रो-आरएनए को सेल प्रसार, कोशिका विभेदन, ओस्टियोजेनेसिस, लिपिड चयापचय, मांसपेशियों का विकास, एडीपोकाइट भेदभाव, तनाव प्रतिक्रिया आदिकार्यों के लिए समृद्ध किया गया और पहचान किए गए माइक्रो-आरएनए के लिए संभावित जीन का अनुमान किया गया। हमारे अध्ययन में पूर्वानुमानित अधिकांश प्रासंगिक लक्ष्य जीन में MYO5A, SIN3B, HSPB1 और NR2F2 शामिल थे। यह अध्ययन मांसपेशियों के लक्षणों से संबंधित आणविक अध्ययन में माइक्रो-आरएनए की भूमिका को समझने में एक महत्वपूर्ण कदम है।
- चूहों और मानव जीनोम में म्यु ओपिओयड रिसेप्टर्स का प्रतिनिधित्व करने वाले जीन की पहचान करने के लिए सिलिको विश्लेषण किया गया था। एनसीबीआई डेटाबेस में उपलब्ध अनुक्रमों के एक बहुत बड़े पूल से म्यु ओपिओयड रिसेप्टर्स के अलग-अलग विभाजन संस्करण निकाले गए। बीसीएम, म्यु, कप्पा और डेल्टा रिसेप्टर्स की संरचना की भविष्यवाणी की गई और आणविक डॉकिंग अध्ययन किए गए। अध्ययनों से

पता चला है कि मानव और चूहों दोनों में, बीसीएम को एमओआर के लिए उच्चतम आत्मीयता और कप्पा 1 ओपिओयड रिसेप्टर्स के लिए कम से कम आत्मीयता है। ओपिओयड रिसेप्टर्स के लिए बीटाकेसोमोर्फिन आत्मीयता का क्रम म्यु > डेल्टा > कप्पा था।

- नेशनल फेलो परियोजना के तहत लादाखी क्षेत्र के देशी पशुधन-लदाखी मवेशियों, लदाखी याक, लदाखी गधे, डबल कूबड़ वाले ऊंट और ज़ांस्कर टटू में सापेक्ष एंटीऑक्सिडेंट स्तर का मूल्यांकन किया गया। उच्च ऊंचाई वाले क्षेत्र की अन्य प्रजातियों की तुलना में लदाखी याक और ज़न्स्कार टटू में FRAP मान काफी ( $p \leq 0.05$ ) अधिक थे। अन्य प्रजातियों की तुलना में ज़ांस्कर पोनीज़ में DPPH (48.16) सबसे कम था। जीएसएच स्तर दोहरे कूबड़ वाले ऊंट में सबसे अधिक था, इसके बाद लदाखी याक, ज़न्स्कार पोनी, लदाखी गधा और लदाखी मवेशी थे। FRAP के संदर्भ में एंटीऑक्सिडेंट क्षमता, और कम ग्लूटाथियोन (GSH) स्तर का अनुमान लदाखी गायों, गिर, थारपारकर, साहिवाल, करण फ्रीज, होल्स्टीन फ्रिसियन और मुरा भैंस में लगाया गया। उष्णकटिबंधीय क्षेत्रों के मवेशियों की नस्लों की तुलना में उच्च ऊंचाई अनुकूलित मवेशियों में FRAP मान (3.74) काफी में अधिक था ( $p \leq 0.05$ )। एंटीऑक्सिडेंट, FRAP, DPPH और GSH पर गर्मी के तनाव के प्रभाव की जांच करने के लिए, विभिन्न प्रकार के मवेशियों और भैंस के सीरम नमूनों का अध्ययन किया गया। सर्दियों और उमस के मौसम की तुलना में गर्मी के दौरान सभी 5 नस्लों में FRAP मूल्यों में महत्वपूर्ण ( $p < 0.05$ ) वृद्धि के संकेत मिले। हालांकि, TAC, SAC और GIC मवेशियों की नस्लों ने FRAP मूल्यों में सबसे कम वृद्धि दिखाई, जिससे इन नस्लों को गर्मी के मौसम में ऑक्सिडेटिव तनाव से कम से कम प्रभावित होने का सुझाव दिया गया।
- जीनोम वाइड एसएनपी की पहचान करने और सूचीबद्ध करने के लिए, जीनोटाइपिंग-बाय-सीक्वेंसिंग



(जीबीएस) डेटा 13 देशी और 2 विदेशी मवेशी नस्लों में उत्पन्न किया गया। 82, 878 एसएनपी की कुल पहचान की गई थी, जो बोवाइन जीनोम में 30 केबी की औसत एसएनपी-से-एसएनपी दूरी के साथ थी। देशी मवेशियों में पहचाने गए एसएनपी का एक बड़ा हिस्सा नवीन था और भविष्य में जिसे विशिष्ट जीनोमिक संसाधन के रूप में इस्तेमाल किया जा सकता है। इस प्रकार, बड़ी संख्या में विशिष्ट एसएनपी की पहचान करने के लिए जीबीएस तकनीक को सफलतापूर्वक नियोजित किया गया। साहिवाल गायों, होल्स्टीन फ्रेशियन गायों और मुराह भैंसों के पीबीएमसी में गर्मियों और सर्दियों के तनाव के दौरान तुलनात्मक ट्रांसक्रिप्टम बदलावों का विश्लेषण किया गया ताकि पीक समर (टीएचआई>85) और विंटर (टीएचआई<72) अवधि के बीच ट्रांसक्रिप्टामिक बदलावों को समझा जा सके। विश्लेषण से पता चला कि तीनों नस्लों में गर्मी के मौसम के दौरान अपेक्षाकृत अधिक प्रतिक्रियात्मक प्रतिक्रिया थी। साहिवाल गायों पीबीएमसी में, कुल 453 जीनों को अलग-अलग व्यक्त किया गया, जिनमें से 275 जीनों को अप रेगुलेट और 178 जीनों को डाउन-रेगुलेट किया गया। मुराह भैंसों में, कुल 1345 जीनों को आंशिक रूप से व्यक्त किया गया जिनमें से 578 जीनों को अप रेगुलेट और 767 जीनों को डाउन-रेगुलेट किया गया।

- मवेशी फाइब्रोब्लास्ट में क्रिस्पर-कैस9 आधारित  $Na^+/K^+ATPase$  अल्फा आइसोफोर्म जीन ( $ATP1A1$ ) की नॉकआउट का गर्मी तनाव प्रतिक्रिया में इसकी भूमिका को समझने के लिए अध्ययन किया गया। परिणामों से पता चला कि  $Na^+/K^+ATP1A1$  नॉकआउट सेल में साइटोटोक्सिसिटी 2h पर 40% तक गर्मी के तनाव के तुरंत बाद बढ़ गई और अस्थिर क्रिस्पर से संपादित कोशिकाओं की तुलना में 4h पर 72% और 8h पर 78% तक पहुंच गई। माइटोकॉन्ड्रियल झिल्ली का विधुवण

$Na^+/K^+ATP1A1$  उत्परिवर्ती ऊष्मा कोशिकाओं में सामान्य ताप पर बल देने वाली कोशिकाओं की तुलना में अधिक था, जो तनाव की परिस्थितियों में झिल्ली क्षमता को बनाए रखने में इसकी भूमिका को दर्शाता है। इसके अलावा, परिणाम गर्मी के तनाव के तहत एटीपी1ए1 की संभावित भूमिका को उजागर करते हैं।

- “एसएनपी इन इंडिजिनस एनिमल जेनेटिक रिसोर्सेज” पर एक एसएनपी डेटाबेस भी बनाया गया जिसमें याक, मवेशी और भैंस में पहचाने गए एसएनपी के बारे में जानकारी दी गई है।
- संस्थान विभिन्न सरकारी एजेंसियों को आनुवंशिक दोष / रोग परीक्षण सेवाएँ भी प्रदान करता है। गुणसूत्र संबंधी दोषों के लिए कुल 344 बैल की जांच की गई। 165 मवेशी, 236 नर भैंस, एक घोड़े और घोड़ी की जांच की गई। दो बैलों का करियोटाइप असामान्य पाया गया था। BLAD, सिटुलिनमिया फैक्टर XI की कमी और DUMPS (एचएफ और एचएफ क्रॉस) के लिए आनुवंशिक बीमारियों के डीएनए परीक्षण के लिए कुल 20 मवेशियों (18) और भैंस (2) की जांच की गई।
- नेटवर्क परियोजना के तहत, नए पशुओं और मुर्गों के फेनोटाइपिक और जीनोटाइपिक लक्षण स्थापित करने पर कार्य चल रहा है। अंकलेश्वर, कड़कनाथ मुर्गी और असम के स्थानीय सुअर और बकरी (टीएसपी के तहत) का संरक्षण उनके प्रजनन क्षेत्र में जारी है।
- पिछले वर्ष के दौरान कुल 7 अनुसंधान परियोजनाएं पूरी हुईं। वर्तमान में संस्थान में पाँच बाह्य वित्त पोषित और एक राष्ट्रीय फेलो परियोजना सहित 22 अनुसंधान परियोजनाएँ चल रही हैं।

- उच्च प्रभाव कारक के राष्ट्रीय और अंतर्राष्ट्रीय पत्रिकाओं में कुल 48 शोध पत्र प्रकाशित हुए। 24 तकनीकी/लोकप्रिय लेख प्रकाशित हुए हैं। संस्थान द्वारा दो पुस्तकें, एक मोनोग्राफ, एक तकनीकी बुलेटिन तथा एक प्रशिक्षण पुस्तिका प्रकाशित किए गए।
- वैज्ञानिक और शैक्षणिक कर्मचारियों के लिए लघु पाठ्यक्रम और मॉडल प्रशिक्षण पाठ्यक्रम आयोजित किया गया। आईसीएआर संस्थानों के प्रशासनिक, तकनीकी और सहायक कर्मचारियों के कौशल को बढ़ाने के लिए दो प्रशिक्षण कार्यक्रम आयोजित किए गए।
- ब्यूरो के वैज्ञानिकों ने मेरा गाँव गौरव में भाग लिया और विभिन्न गाँवों का दौरा कर किसानों के बीच अपने घर और खेत में जागरूकता पैदा की। संस्थान की गतिविधियों के प्रदर्शन के लिए विभिन्न स्थानों पर पशु आनुवंशिक संसाधन पर प्रदर्शनी आयोजित की गई और किसानों को स्वदेशी जानवरों के लाभों के बारे में जागरूक किया गया।
- संस्थान ने अलग-अलग अवसरों पर स्थापना दिवस, ब्यूरो दिवस, गणतंत्र दिवस और स्वतंत्रता दिवस, जय किसान जय विज्ञान, राष्ट्रीय अभियान अभियान, सतर्कता सप्ताह, अंतर्राष्ट्रीय योग दिवस, कृषि शिक्षा दिवस, हिंदी पखवाड़ा जैसे विभिन्न कार्यक्रम अपने परिसर में आयोजित किये।
- संस्थान अनुसंधान समिति (आईआरसी) और अनुसंधान सलाहकार समिति (आरएसी) की बैठकें समय पर हुईं और अनुसंधान परियोजनाओं की प्रगति की समीक्षा की गई।
- एनबीएजीआर के 22 स्टाफ सदस्यों की टीम ने आईसीएआर (उत्तर क्षेत्र) खेलों में भाग लिया।

बास्केट बॉल और साइकिल रेस में क्रमशः दूसरा व तीसरा स्थान प्राप्त किया।

- ब्यूरो के कर्मचारियों ने स्वतंत्रता दिवस और गणतंत्र दिवस हर्षोल्लास से मनाया। इस अवसर पर विभिन्न सांस्कृतिक गतिविधियों का आयोजन किया गया। गणतंत्र दिवस के अवसर पर आयोजित वार्षिक खेल-कूद प्रतियोगिता-2018 के विभिन्न कार्यक्रमों में सभी कर्मचारियों ने सक्रिय रूप से भाग लिया।
- महानिदेशक, डीडीजी (एएस), आईसीएआर सहित कई विशिष्ट व्यक्तियों ने संस्थान का दौरा किया।
- वैज्ञानिकों को देश के भीतर प्रशिक्षण कार्यक्रमों के लिए प्रतिनियुक्त किया गया और कार्यशालाओं, संगोष्ठियों और सम्मेलनों में भाग लेकर अपने शोध कार्य को प्रस्तुत किया।
- एनबीएजीआर वैज्ञानिक आईसीएआर-नेशनल डेयरी रिसर्च इंस्टीट्यूट की पशु आनुवंशिक एवं प्रजनन, पशु जैव प्रौद्योगिकी और पशु जैव रसायन विषयों के पीजी संकाय में शामिल हैं और इन प्रभागों में विभिन्न विषयों / पाठ्यक्रमों को पढ़ा रहे हैं। वैज्ञानिक नियमित रूप से मास्टर्स और पीएचडी डिग्री के लिए आईसीएआर-एनडीआरआई सहित विभिन्न संस्थानों और विश्वविद्यालयों के छात्रों का मार्गदर्शन भी कर रहे हैं।
- वर्तमान में संस्थान में 28 वैज्ञानिक, 15 तकनीकी, 17 प्रशासनिक और 4 कुशल कर्मचारी काम कर रहे हैं। तीन वैज्ञानिकों, एक तकनीकी तथा एक प्रशासनिक कर्मचारी ने अगले उच्च ग्रेड में पदोन्नति प्राप्त की। एक वैज्ञानिक एनडीआरआई में स्थानांतरित हुए। डॉ आर्जव शर्मा निदेशक ने 31 दिसम्बर 2018 को सेवानिवृत्ति प्राप्त की।

N B A G R



## **INSTITUTE'S PROFILE**

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**ORGANOGRAM**

**ABOUT BUREAU**

**ABOUT DIVISIONS**

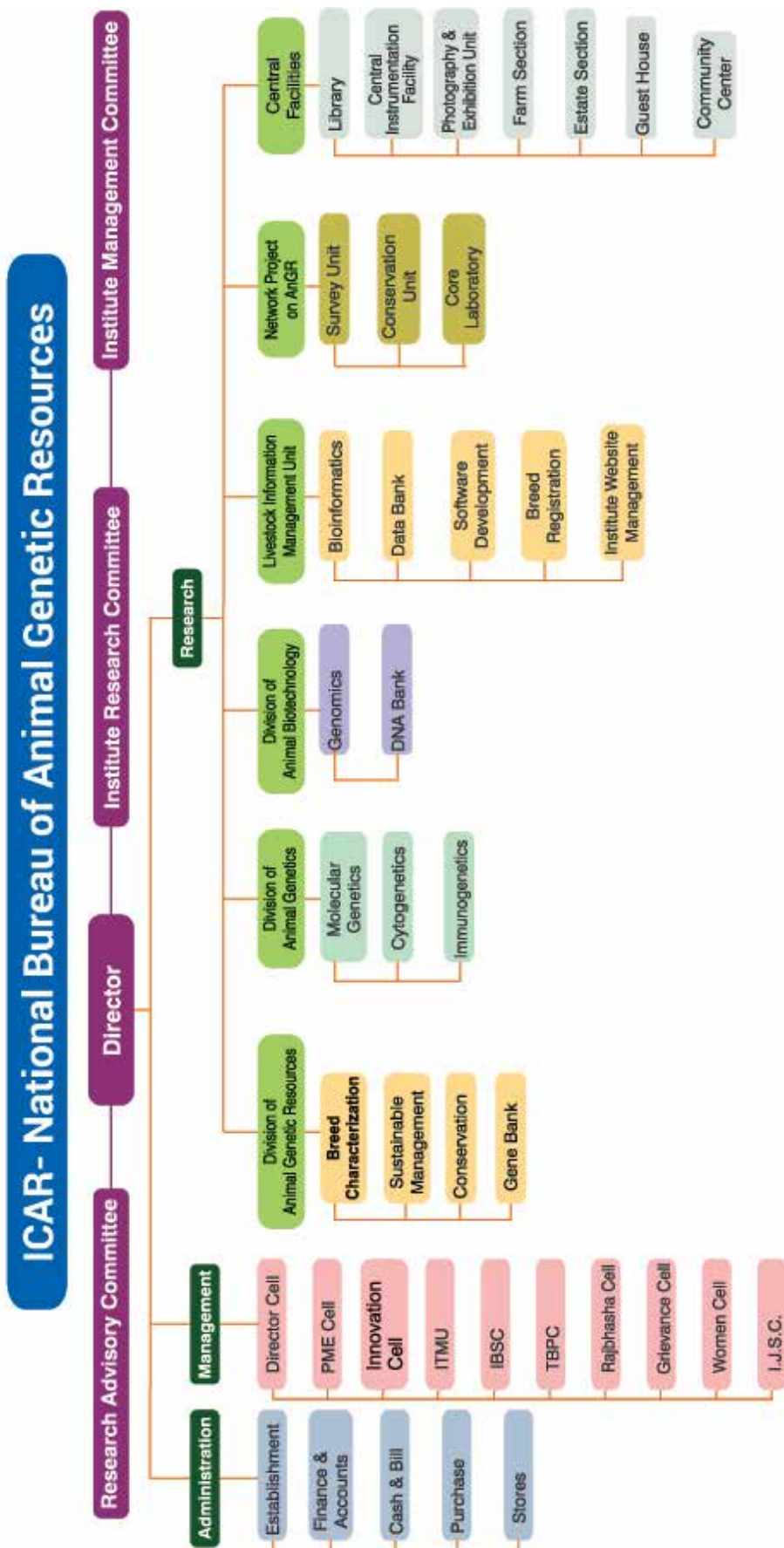
**FINANCIAL OUTLAY**



# N B A G R

## INSTITUTE'S PROFILE

### ORGANOGRAM







## ABOUT BUREAU

The need for the establishment of an institute which can look after the characterization and conservation of Indian indigenous livestock was accepted in principle during 4<sup>th</sup> Five Year Plan. During 5<sup>th</sup> and 6<sup>th</sup> Five Year Plan, various government agencies coordinated the efforts for the establishment of this Institute. Therefore, twin institutes in the form of National Bureau of Animal Genetic Resources (NBAGR) and National Institute of Animal Genetics (NIAG) were set up on 21st September, 1984. These institutes started at Regional Station of National

Dairy Research Institute, Bangalore. Bureau and the institute were then shifted to Karnal in 1985 and temporarily housed in NDRI main campus before shifting to its own campus at Makrampur, Karnal in 1994. The unification of two institutes came on the recommendation of QRT when both the Institute and the Bureau were merged to function as a single unit as National Bureau of Animal Genetic Resources. ICAR-NBAGR has been the nodal organization in India with the mandate and objectives as given below

### MANDATE

- Identification, evaluation, characterization, conservation and utilization of livestock and poultry genetic resources of the country.
- Coordination and capacity building in animal genetic resources management and policy issues.

### OBJECTIVES

- To conduct systematic surveys to characterize, evaluate and catalogue farm livestock and poultry genetic resources and to establish their National Data Bank.
  - To design methodologies for *ex-situ* conservation and *in-situ* management and optimal utilization of farm animal genetic resources.
  - To undertake studies on genetic characterization using modern techniques of molecular biology.
  - To conduct training programmes as related to evaluation, characterization and utilization of animal genetic resources.
- Further, recognising the need for an authentic national documentation system of valuable sovereign genetic resources with known characteristics, a mechanism for “Registration of Animal Germplasm” was required for which the bureau was assigned with important responsibility by the Indian Council of Agricultural Research (ICAR) of being the nodal agency for developing a mechanism of registering the breeds of various domesticated species of Indian livestock. This would provide protection to the valuable animal genetic diversity and facilitate its access for genetic improvement of animal breeds. This mechanism would be the sole recognised process for registration of “Animal Genetic Resources” at national level.

## ABOUT DIVISIONS

Following divisions have been created in 2013 to achieve the institute's mandate and objectives:

### *Animal Genetics Resource Division*

In 1996, the Animal Physiology and Reproduction Section was merged into Animal Genetic Resources Division and since then the division continues in its present form.

At present Animal Genetic Resources Division along with its 'National Gene Bank' is engaged in phenotypic characterization, which is accomplished through systematic/pilot field surveys to assess flocks/herd structure, population status, practices, phenotypic characteristics, body biometry, reproduction and production performance, and marketing of live animals and products. The production performance of local breeds is evaluated and recorded under agro-climatic conditions of their habitat. The surveyed breeds/populations are documented in the form of breed monographs, breed descriptors and charts in addition to research publications. Based on the information, new strategies have been formulated for improvement and conservation of the breeds under field conditions. The *in situ* conservation has been implemented for breeds of various livestock species. In addition, the division is also working in the frontier areas of long term *ex-situ* conservation of germplasm.

### *Animal Genetics Division*

The present Animal Genetics Division is a transformed form of National Institute of Animal Genetics (NIAG) which was co-established with National Bureau of Animal Genetic Resources initially. Animal Genetics Division established in the year 1996 was formally approved in 2014 by the Indian Council of Agricultural Research with the objective 'Molecular, immunological, biochemical, cytogenetic characterization and candidate gene analysis of livestock species'. Scientists working in the fields of cytogenetics,

immunogenetics, and molecular genetics became the part of Animal Genetics Division. The division has presently five principal scientists, three senior scientists, one scientist Senior Scale, one technical officer, one steno grade III and one skilled supporting staff.

During the period under report, scientists from this division completed three IRC and one DBT funded research projects successfully. Four IRC approved research projects are in progress. In addition to this, one ICAR-AGRI Consortia Research Platform project on Genomics is also running in the division. Three more project proposals were submitted from the division for the approval of IRC. One of the important activities of the division is to provide consultancies/services for testing the breeding bulls for any inheritable abnormality and thus generate revenue for the institute. The research findings have been published in reputed journals of high impact factor. Scientists also participated in national and international conferences and fetched awards for their presentations. Apart from this, Scientists being the part of NDRI faculty were involved in teaching and guiding the M.Sc and Ph.D students.

### *Animal Biotechnology Division*

The division was established in 2014, by renaming and reorganizing the erstwhile DNA Fingerprinting Unit. At present there are six scientists, working in the division supported by three technical and one skilled supporting staff. Work in the division is being carried out under the objective of 'Evaluation of functional genes/biomolecules for enhancing AnGR utilization'. Apart from working in the areas of mandated institutional activities on genetic characterization of livestock species, scientists are engaged in various institute and externally funded projects. Major emphasis is on identification and evaluation of genes and transcripts associated with various production/disease resistance/adaptation traits by utilization of genomic tools. There is one National Fellow project and several

mentorship programs as well as four institute projects running in the division. During last year, under externally funded, NASF project on A1A2 beta casein milk proteins, through mice feeding trials transcriptome data has been generated on liver and several differentially expressed transcripts have been identified, with potential role in progression of diabetes. The data was well supported by the histopathological changes in Liver and kidneys and serum biochemical parameters. Under the National Fellow scheme on heat stress adaptation, polymorphism data has been generated on cattle breeds adapted to different agro-climatic conditions. Work has also been carried out in sheep, identifying differentially expressed genes and pathways associated with muscle tenderness, fat metabolism and ion transport in Bandur mutton sheep. Bandur sheep meat found to be having high tenderness as well as high histidine contents. miRNA profiling of Bandur and local sheep identified differentially expressed miRNAs with target genes involved in muscle development and meat quality traits. To understand the genetic basis of white markings inheritance in Nili Ravi buffalo and their impact on heat stress and production parameters, work has been initiated. Criteria for classification of animals into under, over and typical designed and blood samples profiling has shown significantly differential neutrophil counts in three categories. Polymorphism in the candidate genes, potentially associated with white markings also identified. Under another institute funded project on characterization of buffaloes, cytogenetic profiling helped in documentation of pure swamp type buffaloes in Meghalaya state. Mitochondrial D-loop sequence based haplotypes sharing also confirmed these buffaloes as swamp type. As faculty in the Animal Biotechnology discipline at NDRI, Karnal, scientists of the division are also actively engaged in teaching and thesis research guiding activities for Masters and PhD students. Students and scientists of the division have received, best publication award for publishing article in the Journal of Livestock Biodiversity

and several poster and oral presentation awards at various fora. As always, Animal Biotechnology Division also published highest number of quality research papers in the international journals of high repute, among all the divisions during the year.

### *Network Project Unit*

The Network project was initiated in 1996 with the following objectives:

- To characterize the breeds in terms of both qualitative and quantitative traits
- Molecular genetic characterization and candidate gene studies in indigenous breeds to develop the breed descriptors
- To conserve the germplasm

There were 8 centers in VII plan for characterization of breeds. In IX and X plan 12 new centers in each plan were undertaken for characterization of breeds. Genetic characterization and conservation activities were also initiated from IX plan. In XI plan, one core lab was established in NEH region and buffalo genomics work was also taken up. During current XII plan, 17 new breeds/populations have been undertaken for characterization and work on 4 at risk breeds has been started for conservation. The updated achievements include phenotypic and genetic characterization and development of breed descriptors of 11 breeds of cattle (Deoni, Ongole, Gir, Umblachery, Bachaur, Dangi Amritmahal, Khillar, Gaolao, Tho-Tho, Gangatiri), 3 breeds of buffalo (Jaffarabadi, Nagpuri, Surti), 8 breeds of sheep (Changthangi, Deccani, Mecheri, Mandya, Rampur Bushair, Banpala, Coimbatore, Chhota-Nagpuri), 5 breeds of goat (Osmanabadi, Barbari, Attapady, Ganjam, Mehsana), 2 breeds of chicken (Aseel, Ankleshwar), Kutchi Camel, Spiti horse and Arunchali Mithun. Conservation of AnGR includes 5 cattle breeds (Krishna Valley, Ponwar, Kherigarh, Kangayam, Nagori), 3 buffalo breeds (Pandharpuri, Jaffarabadi, Toda), 3 sheep breeds (Magra, Nilgiri, Kilakarsel), 2 goat breeds (Beetal, Surti) and Spiti horse.

## FINANCIAL OUTLAY

### Budget Estimate under Grants & Network Project of NBAGR for the financial year 2018-19 alongwith expenditure

(Rs. in Lakhs)

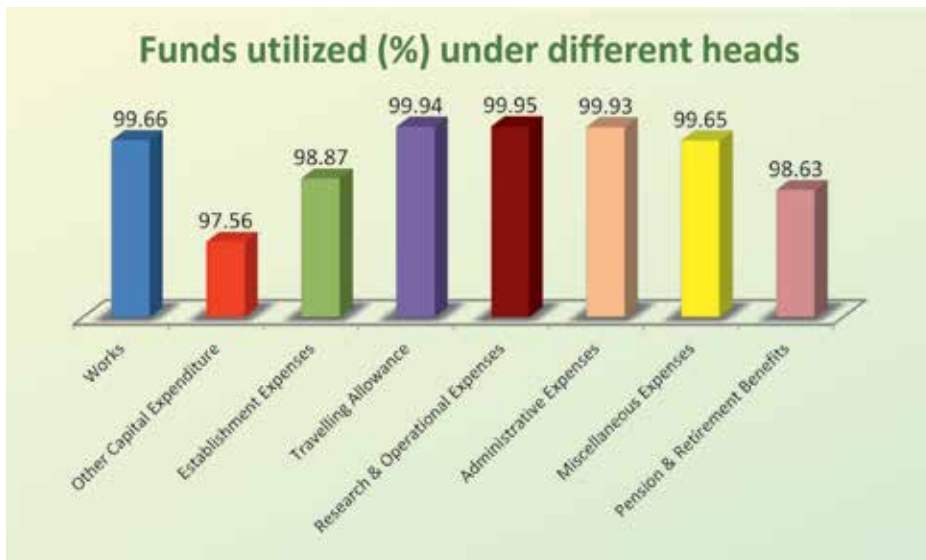
S. N.	Head	Grants		Network Project	
		RE	Exp.	RE	Exp.
<b>1.</b>	<b>Capital</b>	<b>49.76</b>	<b>48.85</b>		
	i) Works	14.50	14.45	-	-
	ii) Other capital expenditure	35.26	34.40	-	-
<b>2.</b>	<b>Revenue</b>	<b>1555.29</b>	<b>1542.16</b>	<b>107.33</b>	<b>107.15</b>
	i) Establishment Expenses	1135.64	1122.77	-	-
	ii) Traveling Allowance	16.90	16.89	-	-
	iii) Research & Operational expenses	201.30	201.20	-	-
	iv) Administrative Expenses	195.70	195.57	-	-
	v) Miscellaneous Expenses	5.75	5.73	-	-
<b>3.</b>	<b>Pension &amp; Retirement Benefits</b>	<b>112.00</b>	<b>110.47</b>	-	-
	<b>Grant Total</b>	<b>1717.05</b>	<b>1701.48</b>	<b>107.33</b>	<b>107.15*</b>

\*Includes Releases of Rs.100.50 lakhs

### Revenue Generated during the year 2018-19

S. N.	Head of Account	Amount (Rs.)
1.	Sale of Publication & Advertisement	17200
2.	Licence fee	197799
3.	Training Programs - Income	22900
4.	Hostel and Guest house rent	461745
5.	Sale of Technology	819164
6.	Sale of farm Produce	151452
7.	Others Misc. Revenue Receipts	3735983
	<b>Total</b>	<b>5406243</b>











N B A G R



## **RESEARCH PROJECTS**

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**INSTITUTIONAL RESEARCH PROJECTS**

**EXTERNAL FUNDED PROJECTS**

**NATIONAL FELLOW PROJECT**

**POST DOCTORAL FELLOWSHIPS**

### INSTITUTIONAL RESEARCH PROJECTS

#### Completed Projects

S.N.	Project	Workers	Duration
1	Characterization of Mangadh Dahodi cattle of Gujarat.	RAK Aggarwal, PK Vij, MS Tania and Sukram Ninama; Prakriti Foundation	October, 2017 to March, 2019.
2	Deciphering the molecular basis of male sub-fertility or sterility in bovines.	Sonika Ahlawat, Rekha Sharma and Sachinandan De (NDRI) and Reena Arora (from Nov.2014)	April, 2014 to March, 2018.
3	Study of the genetic variability present across the Goat Major Histocompatibility complex Class II antigens.	Jyotsna Behl and NK Verma	April, 2015 to March, 2018, extended up to March, 2019.
4	Genome wide diversity analysis of Indian Yak populations	Jayakumar S, SP Dixit, Karan Veer Singh and Avnish Kumar (w. e. f. May, 2018)	April, 2015 to March, 2018, extended up to March, 2019
5	Skeletal Muscle transcriptome profiling of Bandur (Mandya) sheep.	Reena Arora, Sonika Ahlawat and RK Viji	April, 2016 to March, 2019.
6	Development of Mobile Application on Farm Animal Genetic Resources of India.	Avnish Kumar and DK Yadav	October, 2017 to March, 2019
7	Delineating Beta Casein Variants in Indian Cows and Potential Health Implications of A1A2 Milk. (NASF)	Monika Sodhi, M Mukesh, RS Kataria and SK Niranjana	July, 2015 to June, 2018, extended up to December, 2018.

#### Ongoing Projects

S.N.	Project	Workers	Duration
1	Identification of Genetic and phenotypic variation associated with Tick infestation in Indian Cattle	Karan Veer Singh and Kamal Jaiswal, BBAU Lucknow. (Jayakumar S up to 3.5.17 and Vikas Vohra up to 29.06.18).	April, 2016 to March, 2019, extended up to March 2020
2	Understanding the molecular basis of characteristic white markings and their inheritance in Nili Ravi buffalo	RS Kataria, M Mukesh, Vikas Vohra (NDRI), Sanjay Kumar & KL Mehra-CIRB-Nabha Campus and KP Singh-CIRB-Hisar.	July, 2018 to June, 2020
3	Characterization of hybrid sterility locus (PRDM9) in Equines, Camels and Pigs.	Sonika Ahlawat, Rekha Sharma, Reena Arora and Karan Veer Singh	July, 2018 to June, 2021
4	Identification and Characterization of goat germplasm of Andhra Pradesh and Telangana states	NK Verma, RAK Aggarwal, Rekha Sharma and PS Dangi	October, 2017 to March, 2020
5	Karyotyping and DNA Testing for Screening Genetic Defects in Indian Bovines. (Service project)	SK Niranjana and Jayakumar S	April, 2016 to March, 2021.
6	Phenotypic and Genetic Characterization of Yak and donkey populations of North trans-Himalayan region of India	SK Niranjana, Rahul Behl, Jyotsna Behl, M Iqbal (CAHO, Leh) and Vijay K Bharti (DIHAR, Leh)	July, 2017 to March, 2020



# N B A G R

## RESEARCH PROJECTS

7	Phenotypic and genetic characterization of Non-descript cattle in Madhya Pradesh	Jayakumar S, SK Niranjana and Ajit Pratap Singh (NDVSU, Jabalpur).	July, 2018 to March, 2020.
8	In-silico and in-vitro analysis of genome-wide SNPs in indigenous and exotic cattle for local adaptation.	Sanjeev Singh, I Ganguly, SP Dixit, and AK Bhatia	July, 2018 to June, 2021
9	Study on the Variability and Evolution of Bovine Beta-Defensin Genes.	Jyotsna Behl, Jayakumar S, Rahul Behl and NK Verma	July, 2018 to June, 2021
10	Conservation of Sahiwal and Haryana cattle at Gaushalas	RK Pundir, Arjava Sharma (up to 31.12.2018), PK Singh, AK Mishra and KN Raja	April, 2015 to March, 2020
11	Evaluation of livestock policies and programmes for the management of Animal Genetic Resources in Haryana and Punjab states	PK Singh, RK Pundir, Arjava Sharma (up to 31.12.2018) and HK, Verma (GADVASU)	July, 2017 to June, 2019
12	Characterization and evaluation of lesser known cattle populations (Vandharvi, Zari and Kamma) of Telangana state.	RK Pundir, PK Singh and PS Dangi and Sabyasachi Das (WASSAN-NGO)	July, 2017 to June, 2020.
13	Characterization of non-described cattle population of Kerala and Tamil Nadu.	KN Raja, AK Mishra, R Saravanan (TANVAS) and K Anil Kumar	October, 2017 to September, 2020.
14	Identification, characterization and evaluation of mixed indigenous cattle populations of Haryana, Punjab and North-West Rajasthan	Anand Jain DK Yadav and HK Singh (CHRS-Rohtak)	October, 2017 to March, 2020.
15	Characterization and evaluation of some non-descript buffalo populations of Central and Eastern India	Karan Veer Singh, Vikas Vohra (PI-up to 29.06.18), RS Kataria, Monika Sodhi, PS Dangi, SV Kuralkar (PGIVAS, Akola) and R Das (VO-ARD, Tirpura)	October, 2017 to September, 2020.
16	Phenotypic characterization of some less known sheep populations of Uttarakhand and Andhra Pradesh	AK Mishra, KN Raja, Sunil Kumar (Pantnagar) and R Vinoo (Andhra Pradesh)	July, 2018 to June, 2022
17	Network Project on Animal Genetic Resources.	RK Viji (w.e.f.01.02.2019) Director NBAGR, Project coordinator and MS Tandia (I/c, Network Project)	1992- Contd.
18	Evaluation of Kadaknath, Desi and broiler chicken meat for Histidine containing dipeptides	Rekha Sharma, Sonika Ahlawat, MS Tandia, Vivek Sharma (NDRI) and Mohan Singh (NDVSU, Jabalpur)	July, 2018 to June, 2021
19	Characterization of local goat and cattle populations of Mahakaushal region of Madhya Pradesh and Jharkhand states.	MS Tandia, PK Vij, RAK Aggarwal, Rekha Sharma, PC Chandran, Amitava Dey, Reena Kamal (ICAR for ER-Patana), Mohan Singh, (NDVSU, Jabalpur).	July, 2018 to June, 2022.

### EXTERNAL FUNDED PROJECTS

S.N.	Project	Workers	Duration
1	CRP on Agro-biodiversity Conservation of Animal Genetic Resources.	MS Tantia, RAK Aggarwal, PK Vij, and Rekha Sharma	June, 2015 to March, 2017, extended up to March, 2020
2	ICAR-AGRI Consortia Research Platform project on Genomics: - Identification of markers for economic traits and Transcriptomics study in Buffalo and goats.	RK Vijh, Reena Arora, Sonika Ahlawat, Jayakumar S and SP Dixit	June, 2015 to March, 2017, extended up to March, 2020

### NATIONAL FELLOW PROJECT

S.N.	Project	Worker	Duration
1	Genome data mining to unravel molecular basis of thermo tolerance and adaptation to diverse environment in native cattle and buffaloes.	Manishi Mukesh	May, 2011 to May, 2016. Phase II up to 23rd May, 2021

### POST DOCTORAL FELLOWSHIPS

S.N.	Name of Scholar	Title of Project	Name of Mentor	Funding Agency & Nature of Fellowship
1	Dr. Manoj Kumar Singh	Establishing colostrum metabolome resources of India: implications for human health.	Dr. M Mukesh	Science and Engineering Research Board (SERB) SERB N-PDF
2	Dr. Namita Kumari	Exploring genetic diversity across MHC class II locus and its association with differential immune response in indicus, cross breed and exotic cattle.	Dr. RS Kataria	Department of Biotechnology (DBT)
3	Dr. Kusum	X-chromosome genetic diversity and selection signature for cattle improvement.	Dr. SP Dixit	Science and Engineering Research Board (SERB) SERB N-PDF



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## **RESEARCH ACCOMPLISHMENTS**

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**IDENTIFICATION AND EVALUATION OF ANIMAL GENETIC RESOURCES**

**GENOMICS AND BIOINFORMATICS**

**CONSERVATION AND SUSTAINABLE UTILIZATION OF ANIMAL GENETIC RESOURCES**

**NETWORK PROJECT ON ANIMAL GENETIC RESOURCES**

## IDENTIFICATION AND EVALUATION OF ANIMAL GENETIC RESOURCES

### New Registered Breeds of AnGR

Breed registration Committee in its meeting held on 5<sup>th</sup> September, 2018 at New Delhi approved registration of fifteen new breeds of livestock and poultry. This includes two breeds of cattle, three buffalo, six goat, and one each of sheep, pig, donkey and chicken. Total number of indigenous breeds now in the country is 184, which include 43 for cattle, 16 buffalo, 34 goat, 43 sheep, 7 horses & ponies, 9 camel, 8 pig, 2 donkey, 1 yak, 19 chicken, 1 duck and 1 geese.

**Ladakhi cattle:** Ladakhi cattle are native to Ladakh region of Jammu & Kashmir. These are small sized and short statured black or brown colored animals well adapted to extreme cold climatic and hypoxic conditions. Body is compact with short legs that make this cattle more adapted to mountainous terrains. These cattle are reared under extensive system for milk, draft and manure purposes. Horns are curved slightly upward and forward ending with pointed tips over the forehead. Forehead is straight, small and hairy with slightly long face. Udder is small

### New breeds registered

S.N.	Breed	Home Tract	Accession Number
<b>Cattle</b>			
1	Ladakhi	Jammu and Kashmir	INDIA_CATTLE_0700_LADAKHI_03042
2	Konkan Kapila	Maharashtra and Goa	INDIA_CATTLE_1135_KONKANKAPILA_03043
<b>Buffalo</b>			
3	Luit (Swamp)	Assam and Manipur	INDIA_BUFFALO_0212_LUIT_01014
4	Bargur	Tamil Nadu	INDIA_BUFFALO_1800_BARGUR_01015
5	Chhattisgarhi	Chhattisgarh	INDIA_BUFFALO_2600_CHHATTISGARHI_01016
<b>Sheep</b>			
6	Panchali	Gujarat	INDIA_SHEEP_0400_PANCHALI_14043
<b>Goat</b>			
7	Kahmi	Gujarat	INDIA_GOAT_0400_KAHMI_06029
8	Rohilkhandi	Uttar Pradesh	INDIA_GOAT_2000_ROHILKHANDI_06030
9	Assam Hill	Assam and Meghalaya	INDIA_GOAT_0213_ASSAMHILL_06031
10	Bidri	Karnataka	INDIA_GOAT_0800_BIDRI_06032
11	Nandidurga	Karnataka	INDIA_GOAT_0800_NANDIDURGA_06033
12	Bhakarwali	Jammu and Kashmir	INDIA_GOAT_0700_BHAKARWALI_06034
<b>Pig</b>			
13	Ghurrah	Uttar Pradesh	INDIA_PIG_2000_GHURRAH_09008
<b>Donkey</b>			
14	Halari	Gujarat	INDIA_DONKEY_0400_HALARI_05002
<b>Chicken</b>			
15	Uttara	Uttarakhand	INDIA_CHICKEN_2400_UTTARA_12019



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in size and bowl shaped. Milk yield is around 2 to 5kg/day. Milk has high fat percentage of around 5% and used mainly for preparation butter and *churpi*, important part of diet of local people.



**Konkan Kapila:** Distributed in Konkan region of Maharashtra and Goa. The animals are of various coat colours, predominant being reddish brown/black, however white/grey, mixed and in few animals brown or fawn coat colour is also available. The animals are small to medium in size with compact body, straight face, small to medium sized hump and dewlap. Generally straight and small sized horn emerge from side of the poll behind and above eyes in outward and going upwards and backwards ending with pointed tips. Konkan Kapila cattle are low milk producers (around 2.25 kg/day) and possess good draft ability suited to hilly terrain and hot and humid climate of its native tract.



**Luit buffalo (Swamp):** These are swamp buffaloes having 48 diploid no. of chromosome (2N) and distributed mostly in upper Brahmaputra valley of Assam. These are also found in some areas of Mizoram, Manipur and Nagaland bordering Assam. Luit is a medium sized black coloured buffalo with compact body and strong built up. Forehead is



broad with conical face and wide muzzle. Eyes are prominent. Horns are broad at base, curved upward to form a semi circle and taper to a narrow tip. Light white stockings up to the knee are present in both fore and hind legs. Tail is short reaching up to the hocks. Udder is bowl shaped and small in size. Lactation milk yield ranges from 385 to 505kg. Bullocks are excellent draft animals for carting and ploughing especially in muddy field for paddy cultivation.

**Bargur buffalo:** These buffaloes are found in the Bargur hills in Tamil Nadu. Coat colors vary from black to light brown or brownish black. Greyish white stockings from carpal/tarsal joint to fetlock are present predominantly in females. These buffaloes are maintained under extensive system and are reared for manure, milk and meat (male calves are sold for cara-beef). The animals are adapted to graze in the hilly terrain due its small size (about 102 cm in height). The milk yield of the animals ranges from 1.5 to 2.0 liters per day and mainly used for house hold consumption.



**Chhattisgarhi buffalo:** These buffaloes are distributed throughout the Chhattisgarh state. Coat colour is black. Animals are medium built with proportionate body. Horns are medium to large in size and directed laterally backwards and then upwards with pointing tips. These buffaloes are reared under extensive system for providing draught power, milk and meat. Males have excellent ploughing ability, and preferred over cow bullocks



specifically in rice fields. Milk yield ranges from 3 to 6 kg/day.

**Panchali sheep:** Panchali is a dual purpose sheep reared for milk & meat in Panchal area of Gujarat. Animals are large in size, and have long legs and excellent migration ability. Coat color is white. Head or facial parts are black, blackish brown, brown



and light brown in color. Ears are long and pendulous. Tail is long. Udder is well-developed. Milk yield ranges from 0.4 to 1.2 litre/ day. Animals attain 18 to 20kg body weight at 3 to 4 months of age. Adult weight varies from 53 to 82kg in males and 32 to 73kg in females. Wool is coarse and annual production is nearly one kg.

**Kahmi goat:** This goat is native to Saurashtra region of Gujarat. Coat color is unique - neck and face are reddish brown while rear abdominal part is black, locally called *Kahmi*. Ears are long, tubular & coiled, locally called *veludi*. Wattles are present in majority of goat. Forehead is convex. Horns are directed upwards and backwards. These goats are used both for meat & milk. Average daily milk yield is about 1.7kg. Average adult body weight is 56kg in males and 48kg in females. Average liter size is 1.4.



**Rohilkhandi goat:** Native to Rohilkhand region of Uttar Pradesh, and is reared for meat and milk. Coat colour is predominantly black with star or patch on neck and face in some animals. Majority of animals are horned which are curved, and

directed laterally and outwardly. Beard and wattles are absent in both sexes. Forehead is slightly convex. Tuft of hair (black



or brown) is present in thigh region. Tail is bunchy. Adult body weight ranges from 25 to 36 kg in male and 21 to 31 kg in female. Twinning is common and triplets are frequently observed. Average litter size is 1.57. Daily milk yield ranges from 450 to 740 g.

**Assam Hill goat:** Distributed in Assam and adjoining areas of the Meghalaya. Assam Hill goats are mostly white with occasional black patches on backline and legs. These goats are short legged



with small body size. Both buck and does are bearded and have short cylindrical horns which are directed upwards and outwards. Ears are medium in size, horizontally placed with pointed tips. This is an important meat type animal with high prolificacy. These goats are reared mainly for meat. Adult body weight ranges from 15 to 26kg. Age at first kidding ranges from 337 to 447 days. Average litter size is 1.6.

**Bidri goat:** These are black colored goats found in north-eastern part of Karnataka. Muzzle, eyelids and hooves are black. Horns are present and are directed backward, outward and downward. Ears are pendulous. Goats are reared



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for meat only. Twining is common but first kidding is single. Average litter size is 1.7. Adult weight varies from 23 to 52kg in males and 19 to 45kg in females.

**Nandidurga goat:** These are white colored goats found in southern part of Karnataka. Muzzle, eyelids and hooves are black. Ears are leafy and pendulous. Horns are directed backward, downward and



inward touching neck in few animals. These are reared for meat only. Twining is common. Adult weight varies from 26 to 56kg in males and 24 to 41kg in females.

**Bhakarwali goat:** These are white colored goats distributed in Jammu division of Jammu & Kashmir. Face or hind quarters are black in some animals. Pure



black goats are also found. Whole body is covered with long hairs. These are large sized goats having convex head. Ears are pendulous. Horns are screw type and are carried upwards and backwards. These are reared for meat and milk. Udder is pendulous. Adult body weight varies from 35 to 60kg in males and 30 to 50kg in females. Average daily milk yield is about 900g.

**Ghurrah pig:** These pigs are native to Bareilly division and adjoining parts of Lucknow division of Uttar Pradesh. These are black colored medium sized pigs with flat belly, angular body and long straight snout. Legs below hock joint are white. Thick line of hairs is present from neck to shoulders. Head is elongated with triangular

face and short leaf shaped vertically erected ears. Adult male weighs about 46kg and female about 48kg. Litter size is 6.85 at birth and 5.65 at weaning.



**Halari donkey:** Native to Saurashtra region of Gujarat. These donkeys are white in colour. Muzzle and hooves are black. Forehead is mostly convex.



Halari donkey has a strong built and large size with an average height at wither of 108cm in males and 107cm in females, and average body length of 117cm in males and 115cm in females. These donkeys are very docile in temperament and are used as pack animals during pastoralist migration and for transportation as donkey cart. Halari Donkey can walk approx. 30-40 km in a day during migration.

**Uttara chicken:** Distributed in Kumaon region of Uttarakhand. Plumage is black in colour. Comb is single. These birds have feathered shank which is not present in any other indigenous breed of chicken. About 18% of birds have bunch of feathers on head (crest/crown). Broodiness is usual. The birds are more noisy and flighty.



Annual egg production ranges from 125 to 160 and egg weight from 49.8 to 52.7g. Adult weight is about 1.3kg in cocks and 1.1kg in hens.



## Identification and Characterization of New Germplasm

### *Mangadh dahodi cattle of Gujarat*

Survey for characterization of Mangadh dahodi cattle was undertaken in Mahisagar and Dahod districts of Gujarat. Estimated population of Mangadh dahodi population is around 2 lakh. The animals are primarily reared for agricultural operations and to some extent for milk production. The herd size varied from 2 to 10 with an average of 5.5 cattle per household. These cattle are reared in low input production system of management. The animals of Mangadh dahodi cattle are small sized. Coat colour is mostly white, while few are whitish grey or grey in colour. Males generally have dark grey colour at hump and back as compared to females. Skin

colour is grey. Muzzle, eyelids and tail switch are black in colour. Hooves are either black or grey in colour. Horns are greyish black in colour, thick at the base and are curved upwards, outward, inwards and backwards with pointed tips. Ears are horizontal. Forehead is straight. Hump is medium sized in males and small in females. Dewlap is small to medium in size. Naval flap and penis sheath flap is small in size. Udder is bowl shaped and small in size. Teats are cylindrical with rounded tip. Milk vein is not prominent. Daily milk yield ranges from 1.5 to 4.5 kg. Lactation length ranges from 155 – 220 days. Age at first calving ranges from 4.5 to 5 years. Calving interval varies from 15 to 18 months.



*A bull and cow of Mangadh dahodi cattle*

### *Jhari cattle of Telangana state*

Two surveys were conducted for Jhari cattle characterization in 4 districts of Telangana i.e. Adilabad, Asifabad/Kumuram Bheem, Nizamabad and Jagtial. A total of 193 animals of different age and sex from 17 villages belonging to 73 farmers were recorded for management, physical characteristics, morphometric traits and performance. Habitat and socio-economic parameters were also recorded. Jhari name was originated from the name of a village from Asifabad district. In the state there are 48.8 lakh



*Jhari cow*

cattle heads including 4.5 lakh crossbreds and 44.3 lakh indigenous. The surveyed districts



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had larger proportion of indigenous cattle as compared to crossbreds.

Jhari cattle are grey and white colored animals. Grey is predominate in males and white in females. Body was small to medium, compact and cylindrical in shape. Face is the major character for differentiating with other cattle population i.e. longer and convex type. The other differentiating characters is horns which are longer and thin at the base as compare to Ongole or its grades. Hump was moderate in bullocks and smaller in cows. Muzzle (92%) and eyelids (99%) were black. Horns were black (77%) and curved (93%) with outward and then upward orientation. Ears were smaller in length and horizontal in orientation. Tail was above the hock with black switch (81%). Naval flap was small, touching to body. Legs were strong and long. Udder was not developed and mostly bowl shaped (86%). Teats were 6-10 cm long and mostly funnel(79%). Temperament of cattle was docile.

Morphometric traits were recorded on 193 animals of different age and sex. The average body length, height at wither, chest girth, paunch girth, horn length, ear length, face length, face width, tail length without switch and tail length with switch in cows (157) were

102.44±0.71cm, 110.08±0.61 cm, 138.62±0.90 cm, 142.04±1.12 cm, 17.24±0.47 cm, 19.27±0.14 cm, 41.87±0.24 cm, 20.92±0.15 cm, 72.21±0.58 cm and 89.55±0.83 cm, respectively. The corresponding averages in bullocks (7) were 107.42±0.68 cm, 118.28±2.15 cm, 162.71±3.78 cm, 160.00±4.08 cm, 20.85±0.91 cm, 21.85±0.14 cm, 46.85±0.79 cm, 24.71±0.60 cm, 78.00 ±1.19 cm and 98.28±6.00 cm, respectively.

Birth weight ranged from 12-18 kg in female and 14 to 24 kg in males. Average adult body weight was 184.85±3.26 (158) in cows and 264.14±12.95 (7) in bullocks estimated from the morphometric traits. The daily milk yield ranged from 1.0 to 3.0 kg. Lactation length varies from 90 to 150 days. Calving interval ranged from 15 to 24 months. A pair of bullock may plough one acre of land in 6 to 8 hours. Bullocks were also used for transportation and load carrying. Average duration of bullocks work was 4 to 6 hours per day, around 40 days in a year.

### *Kuttampuzha and Vilwadri cattle of Kerala*

Survey was conducted in Ernakulum and Trissur districts of Kerala and the information on body biometry, phenotypic characters, reproduction performance, utility and management practices were recorded for Kuttampuzha and Vilwadiri



*Kuttampuzha cattle*



*Vilwadiri cattle*

cattle populations. Both Kuttampuzha and Vilwadiri cows are small in size. Kutampuzha cattle are also called as Periyar cattle because of its distribution in the villages on both sides of Periyar river. Periyar cows are maintained under semi-extensive system of management where the animals are allowed to graze in the forest and rubber plantation area whereas; Vilwadiri animals are maintained under extensive system of rearing. The coat colour of Kuttampuzha cattle varies from grey-18.35% balck-21.25% brownish black-40.15% and mixiture-19.25% whereas for Vilwadiri cattle dark tan – 30.5%, black – 26.5%, grey – 11.0%, brownish tan – 5.65% and mixed – 26.35 % with straight forehead and curved horns. The body biometric traits viz., body length, height at withers, heart girth, paunch girth, horn length, ear length, face length, tail length and tail up to switch for Kuttampuzha cattle was observed to be  $101.87 \pm 1.66$ ,  $96.81 \pm 0.76$ ,  $129.96 \pm 1.48$ ,  $139.87 \pm 2.76$ ,  $11.65 \pm 0.95$ ,  $16.71 \pm 0.32$ ,  $37.55 \pm 0.45$ ,  $67.06 \pm 1.50$  and  $84.03 \pm 1.96$  and for Vilwadiri cattle were  $98.71 \pm 1.58$ ,  $93.75 \pm 1.12$ ,  $125.20 \pm 2.26$ ,  $134.98 \pm 2.63$ ,  $18.066 \pm 1.27$ ,  $16.20 \pm 0.18$ ,  $35.50 \pm 0.44$ ,  $65.90 \pm 1.01$  and  $77.09 \pm 1.53$ . There is a significant difference in height at withers, heart girth and tail length up to switch between these two cattle populations. These cattle populations

produced about 1.2 to 2.5 litres of milk per day under the extensive system of rearing and are aggressive in behaviour. In Vilwadiri cattle only natural breeding is followed were as in case of Kuttampuzha cattle few crosses were also observed with Vechur semen. Age at first calving, calving interval and lactation length for Kuttampuzha cattle was 2.5 - 3.5 years, 14 -18 months and 5.5 - 6.5 months, respectively.

### *Cattle population of Chambal region of Madhya Pradesh*

A pilot survey was carried out to explore and characterize the homogenous population(s) of native cattle populations of Madhya Pradesh (MP). Gwalior and Chambal Division (Bhind, Morena, Sheopur, Gwalior and Datia districts)



*Bawri (Garri) cattle in Sheopur district of Madhya Pradesh*

of Madhya Pradesh have the white and grey type cattle, as mixed populations distributed across the region. These cattle mostly reared for milk purpose and produce 2-7 Kg milk/ day. In Dang (ravine) areas of Gwalior, pastoralism is also followed by Gurjar community. Shivpuri, Sheopur and Guna districts of Madhya Pradesh have white and grey type native cattle populations, distributed across the region. Almost 90% cattle were of this type. These cattle mostly reared for milk purpose and produce 2-7 Kg milk/ day. In Dang (ravine) areas, pastoralism is also followed by Gurjar community. Other than coat colour i.e. Grey-white; the population is largely non-homogenous, not qualifying to a breed standard and distributed in almost all of the area, therefore the population can be described as Grey-white cattle only (instead of calling Non-descript). Rest of animals was crosses of Jersey and Gir cattle.

A unique cattle population was explored in Sheopur district that was different from the existing registered cattle breeds. Locally known as “Bawri” (also known as Garri) is being raised by Gurjars for milk under extensive system in ravine areas. For physical distinctions: it is medium in size; moderate to wild in temperament; coat is red-dane splashed with white colour; white to pink horns, hooves and tail switch; long and pointed horns, adapted to low water intake and grazing in rough terrain of ravine area. Milk production is 2-4 Kg. Herd size is 20-80; with a population size of about 20-25 thousand within defined area. This population can be further characterized and documented, as it has shown homogeneity and breed characteristics. During this pilot survey, a total of 113 animals of Bawri/ Garri cattle were studied for its phenotypic and morphometric characteristics.

### *Indigenous cattle populations of Haryana, Punjab and North-West Rajasthan: An evaluation of purity*

Survey was conducted in the Sirsa district of Haryana, Hanumangarh district of Rajasthan and Jalandhar and Ludhiana districts of Punjab. Two types of management systems were observed during the survey in Haryana and Rajasthan. The farmers who migrated from Lunkarnasar area of Rajasthan maintained indigenous cattle including Rathi x Sahiwal, Rathi, Sahiwal and also crosses of exotic breeds viz. HF and Jersey in very low proportion. Such farmers maintained large cattle herds under extensive to semi-intensive system of management. Cattle keeping is their primary occupation and source of livelihood. They migrate to nearby areas during lean periods. On the other hand, there were stationary farmers keeping small cattle herds under semi-intensive to intensive system of management. The cattle in these herds were crosses of exotic breeds viz. Holstein Friesian and Jersey. In Jalandhar and Ludhiana districts, a total of 56 cattle herds were surveyed having about 901 cattle, 352 buffaloes, 22 goats, 1 sheep, 21 horses, 11 dogs, 16 poultry and 4 ducks. The cattle being maintained were HF crosses which might have stabilized over the generations of breeding. The size was large, coat colour was black and white patches in most of the animals while some were almost complete black. The peak yield, recorded at random through interview, showed large variation. The resource poor farmers reported very low milk production in their HF crossbred cattle. One herd of HF crossbred cattle was in pathetic condition; it was infected by FMD and tick born diseases (theileriasis) the previous year; the owner suffered huge losses. A few farmers maintained Rathi, Sahiwal, Rathi X Sahiwal crosses and one farmer maintained Gir cattle. The crossbreds were reported to have the advantage of higher



milk production and lower age at first calving while disease resistance and longevity of milk production were better in indigenous breeds. Some of the farmers also reported reverting back to maintenance of indigenous cattle. For the resource poor farmers the indigenous cattle (Rathi and Sahiwal) are certainly a better choice.

### *Sheep population of Andhra Pradesh*

Phenotypic characterization and evaluation of Macherla Brown sheep population was initiated in Guntur district of Andhra Pradesh. Data pertaining to morphology, body biometry and body weight were recorded on 120 ewes, 24 rams and 89 lambs. Macherla Brown is mutton type local sheep inhabiting in the villages adjacent to Krishna River in Guntur, Krishna, Prakasham and Nalgonda, districts. It is also known as Gukkala jala and Guntur local. It is medium to large in size with coat color mainly white with black or brown patches on different parts of the body which is the characteristic of this breed. The convex head, leafy ears, black muzzle, and long hairs on thighs are predominant. Majority of females (99%) are polled however horns are noticed in both the sexes and horns are of mainly curved types. In majority of animals horns were oriented backward, downward and forward. The ear length ranged from 13 to 20 cm. The

pendulous lobules (wattles) hanging from the throat region are seen in both males and females and are present in 69.23% of animals. The tail is very small and thin. The udder is medium sized.

The average adult body weight of males and females animals were  $57.27 \pm 1.42$  and  $45.03 \pm 0.56$  kg, respectively which varies from 41 to 69 kg in males and 32 to 60 kg in females. The overall body length, height, chest girth, paunch girth, face length, face width, ear length and tail length were  $72.84 \pm 0.32$ ,  $72.84 \pm 0.32$ ,  $90.64 \pm 0.45$ ,  $92.67 \pm 0.53$ ,  $27.64 \pm 0.19$ ,  $9.82 \pm 0.10$ ,  $16.61 \pm 0.11$  and  $10.30 \pm 0.18$  cm respectively. Body weight of lambs in the age groups of 0-1, 1-3, 3-6 and 9-12 months were ranges between 4-16, 10-22, 18-37 and 24-50 kg respectively. The average flock size is 149.21 (range: 50 to 313). The flocks consist of 143.00 Macherla Brown and 6.21 other local sheep. Macherla Brown sheep flocks comprising 3.54 male, 111.00 female and 28.46 lambs.

Sheep are primarily maintained on grazing (extensive system) however 16.67% farmers provide concentrate to sheep especially during breeding season, pregnant ewes, lambs and during scarcity period. The majority (62.50%) of farmers kept sheep in open area. The distance covered by majority of sheep farmers (91.30%) for grazing was 8 to 10 km. The sheep are



*Macherla Brown male*



*Macherla Brown female*



generally not shorn and body is covered with hairs. The marketing age of male lambs was reported as 3 months and the cost of surplus lambs was reported as Rs. 3000 to 4000 by farmers. The ewes are bred through natural service, the rams per flock was observed to be 3.20 with a ram-ewe ratio of 1:34.59. In all the studied flocks only Macherla Brown rams are being used for breeding purpose. The farmers select their rams based on body size and colour pattern. The lambing season noticed are January to March and from August to October with an average of 80 to 85 percentage of annual lambing. The breeding life of ewes is reported to be 8 to 9 years. Twining is reported to be more than 10% by majority of farmers. However about 26% reported it as 1 to 2%. Majority of sheep farmers vaccinate their animals against FMD, PPR, Sheep pox, ET and BT. The major diseases noticed were FMD, PPR, Pox and ET in adults and Pneumonia in Lambs. The survey reveals that the Macherla Brown sheep is phenotypically different from other sheep breeds of the region and is famous for mutton production.

### *Local cattle and goat populations of Mahakaushal region of Madhya Pradesh and Jharkhand*

Preliminary survey was conducted in the tract of populations where some prior information

was available. In Jharkhand (Palamu region) one cattle and one goat population was identified and found to be uniform and candidates for characterization. In MP local cattle and buffalo population of Mahakaushal region was also uniform and different from known breeds. In Chhattisgarh local goat population was uniform.

In Jharkhand 3 districts (Palamu, Latehar and Gadhwa) were finalized as breeding tract and survey was conducted. Data on about 350 cattle/goat keepers have been collected for socio-economic parameters and management of livestock. Morphometric and biometric information on more than 500 animals of each species has also been collected.

### *Native goats of Telangana state*

Goats of Telangana state which have the origin of Mahbubnagar district are locally known as Mahbubnagari or Palamoor goat. Here, goats are reared mainly by SC/ST communities having no or little land holdings. Data on phenotypic attributes and management practices was recorded on 207 goats belonging to different flocks distributed in Mahabubnagar, Nagarkurnool, Jogulamba Gadwal, Medak, Adilabad, KB Asifabad and, Bupnapally districts of Telangana state. Blood samples were also collected from animals of different flocks for genetic study.



*Goat of Jharkhand*



*Cattle of Jharkhand*



*Goats of the Telangana state*

Goats with coat colour black, white, brown, with or without spots, splashes, with or without facial stripes existed in the flock. In Nallamala forest area, majority of goats were of black/brown and white splashes on their coat. Animals in Adilabad, Asifabaad, Bhupapally districts were mostly (60-70%) black. Wattles were present in 80% of animals. Prolificacy is good (60% twinning). Horn are thin, pointed, directing backward in females but thicker in males. Animals are with long tapering mouth, medium sized drooping ears, long and thin legs. Nose is either roman or flat. Muzzle is black/brown. Horn and hooves are grey.

The average body measurements (in cm) of adult mixed colour male goats for height,

length, chest girth, paunch girth, face length, horn length, ear length, tail length were 73.48±1.09, 67.13±1.19, 80.0±1.35, 79.26±1.50, 18.35±0.41, 13.96±1.20, 13.83±0.36, 13.35±0.42 respectively; for females 70.53±0.52, 67.22±0.51, 80.45±0.60, 81.45±0.71, 18.44±0.20, 13.88±0.42, 11.34±0.58, 13.37±0.23, respectively. The body weights were 38.70±1.91, 37.69±0.68 kg. The measurements for same traits in black male goats were 72.18±1.37, 65.27±1.13, 78.73±1.73, 79.64±1.78, 16.82±0.62, 12.56±1.14, 14.36±0.41, 14.09±0.46; for females, 72.03±0.77, 68.03±0.77, 81.31±0.69, 83.72±1.05, 18.17±0.26, 13.36±0.74, 12.42±0.83, 13.97±0.37cm and body weights were 37.27±2.52 and 40.42±1.02 kg.

### Average body measurements (in cm) of native goats of Telangana state

Group	Mixed colour coat				Black			
	3 to 9 Months		Adult		3 to 9 Months		Adult	
Age/Sex	Females	Male	Females	Male	Females	Male	Females	Male
Traits/ N	13	8	102	23	7	7	36	11
HW	56.77±1.14	58.00±1.31	70.53±0.52	73.48±1.09	59.71±2.30	60.57±1.62	72.03±0.77	72.18±1.37
BL	52.69±1.08	57.50±1.34	67.22±0.51	67.13±1.19	59.59±2.28	56.29±1.44	68.03±0.77	65.27±1.13
CG	62.54±1.04	62.75±1.45	80.45±0.60	80.30±1.35	68.00±1.83	63.86±0.88	81.31±0.69	78.73±1.73
PG	63.69±1.36	62.25±1.82	81.45±0.71	79.26±1.50	68.71±1.48	64.71±1.41	83.72±1.05	79.64±1.78
FL	14.69±0.46	13.88±0.58	18.44±0.20	18.35±0.41	15.14±0.63	14.00±0.69	18.17±0.26	16.82±0.62
HL	4.23±0.74	4.75±1.15	13.88±0.42	13.96±1.20	4.57±0.84	4.86±0.91	13.36±0.74	12.56±1.14
EL	11.15±0.56	13.00±0.57	11.34±0.58	13.83±0.36	12.14±0.51	12.43±0.61	12.42±0.83	14.36±0.41
TL	11.62±0.47	11.63±0.65	13.37±0.23	13.35±0.42	12.86±0.67	13.14±0.94	13.97±0.37	14.09±0.46
BW	19.54±1.01	19.63±1.15	37.69±0.68	38.70±1.91	22.00±2.04	21.43±1.55	40.42±1.02	37.27±2.52

HW-Height at Withers, CG-Chest Girth, PG- Paunch Girth, FL-Face Length, HL-Horn Length, EL- Ear Length, TL- Tail Length BW- Body Weight

Goats are kept under semi-extensive management sending them for pasture/jungle grazing during day time. The animals come back in the evening and stay at home in the night. Goat houses are kept either in open space or in temporary structures without any proper arrangement of water and electricity. Breeding is through natural mating. These goats have early maturity and give multiple births second kidding onward. Prolificacy is good with singlet in first kidding and 60 % twining in subsequent kiddings. Triplets in few cases were seen but quadruplets were rare. Genomic DNA of 31 Mahbubnagar goats genotyped for the reported SNPs in the candidate genes for prolificacy (GDF9, BMP15 and BMP1B), however, did not support their association with prolificacy trait.

## Evaluation of AnGR

### *Delineating Beta Casein variants in Indian cows and potential health implications of A1A2 Milk*

A study was conducted to investigate the time course effects of milk with different genotypes (A1A1, A2A2 & A1A2) with respect to A1/A2 allele of beta casein on the liver, kidney and pancreas of C57BL/6 mice. The mice were divided into four groups (three experimental groups and one control group) and were fed with milk powder based diet. The milk powder was prepared from specific milk genotype that is A1A1, A1A2 & A2A2. After trial, the mice were sacrificed at an interval of 3, 6 & 9 months and tissue (liver, kidney and pancreas) samples were surgically removed. Histological examination of the liver from mice fed with A1A1 and A1A2 milk showed fatty liver changes beginning from the 3 months while mice fed with A2A2 milk based diet did not showed any fatty changes even after 9 months. Congestion was observed in the liver of mice fed with A1A1 and A1A2 milk

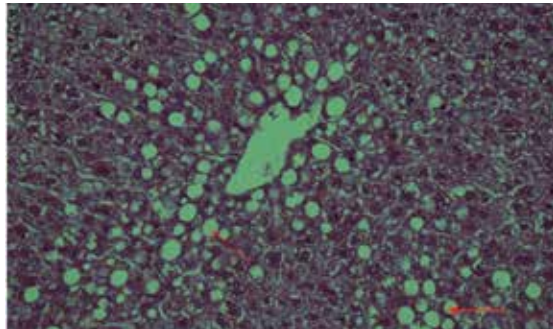
based diet from 6 month onwards. Karyomegaly which is also a sequale of the cellular injury was observed in the mice fed with A1A1 and A1A2 milk based diet from 6 months onwards and which progressed till 9 months. Mild congestion was also observed in the liver of control group after 6 months which may be due to the age. Congestion was observed in the mice fed with A1A2 milk based diet at all points of time which further signifies the damage to the liver by the diet. However, in A1A2 group, cellular swelling was observed after 6 months of feeding that persisted till 9 months of trial as well. Liver amyloids were observed in mice group fed with A1A1 & A1A2 diets at the stage of 9 months while karyomegaly was observed only in A1A2 group both at 6 and 9 months of trial.

The kidney tissues from mice fed with A1A1 diet showed focal interstitial nephritis at all three time points of trial. The sign of degenerative changes observed in the kidney of mice fed with A1A1 diet at 3 months of trial eventually got transformed to hyaline degenerative changes indicating time dependent progression. Kidney samples from mice fed with A1A2 diet showed cellular swelling in renal tubules after 3 months which were sustained till completion of trial period. However, haemorrhage in focal areas were observed only after 9 months of trial.

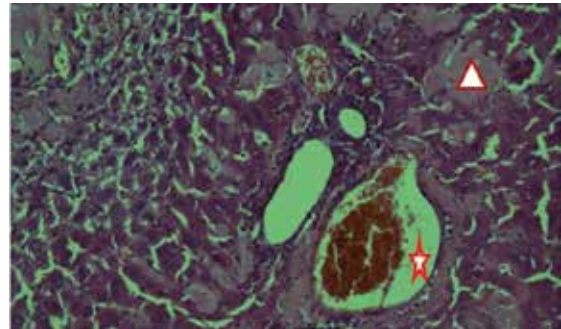
Mild congestion and mononuclear cell infiltration was observed in the pancreas of A1A1 and A1A2 group mice from 6 month onwards. However, vacuolar degeneration and fibrous tissue in between acinar cells were observed in A1A1 group at 9 months. In control samples, as such no abnormality was detected, however in the 9<sup>th</sup> month, very mild congestion was observed in few animals. The present study has helped to record the crucial histological changes on some selected tissues of mice fed with A1A1, A2A2 and A1A2 based milk diets.



### A1A1 Group

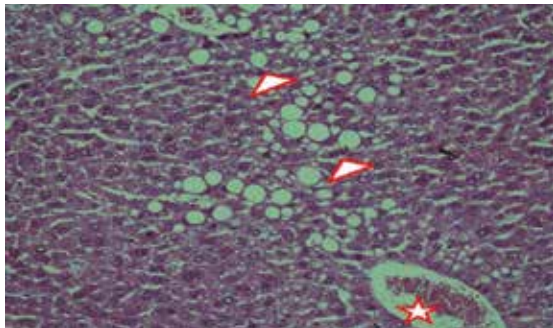


Fatty changes in the form of fatty vacuoles in the liver of mice visible from 3 month onwards (arrows).

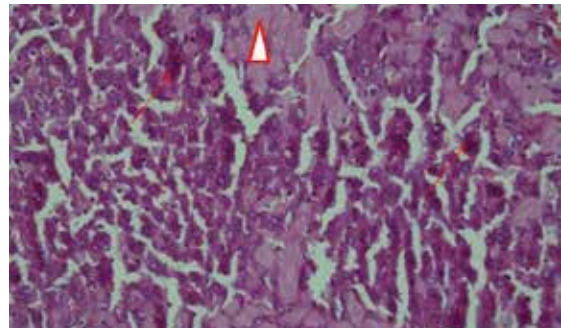


Amyloid deposition (shown by arrowhead) in the liver after 9 months while congestion (depicted by star) was seen in liver from 3 month onwards.

### A1A2 Group

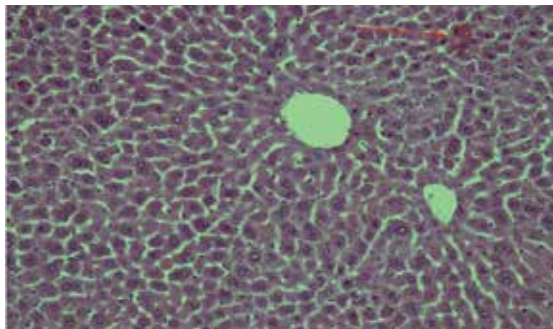


Fatty changes in the form of fatty vacuoles (arrow head) were visible in the liver of mice from 6 month onwards. Congestion is shown by star.

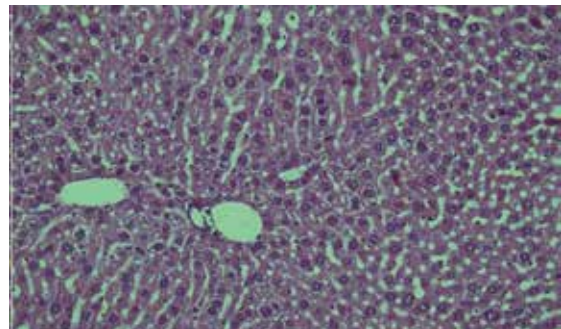


Amyloid deposition (arrowhead) in the liver at 9 months, while pyknosis in the liver is depicted by arrows.

### A2A2 Group

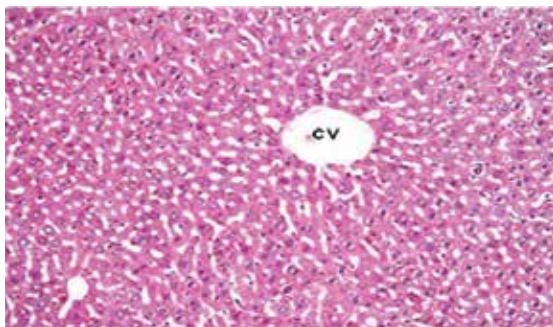


Mild congestion (shown by arrow) was observed in the liver after 6 months

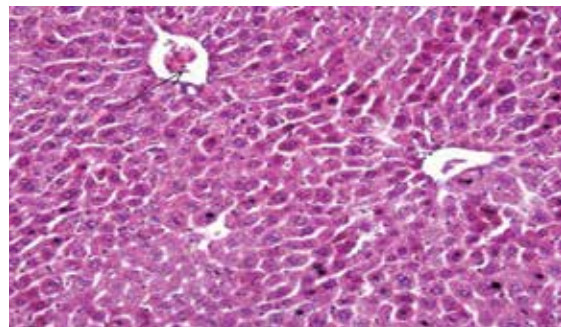


Normal hepatic architecture was observed even after 6 months. No fatty changes were observed.

### Control Group



Normal hepatic architecture was observed even after 9 months



Mild congestion (shown by arrow) was observed in the liver from 6 month onwards



# N R A G R

## RESEARCH ACCOMPLISHMENTS

### *Livestock policies and programmes for management of AnGR in Haryana and Punjab states: An evaluation*

Information on animal husbandry practices, production and productivity of animals (Q-1) was collected from 10 farmers from Hisar district of Haryana. Veterinary/ Animal Sciences institutions of Hisar viz. CIRB, NRC (E), GLE, Hisar, Haryana Veterinary Vaccine Institute, Haryana Veterinary Training Institute were visited to understand role of these institutions in livestock development. Two visits were made to Ferozpur district of Punjab. Interacted with 46 farmers keeping dairy animals, goats, pigs and poultry to collect information as per Q-1 from these farmers. The Deputy Director (Animal Husbandry) and three VOs of Ferozpur district were also approached to collect information as per Q-2. We also visited traditional Gujjar community, who are rearing Sahiwal cattle in

Fazilka district. In a visit to Ludhiana district of Punjab, information was collected from 13 farmers (9 dairy and 4 pig units) as per Q-1 and from 11 VOs as per Q-2. The production and productivity data on livestock of Haryana and Punjab state for the last 18 years were collected and analyzed to know the growth of livestock sector in these states. Major problem so far identified after interaction with farmers and VOs/other technocrats are non-availability of genetically superior germplasm, marketing of livestock as well as livestock products, quality feed on reasonable rates, veterinary services at the door of farmers, problems in getting finance and insurance claims etc. Due to poor price of milk, farmers are reducing the herd size. Piggery is growing at a faster rate in last five years in the state of Punjab due to better marketing. In poultry, the market is controlled by businessmen at Delhi and mostly based on demand and supply rather than cost of production basis.



## GENOMICS AND BIOINFORMATICS

### Genetic characterization of AnGR

#### *Genotypic characterization of Mangadh dahodi cattle of Gujarat*

Genotypic characterization of Mangadh dahodi cattle using 24 microsatellite markers revealed 11.62 number of observed alleles and 5.37 of effective number of alleles. Average observed and expected heterozygosity values were 0.755 and 0.759 respectively. The mode shift indicator i.e. qualitative method of estimation of bottleneck, showed the normal L-shaped curve in graphical representation of proportion of alleles verses class of frequency distribution. The L shaped curve indicated the abundance of low frequency (<0.10) alleles.

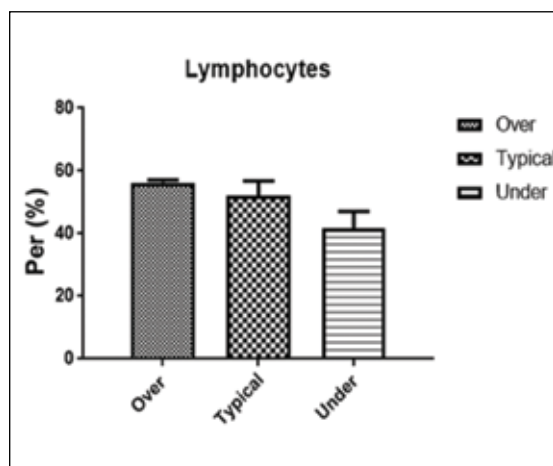
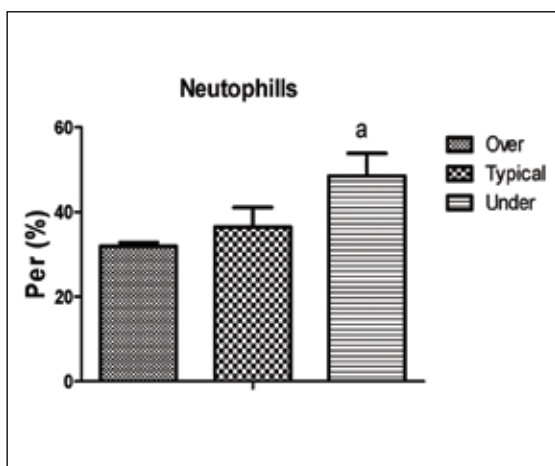
#### *Genetic diversity in Telangana goats*

DNA extracted from the blood was analyzed to estimate the genetic diversity: A total of 145 alleles were detected in black and 160 in splashed populations of Telangana goat. Highest number of alleles 11 and 13 were observed at ILSTS058 locus in both the populations. The mean observed number and effective number of alleles across all the loci were  $6.59 \pm 0.57$ ;  $3.33 \pm 0.37$  and  $7.27 \pm 0.63$ ;  $3.33 \pm 0.39$  for black and splashed populations, respectively. Difference in the observed and expected number of alleles in both the populations suggested presence of several low frequency alleles in these populations. In accordance with allelic diversity, estimate of observed heterozygosity ( $H_o$ ) was not very high,  $0.504 \pm 0.043$  and  $0.474 \pm 0.047$  for black and splashed populations, respectively. Nine loci in black and ten in splashed populations of Telangana goat deviated from HWE ( $P < 0.01$ ). Observed heterozygosity was less than the expected heterozygosity and correspondingly

$F_{IS}$  analysis identified significant heterozygote deficiency (15.4% in black and 17.5% in splashed population). Genetic differentiation was not strong among the two groups of Telangana goats. Population assignment reported 32% of animals being assigned to the wrong group. Principal coordinate analysis did not discriminate two groups of populations and genetic differentiation as reported by  $F_{ST}$  was only 6 percent. Nei's genetic identity among the two groups was also very high (0.998). Analysis indicated that two groups of Telangana goat differentiated on the basis of coat colour were also not distinct hence, it has been concluded that Telangana goats lack homogeneity at phenotypic as well as genetic level.

#### *Characterization of coat colour associated genes in Nili Ravi buffalo*

Among buffalo breeds of India, Nili Ravi is known for distinct five different white markings mostly and also called 'Panch Kalyani'. These white marking patterns are highly variable. Under this study, Nili Ravi buffaloes available at CIRB, Nabha were characterized for white markings. Based on phenotypic appearance of the animals i.e. white markings, a classification criteria to segregate animals into typical, over and under white Nili Ravi was developed. Based on white markings, 482 animals of the herd were classified and out of these majority (45.8%) were typical Nili Ravi type having all the five markings and 29.4% were over white, whereas 24.6% could be classified into under white type animals. Complete blood count (CBC) profile of animals of different categories indicated neutrophil count to be significantly higher in under white animals and lymphocyte count to be lower comparatively, an indication of higher stress levels.



*Neutrophils and lymphocytes counts of over, under and typical white Nili Ravi buffaloes. <sup>a</sup>Neutrophils count significantly higher in under white animals.*

Primers designed and PCR optimized for the amplification of coding and promoter regions of KIT (proto-oncogene, receptor tyrosine kinase), MC1R (melanocortin 1 receptor), MITF (Microphthalmia-associated transcription factor) genes reported to be associated with skin pigmentation. Sequencing of these genes in Nili Ravi and Murrah buffaloes has revealed relative conservation of MC1R gene among buffaloes. Buffalo MC1R gene ORF was found to be 954 nucleotides long coding for polypeptide of 317 amino acids. MITF promoter region has shown polymorphism with the identification of four SNPs in the immediate up-stream region of the gene. Promoter analysis indicated presence of 19 and 18 transcription factor (TF) binding sites in MITF and KIT genes, respectively, predominant binding sites for Zinc Finger Protein (ZNF333) transcription factor and Krueppel-like factor (KLF)- a tumor suppressor factor respectively in two genes. Further, the data is being correlated with white markings.

### ***Genome-wide SNPs in indigenous and exotic cattle for adaptation***

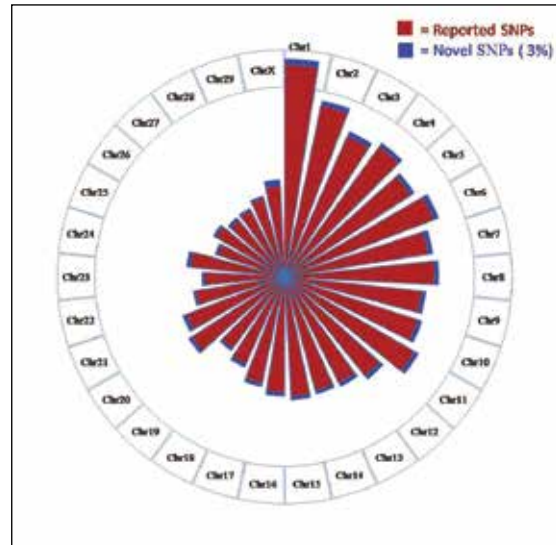
In silico experiments were designed to explore genetic basis of local adaptation of Indian native cattle breeds utilizing cattle HD chip genotyping data on seven native cattle breeds - Haryana, Tharparkar, Gir, Sahiwal, Kangyam, Ongle and

Vechur. The phenotypic (environmental) file was generated from the data obtained from the Indian meteorological department for monthly mean maximum and minimum temperature and total rain fall (<http://www.imd.gov.in>). Mean values of the 22 different bioclimatic predictors was calculated in different agroclimatic regions of seven different native breeds. Out of these, 16 bioclimatic predictors were used in the univariate analysis using SAMBADA software. Genotypic file of 4, 70,703 (14, 12,109 genotypes) SNP data was split into blocks of 10,000 markers each and the blocks were merged into 6 major blocks of 20-30 smaller blocks for further analysis. SAMBADA software was optimized for the genome wide association studies, Variant Effect Prediction (VEP) for the identification of deleterious mutations and RaptorX for protein structure analysis. A list of 3,04,704 unique rsIDs (variants) with significant association with environmental variables was prepared from all the 6 blocks combined and used as an input file for the Variant Effect Prediction tool. A total of 113 deleterious missense variants with high confidence were obtained. Further studies on these variants will be helpful in the analysis of functional diversity in these breeds of cattle.

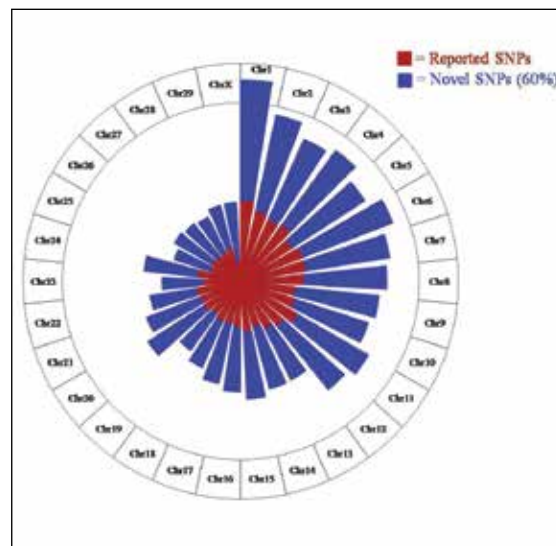


### Genome-wide QTLs for different traits in Sahiwal cattle

In case of Sahiwal cattle, a total 450431 and 25821 genome wide SNPs were identified with reference to *Bos taurus* and *Bos indicus* genomes respectively and 8266 genome wide SSRs were identified in the Sahiwal cattle. About 90% of the SNPs were genotyped in at least half of the samples showing high genotyping efficiency. The novel SNPs with reference to *Bos taurus* were 14,908 and 1,50,231 with *Bos indicus* genomes respectively. The missense to silent ratio was found to be 0.5 to 0.6 while the transition to transversion ratio was 2.3-2.4. SIFT analysis revealed 89 SNPs having deleterious effects on the protein structure and function. Total 22,762 SNPs were mapped to production trait QTLs while 42,314 SNPs were mapped to QTLs associated with reproduction traits. The mastitis QTLs had 5,765 SNPs mapped within the QTLs. Tick resistance and heat tolerance QTLs had 7,689 and 2,300 SNPs. Among the validation set of 25 SNPs, 22 SNPs were successfully validated. Less than 1% of SNPs identified in the present study in Sahiwal cows were mapped to the existing bovine SNP chips. The selection sweep regions in Sahiwal cattle comprised of 1764 genes. The genes responsible for domestication and tropical adaptation were found to be selected in Sahiwal cattle.



Chromosome wise distribution of novel SNPs in Sahiwal (*Bos taurus* as reference)



Chromosome wise distribution of novel SNPs in Sahiwal (*Bos indicus* as reference)

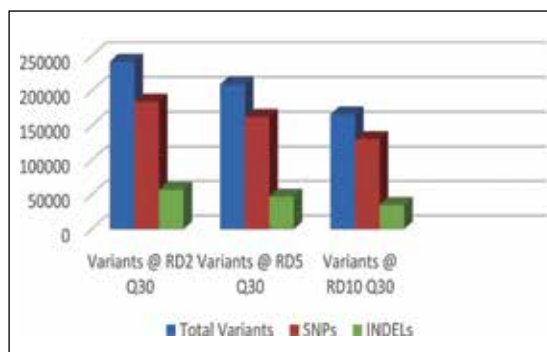
### SNPs mapped to production trait QTLs in Sahiwal cattle

Production traits for QTLs	No. of SNPs
Milk yield	15912
305-day milk yield	1818
Milk fat yield	1231
Milk fat percentage	424
Milk protein yield	1717
Milk protein percentage	1651
Lactation persistency	9

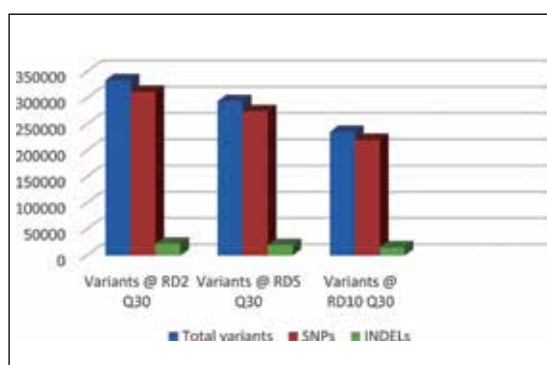


### Genome-wide SNPs in Murrah buffalo

In Murrah buffaloes, a total of 1,30,688 high quality SNPs along with 35,110 INDELS; 2,19,856 high quality SNPs along with 15,201 INDELS were identified in Murrah and water buffalo genome, respectively. All the SNPs identified in the study were structurally and functionally annotated. Further the SNPs located in the candidate genes affecting milk production (Milk yield, milk fat percentage), fertility, and other major genes were also annotated. A total of 483 SNPs in a total of 66 genes affecting milk production; 436 SNPs in 38 genes affecting fertility and 559 SNPs in 72 genes affecting other major traits, were annotated. The reads obtained through this ddRAD approach has a genome coverage of 13.4% and 14.8% of Murrah and water buffalo genome, respectively. The SNPs identified and annotated in the present study may be used for genotyping in larger number of samples for further association studies.



Variants identified using Murrah buffalo reference genome



Variants identified using Mediterranean water buffalo reference genome

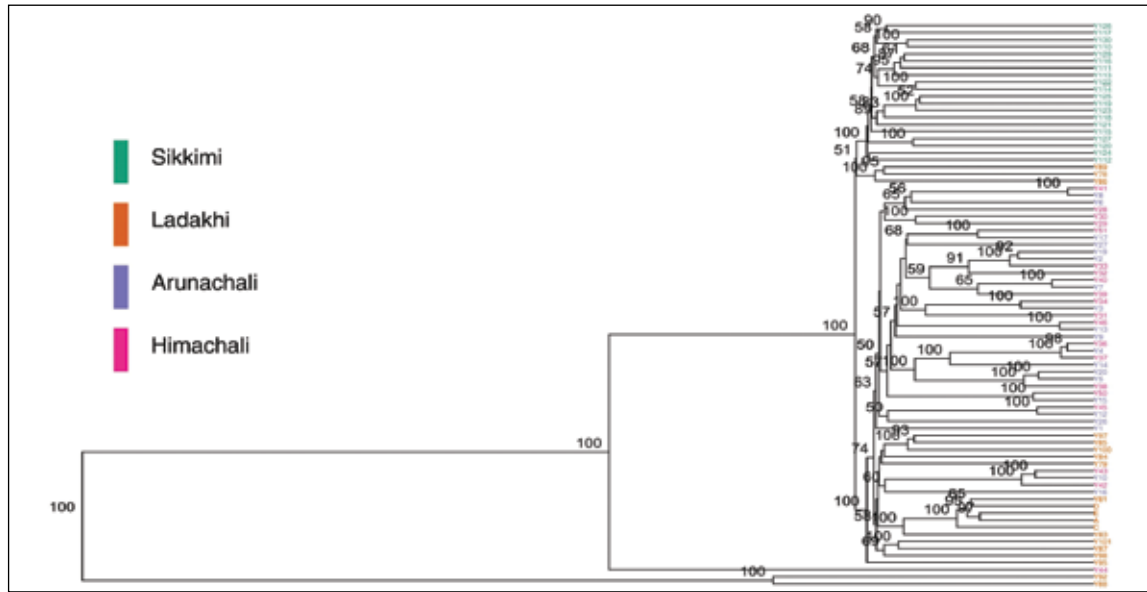
### Genomic diversity of Indian yaks

In the present study, a total of 80 samples of Indian yaks belonging to Arunachali yak, Himachali yak, Ladakhi yak and Sikkimi yak were used for the identification of genome wide SNPs and INDELS with cattle and buffalo as outgroup. High throughput sequencing of the DNA samples carried out using Illumina TrueSeq chemistry on Illumina HiSeq 2000 platform. The raw reads obtained were further processed for quality filtration and alignment with the yak genome. The total number of SNPs identified in

Arunachali, Himachali, Ladakhi and Sikkimi yaks were 2,56,051, 2,41,934, 3,12,518 and 1,50,425, respectively. Overall, a total of 5,79,575 high quality SNPs along with 50,319 INDELS were identified with an coverage of 9.42% in the Indian yaks. The observed and expected heterozygosity were 0.3362 and 0.2981; 0.3435 and 0.2992; 0.3136 and 0.3073; 0.2831 and 0.2817 in Arunachali, Himachali, Ladakhi and Sikkimi yaks; respectively. The genetic distance calculated using genome wide SNPs in the Indian yaks revealed that Ladakhi and Sikkimi yak populations to be distinct.

### Number of SNPs and INDELS identified in Indian yak populations

Population	Variants					
	SNPs			INDELS		
	RD2	RD5	RD10	RD2	RD5	RD10
Arunachali	2,94,593	2,69,342	2,56,051	25,014	23,194	21,892
Himachali	2,83,880	2,60,572	2,41,934	23,582	21,752	19,935
Ladakhi	3,90,342	3,52,140	3,12,518	27,773	25,176	21,954
Sikkimi	2,01,014	1,78,435	1,50,425	15,596	14,035	11,710

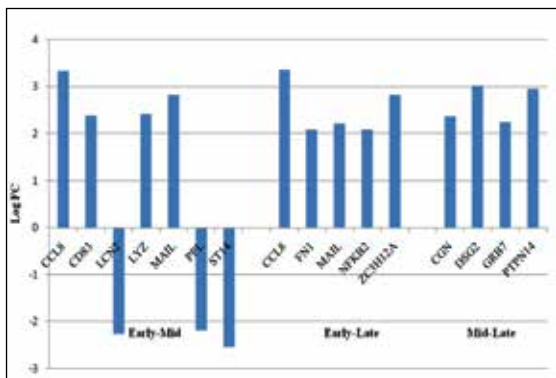


Genetic distance among Indian yaks

### CRP-Genomics-Animal Component

In order to understand the interplay of different genes and pathways involved in lactation, a comprehensive milk transcriptome profiling from three lactation stages of Murrah buffalo was performed by RNA sequencing. The raw reads were filtered and mapped to the *Bubalus bubalis* as well as *Bos taurus* reference assemblies. The average mapping rate to water buffalo and Btau 4.6 reference sequence, across all the stages was 75.5% and 75.7% respectively. Based on a threshold of  $>0.01$  RPKM, 13,618, 13,508 and 13,917 genes were observed in our dataset for early, mid and late lactation respectively. The top 20 genes, with highest expression were analyzed for major biological pathways involved in each stage of lactation. Antigen presentation, Nef mediated downregulation/modulation of MHC class I complex, cell surface expression and endosomal/vacuolar pathways were common across all the three stages. Pairwise comparison was done between the 3 stages of lactation for identification of differentially expressed genes.

Genes with  $\log_2$  fold change (FC)  $\geq 2.0$  and  $P_{adj} \leq 0.05$  were selected for the analysis. As a result, 216 DE genes between early-mid, 157 between early-late and 219 between mid-late lactation stages were identified. The differential expression of randomly selected genes like *CSN2*, *FABP3*, *LALBA*, *LPIN1*, *PAEP*, *RPS9* and *RPS23* was validated by quantitative PCR (qPCR). *ACTB* and *GAPDH* were used as the reference genes as they showed least variation in expression across the different stages in terms of RPKM (RNAseq data) and Ct values (qPCR). The expression pattern of these genes obtained by qPCR was in agreement with the RNAseq data although the magnitude was different. The network analysis was utilized to understand the interactions between these DE genes. To simplify the complexity of interconnections, a subset of genes was considered in each case. Among the highly connected or hub genes in the early-mid stage comparison, *CD83*, *LCN2* and *MAIL* were regulated by *NFKB1*. *MAIL* is a member of the ankyrin-repeat family induced by lipopolysaccharide which promotes

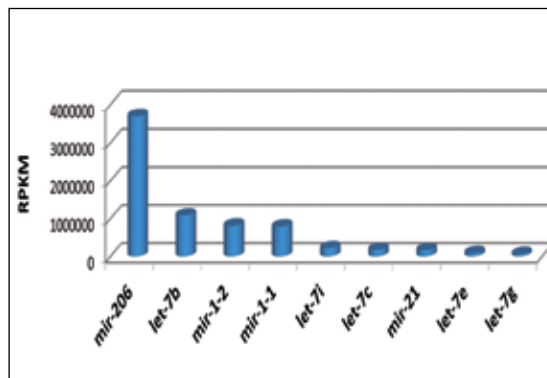


Differential expression of highly connected genes across lactation stages in Buffalo

transcription of Lipocalin-2 (*LCN2*). *LCN2* is known to be involved in innate immune response as well as glucose tolerance and insulin sensitivity in mice and humans. Between early and late stage, *NFKB2* and *MAIL* were connected to *NFKB1*. *NFKB* has been reported to play an important role during pregnancy and involution in mice. The *NFKB* complex is expressed in various cells and plays an important role in the immune system as well as lactation and appears to be an important regulatory factor in buffalo lactation. Other hub genes *DSG2*, *FN1*, *GRB7*, *PPL*, *PTPN14*, *ST14* are associated with cell growth and adhesion, while *CCL8*, *CGN*, *LYZ*, *ZC3H12A* are linked with the immune system. The highly connected genes identified in our study are mainly implicated in immune response, cell growth and angiogenesis. Cell proliferation and growth of the mammary gland continues in the early and mid stage of lactation, while the immune cells may help in maintaining the health of the udder. Further studies are required to verify the impact of the hub genes on the relevant pathways.

### Skeletal muscle transcriptome profiling of Bandur (Mandya) sheep

Since microRNAs can affect muscle growth and metabolism, they present great potential



Highly expressed miRNAs identified in Bandur sheep skeletal muscle with RPKM > 50000

as molecular markers. miRNA profiling is a powerful approach for identifying key regulators of molecular functions which control skeletal muscle development, regeneration and function. Information on gene expression and the regulatory factors involved in myogenesis are very limited for Indian sheep. The miRNAs from the skeletal muscles of Bandur sheep breed studied were identified and characterized. Bandur is a consumer favoured, mutton type sheep of India, mainly distributed in Mandya district of Karnataka. Skeletal muscles from four rams of Bandur sheep of similar age, sex and reared under same management conditions were used for RNA sequencing. The total number of reads (15-36 bp) for each library of Bandur sheep ranged from 19,350,000 to 30,000,000. Highly expressed transcripts with an RPKM value of  $\geq 1000$  were observed to be 34%, whereas 38% transcripts exhibited RPKM between 100-1000 and 28% had RPKM < 100 in Bandur sheep. A total of 110 known mature miRNAs could be identified on comparison with known human and bovine sequences. All the identified miRNAs represented 32 miRNA families and 44 clusters. A total of 499 novel miRNAs were discovered in Bandur sheep. The miRNAs identified in our study were enriched

for functions namely cell proliferation, cell differentiation, osteogenesis, lipid metabolism, muscle development, adipocyte differentiation, stress response etc. Potential gene targets for the identified miRNAs were predicted. Most relevant target genes predicted in our study included *MYO5A*, *SIN3B*, *HSPB1* and *NR2F2*. This study is a stepping stone in understanding the role of miRNAs in molecular pathways relevant to muscle traits.

### ***Molecular docking of Beta Casomorphins (BCMs) with different mu receptors***

In-silico analysis was carried out to identify genes representing  $\mu$ -opioid receptors (MOR) in mice and human genome. Different splice variants of MORs were fished out from a much larger pool of sequences available in NCBI databases. The structure of BCMs, mu, kappa and delta receptors was predicted and molecular docking studies were performed.

For structure prediction, PDB files generated by I-TASSER server were used as input for SOPMA server for the prediction of secondary structure. In the secondary structure of MOR-1; 168 (42.2%) and 173 (43.47%) residues contributed towards alpha helices and random coil respectively while for extended strands and beta turn number of contributing residues was 48 (12.06%) and 9 (2.26%) respectively. To understand the stability of docked or interacting residues, docking study of MORs and bioactive peptide ligands (BCM7/9) was carried out using the fast docking algorithm PatchDock, which identifies shape complementary interactions between binding partners that is receptor and ligand.

The studies showed that both in human and mice, BCMs have highest affinity for MOR and least affinity for kappa 1 opioid receptor. The order of betacasomorphin affinity for opioid receptors was:  $\mu > \delta > \kappa$ .

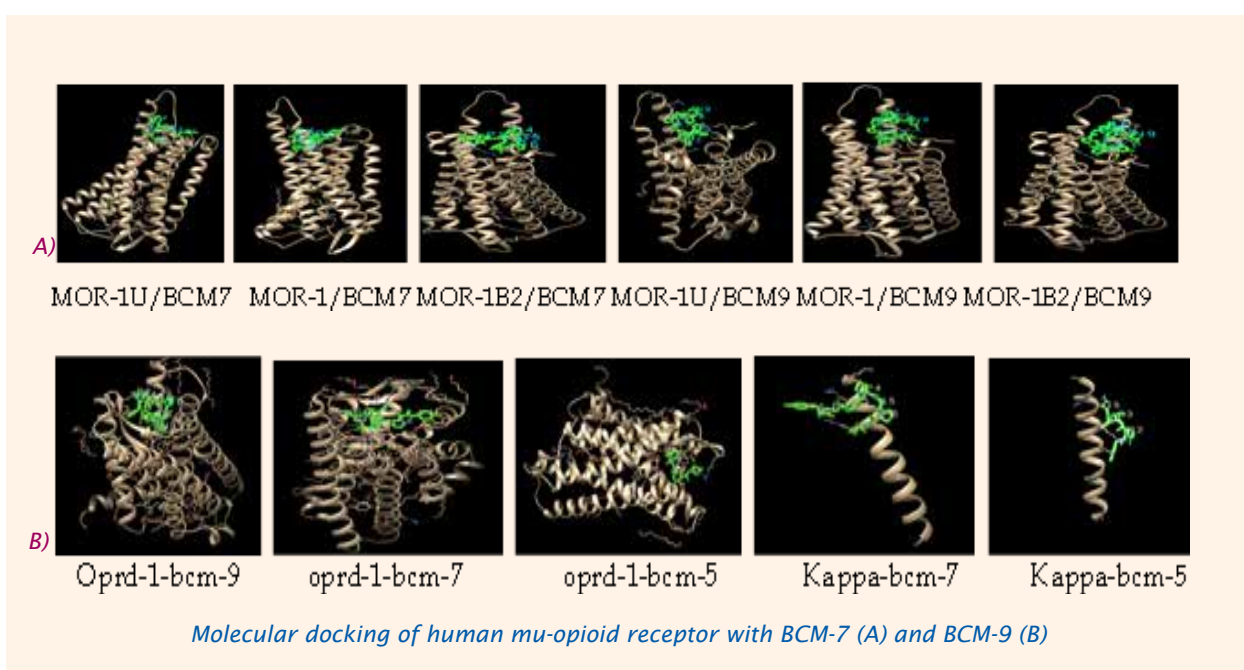
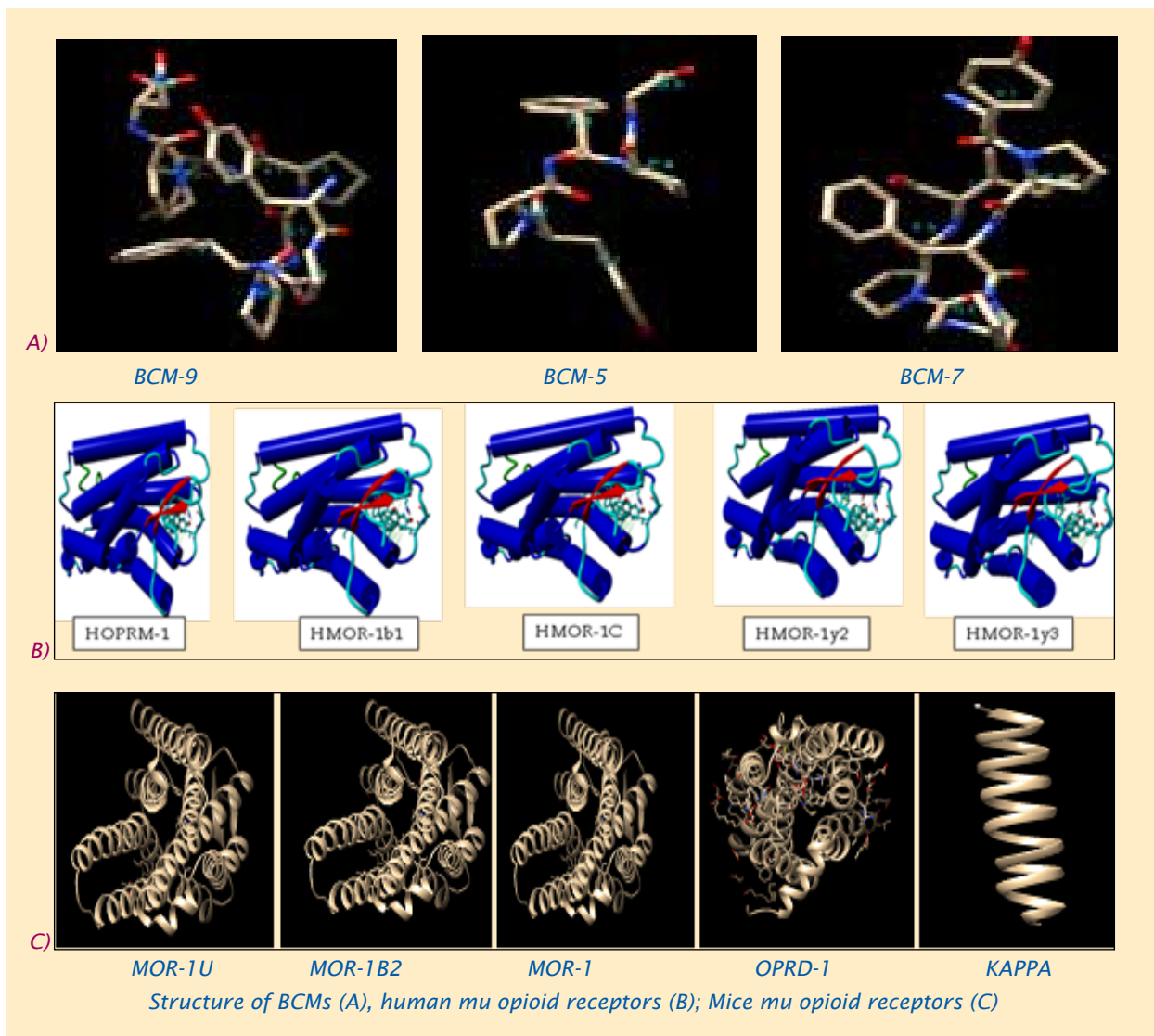
The energy statistics related to interaction of BCMs (BCM-5, BCM-7, and BCM-9,) with opioid receptors revealed that BCM7 forms more stable bond with  $\mu$ -receptor as compared to BCM9. Docking of BCM7/9 with mu receptors (MOR) indicated stable binding of BCM7 as compared to BCM9 in terms of interacting amino acids (TYR128, TRP318, ASN127, LYS233, GLU310, LEU219), ligand and protein atoms involved in hydrogen bonding (BCM7 = LYS 233 (2.22 Å), BCM9 = LYS 233 (3.09 Å), number of hydrophobic interacting amino acid residues (15 in case of BCM7 while 13 in BCM9). These docked atoms in BCM7 helped to increase the binding affinity of the target-receptor molecules and optimized the hydrophobic interactions by captivating the hydrogen bonding at the hydrophobic core of the complex.

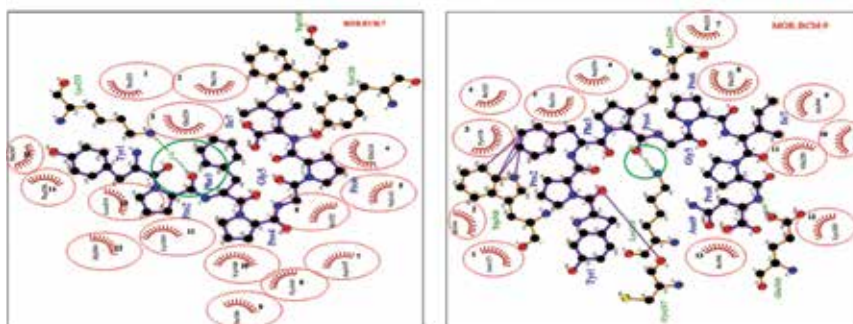
The comparative energy minimization of docked model for MOR-1A-BCM7- (-202241.7 KJ/mole) and for MOR-1A-BCM9 (-184703.0 KJ/mole) also indicated greater binding affinity of BCM7 for mu opioid receptor. Similarly in case of human receptors, the comparative energy minimization for MOR-BCM7 (-156206.5) and MOR-BCM9 (-156113.5 KJ/mole) indicated stable binding of BCM7 compared to BCM9. Interaction of MORs with BCM7 might lead to initiation of diverse downstream signalling pathways and demonstrate pharmacological activities.



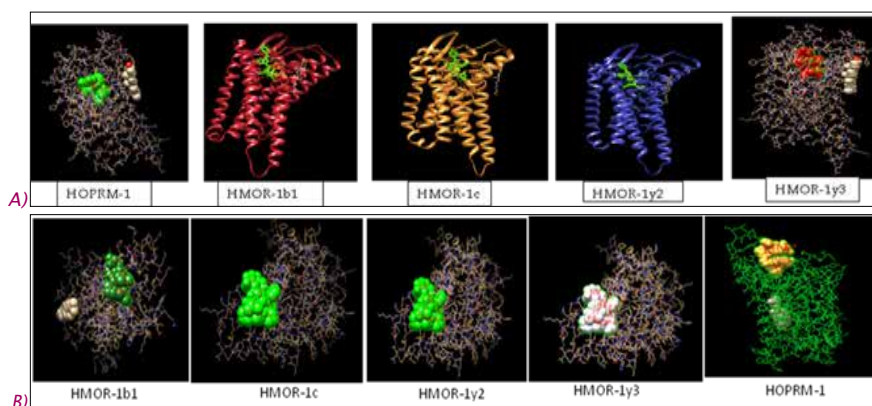
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## RESEARCH ACCOMPLISHMENTS





PDBsum's ligplot results for MOR-BCM7 and MOR-BCM9 interaction. Red arc circles: hydrophobic interaction; green dotted lines/circles: Hydrogen bonds; spoked arcs: protein residues residues involved in hydrophobic interactions.



Molecular docking results of different opioid receptors with BCM-7 (A) and BCM-9 (B)

### Serum antioxidant level in native livestock species of Ladakh adapted to high altitude (National Fellow Project)

Relative antioxidant levels were evaluated in native livestock – Ladakhi cattle, Ladakhi yak, Ladakhi donkey, double hump camel and Zanskar ponies of Leh-Ladakh region. The total antioxidant capacity (TAC) in terms of FRAP, free radical scavenging activity of DPPH (%age scavenging activity of DPPH) and glutathione (GSH) values were estimated in these species (Table). FRAP values were significantly ( $p < 0.05$ ) higher in

Ladakhi yak and Zanskar ponies compared to other species of high altitude region. The DPPH was lowest in Zanskar ponies ( $48.16 \pm 2.66$ ) as compared to other species. The GSH level was highest in double hump camel ( $969 \pm 37.06 \mu\text{M/L}$ ) followed by Ladakhi yak ( $942.1 \pm 44.83 \mu\text{M/L}$ ) Zanskar ponies ( $752.5 \pm 47.2 \mu\text{M/L}$ ), Ladakhi donkey ( $723.1 \pm 51.97$ ), and Ladakhi cattle ( $584.1 \pm 31.11 \mu\text{M/L}$ ). The higher level of antioxidants in different species native to high altitude and constantly exposed to hypobaric hypoxia condition might be providing cellular protection against oxidative stress prevalent at high altitude.

### Antioxidant parameters in different species adapted to high altitude

Parameters	Ladakhi cattle (n=47)	Ladakhi yak (n=29)	Ladakhi donkey (n=7)	Double hump camel (n=5)	Zanskar ponies (n=10)
FRAP (mM/L)	$3.74 \pm 0.26$	$5.27^* \pm 0.22$	$4.64 \pm 0.42$	$4.61 \pm 0.17$	$6.22^* \pm 0.34$
DPPH % Inhibition	$63.82 \pm 1.32$	$63.41 \pm 1.62$	$66.95 \pm 1.68$	$60.43 \pm 2.79$	$48.16^* \pm 2.66$
GSH ( $\mu\text{M/L}$ )	$584.1 \pm 31.11$	$942.1^* \pm 44.83$	$723.1 \pm 51.97$	$969^* \pm 37.06$	$752.5 \pm 47.2$

Values are expressed as mean  $\pm$  SE. \* indicates the Significant ( $p < 0.05$ ) difference between different

### Antioxidant parameters in different types of cattle and Murrah buffaloes

Parameters	LAC	GIC	TAC	SAC	KFC	HFC	MUB
FRAP(mM/L)	3.74*±0.26	2.12±0.07	2.41±0.15	2.40±0.09	1.96±0.09	2.38±0.13	1.10±0.05
GSH (µM/L)	584.1*±31.11	140.8±3.99	144.3± 9.41	140.1±7.31	138.6±10.33	129±5.97	40.16±2.98

Values are expressed as mean ± SE. \* indicates the Significant (p<0.05) difference between cattle

#### **Comparative serum antioxidant level in alpine and tropically adapted native cattle**

The effect of altitude on the antioxidant system was studied in native cattle breeds of India. The antioxidant capacity in terms of FRAP, and reduced glutathione (GSH) level was estimated in six different breeds of cattle viz., Ladakhi cows (LAC), Gir (GIC), Tharparkar (TAC), Sahiwal (SAC), Karan Fries (KFC), Holstein Frisian (HFC) and Murrah buffaloes (MUB). FRAP values were significantly (p<0.05) higher in high altitude adapted LAC (3.74 ± 0.26) as compared to cattle breeds from tropical regions. GSH level was also observed to be significantly (p<0.05) higher in LAC (584.1 ± 31.11 µM/L) when compared to GIC (140.8 ± 3.99), TAC (144.3 ± 9.41), SAC (140.1 ± 7.31), KFC (138.6 ± 10.33), HFC (129 ± 5.97) and MUB (40.16 ± 2.98) breeds from lower altitude region. The higher antioxidants in Ladakhi cattle might be essential to counter free radicals generated due to both oxidative and reductive stress. At high altitude, the presence of specific environmental stressors like low partial pressure of oxygen, UV radiation and extreme cold weather can be potential source of free radical generations at high altitude. Therefore, native breeds of Ladakh might have developed strong cellular antioxidant system to protect themselves from reactive oxygen and nitrogen species (RONS).

#### **Comparative serum antioxidant level in cattle across different seasons**

Antioxidant defense system is integral part and play major role in animal response to stressful conditions. It allows the cellular system to protect the individuals from oxidative damage by

protecting various biomolecules. To investigate the impact of heat stress on antioxidants, FRAP, DPPH and GSH were estimated in serum samples of different cattle types and buffaloes. For this study, a total of 500 serum samples were used from five breeds of cattle; Gir (GIC), Tharparkar (TAC), Sahiwal (SAC), Karan Fries (KFC), Holstein Frisian (HFC) and Murrah buffaloes (MUB) across different seasons (winter, spring, summer and humid).

Total antioxidant capacity in terms of FRAP values across different season are shown in tables. The maximum FRAP values were observed during hot summer. The data indicated significant (p<0.05) increase in FRAP in all the 5 breeds during hot summer in comparison to winter and humid season. However, TAC, SAC and GIC cattle breeds showed lowest increase in FRAP values suggesting these breeds to be least affected by oxidative stress during summer season (Table). On the other hand, the exotic HFC and cross bred KFC showed highest FRAP values of 4.71 ± 0.21 mM/L and 4.68 ± 0.12, respectively during hot summer season.

DPPH radical scavenging activity was also measured to evaluate the impact of seasonal variations. The data showed significant (p<0.05) increase in DDPH radical scavenging activity during hot summer and humid seasons in comparison to spring season in all the cattle breeds and Murrah buffalo. The maximum increase in scavenging activity was found in HFC and KFC cattle in summer season. Amongst the five breeds, native cattle showed minimal oxidative stress during hot and humid seasons.

### Antioxidant capacity (FRAP) in cattle breeds and Murrah buffalo in different seasons

Breed	n	FRAP (mM) in different Season			
		Winter	Spring	Summer	Humid
GIC	99	2.12 ± 0.07	3.60* ± 0.13	4.65* ± 0.13	2.10 ± 0.10
TAC	91	2.41 ± 0.15	3.74* ± 0.23	4.36* ± 0.08	2.52 ± 0.08
SAC	98	2.40 ± 0.09	4.42* ± 0.20	4.44* ± 0.12	2.73 ± 0.10
KFC	86	1.96 ± 0.09	4.66* ± 0.18	4.68* ± 0.12	2.60* ± 0.08
HFC	71	2.38 ± 0.13	4.66* ± 0.36	4.71* ± 0.21	3.05 ± 0.10
MUB	59	1.10 ± 0.05	2.85* ± 0.10	-ND-	1.53* ± 0.17

Values are presented as mean ± SEM; \*indicates significant difference ( $p < 0.05$ ) within the same row in comparison to different seasons

### Free radical scavenging activity in cattle breeds and Murrah buffalo in different seasons

Breed	n	Scavenging activity (%) in different Season			
		Winter	Spring	Summer	Humid
GIC	89	70.31 ± 1.39	36.39* ± 1.93	71.81 ± 0.67	74.84* ± 0.46
TAC	95	67.02 ± 1.17	37.43* ± 0.86	64.52* ± 6.61	74.91* ± 0.60
SAC	93	63.84 ± 1.31	34.88* ± 3.33	71.63* ± 0.75	75.66* ± 0.40
KFC	85	61.30 ± 1.59	60.41 ± 3.70	75.05* ± 0.36	76.53* ± 0.62
HFC	69	64.32 ± 0.50	68.26 ± 1.26	75.25 ± 4.46	76.20* ± 0.39
MUB	63	60.25 ± 0.49	59.71 ± 1.79	-ND-	71.89* ± 0.93

Values are presented as mean ± SEM; \*indicates significant difference ( $p < 0.05$ ) within the same row in comparison to different seasons

### Reduced glutathione (GSH) level in cattle breeds and Murrah buffalo in different seasons

Breed	n	GSH (mg/dL) in different Season			
		Winter	Spring	Summer	Humid
GIC	89	1.41 ± 0.04	1.30 ± 0.05	1.12* ± 0.06	1.01* ± 0.07
TAC	95	1.44 ± 0.09	1.54 ± 0.10	1.11* ± 0.04	1.03* ± 0.06
SAC	93	1.40 ± 0.07	1.75 ± 0.13	1.14* ± 0.09	1.01* ± 0.06
KFC	85	1.39 ± 0.10	1.48 ± 0.21	0.81* ± 0.05	0.85* ± 0.04
HFC	69	1.29 ± 0.06	2.18 ± 0.29	1.05* ± 0.08	0.99* ± 0.07
MUB	63	0.40 ± 0.03	0.28 ± 0.03	-ND-	0.31* ± 0.03

Values are presented as mean ± SEM; \*indicates significant difference ( $p < 0.05$ ) within the same row in comparison to different seasons

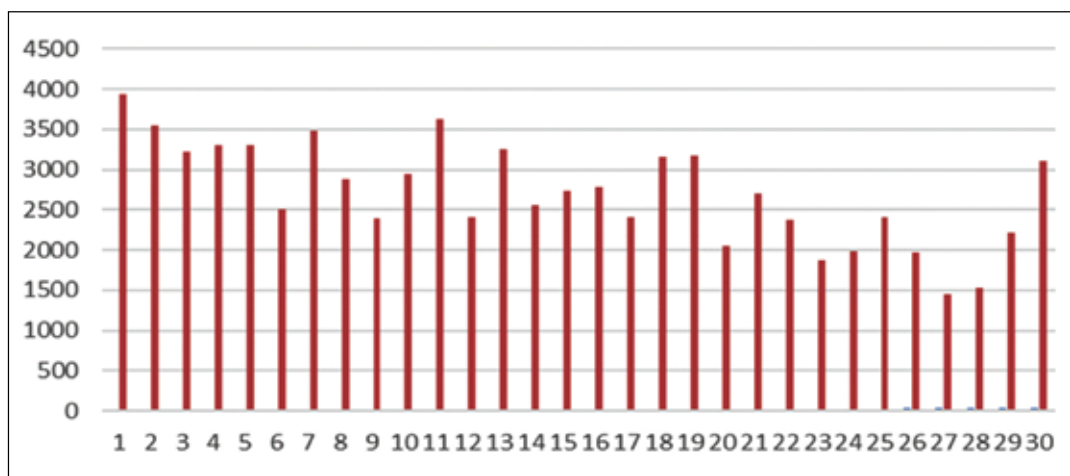
Additionally, to determine the extent of oxidative stress, reduced glutathione (GSH) level was measured across different seasons. The GSH level decreased significantly ( $p < 0.05$ ) during hot summer and humid seasons in comparison to winter and spring seasons in all the cattle types and Murrah buffaloes. The exotic HFC and cross bred KFC cattle showed maximum decrease in GSH level (mg/dL) from  $2.18 \pm 0.29$  in winter to  $0.99 \pm 0.07$  in summer and from  $1.48 \pm 0.21$  in winter to  $0.85 \pm 0.04$  in summer, respectively. The GSH values like other antioxidant parameters indicated that native cattle experience lower oxidative stress in comparison to exotic and

cross-bred cattle during higher THI associated summer stress.

#### Generation of genome wide SNP data using GBS approach

In order to identify and catalogue genome wide SNPs in Indian cattle breeds from different agroclimatic regions, genotyping-by-sequencing (GBS) data was generated in 13 native and 2 exotic cattle breeds. DNA samples from 111 unrelated individual of native and exotic cattle breeds: Rathi (9), Tharparkar (9), Ladakhi (9), Gir (9), Kangyam (9), Ongole (9), Malvi (9), Red Kandhari (9), Malnad Gidda (6), Hariana (6), Kankrej (6), Sahiwal (6), Amritmahal



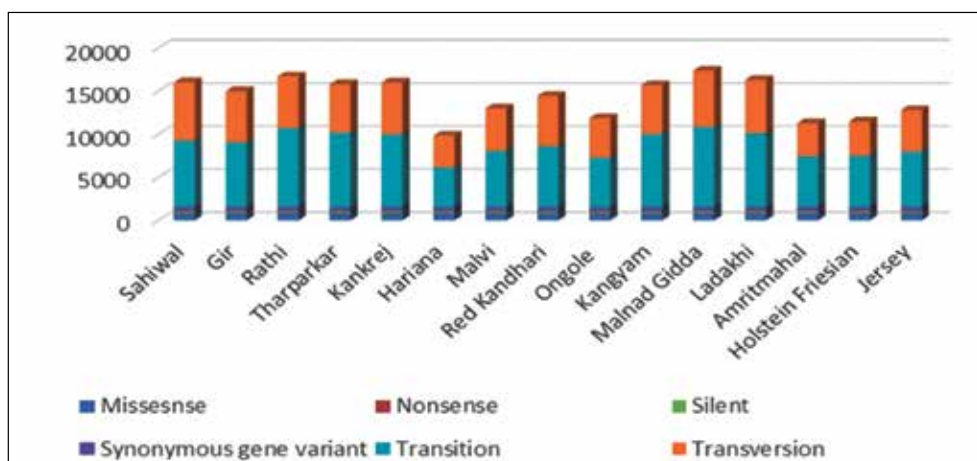


Chromosome wise number of variants

(3), Holstein Frisian (6) and Jersey (6) were utilized for the study. The PstI GBS libraries were prepared as per standard procedures. The libraries were purified and subjected for single-end sequencing using Illumina platform. The raw sequence data (100-nt fastqc files) were processed through GBS analysis pipeline as implemented in TASSEL v3.0. The association between reads and individual samples were established by the recognition of barcode sequence followed by TGCAG (remaining nucleotides post PstI digestions). The sequences were trimmed to 64 bp and aligned to the *Bos taurus* reference genome (UMD 3.1) using the Burrows-Wheeler alignment tool. The default parameters as mentioned in the pipeline were used for filtering to eliminate low quality SNPs, and calling rate was

performed at 80%. The minimum minor allele frequency (mnMAF) was set to 0.01. The overall data produced 119 million reads. A total of 82,878 SNPs were identified with an average SNP-to-SNP distance of 30 kb across the bovine genome. The highest number of SNPs were detected on BTA1 (3,930 SNPs) followed by BTA11 (3,622 SNPs) and the least number on BTA27 (1,449 SNPs) chromosome. The chromosome wise data on number of variations identified in each of the chromosome is shown in figure.

In the data set, a large proportion of variants (57.6%) were found in the intergenic regions, followed by intronic region (29.2%). The number of variants in 3'UTR and 5'UTR accounted for 0.294%, and 0.008%, respectively. The variants in



Proportion of different types of SNPs in coding region

### Variants identified in coding region of genome in different cattle breeds

Breeds	SNPs Details										
	Missense		Nonsense		Silent		Synonymous gene variant		Transition	Transversion	Ts/Tv ratio
	count	%	count	%	count	%	count	%	count	count	
Sahiwal	781	74.95	50	4.798	211	20.25	558	0.615	7682	6737	1.1403
Gir	801	75.709	54	5.104	203	19.187	534	0.589	7468	5932	1.2589
Rathi	798	75.425	53	5.009	207	19.565	538	0.593	9108	6008	1.516
Tharparkar	804	75.992	52	4.915	202	19.093	533	0.588	8603	5607	1.5343
Kankrej	793	74.811	54	5.094	213	20.094	542	0.598	8431	5962	1.4141
Hariana	801	75.852	51	4.83	204	19.318	537	0.592	4545	3705	1.2267
Malvi	807	76.562	48	4.494	213	19.944	534	0.589	6459	4925	1.3115
Red Kandhari	803	75.258	48	4.494	202	19.093	538	0.593	7035	5829	1.2069
Ongole	792	75.5	52	4.95	205	19.542	545	0.601	5706	4555	1.2527
Kangyam	788	74.763	51	4.839	215	20.398	550	0.606	8424	5669	1.486
Malnad Gidda	816	76.764	46	4.327	201	18.909	527	0.581	9272	6503	1.4258
Ladakhi	802	75.875	56	5.298	199	18.827	531	0.585	8542	6156	1.3876
Amritmahal	807	76.562	47	4.463	206	19.563	535	0.59	5846	3831	1.523
Holstein Friesian	794	75.189	55	5.208	207	19.602	540	0.595	5923	3958	1.4965
Jersey	800	75.973	47	4.463	206	19.563	542	0.597	6401	4791	1.336

the exonic region accounted for 1.549% of total variants. As expected, transition variations (Ts) were more abundant as compared to transversion variation (Tv) in all the cattle breeds. The Tv/Ts ratio ranged from 1.1403 in Sahiwal to 1.5343 in Tharparkar cattle. The Ts count was maximum in Malnad Gidda (9272) followed by Rathi (9108) while two exotic cattle showed relatively low number of Ts variation; Holstein Friesian (5923) and Jersey (6401). On the other hand, the Tv count was highest in Sahiwal (6737) followed by Malnad Gidda (6503). Similar to Ts, Tv variation was also relatively lower in two exotic breeds; Holstein Friesian (3958) and Jersey (4791). All the breeds exhibited similar synonymous variants with highest number of variants in Sahiwal cattle (558) and lowest number of such

variants in Malnad Gidda (527). The data also showed large number of missense variation with maximum count in Malnad Gidda (816), and minimum in Sahiwal (781) cattle. The breed wise data on number of missense, nonsense, sense, synonymous, transitions and transversions variations are summarized in table.

#### ***Annotation of SNPs to genes associated with heat stress and immunological response***

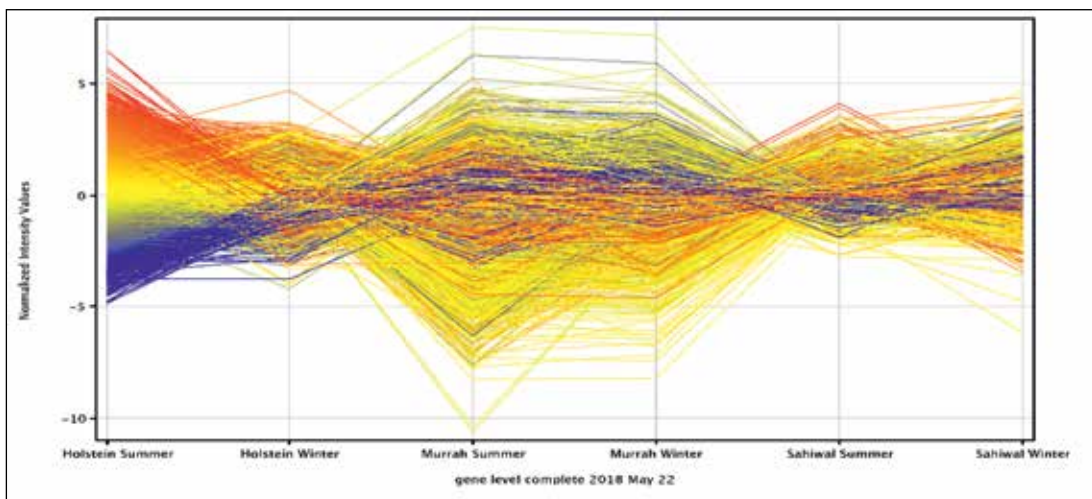
Additionally, efforts were made to annotate SNPs with genes related to immunological and heat stress response. Several SNPs could be annotated to genes with immune function such as *IL1A*, *IL1B*, *IL11RA*, *IL12RB1*, *IL17IL18*, *IL18R1*, *IL4*, *IL4L1*, *IL6*, *TNFAIP8L1*, *TNFRS138*, *TNFRSF*, *TNFRSF25*, *TNFRSFB6*, *TNFSF10*, *TNFSF8*, *TNFSF13*, *TNFSF15*, *TNFSF18* etc.

Similarly, several SNPs could be annotated to genes belonging to heat shock family such as *HSF1*, *HSF2*, *HSF5*, *HSPA12A*, *HSPA12B*, *HSPA13*, *HSPA4*, *HSPA8*, *HSPB6*, *HSPB7*, *HSPB9* etc. Many SNPs could also be linked to genes associated with osmoregulation and ion homeostasis such as *ATPSH*, *ATP5I*, *ATP4A*, *ATP5AI*, *ATP5G2*, *ATP8B1*, *ATP8B2* etc. A large proportion of SNPs identified in native cattle were novel and could be used in future as indicine specific genomic resource. Thus, the GBS technique was successfully employed to identify large number of specific SNPs.

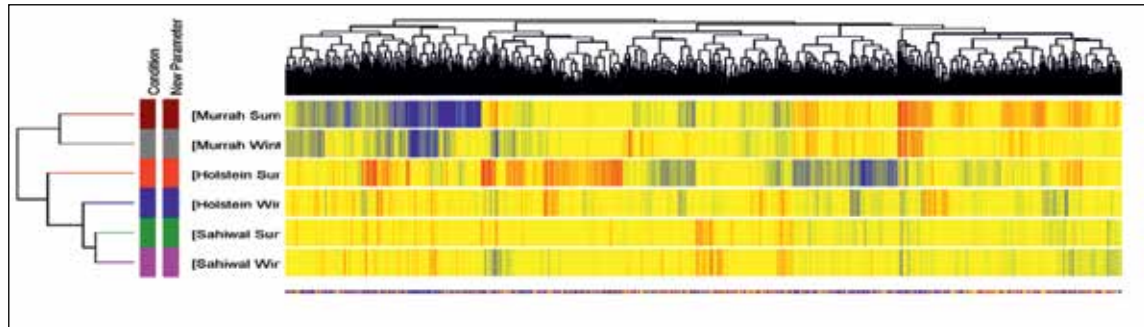
***Transcriptome changes in PBMCs of cattle and Murrah buffaloes during summer and winter***

The PBMCs of Sahiwal cows (SAC), Holstein Frisian cows (HFC) and Murrah buffaloes (MUB) was analyzed to understand the transcriptomic variations between peak summer (THI>85) and winter (THI<72) period. The data was generated using Agilent bovine oligonucleotide array in 4 × 44 K format with design ID V2:023647 having 43,803 probes. The extracted RNA from all PBMC samples was intact and yield and specific activity of Cyanine3 (Cy3)-labeled complementary RNA (cRNA) was higher than

cut of values (the yield of cRNA was >1.65 µg and specific activity was >9.0 pmol Cy3 per µg cRNA), ensuring successful microarray hybridization. A quantile normalization was performed on data sets to remove any technical variations. Overall microarray data analysis revealed a total of 3907 differentially expressed genes during summer and winter seasons in SAC, HFC and MUB PBMCs with FDR < 0.01. With an additional cut off criteria i.e., fold change of 2 or more, a total of 2,775 genes were found to be differentially expressed. The line plot showing transcriptional pattern of DEG filtered at 2-fold cutoff criteria is depicted in figure. The normalized transcriptome data was further categorized using hierarchical and k-means clustering tools. Overall analysis revealed substantial differences in transcriptome signature of PBMCs across three breeds during two seasons (Fig.2). The generated heat maps indicated several differentially expressed genes between the breeds. The analysis revealed that there was relatively greater transcriptional response during the summer season in all three breeds. In Sahiwal cows' PBMCs, a total of 453 genes were differentially expressed of which 275 genes were up-regulated and 178 genes were down-regulated. In Holstein Frisian



*Line lot showing differential gene expression pattern during summer and winter*



*Hierarchical clustering showing differential transcriptome signature in Sahiwal, Holstein Frisian and Murrah buffaloes PBMCs during peak summer and winter*

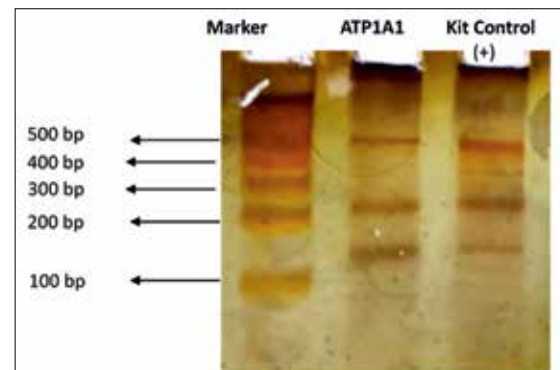
cows, a total of 1,917 genes were differentially expressed, of which 835 genes were up-regulated and 1082 genes were downregulated. In Murrah buffaloes, a total of 1345 genes were found to be differentially expressed, of which 578 genes were up-regulated and 767 genes were down-regulated. Out of 3907 differentially expressed genes, a total of 87 genes were commonly up-regulated at FDR 0.01 and FC value >2.0 across the three breeds, suggesting their strong association with heat stress response. Some of the top most up-regulated genes were; transforming growth factor beta regulator 1 (TBRG1), jagged 2 (JAG2), polo-like kinase 2 (PLK2), serine/arginine repetitive matrix 1 (SRRM1), heat shock 70kDa protein 5 (HSPA5), amnionless homolog (AMN), chromo domain helicase DNA binding protein 2 (CHD2), AF4/FMR2 family, member 1 (AFF1), WD repeat domain 59 (WDR59), DENN Domain Containing 1B (DENND1B), WD repeat and SOCS box containing 2 (WSB2), junctophilin 1 (JPH1), G0/G1switch 2 (G0S2), methyltransferase like 12 (METTL12), tubulin, alpha 3e (TUBA3E), trans-golgi network vesicle protein 23 homolog B (TVP23B) etc. The top pathways identified were EGFR1 signaling pathway, MAPK signalling pathway, B Cell receptor signaling pathway, mRNA processing, insulin signaling, mRNA processing, TGF beta signaling pathway, TNF alpha signaling

pathway, electron transport chain, apoptosis, TCR signaling pathway etc.

### ***CRISPR-Cas9 based knockout of Na<sup>+</sup>/K<sup>+</sup> ATPase alpha isoform gene (ATP1A1) in cattle fibroblast to understand its role in heat stress response***

In previous study on genome wide transcriptome analysis revealed the crucial role of *ATP1A1* gene under heat stress condition. Further, to validate their roles under heat stress condition, *ATP1A1* gene was selected to knockout from cattle fibroblasts. Cells transfection was carried out on cattle fibroblasts. The post-transfection cells were analysed for genome modification efficiency.

The *ATP1A1* (-) knockout cattle fibroblasts were exposed to heat stress at 42°C for one hour and thereafter allowed to recover at 37°C and harvested at different time intervals (2h, 4h, 8h,

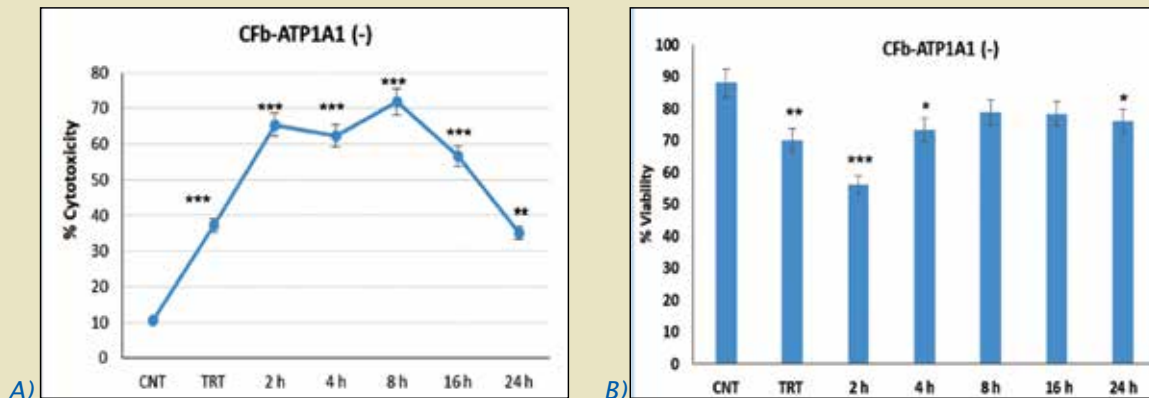


*Gel image of genomic cleavage detection assay of transfected cells for ATP1A1 target gene.*

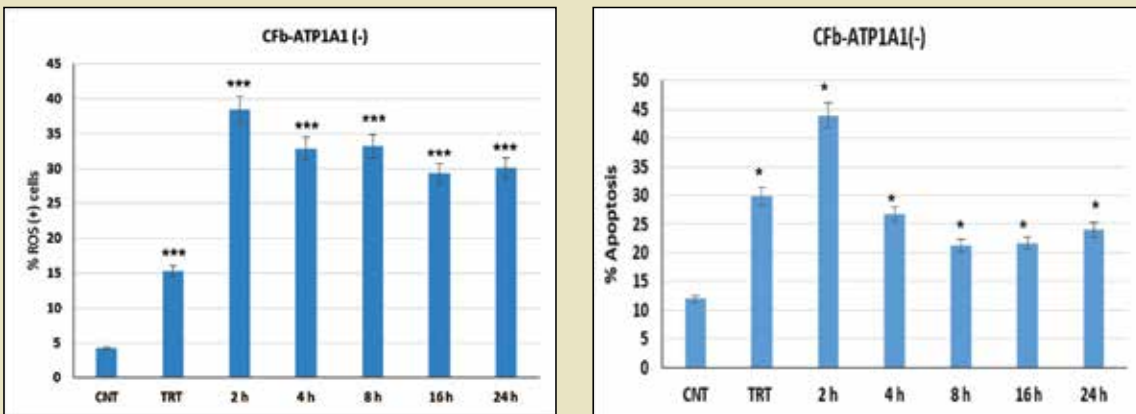


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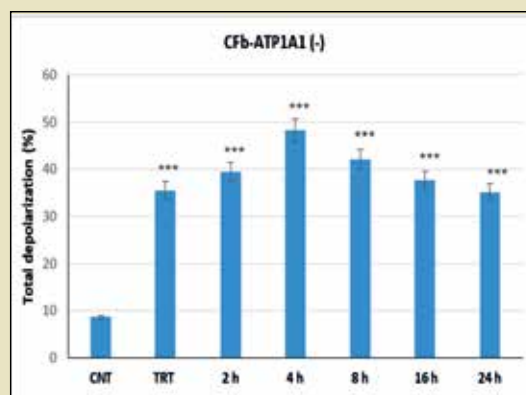
## RESEARCH ACCOMPLISHMENTS



(a) Cytotoxicity (%) and (b) cell viability of ATP 1A1 knockout cattle fibroblast [CFb-ATP1A1 (-)] after heat stress and at different recovery time points (post heat treatment) as compared to control (untreated). CNT-control, TRT- treated. Data are presented as means of three separate experiments, error bars indicates SEM. The asterisk indicates a significant difference between control and respective sample. \* $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$ .



(a) Oxidative stress (b) apoptosis of ATP1A1 knockout cattle fibroblast [CFb-ATP1A1 (-)] post heat stress compared to control (untreated). CNT-control, TRT- treated. Data are presented as means of three separate experiments, error bars indicates SEM. The asterisk indicates a significant difference between control and respective sample. \* $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$ .



Depolarization of mitochondrial membrane potential of ATP1A1 knockout cattle fibroblast [CFb-ATP1A1 (-)] post heat stress compared to control (untreated). CNT-control, TRT- treated. Data are presented as means of three separate experiments, error bars indicates SEM. The asterisk indicates a significant difference between control and respective sample. \*\*\*  $p < 0.001$ .

16h, and 24h) by trypsinization. Various cellular parameters *i.e.*, viability, cytotoxicity apoptosis, and changes in mitochondrial membrane potential were determined. The results showed that the cytotoxicity in  $\text{Na}^+\text{K}^+\text{ATP1A1}$  knockout cells increased immediately after exposure to heat stress to 40% at 2h of recovery and reached to 72% at 4h and 78% at 8h as compared to unstressed CRISPR-edited cells. The viability of the cells also decreased after exposure to heat stress to 70.12%, 56.1%, 73.23%, 78.7% 78.3% and 76% at TRT, 2h, 4h, 8h, 16h, and 24h, respectively. while, the oxidative stress in *ATP1A1* (-) cells increased immediately after heat stress by 3.6-fold and reached to 9.15 fold at TRT (0h) and 2h respectively ( $p < 0.05$ ) compared to unstressed CTR cells. The production of ROS after 4h and 8h recovery time points were 7.8- and 8.1-folds, respectively ( $p < 0.05$ ). The total

apoptosis increased by 30% post stress (TRT 0h) and reached to maximum level at 2h post recovery with 43.2% ( $p < 0.05$ ) higher values than non-transfected heat stressed cells. At later stages of recovery, the apoptosis percentage were 26.2%, 21.3%, 21.7% and 24.1% at 4h, 8h, 16h, and 24h, respectively ( $p < 0.05$ ). The effect of heat stress on depolarization of mitochondrial membrane potential ( $\Delta\Psi\text{m}$ ) was evaluated in CRISPR-edited cells. The depolarization increased significantly ( $p < 0.05$ ) in knockout cells by 35.1% (TRT-0h), 39.2% (2h), 48.8% (4h), 42.6% (8h), 37.7% (16h), 35.4% (24h), post heat stress. The depolarization of mitochondrial membrane was higher in *NaK<sup>+</sup>ATP1A1* mutant heat stressed cells compared to normal heat stressed cells, indicating its role in maintaining the membrane potential under stress conditions. Also, the results highlight the potential role of *ATP1A1* played under heat stress.



### CONSERVATION AND SUSTAINABLE UTILIZATION OF ANIMAL GENETIC RESOURCES

#### National Gene Bank

Germplasm repository at NBAGR is being strengthened by preserving diversified form of

germplasm (semen, embryos, DNA, epididymal sperms and somatic cells). The germplasm procured during this year is given in Table below.

#### Germplasm received from April 2018 to March 2019

Germplasm	Species	Breed/ Population	Number
Semen	Cattle	Bargur	9000
Semen	Goat	Gaddi	500
Semen	Buffalo	Pandharpuri	8400
Somatic Cells	Mithun	Nagaland	420
Somatic Cells	Donkey	Laddakhi	555
Somatic Cells	Yak	Laddakhi	384
<b>Total</b>			<b>19259</b>

#### Conservation of Sahiwal and Haryana cattle at Gaushalas

During the year, 42 Haryana and 11 Sahiwal cows were inseminated with elite male semen of Haryana (66 AI) and Sahiwal (14 AI), respectively. A total of 16 calving (2 Sahiwal and 14 Haryana) were happened in Jundla Gaushala. State Animal Husbandry Department, Karnal has provided liquid nitrogen every month in LN2 containers to the Gaushalas. During the year Controlled Internal Drug Release (CIDAR) treatment was

applied to 13 Haryana and 2 Sahiwal cows with the help of Sate Animal Husbandry Department Karnal. Health camps was also organised at Jundla Goshala. A total of 62 (7 Sahiwal (6 F + 1 M) and 55 Haryana (30 F +25M)) calves were born in the project since its inception. In Sahiwal, monthly daily milk yield ranged from 4.5±1.5 kg to 7.25±1.25 kg. In Haryana, monthly daily milk yield ranged from 1.55±0.324 to 4.81±0.56 kg. Average birth weight in Sahiwal calves was 18.40±2.03 (5) kg and in Haryana calves 17.97±0.35 (45) kg.



Cows in Gaushala



Calves born in Gaushala

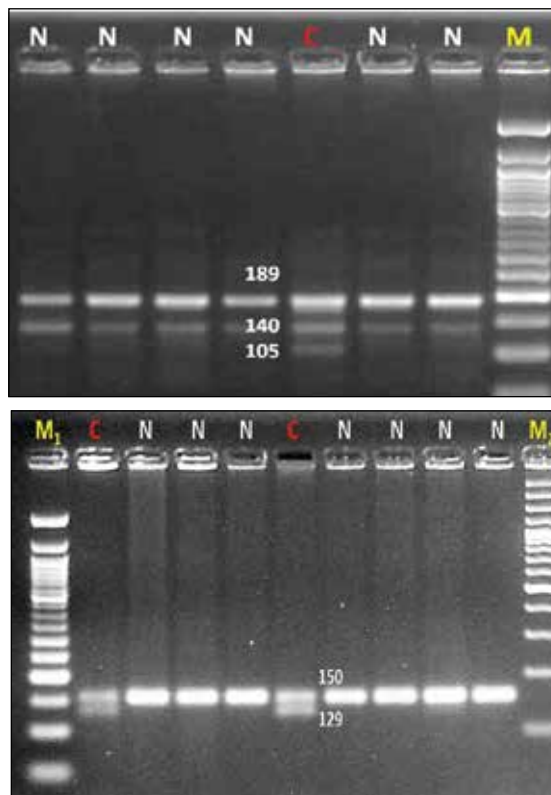


### *CRP on agrobiodiversity - conservation of Animal Genetic Resources*

Methods have been standardized for establishment and characterization of cell lines from different species which can be used as genetic material to restore precious germplasm, if need so arises. Somatic cell lines of Kharai Camel, Nagaland Mithun, Ladakhi Yak, Ladakhi and Kutchi Donkey were generated and deposited with National Gene Bank at NBAGR.

### *Karyotyping and DNA testing for screening genetic defects in Indian bovines*

Three new lethal genetic diseases –Holstein haplotypes –HH1 and HH3 and Holstein cholesterol deficiency (HCD) – were reported in crossbreds through direct sequencing of PCR products. These three lethal mutations were additional to the other two - Jersey Haplotype (JH1), and HH4 reported during last year. PCR based tests were developed for screening of HH1, HH3. Tetra primers-ARMS PCR for HH1 Primer-introduced restriction analysis for HH3, PCR-RFLP for HH4 were developed for screening of in cattle. These tests were successfully validated through direct sequencing. A multiplex test based on iPLEX technology using MALDI-TOFF platform was developed for screening of eight single nucleotide mutations, HH1, HH3, HH4, JH1, CVM, BLAD Citrullinemia and DUMPS. The result showed all the carriers to be heterozygous in iPLEX. All five lethal mutations – JH1, HH1, HH3, HH4 and HCD were screened in about 100 cattle of HF, Jersey and crossbreds. The proportion of carriers for HH1, HH3, HH4 and HCD were found to be 1.7 to 3.3 % in HF bulls. The JH1 was found at very high frequency of 23.3 % in Jersey bulls and it was also not found in



*PCR based tests developed for screening of HH1 (A) and HH3 (B) genetic diseases in Indian Hostein Fresian cattle*

other genetic groups. Services for chromosomal screening were provided to different government agencies. Cytogenetic screening of 165 cattle males, 236 buffalo males and one horse and mare each was conducted. Two bulls were found to carry abnormal karyotypes. A total of 20 bulls of cattle (18) and buffalo (2) were screened for DNA testing for genetic diseases for BLAD, Citrullinemia Factor XI deficiency and DUMPS (HF and HF crosses only).

### *Development of a SNP database for indigenous AnGR*

A SNP database on “SNPs in Indigenous Animal Genetic Resources” was also created containing the information about the SNPs identified in Yak, cattle and buffalo along with their annotation details.



### NETWORK PROJECT ON ANIMAL GENETIC RESOURCES

#### ***Conservation of Ankleshwar chicken*** (AAU, Anand, Gujarat)

Fifty Ankleshwar Chicken Keepers (ACKs) had been identified at Umarwada village of Ankleshwar Taluka. ACKs were given the knowhow regarding importance of the project and technical guidance about management of birds. Each ACK was given 8 to 10 weeks reared 20 pullets and 10 cockrels of Ankleshwar breed along with one night shelter, one waterer and one feeder with 30 kilogram feed. Pullets had started egg laying with average age at first egg of 161.5 days and entail egg weight of 30 gram. Body weight of Ankleshwar Chicken measured at day old 4<sup>th</sup>, 6<sup>th</sup> and 8<sup>th</sup> week were  $29.28 \pm 0.12$ ,  $108.36 \pm 3.40$ ,  $222.64 \pm 7.08$  and  $379.80 \pm 14.60$  g, respectively. Body weight of pullets of Ankleshwar Chicken at 12, 16 and 20 weeks were  $479.65 \pm 11.91$ ,  $523.07 \pm 11.73$  and  $853.56 \pm 13.86$  g, respectively. Body Weight of cockerel at 12 and 20 weeks of age were  $648.53 \pm 18.26$  and  $1186.90 \pm 18.56$  g, respectively. Mortality recorded was very high (40 %).

#### ***Characterization of Balangir goat*** (BAIF CRS, UruliKanchan, Pune, Maharashtra)

Preliminary field survey was conducted in the districts around Balangir. Three districts in Odisha state were selected which covers about 449 farmers and 5000 goats. Data on herd management, socio economics of goat keepers and production environment of the breed tract for 449 herds have been computerized. Data on fodder species and other related information have been collected. Information gathered on 3454 goats in respect to morphometric data. Growth measurements of 5261 goats were collected.

District	Project Location
Balangir	Bandhapada, Durgapali, Randa, and Patharla
Sonepur	Boghia, Ranisarda, Pua, Binika
Bargarh	Chhuriapali, Ghess, Attavira, Diptipur.

Kidding pattern was quite mixed, with random occurrence of single, twins and triplets. Colour pattern observed were brown, black and white, with brown having dominance. The purpose of goat rearing is mainly for meat. Castration is practised for fattening of the male buck for selling and in social functions. The market price is around 7,000 to 10000 per castrated male. Average age at slaughter is 1.5 to 2 years. Breeding buck locally called as “Buka” and castrated one is called as “Melchha”. Grazing in nearby forest or fallow land is the common feeding practice. During night, soft tree branches and some grass are offered. Locally available fodder is the major fodder source. Some of the grasses available are Kothu grass, Simili leaves, Chakada leaves, Dubho grass, Panapatri leaf etc. Farmers are also feeding tree leaves of Mahua, Neem, etc. available almost throughout the year.

#### ***Characterization of Kathani cattle***

(BAIF, Development Research Foundation, Urulikanchan, Pune, Maharashtra)

Preliminary survey was undertaken in Chandrapur, Gadchiroli and Gondia districts and cattle were called ‘Local’ or ‘Gavathi or Mulakhi’. Some old farmers also told that there was Kathani named local jowar variety straw as fodder source hence name came as “Kathani”. There is “Kathani” river near Gadchiroli city. Socio-economic status, general feeding and management practices data collected on 9,750 Kathani cattle owners from 118 randomly selected villages distributed in 13 tehsils of 3 districts. Kathani cattle population was observed to be 68,146 in the survey area with an average herd size of 5.30. 75.1% farmers were landholders and landless was 24.9 %. Kathani cattle were mainly used for agricultural operations. Kathani animals being reared on very low nutritive value

feed and fodder resources. The fodder like Tanis (paddy leftover after harvest), different Kutars (after harvest leftover) like chickpea, pigeon pea, wheat, mung, black gram and Kukus (rice bran) having average dry matter content 83.94%, crude fiber 25.21% and crude protein 9.59%.

### *Programme under tribal sub plan*

Under tribal sup plan two districts, namely, Gadchiroli and Nandurbar from Maharashtra state enlisted under aspirational districts notified by Niti Aayog and Gadchiroli district falls under Kathani cattle survey area. As per NBAGR guidelines, farmer incentive programmes like training/capacity building, awareness/exposure visits, deworming supplements, animal health camps, mineral mixture distribution etc. were under taken in 15 villages and total 990 SC/ST families benefited.

### *Characterization of Marwari and Sindhi camel*

*(ICAR-NRC on Camel, Bikaner, Rajasthan)*

**Marwari Camel:** Survey was under taken in Pali and Sirohi District of Rajasthan for characterization of Marwari Camel. A total of 17 farmer from 10 villages located in 5 tehsil were surveyed. The farmers mostly belonged to Dewasi and Rewari community. Total number of Marwari camel was 220 among the surveyed farmers. Besides camel they kept sheep, goat and cattle. Body measurement of 43 Marwari camel was also taken. Average chest girth, body length, Height at wither, fore limb length, hind limb length, tail length, neck length, face length, distance between eyes, ear length, were 189.37 cm, 141.37 cm, 194.49 cm, 142.00cm, 149.91 cm, 47.93 cm, 100.16 cm, 36.65cm, 20.11 cm and 8.06 cm, respectively. The dimension of the foot pads of fore limb was 18.77 (L) X 18.37cm (W) while dimension of foot pads of hind limb was 18.10 (L) X 17.80 cm.

**Sindhi Camel:** Survey was under taken in Jaisalmer and Barmer District of Rajasthan for characterization of Sindhi Camel. A total of 76 farmer from 26 villages located in 5 tehsil were surveyed. The farmers belonged to Rajput, Dewasi, Meghwal, Muslim and Raika community. Total number of Sindhi camel was 708 among the surveyed farmers. Body measurement of 86 Sindhi camel was also taken. Average chest girth, body length, Height at wither, fore limb length, hind limb length, tail length, neck length, face length, distance between eyes, ear length, were 202.36 cm, 154.84 cm, 199.53 cm, 142.54cm, 159.74 cm, 54.23cm, 109.73cm, 44.61cm, 26.31 cm and 11.68cm, respectively. The dimension of the foot pads of fore limb was 19.97 (L) X 19.23 cm (W) while dimension of foot pads of hind limb was 17.26 (L) X 16.73 cm. Hair sample from 41 animals were collected for hair quality analysis.

A radio talk programme Unta Ri Banta was initiated from November, 2018 for 6 month for wide dissemination of knowledge pertaining to camel husbandry and conservation in project area. The programme is being broadcasted in Pali, Sirohi, Jodhpur, Jaisalmer, Barmer and Bikaner districts.

### *Characterization of Manipuri duck*

*(CAU, Imphal, Manipur)*

As per the technical programme, 500-1000 ducks have been identified so far for data recording in each district with some variation. Data recording has been started. For smooth management of the project, proposal for organizing 6 training programmes, 2 in each districts was already submitted. As approved by the competent authority, one training programme has already been conducted to aware the farmers about the project activities and also to disseminate knowledge on "Scientific Rearing of Ducks".

### **Characterization of Poonchi chicken** (SKAUST, Jammu, Jammu & Kashmir State)

Engagement of Project staff has been done and a training programme was conducted for the supervisor and enumerators on various aspects of characterization of Poonchi chicken after visiting native tract of the Poonchi chicken, preliminary breeding tract of Poonchi chicken was identified. Topography of district Poonch is hilly and mountainous barring few-low lying valleys. Rajouri district is located in the foothills of Peer Panchal range. Farmers rearing Poonchi Chicken population are majority landless to marginal farmers. The farmers used to rear the Poonchi chicken population mainly for meat and egg.

These birds are let loose in the day time and kept in wooden house at night. This chicken population is mainly reared under very low inputs. The feed mainly includes crushed maize, left over feed, grains and kitchen wastes. Poonchi Chicken population have excellent capacity for cold tolerance and survive even on ice. Flock (Cock:Hen) ratio : 1:3.

- **Body Colour:** Different colour patterns like red with patches, complete black, brown, multicolour etc. Plumage Colour : Black,Brown, Redish –yellow. Skin colour –Yellow
- **Shank Colour-** Yellow , some brown, few feathered shank
- **Comb-** Red in colour. some brown Prominent in males
- **Comb Type-**Single, some pea, few butter cup

- **Ear lobe-** Red, brown, some balck
- **Neck-**Feathered, few naked
- **Egg weight-up to 50 gm.** Egg shell- Brown and brownish tinge. Annual egg production- 90-110 eggs. No vaccination is practiced.

### **Characterization of Vandarvi and Kamma cattle populations of Telangana** (WASSAN, Hyderabad, Telangana)

Survey was conducted in Nagarkurnool and Rajanna Sircila districts of Telangana and Kurnool district of Andhra Pradesh. Breeders are identified and their grazing practices, production systems were recorded. Biometrics of 257 Kamma cattle of different age groups, milk recordings from (70) cows and reproductive data of 114 animals from 57 breeders and biometrics of Vandera animals (180), milk recordings from (40) cows and reproductive data of 40 animals from 20 breeders of Vandera cattle in Rajanna sircilla district were recorded. A market study was done at Kurumurthy Cattle Fair, where 2000 – 3000 cattle are marketed. Orientation & Training programs were held with rearers and breeders along with the Animal Husbandry staff.

### **Conservation of local pig and goat -tribal sub plan programme** (AAU, Khanapara, Assam)

60 beneficiaries each for piggery and goatery components were selected from different 12 villages under Baksa district based on their interest on livestock rearing, past experience and economic condition. Two awareness programmes for the beneficiaries of piggery and goatery units were organized separately on 11.01.19 and 12.01.19 where all the selected

### **Age and sex wise number of goats under recording**

Sex / Age	1-3	4-6	7-9	10-12	>13	Total
Female	1059	554	118	214	572	2517
Male	455	267	66	61	88	937
<b>Total</b>	<b>1514</b>	<b>821</b>	<b>184</b>	<b>275</b>	<b>660</b>	<b>3454</b>

### Awareness programmes conducted

S. N.	Description	Quarter 2		Quarter 3	
		Target	Achieved	Target	Achieved
1	Training/capacity building (no.)	4	1	4	4
2	Awareness camp/ exposure visits (no.)	6	4	6	8
3	Deworming doses distribution(doses)	-	192	-	468
4	Animal Health camps arranged (no.)	4	2	4	6
5	Mineral mixture distribution (kg.)	-	40	-	410

beneficiaries participated. Expert on concerned field from the College of Veterinary Science, AAU, Khanapara took part in the programme to train up the beneficiaries about scientific rearing of pig and goat. Input distribution for piggery was organised on 24.01.19 at Khandikar under Baksa. In first phase 40 beneficiaries were invited based on the availability of fund. Out of 40 beneficiaries 5 were selected for breeding unit and rest 35 were selected for providing fattening unit. 4 piglets (2M+2F) were distributed for the breeding units and 2 piglets (1M+1F) distributed for the fattening units. For goatery also initially 40 beneficiaries were invited. All the beneficiaries were distributed 2 animals each. Besides, the beneficiaries were also given feed, medicines, utensils, fund for housing etc. Both the input distribution programmes were organised in presence of some invited dignitaries who also gave away the inputs.

#### *Tribal sub plan programme on conservation of Kadaknath fowl* (Chhattisgarh Kamdhenu Vishwavidyalaya, Anjora, Durg, Chhattisgarh)

Preliminary survey was conducted and one village was selected where only Kadaknath fowl is being maintained. Three days training programme was conducted to create awareness about the project activities and scientific rearing of fowl.

#### *Genetic characterization of livestock breeds* (Core Lab, NBAGR, Karnal, Haryana)

Genetic characterization of all the populations is being done at core lab. In last year 3 camel breeds namely Kharai, Marwari and Sindhi; Kathani cattle and Bolangir goat have been completed with requisite number of SSR markers in 48 random samples of each breed. Various genetic parameters have also been defined for each breed/population.

### Population diversity in livestock populations under Network Project

Population	N	Na	Ne	Ho	He	F
Kathani cattle	46.72±0.31	9.84±0.71	4.25±0.40	0.69±0.05	0.69±0.03	0.03±0.04
Balangir goat	45.09±0.54	8.22±0.63	3.69±0.43	0.57±0.05	0.64±0.04	0.13±0.05
Marwari camel	46.13±0.39	8.78±0.96	3.83±0.39	0.54±0.05	0.67±0.03	0.20±0.06
Sindhi camel	45.65±0.44	8.52±1.06	3.93±0.45	0.53±0.04	0.58±0.03	0.12±0.05
Kharai camel	44.73±0.53	7.04±1.03	3.04±0.32	0.59±0.05	0.68±0.04	0.08±0.04

Values are mean ± SE. N = Number of animals; Na = No. of different Alleles, Ne = No. of effective Alleles; Ho = Observed heterozygosity = No. of Hets / N; He = Expected heterozygosity = 1 - Sum pi<sup>2</sup>; uHe = Unbiased expected heterozygosity = (2N / (2N-1)) \* He; F = Fixation Index = (He - Ho) / He = 1 - (Ho / He)



N B A G R



## **PUBLICATIONS**

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**RESEARCH ARTICLES**

**RESEARCH ABSTRACTS**

**BOOK CHAPTERS, TECHNICAL & POPULAR ARTICLES**

**BOOKS, COMPENDIA, MANUALS, MONOGRAPHS  
& TECHNICAL BULLETINS**

**LEAFLETS**

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## RESEARCH ABSTRACTS

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2. Deswal S, Singh S, Jeevan C, Ganguly I and Dixit SP (2019). Copy number variation of Y-linked zinc finger protein 280b (ZNF280BY) in 5 different breeds of Indian Buffalo (*Bubalus bubalis*). XVI National Symposium on “Animal Genetic Resources for Food and Social Security” at ICAR-NBAGR, Karnal from February 7-8, 2019.
3. Deswal S, Singh S, Jeevan C, Ganguly I and Dixit SP (2019). Identification of Y-chromosome haplogroup and estimation of genetic diversity in Indian buffalo using Y-specific STR markers. XVI National Symposium on “Animal Genetic Resources for Food and Social Security” at ICAR-NBAGR, Karnal from February 7-8, 2019.
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2. Ganguly I, Jeevan C, Kumar S and Singh S (2019). Paternal lineages and haplotype diversity of mammalian Y-chromosome with special reference to cattle. In compendium: Tools for genetic improvement of animal welfare and productivity. Edited by Mukherjee A, Bhakat M, Gupta AK and Deb SM. Under 34<sup>th</sup> National Training Programme organized under CAFT (AG&B), AGB Division during February 25 – March 17, 2019.
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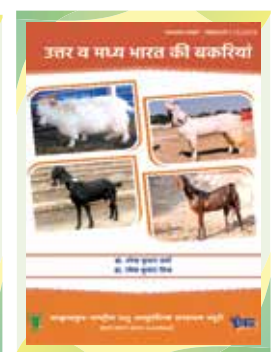
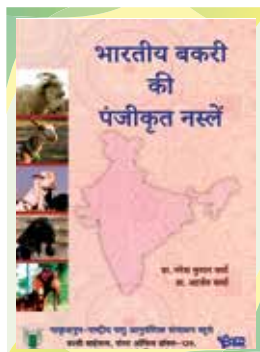
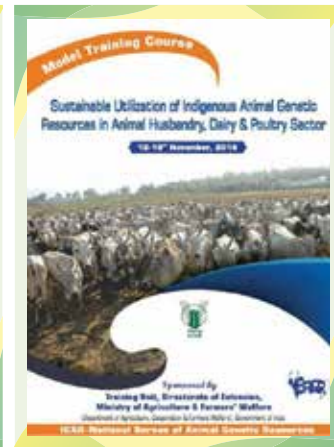
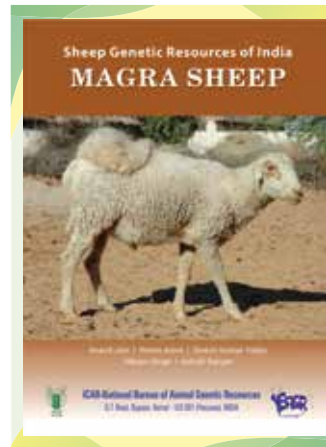
## BOOKS, COMPENDIA, MANUALS, MONOGRAPHS & TECHNICAL BULLETINS

1. Compendium “Animal Genetic Resources for Food and Social Security” (2019). Editors: Ed. Kataria RS, Mishra AK, Niranjana SK, Raja KN and Singh KV. XVI National Symposium on Animal Genetic Resources for Food and Social Security at ICAR- NBAGR Karnal from February 7-8, 2019.
2. Compendium on "Sustainable Utilization of Indigenous Animal Genetic Resources in

- Animal Husbandry, Dairy & Poultry Sector". Edited by Ahlawat S, Sharma R, Raja KN and Sharma A. Under Model Training Course on "Sustainable Utilization of Indigenous Animal Genetic Resources in Animal Husbandry, Dairy & Poultry Sector" during November 12-19, 2018.
3. Monograph: Sheep Genetic Resources of India: Magra Sheep. By Jain A, Arora R, Yadav DK, Singh V and Ranjan A. Monograph No. 112/2018.
  4. Training Manual "Breeding Specialization for Judging Various Animal Events" (2018). Editors: Singh PK, Verma HK, Sharma RK, Bharti, Jadoun YS. Directorate of Extension, GADVASU, Ludhiana and ICAR-NBAGR, Karnal. Pp 1-154.
  5. Technical Bulletin: भारतीय बकरी की पंजीकृत नस्लें द्वारा एन के वर्मा व आर्जव शर्मा। एन बी ऐ जी आर -110/2018. पेज संख्या 32.

## LEAFLETS

1. "भारतीय पशुधन - पशु विविधता" द्वारा डॉ करन वीर सिंह, अनिल कुमार मिश्र एवं आर्जव शर्मा । NBAGR-113/2019.
2. "भारतीय भैंस की नस्ले" द्वारा डॉ करन वीर सिंह, रणजीत कटारिया, साकेत निरंजन, अवनीश भाटिया एवं आर्जव शर्मा । NBAGR-114/2019.
3. "उत्तर व मध्य भारत की बकरियां" द्वारा एन के वर्मा व आर के विज । NBAGR-115/2019.



N B A G R



## **AWARDS & RECOGNITIONS**

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### AWARDS & RECOGNITIONS

NBAGR organized ceremonial function, for the award of breed registration certificates, on Decemeber 12, 2018 at ICAR Krishi Bhawan, Delhi. The certificates were given to the stakeholders/applicants by Sh. Radha Mohan Singh Ji, Hon'ble Union Minister of Agriculture and Farmers Welfare, Govt. of India.



*Hon'ble Minister awarding the breed registration certificate to the NBAGR Scientist*

Dr Sonika Ahlawat received Jawaharlal Nehru Award for P.G. Outstanding Doctoral Thesis Research in Agricultural and Allied Sciences (2017) from honorable Minister of Agriculture & Farmers' Welfare, Sh. Radha Mohan Singh.



*Dr. Sonika Ahlawat receiving Jawahar Lal Nehru Award*

Dr. M.S. Tantia was conferred with the prestigious Dr. P.G. Nair Award for scientific contribution in the field of identification, evaluation,

characterization, conservation and utilization of livestock and poultry genetic resources of the country from January, 2015 to December, 2017.



*Dr. M.S.Tantia receiving Dr. PG Nair Award*

Prof. K.N. Sharma memorial Award 2018 for best publication in Journal of Livestock Biodiversity was awarded to the article "STR markers based genetic diversity evaluation of Chilika buffalo of Odisha state" by Ravinder Singh, S Lava Kumar, Ankita Gurao, SK Mishra, SK Niranjan, V Vohra, SK Dash and RS Kataria.

Dr. RK Vijh was conferred with first Dr DS Balain memorial award, for his outstanding scientific contribution, during XVI National Symposium organised by Society for Conservation of Domestic Animal Biodiversity. The award was presented by Mrs. Vidya Wati Balain.



*Dr. RK Vijh receiving Dr DS Balain Memorial Award*



Dr. Anil Kumar Mishra was conferred with recognition for outstanding contribution in reviewing by Elsevier journal Small Ruminant Research.

Dr. Anil Kumar Mishra was conferred with Fellowship of National Academy of Dairy Science (India) on September 9, 2018.

Best poster award to Dr. Anurodh Sharma for the poster entitled “Genome-wide runs of homozygosity in Indian native cattle” by Anurodh Sharma, Sanjeev Singh, Indrajit Ganguly, Avnish Kumar, S Jayakumar and S P Dixit in XVI National Symposium on “Animal Genetic Resources for Food and Social Security” at ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana, February 7-8, 2019.

Best poster award to S. Lava Kumar for the poster entitled “Genetic diversity analysis of Odisha buffaloes using STR markers reveals unique population structure of Manda buffalo” by S. Lava Kumar, Ravinder Singh, S.K. Mishra, V. Vohra, Prem Kumar, S.K. Niranjana, S.K. Dash and R.S. Kataria (2018) in International Conference on Biotechnological Research and Innovation for Sustainable Development XV BRSI Convention, The Biotech Research Society, India at CSIR Indian Institute of Chemical Technology (CSIR-IICT), Hyderabad, November 22-25, 2018.

Third Best Poster Award to Ms. Mandeep Kaur for the poster entitled “Increasing pollution and depleting diversity” by Mandeep Kaur, Ashish Kumar, Rakesh Kumar, Sonika Ahlawat and Reena Arora on International Biodiversity Day at ICAR-NBAGR, Karnal, May 22, 2018.

Best poster award to Dr. Manishi Mukesh for the poster entitled “Endurance trial at high altitude of

Ladakh unfolds superiority of Zanskari ponies” by Manishi Mukesh R S Kataria ,SK Niranjana, Monika Sodhi , Ankita Sharma , Preeti Verma, Vijay K Bharti , Col Ajay Garg , Capt MC Yadav , Capt Anurag , Prince Vivek and Bhuvnesh Kumar in XVI National Symposium on “Animal Genetic Resources for Food and Social Security” at ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana, February 7-8, 2019.

Best poster award to Dr. Namita Kumari for the poster entitled “Identification of novel allelic patterns through genetic diversity analysis of MHC class II locus of indigenous, crossbred and exotic cattle breeds” by Namita Kumari, Shubham Loat, Shallu Saini, Nitika Kumari, S.K. Mishra, Anurag Kumar and R.S. Kataria in National Conference on “Advances in Biotechnology: An Interdisciplinary Approach” at Sharda University, NOIDA, November 2-3, 2018.

Dr. NK Verma was conferred with ‘Bharat Jyoti Award’ 2018, for meritorious services, outstanding performance and remarkable role conferred in the field of Science and Technology by India International Friendship Society during a seminar on Economic growth and National integration at New Delhi on June 2, 2018.

Best oral presentation award to Ravinder Singh for the paper entitled “Comparative Modeling and Mutual Docking of Structurally Uncharacterize 1 HSP-70 and HSF-1 Proteins in Indian Water Buffalo” by Ravinder Singh, Ankita Gurao, SK Mishra, Ankita Behl, Vikash Kumar, Saroj Rani, Namita Kumari, Anurag Kumar, Prem Kumar, S Lava Kumar, Shallu Saini and RS Kataria in International Conference on “New Horizons in Green Chemistry & Technology” organized by Uttranchal College Of Applied & Life Sciences, Uttaranchal University, Dehradun, November 27-28, 2018.

Best oral presentation award to Dr. Rekha Sharma for the paper entitled “Milk of grazing indigenous cattle: A potential functional food” by Rekha Sharma, Ahlawat S, Aggarwal RAK, Dua A, Sharma V and Tantia MS (2018) in National Conference on “Challenges and opportunities for the new generation dairy foods in India” and 5<sup>th</sup> convention of National Academy of Dairy Science (India) held at Sri Venketeswara Veterinary University, Tirupati (AP), September 9-10, 2018.

Best oral presentation award to Dr. Rekha Sharma for the paper entitled “Value addition to indigenous cattle and buffalo by delineating milk sialic acid concentration” by Rekha Sharma, Sonika Ahlawat, Himani Sharma, RAK Aggarwal, Vivek Sharma and MS Tantia in XVI National Symposium on “Animal Genetic Resources for Food and Social Security” at ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana, February 7-8, 2019.

Third best poster award to Ms. Shallu Saini for the poster entitled “Documentation of allelic diversity at DRB3 locus of major histocompatibility complex class II in indicus, exotic and crossbred cattle” by Shallu Saini, Shubham Loat, Namita Kumari, S.K. Mishra, Nitika Dhilor, Anurag Kumar and R.S. Kataria (in International Conference on New Horizons in Green Chemistry & Technology (ICGCT-2018) organized by Uttaranchal College Of Applied & Life Sciences, Uttaranchal University, Dehradun, November 27-28, 2018.

Second best oral presentation award to Dr. Sonika Ahlawat for the paper entitled “Comparative

analysis of Boule promoter DNA methylation and gene expression in bulls with differential semen motility” by Sonika Ahlawat, Rekha Sharma, Reena Arora, Himani Sharma and MS Tantia in XVI National Symposium on “Animal Genetic Resources for Food and Social Security” at ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana, February 7-8, 2019.

Best oral presentation award to Dr. Sonika Ahlawat for the paper entitled “Identification of incompatible alleles of hybrid sterility locus (PRDM9) in bovids” by Sonika Ahlawat, Rekha Sharma, Reena Arora, Priyanka Sharma, RS Kataria and Sachinandan De in National Symposium on “Bridging biochemical interventions and environmental remediation’s for one health improvement” at LUVAS, Hisar, November 2-3, 2018.

सोनिका अहलावत, नेहा, रेखा शर्मा, रीना अरोड़ा एवं मधुसूदन टांटिया (2017) “समेकित कृषि: सतत आजीविका के लिए एक उत्कृष्ट विकल्प”, पशुधन प्रकाश में प्रकाशित लेख को द्वितीय पुरस्कार (2017) पशुधन प्रकाश 8: 50-55.

New ISO certificate ISO 9001:2015 was obtained by the ICAR-NBAGR during August-2018.



N B A G R



## **CAPACITY BUILDING AND HUMAN RESOURCE DEVELOPMENT**

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**CAPACITY BUILDING PROGRAMMES ORGANIZED**

**TRAINING PROGRAMMES AND OTHER  
SCIENTIFIC EVENTS ATTENDED**

**TEACHING AND GUIDANCE**

**EXHIBITIONS**

**LIBRARY ENRICHMENT**

### CAPACITY BUILDING PROGRAMMES ORGANIZED

#### Training Programmes

Type of training	Title of training	Time & Duration	Course Director / Coordinator	Attending participants	Funding agency
HRD Training	Professional and personal skill development for Technical and Administrative staff of ICAR	June 19-21, 2018 (3 days)	Dr Reena Arora, Dr Jayakumar S & Dr Karan Veer Singh	31 technical and administrative ICAR staff	ICAR-HRD Fund
Short-term Training	Characterization, Evaluation and Conservation of indigenous livestock and Poultry Genetic Resources	May 1-7, 2018	Dr Arjava Sharma Dr Vikas Vohra & Dr Raja K N	15 Veterinary Officers of Odisha State	OLRDS Odisha Livestock Research & Development Society
Model Training Course	Sustainable Utilization of Indigenous Animal Genetic Resources in Animal Husbandry, Dairy & Poultry Sector	November 12-19, 2018	Dr Sonika Ahlawat, Dr Rekha Sharma & Dr Raja K N	26 Officers of the State Animal Husbandry Department	Ministry of Agriculture, Dept. of Agri, Coop & Farmers Welfare, GOI

#### Interactive Meet

NBAGR in collaboration with ASD, ICAR organized an interactive meet on “Farm Animal Genetic Resources: Evaluation, Characterization and Registration” on 03.12.18 at NASC Complex, Delhi and was presided by Dr. T. Mohapatra, Secretary, DARE and DG, ICAR.

The meeting was attended by Dr. J. Jena, DDG (AS), Dr. S. Honnapagol, AHC, DADF, GOI and representatives from ICAR species specific institutes, SAH, NGOs and ASD, ICAR. Director NBAGR and scientists presented the overview of AnGR. The meeting was attended by Animal Husbandry Officers & State Livestock



*Demonstration of fire extinguishing practices during a skill development training programme*



*Training participants and coordinators of Model Training Course*



# N B A G R

## CAPACITY BUILDING AND HUMAN RESOURCE DEVELOPMENT

Development Board Officers of more than 16 States, 12 state University Officers including two Vice Chancellors and representatives of 10 NGOs and 15 ICAR Institute Scientists.

### *Lead papers in National and International Seminar/Short Courses*

1. Dr. SP Dixit presented a paper on Perspectives and Challenges of Genomic Selection in sheep during National Seminar on “Current Scenario Future Strategies for Augmenting Productivity of Small Ruminants” at Bihar Animal Sciences University, Patna from 14-16th February-2019.
2. Dr. RK Pundir presented a paper on Enhancement of indigenous cattle milk productivity in India. Guest Lecture presented in, 8th International Science Congress (ISC-2018) organized by International Science Community Association in Collaboration with Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala on December 8-9, 2018 at Maharishi Markandeshwar University, Mullana, Ambala, Haryana, India.
3. Dr. RK Pundir presented a paper on Use of indigenous cattle diversity in enhancement of milk production and productivity, paper presented in National Conference on Challenges and opportunities for the new generation Dairy foods in India; held at College of Dairy Technology, Sri Venkateswara Veterinary University, Tirupati-517502, during Sept 9-10, 2018.
4. Dr. RK Pundir presented a paper on Characterization and evaluation of Jhari cattle in Telengana state, XVI National Symposium on Animal Genetic Resources for food and social security held on February 7-8, 2019 at National Bureau of Animal Genetic Resources (NBAGR), Karnal, pp 108.
5. Dr. P.K. Singh presented a paper on Characterization, registration and conservation of cattle diversity in India and role expected from Gaushalas. In the workshop on “Economically sustainable Gaushala Management- Successful Case Studies” organized by Indian Cattle supported by Bombay Gow Rakshak Trust, Mumbai at



*Dignitaries and participants of Interactive meet*

The Hotel Ambassador, Near Marine Drive, Veer Nariman Road, Church gate, Mumbai on 10<sup>th</sup> March 2019.

6. Dr. RK Pundir presented a paper on “Cattle breeds and their characteristics” lecture delivered in the training program *Breeding Specialization for judging various animal events* held at GADVASU, Ludhiana during 28.05.2018 to 01.06.2018.
7. Dr. RK Pundir presented a paper on Status of bovine genetic resources and their contribution to rural farm economy. Invite paper presented in ICAR summer/winter school on Technology transfer management for ensuring sustainability and food security through promotion of neglected and underutilised livestock and agriculture crops held at Directorate of Extension, SKUAST, Srinagar during July 17 to August 06, 2018.
8. Dr. RK Pundir presented a paper on Indian breeds of cattle and buffalo, conservation and sustainable utilization for improving farm

economy in ICAR summer/winter school on Technology transfer management for ensuring sustainability and food security through promotion of neglected and underutilized livestock and agriculture crops held at Directorate of Extension, SKUAST, Srinagar during July 17 to August 06, 2018.

### *SOC DAB Symposium*

The bureau has successfully organized XVI symposium of Society for Conservation of Domestic Animal Biodiversity at ICAR-National Bureau of Animal Genetic Resources, during 7-8 February, 2019. More than 240 delegates participated in the symposium and deliberated upon the important issues on livestock and poultry genetic resources characterization, improvement and conservation during three technical sessions. During a separate brain storming session on ‘Management of stray Cattle’ participants put forth their views and recommendation made. To encourage young professionals/students a young scientist award session organized, awarding the prize to the best presentation.



### TRAINING PROGRAMMES AND OTHER SCIENTIFIC EVENTS ATTENDED

#### Seminars/ Workshops/ Symposia/Training

Type of event	Title of Event	Time & Duration	Place	Attending participants
CAFT Training	Tools for genetic improvement of animal welfare and productivity	February 25-March 17, 2019 (21 days)	ICAR-NDRI, Karnal	Sonika Ahlawat
National Symposium	Animal Genetic Resources for Food and Social Security	February 7-8, 2019	ICAR-NBAGR, Karnal	All NBAGR Scientists
Brainstorming workshop	Genomic selection and its implementation in India: The way forward	September 17, 2018	ICAR-IVRI, Izatnagar	Jayakumar S
Interactive meet	Characterization and Registration of Animal Genetic Resources in India	December 3, 2018	NASC Complex, Delhi	10 NBAGR Scientists

NBAGR Participated in three day event of 4th Agri Leadership Summit from 15th to 17th February, 2019 at India International Horticulture Market, (IIHM), Ganaur, Sonapat and installed an Exhibition to showcase the activities of institute.

The user interface for mobile app was enhanced by inclusion of more links on general information,

breeding tract, population, morphology, performance, and breeding tract. Looks for the links / buttons was also improved. Display of data was arranged in tabular form. Facility for downloading breed descriptor as pdf file was also developed. The pdf file for breed descriptor includes photographs of male and female animals along with values of trait for breed.

### TEACHING AND GUIDANCE

Teaching & Academic activity:-Nine scientists of NBAGR are regularly teaching various courses of M. V. Sc and Ph.D students of NDRI, Karnal. Guided one PhD and one

M.V.Sc student for their dissertation work under the supervision of scientist of NBAGR. Currently institute has MoU with seven universities.

#### M.Sc./M.Tech/M.V.Sc. thesis submitted from ICAR-NBAGR during 2018-19

S. N.	Title	Student Name	Guide's Name	University to which submitted
1.	Molecular cloning, expression and characterization of mu-opioid receptors with special reference to its interaction with bovine beta-casomorphins	Amarjeet	Dr. Monika Sodhi, Principal Scientist	NDRI Deemed University
2.	Genetic Characterization of Buffaloes of Odisha State Using Microsatellite marker and Mitochondrial D-Loop Sequencing.	S. Lava Kumar	Dr. R.S. Kataria, Principal Scientist	NDRI Deemed University
3.	Comparative studies on genetic diversity using simple sequence repeats in dairy buffalo breeds.	Narender Pratap Singh	Dr. Vikas Vohra, Principal Scientist	NDRI Deemed University
4.	Identification of SNPs using ddRAD approach and their annotation in Murrah buffalo.	Surya T.	Dr. Jaya Kumar S. Senior Scientist	NDRI Deemed University



### EXHIBITIONS

Bureau participated in a number of events and displayed its activities. NBAGR stall received best stall award at Pashu Palan Mela, GADVASU, Ludhiana (15-16 March, 2019).

S.No	Place	Date
1	National Sheep and Wool fair ICAR-CSWRI, Avikanagar, Rajasthan	September 29, 2018
2	Kharif Kisan Mela, ICAR-CSSRI, Karnal	October 9, 2018
3	Farmers Scientist Workshop, Kisan Mela, ICAR-IIWBR, Karnal	October 15, 2018
4	4 <sup>th</sup> Agri LeaderShip Summit Ganaur, Haryana	February 15-17, 2019
5	Buffalo Fair, ICAR-CIRB, Hisar, Haryana	February 18, 2019
6	National Agricultural Fair, ICAR-IARI, New Delhi	March 5-7, 2019
7	Pashu Palan Mela, GADVASU, Ludhiana	March 15-16, 2019

### LIBRARY ENRICHMENT

The NBAGR library has been playing an important role in serving the scientists and technical staff of the bureau. Books and journals are regularly being procured in the library. Seventeen Indian Journals and Six foreign journals have been subscribed for the benefit of

scientific readers during the current year. The status of NBAGR library Catalogue is as follows:

Total collection	4196
No. of Scientific Journals	23
No. of Newspapers	07



*Sh. Parshottam Rupala, Hon'ble MoS for Agriculture and Farmers' Welfare visiting NBAGR stall*



N B A G R



## **INSTITUTE ACTIVITIES**

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**MEETINGS**

**CELEBRATIONS**

**MERA GAON MERA GAURAV**

**SPORTS**

**राजभाषा प्रकोष्ठ की गतिविधियां**

**DISTINGUISHED VISITORS**

### MEETINGS

#### *Institute Research Committee meeting*

IRC meeting was held on May 17, 2018 wherein final reports of the completed projects and new project proposals were discussed and approved.

#### *Research Advisory Committee meeting*

Research Advisory Committee meeting was held on July 23, 2018 under the chairmanship of Dr. VK Taneja, Former Vice Chancellor, GADVASU Ludhiana. Dr. RS Gandhi, Assistant Director General (AP&B), ICAR, Krishi Bhawan, New Delhi also attended the meeting.



*RAC meeting in progress*

#### *Breed registration Committee meeting*

A meeting of Breed Registration Committee was held on September 5, 2018 at ICAR, Krishi Bhawan, New Delhi which approved registration of fifteen new native breeds of livestock and poultry.



*Breed registration committee meeting in progress*

#### *Quinquennial Review Team Meetings*

Quinquennial Review Team (QRT) had three meetings, first on June 22-23, 2018; second on October 29, 2018 and the third meeting on January 29, 2019 under the chairmanship of Dr. R.N. Sreenivas Gowda, Former Vice-Chancellor, KVAFSU, Bidar. All other members of the committee viz. Dr. Dharmeshwar Das, Former Joint-Director (A), IVRI, Izatnagar; Dr. U. D. Umrikar Former Prof. & Head (AGB), BVC, Parel, Mumbai; Dr. D. N. Rank Prof. & Head (AGB), AAU, Anand; Prof. P. Kumarasamy Prof. & Head (AGB), TANUVAS, Chennai; Dr. K. V. Bhat, Former Principal Scientist, NBPGR, New Delhi and Dr. P.K. Singh of NBAGR, Karnal (Member Secretary) attended all the meetings. The QRT interacted with the Director, HoDs, Scientists, Administrative and technical staff of the Bureau, visited different labs of the Bureau/Gaushala and evaluated the research accomplishment and facilities added during the period under assessment (April 2012 to March 2017).



*QRT meeting in progress*



*QRT team interacting with NBAGR scientists*

### CELEBRATIONS

**International Biodiversity Day** was celebrated on May 22, 2018 at the Bureau. On this occasion, a poster competition of School students of different schools located at Karnal (Haryana) and Research Scholars studying/working at ICAR-NBAGR, Karnal was organized on the theme “Increasing pollution and depleting Biodiversity”. In this competition, 6 schools of Karnal and 8



*Celebration of International Biodiversity Day*

Research scholars of the Bureau participated. In the school group, Pratap Public School and Adarsh Public School were ranked first whereas in the Research Scholar groups, the poster presented by Ankita Sharma and others was ranked first. On this occasion, the “Breed Saviour Award” was also organized in coordination with an NGO “SEVA” from Madurai, Tamil Nadu. A total of 20 farmers from the different parts of the country were awarded with Breed Saviour Award carrying Rs. 10,000 cash and a citation. The Director of the Bureau called all the winners of Breed Savior to act as Ambassadors of the Livestock conservation and requested them to create awareness among the people of their area for conservation of precious Livestock diversity of India. After distributing awards, Dr. R.M. Acharya, former DDG, ICAR, New Delhi and Chief Guest of the function spoke on the importance of conservation of local breeds and recognizing farmers or livestock keepers for their efforts in their family for many generations.



*Enthusiastic livestock keeper being felicitated with Breed Saviour Award*



*School students expressing their views on importance of biodiversity*

**Independence Day** was celebrated on August 15, 2018. Director NBAGR hoisted the tricolor. Children presented a cultural programme on this occasion.

**Sadbhavna Diwas** was celebrated on August 20, 2018 with a theme to promote national integration and communal harmony among people of all religions, languages and regions. The Bureau staff was administered the “Sadbhavna Pledge”.

First monthly death Anniversary of Bharat Ratna Late Sh. Atal Bihari Bajpayee ji, former Prime Minister of India, was celebrated on September 16, 2018.

**Swachhta Hi Sewa Pakhwada** was celebrated from September 15 - October 2, 2018.





*Contributing to the cause of cleanliness*



*Flag hoisting during Republic day*

**Foundation Day** of National Bureau of Animal Genetic Resources was celebrated on September 21, 2018. The first Breed Conservation Award function was organized on this occasion. Dr. GS Rajoria, the president, Indian Dairy Association, delivered the foundation day lecture. New publications of NBAGR were released on this occasion. The winners of different Hindi competitions were also given prizes by the Chief Guest.



*Released of Monograph on Foundation Day*

**Republic Day** was celebrated with great pride on January 26, 2019 to honor the Constitution of India as it ages to become a septuagenarian. The theme of this year's celebration was 'Gandhi' as India celebrates his 150<sup>th</sup> birth anniversary in 2019. As per tradition, national flag was hoisted by the Director. Cultural performances by children of NBAGR family made it even more spectacular.

**Rashtriya Mahila Kisan Diwas** was celebrated on October 15, 2018 in a village school (Govt. Sr. Secondary School at Sangoha, Karnal) for spreading the message of important role being played by farm women and need to empower their children through education at ICAR institutes and agricultural universities. NBAGR team comprising of women scientists and staff organized this event. More than 600 students and teachers of the school actively participated in debate, quiz, and poem recitation to recognize the contribution of women in agriculture. Winners were awarded for their outstanding performance in describing the importance of empowering farm women.



*Celebrating Mahila Kisan Diwas at Govt Sr Sec School, Sangoha*

**Health Camp** was organized by Staff Welfare Fund on February 12, 2019 for NBAGR staff and their families in collaboration with Park, a multi specialty hospital of Karnal. A panel



of doctors examined family members and suggested treatment.



*Health Camp at NBAGR*

Integrity Pledge was taken by 62 staff members. Total 45 of employees also undertook e-pledge. Lecture on “Prevention of corruption and active vigilance in ICAR research system” was held on this occasion. In programme related to vigilance awareness, debate competition and poem recitation was also held. All the staff members actively participated during the vigilance awareness week. Discussion and lecture were held at Gram Sabha, Jundla, Karnal, in which about 55 citizens participated.

On the occasion of 4<sup>th</sup> **International Yoga Day** a one day programme on Yoga practices was organised at Community centre, ICAR-NBAGR, Karnal for the staff and their family members. The morning yoga session was attended by 80 persons, including ladies and children. Shri Dinesh Gulati renowned Yoga sadhak of Karnal looked after the session with his team.



*NBAGR staff attending Yoga Camp*

भारतीय केन्द्रीय सतर्कता आयोग के कार्यक्रम के अंतर्गत राष्ट्रीय पशु आनुवंशिक संसाधन ब्यूरो, करनाल, में अक्टूबर 29 से नवम्बर 3, 2018 सप्ताह को “सतर्कता जागरूकता सप्ताह” कार्यक्रम के रूप में मनाया गया। इस जागरूकता कार्यक्रम के अंतर्गत ब्यूरो के सभी स्टाफ सदस्यों ने दिनांक अक्टूबर 29, 2018 को सत्यनिष्ठा की प्रतिज्ञा ली।

भारतीय केन्द्रीय सतर्कता आयोग के कार्यक्रम के अंतर्गत अक्टूबर 31, 2018 को श्री जे. के. केवलरमानी, पूर्व संयुक्त निदेशक राष्ट्रीय डेयरी अनुसंधान संस्थान, करनाल ने “प्रशासनिक सतर्कता विषय” पर भाषण के रूप में अपने अनुभव साझा किये।



*जुंडला में सतर्कता जागरूकता सप्ताह आयोजन*

20 अगस्त, 2018 को **सद्भावना दिवस** पर शपथ समारोह का आयोजन किया गया।

31 अक्टूबर, 2018 को “सरदार वल्लभाई पटेल की जयंती” को “**राष्ट्रीय एकता दिवस**” के रूप में मनाया गया। इस कार्यक्रम के अंतर्गत संस्थान के सभी कर्मचारियों ने इस दिन “राष्ट्रीय एकता दिवस प्रतिज्ञा” ली।

**महात्मा गाँधी** की 150<sup>वीं</sup> जयंती पर संस्थान में आयोजित किये गये विभिन्न कार्यक्रम:

- स्वच्छता एवं सुविचार - गाँधी जी के दृष्टिकोण से” पर भाषण
- महात्मा गाँधी जी पर डाक्यूमेंट्री का प्रस्तुतीकरण एवं प्रश्नोत्तरी
- महात्मा गाँधी, पर्यावरण एवं स्वच्छता पर विचार
- स्वच्छता अभियान - बच्चों में पर्यावरण जागरूकता

## MERA GAON MERA GAURAV

Linkages were strengthened through Mera Gaon Mera Gaurav programme. Bureau team visited different villages of Karnal namely Raipur Jatan, Kheri Naru, Shahjanpur, Kutana and delivered lectures on different aspects

- » Common infectious diseases in dairy animals and their control in rainy season
- » Care and management of animals and young stock for reducing parasitic infection in rainy season.
- » Common hygienic practices for reducing the infection and parasitic diseases in children.
- » Creating awareness about indigenous livestock breeds and institute's initiatives for their protection.
- » Message of cleanliness, tree plantation and restricting the stubble burning for increasing awareness among the farmers under Rashtriya Swakchhta Abhiyan.

- » Common diseases in livestock during rainy season, their vaccination and prevention.
- » Common water and vector borne human diseases in rainy season and precautionary measures for their prevention in community.
- » Put the messages of awareness about Rashtriya Swakchhta Abhiyan
- » Spreading the message of Beti Bachao Beti Padao among the farmers.



*Scientists sharing their knowledge and experience with farmers*

## SPORTS

Sports contingents of 27 members participated in the ICAR North Zone Sports Meet held at ICAR CIRB, Hisar from November 13-16, 2018. The Bureau excelled in Basketball (Silver medal) and Man's cycle race (Bronze medal).



*NBAGR Squad at ICAR North Zone sports meet, Hisar*

## राजभाषा प्रकोष्ठ की गतिविधियां

### संस्थान राजभाषा कार्यान्वयन समिति की बैठकें

संस्थान में राजभाषा हिंदी के प्रचार-प्रसार व प्रगामी प्रयोग की प्रगति की समीक्षा करने के लिए संस्थान राजभाषा कार्यान्वयन समिति की बैठकें निरंतर की जाती हैं। इन बैठकों में लिए गए निर्णयों का अनुपालन व क्रियान्वयन किया जाता है। इस वर्ष संस्थान राजभाषा कार्यान्वयन समिति की तिमाही बैठकें 26-3-2018, 30-07-2018, 27-11-2018, 26-02-2019 को आयोजित की गई।



संस्थान राजभाषा कार्यान्वयन समिति की बैठक

### हिंदी पखवाड़े का आयोजन

प्रत्येक वर्ष की भांति इस वर्ष भी संस्थान में हिंदी पखवाड़े का आयोजन दिनांक 6-20 सितम्बर 2018 तक किया गया। राजकीय कार्यों में हिंदी के प्रयोग हेतु प्रेरित करने के लिए लिखित/मौखिक प्रतियोगिताओं का आयोजन किया गया। इनमें हिंदी निबंध, पत्र लेखन, अनुवाद, टिप्पणी व मसौदा लेखन प्रतियोगिता में वैज्ञानिकों, कार्मिकों द्वारा उत्साह से भाग लिया गया। मौखिक प्रतियोगिताओं में भाषण, आशु-भाषण, हिंदी शब्द खोज प्रतियोगिता का आयोजन किया गया। वैज्ञानिकों के लिए हिंदी शोध-प्रस्तुतीकरण प्रतियोगिता आयोजित की गई। जिसमें वैज्ञानिकों ने विगत तीन वर्षों में किये गये कार्यों का प्रस्तुतीकरण किया। काव्य-पाठन प्रतियोगिता का आयोजन किया गया जिसमें वैज्ञानिकों व कार्मिकों ने स्व-रचित व प्रसिद्ध हिंदी कवियों की रचनाओं का पाठन किया। सभी प्रतियोगिताओं में स्टाफ सदस्यों द्वारा उत्साह पूर्वक भाग लिया गया।



मूल्यांकन समिति उत्कृष्ट हिंदी कार्मिक का मूल्यांकन करते हुए

### हिंदी पुरस्कार वितरण

हिंदी पखवाड़े में आयोजित हुई सभी लिखित व मौखिक प्रतियोगिताओं के विजेताओं को संस्थान के “स्थापना-दिवस” समारोह जोकि 20 सितंबर 2018 को आयोजित किया गया था, के दौरान पुरस्कृत किया गया। वर्ष 2017-18 के दौरान राजकीय कार्यों में हिंदी के अधिकाधिक प्रयोग हेतु उत्कृष्ट हिंदी कार्मिक का प्रथम पुरस्कार श्री बाबूराम, द्वितीय पुरस्कार श्री शिवचन्द्र व तृतीय पुरस्कार श्री नरेश नरवाल को मिला। हिंदी निबंध लेखन प्रतियोगिता प्रतियोगिता का प्रथम पुरस्कार श्रीमती अनीता चंदा, द्वितीय पुरस्कार श्री राकेश कुमार, तृतीय पुरस्कार श्री नरेश कुमार यादव तथा प्रोत्साहन पुरस्कार श्री रमेश कुमार राणा को मिला। पत्र लेखन प्रतियोगिता में प्रथम पुरस्कार श्री राजकुमार, द्वितीय पुरस्कार श्री रमेश कुमार राणा, तृतीय पुरस्कार श्रीमती अनीता चंदा तथा प्रोत्साहन श्री राकेश कुमार ने जीता। टिप्पणी मसौदा लेखन प्रतियोगिता का प्रथम पुरस्कार श्री कर्मबीर मलिक, द्वितीय पुरस्कार श्री रमेश कुमार राणा, तृतीय पुरस्कार श्रीमती अनीता चंदा तथा प्रोत्साहन पुरस्कार श्री राकेश कुमार को मिला। शब्दार्थ/अनुवाद प्रतियोगिता का प्रथम पुरस्कार श्रीमती अनीता चंदा, द्वितीय पुरस्कार डॉ. साकेत निरंजन, तृतीय पुरस्कार श्री राकेश कुमार तथा प्रोत्साहन पुरस्कार श्री कर्मबीर मालिक को मिला। भाषण प्रतियोगिता में प्रथम पुरस्कार डॉ. सोनिका अहलावत, द्वितीय पुरस्कार श्रीमती अनीता चंदा, तृतीय पुरस्कार श्री रमेश राणा तथा



प्रोत्साहन पुरस्कार डॉ. रेखा शर्मा को मिला। आशु भाषण प्रतियोगिता में प्रथम पुरस्कार डॉ. साकेत निरंजन, द्वितीय पुरस्कार डॉ. रेखा शर्मा, तृतीय पुरस्कार डॉ. पी.के. सिंह और प्रोत्साहन कु. नीतिका ने जीता। राजभाषा शब्द ज्ञान प्रतियोगिता में प्रथम पुरस्कार डॉ. रेखा शर्मा एवम् डॉ. सोनिका अहलावत, द्वितीय पुरस्कार कु. मंदीप कौर एवम् श्री आशीष, तृतीय पुरस्कार श्रीमती अनीता चंदा एवम् श्री कर्मबीर मालिक ने जीता। वैज्ञानिकों हेतु आयोजित की गई शोध-पत्र प्रस्तुतीकरण प्रतियोगिता में प्रथम पुरस्कार डॉ. (श्रीमती) रेखा शर्मा, द्वितीय पुरस्कार, डॉ. (श्रीमती) रीना अरोड़ा और तृतीय पुरस्कार डॉ. साकेत निरंजन ने जीता. काव्य पाठ प्रतियोगिता में प्रथम पुरस्कार डॉ. संजीव सिंह, द्वितीय पुरस्कार डॉ. रेखा शर्मा, तृतीय पुरस्कार डॉ. साकेत निरंजन और प्रोत्साहन पुरस्कार डॉ. एन. के. वर्मा ने जीता।

### संस्थान में हिंदी कार्यों का निरीक्षण

संस्थान में हिंदी कार्यों का निरीक्षण, कृषि अनुसन्धान एवं शिक्षण विभाग, भारत सरकार नई दिल्ली से आये श्री दीपक खली द्वारा दिनांक 10-11 अक्टुबर 2018 को किया गया। उनके द्वारा भेजी गई निरीक्षण रिपोर्ट के अनुसार संस्थान में हिंदी का प्रयोग उत्साहवर्धक है।

### पशुधन प्रकाश के नवम अंक का विमोचन

दिनांक 20 सितंबर 2018 को संस्थान के स्थापना दिवस समारोह के शुभ अवसर पर हिंदी पत्रिका पशुधन प्रकाश के नवम अंक (वर्ष-2018) का विमोचन मुख्य अतिथि डॉ. जी.एस. राजौरिया अध्यक्ष इंडियन डेरी एसोसिएशन के कर-कमलों द्वारा किया गया। इस अवसर पर विशिष्ट



पशुधन प्रकाश पत्रिका का विमोचन

अतिथियों में डॉ. आर.एस. राणा सेवा-निवृत्त निदेशक, राष्ट्रीय पादप आनुवंशिक संसाधन ब्यूरो नई दिल्ली तथा श्री अमरजीत सिंह उप महा-प्रबंधक, अंचल कार्यालय कैनरा बैंक करनाल उपस्थित रहे।

### पशुधन प्रकाश (अंक-8) का श्रेष्ठ लेख पुरस्कार

संस्थान की वार्षिक हिंदी पत्रिका पशुधन प्रकाश के अष्टम अंक (वर्ष-2017) में प्रकाशित लेखों का मूल्यांकन तीन विशेषज्ञ वैज्ञानिकों द्वारा किया गया। इस प्रतियोगिता में प्रथम पुरस्कार डॉ. बट्टी प्रसाद कुशवाहा व सहयोगी, भाकृअनुप-केन्द्रीय भैंस अनुसंधान संस्थान, हिसार, द्वितीय पुरस्कार डॉ. सोनिका अहलावत व सहयोगी, भाकृअनुप-राष्ट्रीय पशु आनुवंशिक संसाधन ब्यूरो, करनाल एवम् तृतीय पुरस्कार डॉ. सत्येन्द्र पाल सिंह, राजमाता विजयराजे सिंधिया कृषि विश्व विद्यालय, कृषि विज्ञान केंद्र, मुरैना को मिला।

### पुरस्कार/उपलब्धि

- नगर राजभाषा कार्यान्वयन समिति करनाल द्वारा वर्ष 2017-18 के दौरान संस्थान को राजभाषा हिंदी में हुए उत्कृष्ट कार्यों के लिए द्वितीय पुरस्कार से सम्मानित किया गया। जिसमें संस्थान निदेशक डॉ. आर्जव शर्मा को एक ट्रॉफी तथा श्री सतपाल, नामित राजभाषा अधिकारी को प्रमाण पत्र प्रदान किया गया।



संस्थान के निदेशक एवं हिंदी अनुभाग पुरस्कार ग्रहण करते हुए

- संस्थान की वार्षिक हिंदी पत्रिका पशुधन प्रकाश के अष्टम अंक (वर्ष-2017) को नराकास करनाल की ओर से दिनांक 30-11-2018 को प्रोत्साहन पुरस्कार प्रदान किया गया।



## DISTINGUISHED VISITORS

1. Dr. N. Murthi Anishetty, FAO Expert visited on 24.04.2018.
2. Sh. Rajiv Gupta, President, U.P. Go Sewa Aayog, Lucknow visited on 21.05.2018.
3. Dr. Santosh Kumar Singh, Agricultural Specialist in Embassy of the USA, New Delhi visited on 25.07.2018.
4. Under-Graduate students of medical stream from KVADAV College for Women, Karnal visited on 08.09.2018.
5. Under-Graduate students of Department of Biotechnology, Ramnarain Ruia College, Mumbai visited on 31.10.2018.
6. Dr.R.S.Gandhi, Assistant Director General (AP&B), ICAR visited on 12.11.2018.
7. A group of 50 progressive female farmers from Banaskantha (Gujarat) visited on 14.12.2018.
8. A delegation from Brazil consisting of Dr. Tarcisio da Cruz Mesquita, Hon'ble Minister of Agriculture and Livestock Belem; Dr. Jose Ribamar Felipe Marques, Director, Buffalo Research and Development Embrapa Eastern Amazon Belem; Dr. Guilherme Minssen, Technical Director, Federation of Agriculture and Livestock (FAEPA) Belem; Dr. Jose Otavio Lemos, Animal Scientist, ABCZ High Director, Uberaba, Minsa Gerais, Brazil visited NBAGR, Karnal on 09.01.2019.
9. A group of 50 progressive farmers from Omkar Sewa Sansthan, Amethi visited NBAGR, Karnal on 15.01.2019.
10. The students of B.Sc. (Hons) Botany, Delhi University visited on 21.01.2019.
11. Under-Graduate and Post-Graduate students from Ramnarain Ruia Autonomous College, Mumbai visited on 02.02.2019.
12. Participants of International Training Programme on "Modern Dairy Technology, Management and Cooperatives" of NDRI, Karnal visited on 14.02.2019.
13. A group of 50 B. Sc. Agril. (Hons.) students from University College of Agriculture Guru Kashi University Talwandi Sabo Bathinda Punjab visited on 02.03.2019.
14. Dr. T.Mohapatra, Secretary, DARE & Director General, ICAR and Dr. J.K.Jena, Dy. Director General (AS & Fy.Sci.), ICAR visited on 23.03.2019.



*International training participants being apprised about Bureau activities*


**पशु-पालन विभाग, पशु पुरस्कार वितरण समारोह**  
**Ministry of Animal Husbandry & Fisheries, Government of India**  
**Ministry of Agriculture & Farmers Welfare, Government of India**  
**श्री राधा मोहन सिंह**  
**SHRI RADHA MOHAN SINGH**  
 Hon'ble Union Minister of Agriculture & Farmers Welfare, Govt. of India  
 (Guest of Honor) / (Aarti) Session, New Delhi - 110 001  
 Organized by  
 पशु आनुवंशिकी संशोधन केंद्र, नई दिल्ली  
 ICAR-Central Inbred Strain Laboratory (CISL) (Hyderabad)



SHRI RADHA MOHAN SINGH  
 Hon'ble Union Minister of Agriculture & Farmers Welfare, Govt. of India

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 Hon'ble Union Minister of Agriculture & Farmers Welfare, Govt. of India

N B A G R



## **PERSONNEL**

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**STAFF**

**PROMOTIONS/TRANSFER AND RESIGNATION**

**SUPERANNUATION**



## Scientific Staff

S.No	Name	Designation
1.	Dr. Arjava Sharma	Director (upto 31.12.2018)
2.	Dr. R.K. Vijn	Director (Acting)
3.	Dr. Anand Jain	Principal Scientist (Act. Director from 01.01.2019 to 30.01.2019)
4.	Dr. M.S. Tantia	Principal Scientist
5.	Dr. P.K. Vij	Principal Scientist
6.	Dr. N. K. Verma	Principal Scientist
7.	Dr. R.A.K. Aggarwal	Principal Scientist
8.	Dr. P.K. Singh	Principal Scientist
9.	Dr. R.K. Pundir	Principal Scientist
10.	Dr. R.S. Kataria	Principal Scientist
11.	Dr. Anil Kumar Mishra	Principal Scientist
12.	Dr. Monika Sodhi	Principal Scientist
13.	Dr. Jyostna Behl	Principal Scientist
14.	Dr. Satpal Dixit	Principal Scientist
15.	Dr. Dinesh Kumar	Principal Scientist
16.	Dr. Reena Arora	Principal Scientist
17.	Dr. Manishi Mukesh	Principal Scientist
18.	Dr. Avnish Kumar	Principal Scientist
19.	Dr. Rahul Behl	Principal Scientist
20.	Dr. Rekha Sharma	Principal Scientist
21.	Dr. Vikas Vohra	Principal Scientist (upto 29.06.2018)
22.	Dr. Saket Kumar Niranjana	Principal Scientist (w.e.f. 04.04.2017)
23.	Dr. Indrajit Ganguly	Principal Scientist (w.e.f. 21.04.2017)
24.	Dr. Sanjeev Singh	Principal Scientist (w.e.f. 29.06.2018)
25.	Dr. Karan Veer Singh	Senior Scientist (w.e.f. 07.02.2017)
26.	Dr. K.N. Raja	Senior Scientist (w.e.f. 07.01.2017)
27.	Dr. Jayakumar S.	Senior Scientist (w.e.f. 07.01.2018)
28.	Dr. Sonika Ahlawat	Scientist, SS



### Technical Staff

S. No.	Name	Designation
1.	Dr. P. S. Dangi	Chief Technical Officer
2.	Sh. S. K. Jain	Asstt. Chief Technical Officer
3.	Dr. P.S. Panwar	Asstt. Chief Technical Officer
4.	Sh. Sanjeev Mathur	Asstt. Chief Technical Officer
5.	Sh. Harvinder Singh	Senior Technical Officer
6.	Sh. Sat Pal	Technical Officer
7.	Sh. Jamer Singh	Technical Officer
8.	Smt. Pravesh Kumari	Technical Officer
9.	Sh. Naresh Kumar	Technical Officer
10.	Sh. Ramesh Kumar	Technical Officer
11.	Sh. Rakesh Kumar	Technical Officer
12.	Sh. Subhash Chander	Technical Officer
13.	Sh. Om Prakash	Technical Officer
14.	Sh. Ramesh Chand	Senior Technical Assistant
15.	Sh. Balwinder Singh	Technical Assistant (Driver)

### Administrative Staff

S. No.	Name	Designation
1.	Sh. Raj Kumar	A.O.
2.	Sh. Sunil Kumar	F&AO
3.	Sh. Karambir	PS to Director
4.	Sh. Balkar Singh	AAO
5.	Sh. Pawan Kr. Gupta	AF&AO
6.	Sh. Ramesh Behl	Assistant
7.	Smt. Anita Chanda	PA
8.	Smt. Amita Kumari	PA
9.	Smt. Indu Bala	Steno Gr.III
10.	Smt. Shashi Bala	Assistant
11.	Sh. Jita Ram	Assistant
12.	Sh. Yoginder	Assistant (Presently on deputation)
13.	Sh. Satish Kumar	UDC
14.	Sh. Shiv Chander	UDC
15.	Smt. Neerja Kaul	LDC
16.	Sh. Naresh Kumar	LDC
17.	Sh. Babu Ram	LDC

### Supporting Staff

S. No.	Name	Designation
1.	Sh. Krishan Lal	SSS
2.	Sh. Ram Sagar	SSS
3.	Sh. Deepak	SSS
4.	Sh. Satbir	SSS

## PROMOTIONS/TRANSFER AND RESIGNATION

### Promotions

Dr. Karan Veer Singh promoted to next higher research grade pay of Rs. 9000/- w.e.f. 07.02.2017 vide order dated 20.04.2018.

Dr.K.N. Raja, Scientist promoted to next higher grade of Sr. Scientist w.e.f. 07.01.2017 vide order dated 09.05.2018.

Sh. Om Parkash promoted to the next grade of T.O w.e.f. 10.06.2018 vide order dated 30.08.2018.

Sh. Shiv Chander promoted to the post of UDC on 14.08.2018.

### Transfer

Dr.Vikas Vohra, P.S. transferred to NDRI on 29.06.2018.

### Resignation

Dr. P. Kathiravan, Sr. Scientist resigned from ICAR services with effect from 10.9.2011.

## SUPERANNUATION

Dr. Arjava Sharma, Director, NBAGR superannuated on 31<sup>st</sup> December, 2018.



Farewell to Dr Arjava Sharma on his Superannuation

*"Comming together is a beginning,  
Staying together is progress,  
and working together is success."*

- Henry Ford



हर कदम, हर डगर  
किसानों का हमसफर  
भारतीय कृषि अनुसंधान परिषद

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## **ICAR-NATIONAL BUREAU OF ANIMAL GENETIC RESOURCES**

*(An ISO 9001:2015 Certified Institute)*

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