

# वार्षिक प्रतिवेदन 2019 ANNUAL REPORT 2019



भाकृअनुप-राष्ट्रीय पशु आनुवंशिक संसाधन ब्यूरो

करनाल-132001 (हरियाणा) भारत

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

Karnal-132001 (Haryana) INDIA



# भारत का राजपत्र The Gazette of India

असाधारण

EXTRAORDINARY

भाग II—खण्ड 3—उप-खण्ड (ii)

PART II—Section 3—Sub-section (ii)

प्रधिकार से प्रकाशित

PUBLISHED BY AUTHORITY

सं. 3364] नई दिल्ली, सोमवार, अक्टूबर 14, 2019/आश्विन 22, 1941  
No. 3364] NEW DELHI, MONDAY, OCTOBER 14, 2019/ASVINA 22, 1941

## कृषि एवं किसान कल्याण मंत्रालय (कृषि अनुसंधान और शिक्षा विभाग)

### अधिसूचना

नई दिल्ली, 11 अक्टूबर, 2019

**का. आ.3699(ब).**—कृषि अनुसंधान और शिक्षा विभाग, कृषि एवं किसान कल्याण मंत्रालय, भारत सरकार को, व्यवसाय निबन्धों के आर्बेटन के भाग III क्र. सं. 7 के तहत प्रदत्त शक्तियों का प्रयोग करते हुए, केंद्र सरकार ने निर्णय लिया है कि नीचे दी गई तालिका के स्तंभ (2) में उल्लिखित प्रजातियों के स्तंभ (3) में निर्दिष्ट पशुधन और कुक्कुट की नस्लों और स्तंभ (5) में उनके परिग्रहण संख्या की पहचान जनहित में आवश्यक और समीचीन है; यह अधिसूचित करती है कि पशुधन और कुक्कुट की उक्त नस्लें स्तंभ (4) में उल्लिखित राज्यों की अधिसूचित नस्लें होंगी, जिन्हें पशुपालन, उत्पादन, प्रजनन, संरक्षण, उपयोग, उपभोग और व्यापार के उद्देश्यों के लिए रखा एवं पाला जाएगा और इस अधिसूचना के भारत सरकार के आधिकारिक राजपत्र में प्रकाशन की तारीख से उपर्युक्त प्रयोजनों हेतु पूरे भारत के लिए अधिसूचित नस्लें होंगी, अर्थात् :-

### तालिका

| क्रम संख्या | प्रजाति | नस्ल    | राज्य                     | परिग्रहण संख्या                |
|-------------|---------|---------|---------------------------|--------------------------------|
| (1)         | (2)     | (3)     | (4)                       | (5)                            |
| 1.          | बोवंश   | अमृतमहल | कर्नाटक                   | इंदिरा_कैटल_0800_अमृतमहल_03001 |
| 2.          | बोवंश   | बछीर    | बिहार                     | इंदिरा_कैटल_0300_बछीर_03002    |
| 3.          | बोवंश   | बरबुर   | तमिलनाडु                  | इंदिरा_कैटल_1800_बरबुर_03003   |
| 4.          | बोवंश   | डामी    | महाराष्ट्र और गुजरात      | इंदिरा_कैटल_1104_डामी_03004    |
| 5.          | बोवंश   | देवनी   | महाराष्ट्र और कर्नाटक     | इंदिरा_कैटल_1108_देवनी_03005   |
| 6.          | बोवंश   | गोलाव   | महाराष्ट्र और मध्य प्रदेश | इंदिरा_कैटल_1110_गोलाव_03006   |
| 7.          | बोवंश   | गिर     | गुजरात                    | इंदिरा_कैटल_0400_गिर_03007     |
| 8.          | बोवंश   | हल्लीकर | कर्नाटक                   | इंदिरा_कैटल_0800_हल्लीकर_03008 |

5344 GI/2019

(1)



# वार्षिक प्रतिवेदन ANNUAL REPORT

2019



भाकृअनुप-राष्ट्रीय पशु आनुवंशिक संसाधन ब्यूरो

करनाल – 132001 (हरियाणा) भारत

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

Karnal - 132001 (Haryana) India



## CREDIT LINE



### Published by

Dr RK Vijh, Director (Acting)  
ICAR-National Bureau of Animal Genetic Resources  
Karnal - 132001 (Haryana) India

### Compiled by

Dr N K Verma, Pr. Scientist & I/c, PME Cell  
Dr P S Dangi, C.T.O., PME Cell

### Editors

Dr N K Verma, Pr. Scientist & I/c, PME Cell  
Dr R S Kataria, Pr. Scientist  
Dr A K Mishra, Pr. Scientist  
Dr S K Niranjana, Pr. Scientist  
Dr Jayakumar S, Sr. Scientist  
Dr Sonika Ahlawat, Scientist

### Photographs

P&E Unit and Project Investigators

### Printing

Intech Printers & Publishers  
343, 1<sup>st</sup> Floor, Mughal Canal Market,  
Karnal - 132001, Haryana  
Tel: 0184-4043541  
E-mail: admn.intech@gmail.com

## CONTENTS

|                      |     |
|----------------------|-----|
| From Director's Desk | i   |
| निदेशक की कलम से     | iii |
| Executive Summary    | v   |
| कार्यकारी सारांश     | ix  |

### INSTITUTE'S PROFILE

|                    |   |
|--------------------|---|
| Organogram         | 2 |
| About Bureau       | 3 |
| Divisional Profile | 4 |
| Financial Outlay   | 6 |

### RESEARCH ACCOMPLISHMENTS

|                                 |    |
|---------------------------------|----|
| Characterization of Native AnGR | 10 |
| Conservation of AnGR            | 16 |
| Genetic Diversity and Genomics  | 17 |
| Network Project on AnGR         | 32 |

### RESEARCH PROJECTS

|                            |    |
|----------------------------|----|
| Ongoing Institute Projects | 38 |
| External Funded Projects   | 40 |
| National Fellow Project    | 40 |

### PUBLICATIONS, TECHNOLOGIES & AWARDS

|  |    |
|--|----|
| Research Articles                                  | 42 |
| Technical Articles/Book Chapters/ Invited lectures | 43 |
| Books and Monographs                               | 46 |
| Patents and Technologies                           | 46 |
| Awards   | 47 |

### CAPACITY BUILDING

|  |    |
|--|----|
| Training Organized                           | 50 |
| Training Attended                            | 50 |
| Presentations in Symposia/Seminars/Trainings | 51 |
| Foreign Visits                               | 52 |
| Mera Gaon Mera Gaurav programme              | 53 |
| Exhibitions                                  | 54 |

### OTHER ACTIVITIES

|                        |    |
|------------------------|----|
| Important Meetings     | 56 |
| Celebrations           | 57 |
| Sports                 | 59 |
| Distinguished Visitors | 59 |

### PERSONNEL

|   |    |
|---|----|
| Staff                                   | 62 |
| Joining/Promotions/Transfer/Resignation | 64 |
| Superannuation                          | 64 |

|                                |    |
|--------------------------------|----|
| राजभाषा प्रकोष्ठ की गतिविधियाँ | 65 |
|--------------------------------|----|

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

I am immensely pleased to put forth "Annual Report - 2019" to our readers and stakeholders of livestock sector, which offers summary glimpse of the achievements of ICAR-NBAGR during year the 2019. Let me start with few lines from the legendary poet, Robert Frost-

*"The woods are lovely, dark and deep,  
but I have promises to keep,  
and miles to go before I sleep,  
and miles to go before I sleep"*

These lines seem to be much true to the exhaustive mandate and endeavors of the Bureau. Over the past few years, ICAR-NBAGR has had a glorious journey of characterizing, evaluating, conserving and documenting the AnGR of our country. Despite this, we still have a long way to go to exhaustively characterize and evaluate the existing livestock and poultry diversity of the country.

During 2019, sincere efforts of our dedicated team of scientists were recognized in the form of Gazette Notification of 184 breeds of livestock and poultry by the Ministry of Agriculture and Farmers' Welfare. Taking inspiration from this acknowledgement, this year witnessed attempts to phenotypically characterize many populations of different species, namely Cheruvaly, Kuttampuzha and Vilwadi cattle of Kerala, Bawri cattle of Madhya Pradesh, Medini cattle of Jharkhand, Jhari cattle of Telengana, Dang buffaloes of Madhya Pradesh, Macherla sheep of Andhra Pradesh, Palamu goat of Jharkhand and native goats of Andhra Pradesh. In addition, genetic characterization for Medini cattle of Jharkhand and Ladakhi

donkeys negated probability of any bottleneck event in the population demography. Additionally, under Network project, phenotypic data was generated for 8 populations of



various species and microsatellite marker based characterization was completed for Kathani cattle, Balangir goat and three camel breeds (Marwari, Sindhi and Kharai). In the area of conservation, ongoing work to maintain and improve Sahiwal and Haryana cattle breeds at Gaushalas of Karnal was continued. Conservation of Ankleshwar and Kadaknath chicken was achieved through Network Project on AnGR. National Gene Bank was enriched with semen doses of 5 cattle and 2 horse breeds and fibroblast cell lines of Jaisalmeri and Bikaneri camel, Halari donkey and Zanskari horse.

Milestones achieved in the field of genomics include comparative analysis of transcripts expressed in milk across three stages of lactation in Sahiwal cattle, identification of gene-network associated with Pashmina production in Changthangi goats, exploration of the genetic basis of local adaptation in cattle from contrasting climatic zones and identification of differentially expressed genes in liver tissue of C57bl/6 mice infected with BCM-7 and BCM-9 peptides. DNA testing and cytogenetic screening services for breeding bulls were provided to various government

agencies. The scientific pursuit of the Bureau was strengthened under 29 institute projects, 2 externally funded projects and one National Fellow project, which were rigorously reviewed, internally and externally by timely organization of meetings of Institute Research Committee and Research Advisory Committee, respectively. Achievements of our scientists are reflected from noteworthy publications in journals of repute and recognitions in the form of awards at various platforms.

Capacity building is an important mandate of the Bureau. In this regard, we organized different training programmes for skill up-gradation of officers of State Animal Husbandry Departments as well as scientific and administrative staff of ICAR institutes. Bureau staff members were also deputed to attend various courses to brush up their skills in their respective fields. Successful organization of International Biodiversity Day, Constitution Day, International Yoga Day, Independence Day, Institute Foundation Day,

Kisan Divas and Breed Conservation Award Ceremony ensured active participation of all members of the Bureau family.

Words of encouragement and appreciation received from esteemed visitors increased momentum to each one of us at ICAR-NBAGR to carve out a special niche for the Bureau at national and international level. I wish to convey my compliments and best wishes to my staff for their personal and professional achievements during the year. I must also acknowledge the efforts of the editorial committee for enthusiastically narrating the Bureau's achievements in the form of the Annual Report. I am confident that readers will be benefitted by the current issue of the Annual Report of ICAR-NBAGR and we hope to receive suggestions for its improvement in future.

**Jai Hind !**

  
(RK Viji)

## निदेशक की कलम से ...

मुझे अपने पाठकों और पशुधन क्षेत्र के हितधारकों के लिए “वार्षिक रिपोर्ट - 2019” को प्रस्तुत करने में अत्यंत प्रसन्नता हो रही है, जो 2019 के दौरान आईसीएआर-एनबीएजीआर की उपलब्धियों की संक्षिप्त झलक पेश करती है। दिग्गज कवि रॉबर्ट फ्रॉस्ट की ये पंक्तियाँ -

*“The woods are lovely, dark and deep,  
but I have promises to keep,  
and miles to go before I sleep,  
and miles to go before I sleep”*

ब्यूरो के संपूर्ण जनादेश और प्रयासों के लिए बहुत हद तक सही हैं। पिछले कुछ वर्षों में, आईसीएआर-एनबीएजीआर ने हमारे देश के पशु आनुवंशिक संसाधन के चरित्रांकन, मूल्यांकन, संरक्षण और दस्तावेजीकरण की शानदार यात्रा की है। इसके बावजूद, हमारे पास देश के मौजूदा पशुधन और कुक्कुट विविधता का विस्तृत रूप से वर्णन और मूल्यांकन करने के लिए अभी भी एक लंबा रास्ता तय करना बाकी है।

2019 के दौरान, कृषि और किसान कल्याण मंत्रालय, भारत सरकार द्वारा पशुधन और मुर्गी पालन की 184 नस्लों के राजपत्र अधिसूचना के रूप में वैज्ञानिकों की हमारी समर्पित टीम के ईमानदार प्रयासों को मान्यता दी गई। इस स्वीकारोक्ति से प्रेरणा लेते हुए, इस वर्ष भी विभिन्न प्रजातियों की कई कम ज्ञात नस्लें, जिनमें केरल की चेरुवली, कुट्टमपुझा और विलवादिरी गोवंश, मध्य प्रदेश की बावरी गोवंश, झारखंड की मेदिनी मवेशी, तेलंगाना की झारी गोवंश, मध्य प्रदेश की झंगरी गोवंश आंध्र प्रदेश की माचेरला भेड़, झारखंड के पलामू बकरी और आंध्र प्रदेश की बकरी का चरित्रांकन व मूल्यांकन किया गया। इसके अलावा, झारखंड की मेदिनी गोवंश और लद्दाखी गधों की आनुवंशिक विशेषता ने जनसांख्यिकी में किसी भी अड़चन की संभावना को नकार दिया। इसके अतिरिक्त, नेटवर्क परियोजना के तहत, विभिन्न प्रजातियों की 8 आबादी के लिए फेनोटाइपिक डेटा उत्पन्न किया गया और कथानी गोवंश, बलागीर बकरी और तीन ऊंट नस्लों (मारवाड़ी,

सिंधी और खराई) के लिए माइक्रोसैटेलाइट मार्कर आधारित लक्षणीकरण पूरा किया गया। संरक्षण के क्षेत्र में, करनाल की गौशालाओं में साहीवाल और हरियाण गोवंश की नस्लों को बनाए रखने



और सुधारने का काम जारी रहा। अंकलेखर और कड़कनाथ कुक्कुट का संरक्षण नेटवर्क प्रोजेक्ट के जरिए किया गया। राष्ट्रीय जीन बैंक को 5 गोवंश और 2 घोड़े की नस्लों और जैसलमेरी और बीकानेरी ऊंट, हलारी गधे और जांस्करी घोड़े की फ़ाइब्रोब्लास्ट सेल लाइनों से समृद्ध किया गया।

जीनोमिक्स के क्षेत्र में प्राप्त मील के पथरों में साहीवाल गोवंश में के तीन चरणों में दूध में व्यक्त किए गए ट्रांसक्रिप्शंस का तुलनात्मक विश्लेषण, चांगथंगी बकरियों में पशुमीना उत्पादन से जुड़े जीन-नेटवर्क की पहचान, विपरीत जलवायु से मवेशियों में स्थानीय अनुकूलन के आनुवंशिक आधार की खोज बीसीएम-7 और बीसीएम-9 पेप्टाइड्स के साथ खिलाया सी57बीएल/6 चूहों के जिगर ऊतक में अंतर-व्यक्त जीन की पहचान शामिल है। विभिन्न सरकारी एजेंसियों को प्रजनन बैल के लिए डीएनए परीक्षण और साइटोजेनेटिक स्क्रीनिंग सेवाएं प्रदान की गईं। ब्यूरो की वैज्ञानिक खोज को क्रमशः 29 संस्थान परियोजनाओं, 2 बाह्य वित्त पोषित परियोजनाओं और एक राष्ट्रीय फेलो परियोजना के तहत मजबूत किया गया, जिनकी क्रमशः संस्थान अनुसंधान समिति और अनुसंधान सलाहकार समिति की बैठकों के समय पर संगठन द्वारा आंतरिक और बाह्य रूप से समीक्षा की गई। हमारे वैज्ञानिकों की उपलब्धियाँ विभिन्न प्लेटफार्मों पर पुरस्कार के रूप में ख्याति और प्रसिद्ध पत्रिकाओं में उल्लेखनीय प्रकाशनों से परिलक्षित होती हैं।

क्षमता निर्माण ब्यूरो का एक महत्वपूर्ण जनादेश है। इस संबंध में, हमने राज्य पशुपालन विभागों के अधिकारियों के साथ-साथ आईसीएआर संस्थानों के वैज्ञानिक और प्रशासनिक कर्मचारियों के कौशल उन्नयन के लिए विभिन्न प्रशिक्षण कार्यक्रम आयोजित किए। ब्यूरो स्टाफ के सदस्यों को भी अपने क्षेत्रों में अपने कौशल को बढ़ाने के लिए विभिन्न पाठ्यक्रमों में भाग लेने के लिए प्रतिनियुक्त किया गया। अंतर्राष्ट्रीय जैव विविधता दिवस, संविधान दिवस, अंतर्राष्ट्रीय योग दिवस, स्वतंत्रता दिवस, संस्थान स्थापना दिवस, किसान दिवस और नस्ल संरक्षण पुरस्कार समारोह के सफल आयोजन में ब्यूरो परिवार के सभी सदस्यों की सक्रिय भागीदारी रही।

सम्मानित आगंतुकों से प्राप्त प्रोत्साहन और प्रशंसा के शब्दों ने आईसीएआर-एनबीएजीआर में हम में से प्रत्येक को राष्ट्रीय

और अंतर्राष्ट्रीय स्तर पर ब्यूरो के लिए एक विशेष स्थान बनाने के लिए गति बढ़ाई। मैं अपने कर्मचारियों को वर्ष के दौरान उनकी व्यक्तिगत और व्यावसायिक उपलब्धियों के लिए शुभकामनाएं देता हूँ। मैं वार्षिक रिपोर्ट के रूप में ब्यूरो की उपलब्धियों को उत्साहपूर्वक बताने के लिए संपादकीय समिति के प्रयासों की सराहना करता हूँ। मुझे विश्वास है कि आईसीएआर-एनबीएजीआर की वार्षिक रिपोर्ट से पाठकों को लाभ होगा और हमें भविष्य में इसके सुधार के लिए सुझाव मिलते रहने की उम्मीद 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 of the country with a broad 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.
- Institute's activities are being carried out under three divisions - 1) Animal Genetic Resources 2) Animal Genetics, and 3) Animal Biotechnology and a Network Project on AnGR.
- Total expenditure under different heads (Capital, Revenue and Pension & Retirement benefits) was 1150.76 lakhs against a total receipt of 1483.72 lakhs. Under Network project, total expenditure was Rs. 96.82 lakhs, against a receipt of Rs. 130 lakhs. Revenue generated during 2019 was 34.70 lakhs.
- Phenotypic characterization of Cheruvally, Kuttampuzha and Vilwadi cattle populations was completed by conducting surveys in Kottayam, Ernakulam and Trissur districts of Kerala. An attempt to characterize the non-descript cattle of Madhya Pradesh led to identification of a unique cattle population "Bawri".
- Phenotypic characters, reproduction performance, utility and management practices were evaluated for Medini cattle of Jharkhand. Microsatellite marker based diversity estimates revealed moderate diversity within the population and negated chances of any bottleneck event in the population demography.
- Jhari cattle of Telengana state were identified to be physically distinct from the other cattle populations of the region like Kamma, Vandharvi and Thurupu on the basis of physical characteristics. Process for registration of Jhari cattle as distinct breed has been initiated.
- Data on physical and morphometric traits on Dang buffaloes that are reared by Gurjar and Dhakhad communities of Madhya Pradesh was recorded.
- Survey carried out in Prakasham district of Andhra Pradesh identified Macherla sheep as a uniform population and it was observed to be phenotypically different from other breeds of the region.
- Phenotypic and genetic characterization of Palamu goat of Jharkhand suggested existence of a distinct goat population harboring sufficient genetic variation for scientific management.
- Native goats of Andhra Pradesh were observed to be mixed type. Management practices adopted for rearing goats are more or less similar in Telangana and Andhra Pradesh.
- Genetic characterization of Ladakhi donkeys using microsatellite markers revealed absence of any recent genetic bottleneck in the population. Comparison with Spiti donkeys of Himachal Pradesh and Brown type donkeys of Andhra Pradesh revealed greater genetic distance with the latter.

- Attempts to conserve Sahiwal and Haryana cattle breeds at Gaushalas of Karnal were continued during the year. With the help of technical inputs from the Bureau and resources from the State Animal Husbandry Department, a total of 67 calves (Sahiwal-5 and Haryana-62) were born in Gaushalas.
- Germplasm repository at NBAGR was strengthened by preserving semen from 5 cattle breeds (Kankrej, Sahiwal, Dangi, Nagori and Rathi) and 2 horse breeds (Marwari and Zanskari). Somatic cell bank was enriched with Jaisalmeri and Bikaneri camel, Halari donkey and Zanskari horse fibroblast cell lines.
- Analysis of genetic variability in goat MHC Class II antigen genes revealed signals of strong positive selection in DRB3.2 gene locus.
- Higher adaptive fitness of the Indian native cattle populations was substantiated by multiplicative allelic diversity with extreme heterozygosity and duplication at cattle MHC DQA locus.
- Differential microRNA profiling of Bandur and local sheep identified higher expression of a group of myomiRs viz. mir-1, mir-133, and mir-206 in Bandur sheep.
- Comparative analysis of transcripts across three stages of lactation in Sahiwal cattle delineated highest expression of genes encoding milk casein and whey proteins in early and mid lactation, with a declining trend towards the late stage. A gradual decline in the percentage of genes involved in metabolism of proteins, mRNA and insulin synthesis from early to late lactation reflected transition from lactogenesis to involution.
- Skin transcriptome profiling of Changthangi and Barbari goat breeds was performed to unravel the gene networks and metabolic pathways that might contribute to fiber development in Changthangi goats. Greater transcript abundance of genes for keratin proteins and keratin-associated proteins was evident in Changthangi goats.
- Four native cattle breeds belonging to contrasting landscape and climatic conditions were genotyped using 777 K BovineHD BeadChip (Illumina) to explore the genetic basis of local adaptation. Breeds from cold hilly region viz Siri & Ladakhi showed higher heterozygosity and genetic variability as compared to breeds from hot arid and semi-arid regions (Kankrej and Hallikar), offering a good potential for their future genetic improvement even with a smaller population size.
- Real time PCR based expression analysis of MC1R, MITF and KIT genes in skin biopsies of over white and under white (black) animals of Nili Ravi breed of buffalo showed higher expression of all the three genes in black skin tissues, KIT being the most variable in expression. GAPDH and RPS23 were identified as most stably expressed genes, which can be considered suitable for normalization of gene expression data in buffalo skin.
- Proton nuclear magnetic resonance (1H-NMR) spectroscopy was used to generate metabolic profile of serum samples of livestock species adapted to high altitude (Ladakhi cattle, Jersey cattle, Ladakhi donkey and Changthangi goat). A total of 46 metabolites common in all the samples were



identified, with glucose and lactate being the most abundant.

- In order to characterize responses associated with thermal stress in native, exotic and crossbred cattle, phenomic and transcriptome data was compared in the three groups. Physiological parameters such as rectal temperature, pulse rate, respiration rate and skin temperature were significantly higher in Holstein Friesian and Karan Fries cows in comparison to native cows during hot summer and humid season. A substantial increase in the rate of apoptosis and oxidative stress in PBMCs of Holstein Friesian and Karan Fries cows was observed in comparison to native breeds during humid season.
- Transcriptome analysis of PBMCs of Sahiwal and HF cattle revealed higher cellular tolerance to summer stress in Sahiwal cattle. Several heat responsive genes and pathways were also identified in PBMCs of cattle and buffaloes.
- A study was conducted to evaluate the effect of intra-peritoneal injection of BCM-7 and BCM-9 peptides in C57bl/6 mice. Blood glucose was significantly higher in BCM-7 group, while serum insulin level was more in BCM-9 group. Transcriptome analysis of liver tissue identified many differentially expressed genes that might be speculated to have role in hyperglycemia and initial phases of diabetes type-1 in mice injected with BCM-7 bioactive peptide.
- DNA testing by SNP genotyping of 16 economically important loci of cattle was carried out using MassARRAY technology in 100 samples from indigenous, exotic and crossbred cattle and seven harmful and beneficial SNPs each were observed at these loci. Cytogenetic screening of 80 cattle males and 52 buffalo bulls was also conducted for various government agencies.
- Under Network project on AnGR, many populations of important livestock species were characterized, which include three populations of cattle (Kathani, Vandarvi and Kamma), two of goats (Balangir and Sojat goat), two of camels (Marwari and Sindhi) and one chicken population (Poonchi). Conservation of Ankleshwar and Kadaknath chicken were other significant achievements. In addition, genetic characterization was completed using microsatellite markers for Kathani cattle, Balangir goat and three camel breeds (Marwari, Sindhi and Kharai).
- Research endeavors of the Bureau were accomplished under 29 institute projects, 2 externally funded projects and one National Fellow project.
- Twenty six research articles were published in national and international journals of high repute. Twenty four technical/popular articles, two books and a training compendium were also published by the institute.
- A patent for “A Kit for Parentage verification kit Buffaloes (*Bubalus Bubalis*)” was granted by Indian Patent Office in December 2019. Four new patent applications were submitted for examination.
- A Model Training Course was organized for officers of State Animal Husbandry Departments. Two training programmes were conducted for scientific and administrative staff of the Bureau.

- A “Farmer Scientist Interaction” workshop was organized at ICAR-NBAGR in collaboration with Department of Farmers’ Welfare, Haryana.
- Bureau staff upgraded their knowledge and enhanced their skills by attending training courses in different parts of the country.
- Scientists of the Bureau actively participated in Mera Gaon Mera Gaurav program to create awareness about the importance of indigenous animal genetic resources.
- Exhibitions on AnGR were organized at various places to showcase institute’s activities and sensitize farmers about the livestock wealth of India.
- Review of progress of different research projects was ensured by timely organization of Institute Research Committee (IRC), Research Advisory Committee (RAC) and Annual Review Meeting of Network Project.
- Enthusiastic participation of Bureau staff on International Biodiversity Day, Constitution Day, International Yoga Day, Independence Day and Institute Foundation day made these celebrations a great success.
- Bureau celebrated Kisan Divas and organized Breed Conservation Award (2019) ceremony to promote individual livestock keeper’s/ communities/institutions engaged in indigenous breed conservation.
- A contingent of 22 players and officials participated in ICAR North Zone Sports Meet – 2019.
- Bureau attracted many visitors including Member of Parliament of Karnal constituency, a delegation from Brazil, Secretary, DARE & Director General and DDG (Animal and Fisheries Science), ICAR, to name a few.



- भाकृअनुप- राष्ट्रीय पशु आनुवंशिक संसाधन ब्यूरो देश का एक मुख्य संस्थान है जो देश की स्वदेशी पशुधन और कुक्कुट नस्लों के विकास और उत्थान के लिए काम कर रहा है। ब्यूरो का जनादेश है 1) देश के पशुधन और कुक्कुट आनुवंशिक संसाधन की पहचान, मूल्यांकन, लक्षणीकरण, संरक्षण और उपयोग और 2) पशु आनुवंशिक संसाधन प्रबंधन और नीति के मुद्दों में समन्वय और क्षमता निर्माण।
- संस्थान की गतिविधियों को तीन विभागों के तहत संचालित किया जा रहा है - 1) पशु आनुवंशिक संसाधन 2) पशु आनुवंशिकी, और 3) पशु जैव प्रौद्योगिकी। पशु आनुवंशिक संसाधन पर एक नेटवर्क परियोजना भी संस्थान द्वारा चलाई जा रही है।
- 2019 के दौरान, विभिन्न मदों (पूँजी, राजस्व और पेंशन और सेवानिवृत्ति लाभ) के तहत 1450.72 लाख रुपये की कुल प्राप्ति के मुकाबले कुल व्यय 1150.76 लाख रुपये था। नेटवर्क परियोजना के तहत 130 लाख रुपये की प्राप्ति के मुकाबले कुल व्यय 96.82 लाख रुपये था। 2019 के दौरान रु 34.70 लाख रुपये का राजस्व प्राप्त हुआ।
- केरल के कोट्टायम, एर्नाकुलम और त्रिसूर जिलों में सर्वेक्षण करके चेरुवली, कुट्टमपुझा और विलवादिरी गोवंश की आबादी का लक्षण-वर्णन पूरा किया गया। मध्य प्रदेश के गैर-विवरणित गोवंश को चिह्नित करने के प्रयास से एक उत्तम मवेशी आबादी "बावरी" की पहचान हुई।
- झारखंड के मेदिनी गोवंश के लिए लक्षण-वर्णन, प्रजनन, उपयोगिता और प्रबंधन का मूल्यांकन किया गया। माइक्रोसैटेलाइट मार्कर आधारित विविधता अनुमानों ने समूह में मध्यम विविधता और पशु सांख्यिकी में किसी भी अड़चन घटना की नकारात्मक संभावनाएं प्रकट कीं।
- तेलंगाना राज्य के झारी गोवंश की पहचान की गयी, जो शारीरिक विशेषताओं के आधार पर कम्मा, वंधरदेवी और थरुपु जैसे क्षेत्र की अन्य गोवंश की आबादी से शारीरिक रूप से अलग थी। अलग नस्ल के रूप में झारी गोवंश के पंजीकरण की प्रक्रिया शुरू की गई है।
- मध्य प्रदेश के गुर्जर और धनखड़ समुदायों द्वारा पाली जाने वाली डांग भैंसों पर भौतिक और रूपात्मक लक्षणों का आंकड़ा संग्रह किया गया।
- आंध्र प्रदेश के प्रकाशम जिले में किए गए सर्वेक्षण में मचेरला भेड़ की पहचान एकसमान पशु-आबादी के रूप में की गई और इसे इस क्षेत्र की अन्य नस्लों से भिन्न पाया गया।
- झारखंड के पलामू बकरी के फिनोटिपिक (प्रारूपी) और आनुवंशिक लक्षण वर्णन द्वारा वैज्ञानिक प्रबंधन के लिए पर्याप्त आनुवंशिक भिन्नता वाली एक अलग बकरी आबादी के अस्तित्व का पता चला।
- आंध्र प्रदेश के देशी बकरियों को मिश्रित प्रकार का देखा गया। तेलंगाना और आंध्र प्रदेश में बकरियों को पालने के लिए अपनाई गई प्रबंधन व्यवस्था कमोबेश एक जैसी है।
- माइक्रोसैटेलाइट मार्करों का उपयोग करते हुए लद्दाखी गधों के आनुवंशिक लक्षण वर्णन ने हाल ही में आबादी में किसी भी आनुवंशिक अड़चन की अनुपस्थिति का पता चला। हिमाचल प्रदेश के स्पीति गधों की तुलना आंध्र प्रदेश के ब्राउन प्रकार के गधों के साथ आनुवंशिक दूरी अधिक पाई गई।
- करनाल की गौशालाओं में साहीवाल और हरियाणा मवेशी नस्लों के संरक्षण के प्रयास वर्ष के दौरान जारी रखे गए। ब्यूरो और राज्य पशुपालन विभाग के संसाधनों की मदद से, गौशालाओं में कुल 67 बछड़े (साहीवाल -5 और हरियाणा -62) पैदा हुए।



- 5 पशु नस्लों (कांकरेज, साहीवाल, डांगी, नागोरी और राठी) और 2 घोड़े की नस्लों (मारवाड़ी और झंस्करी) के वीर्य को संरक्षित करके एनबीएजीआर में जर्मप्लाज्म भंडार में लाया गया। दैहिक सेल बैंक को जैसलमेरी और बीकानेरी ऊंट, हलारी गधा और ज़ांस्करी घोड़ा की फ़िब्रोब्लास्ट सेल लाइनों से समृद्ध किया गया।
- बकरी एम् एच सी कक्षा II एंटीजन जीन में आनुवंशिक परिवर्तनशीलता का विश्लेषण से डी आर बी 3.2 जीन लोकस में मजबूत सकारात्मक चयन के संकेतों का पता चला।
- भारतीय देशी गोवंश की उच्च अनुकूली फिटनेस को विविधता के साथ गोवंश एम् एच सी डी क्यू ए ठिकानों पर अत्यधिक विषमता और दोहराव द्वारा प्रमाणित किया गया।
- बंडूर और स्थानीय भेड़ों के विभेदक माइक्रो-आरएनए प्रोफाइलिंग ने माओमीआरएस के समूह मीर -1, मीर -133 और बंडूर भेड़ में मीर-206 के उच्च अभिव्यक्ति की पहचान की।
- साहिवाल गोवंश में दुग्ध उत्पादन के तीन चरणों के लिपियों के तुलनात्मक विश्लेषण ने प्रारंभिक अवस्था में केसीन और व्हे (मट्ठा) प्रोटीन को प्रारंभिक और मध्य दुग्ध उत्पादन में जीन एन्कोडिंग के उच्चतम अभिव्यक्ति को विलंबित किया, जिसमें अंतिम चरण की ओर गिरावट आई। प्रोटीन के चयापचय में शामिल जीनों के प्रतिशत में एक क्रमिक गिरावट, एमआरएनए और इंसुलिन संश्लेषण जल्दी से देर से दुग्ध पान कराने के लिए लैक्टोजेनेसिस से इन्वैल्यूशन में संक्रमण को परिलक्षित करता है।
- चांगथांगी और बरबरी बकरी की नस्लों की त्वचा प्रतिलेखी रूपरेखा जीन नेटवर्क और उपापचयी मार्गों को उकेरने के लिए की गई, जो चांगथांगी बकरियों में रेशे/बाल के विकास में योगदान कर सकते हैं। केराटिन प्रोटीन और केराटिन-जुड़े प्रोटीन के लिए जीन की अधिक से अधिक ट्रांसक्रिप्ट बहुतायत चांगथांगी बकरियों में स्पष्ट रूप से पाई गई।
- विषम परिदृश्य और जलवायु परिस्थितियों से संबंधित चार देशी मवेशी नस्लों को स्थानीय अनुकूलन के आनुवंशिक आधार का पता लगाने के लिए 777 K बोवाइनहेड बीड चिप (इलुमिना) का उपयोग करके जीनोटाइप किया गया। ठंडे पहाड़ी क्षेत्र की सिसी और लद्दाखी नस्लें उच्च शुष्कता और अर्ध-शुष्क क्षेत्रों (कांकरेज और हल्लीकार) की नस्लों की तुलना में उच्च विषमता और आनुवंशिक परिवर्तनशीलता दिखाती हैं, जो कि एक छोटी आबादी के आकार के साथ भी अपने भविष्य के आनुवंशिक सुधार के लिए एक अच्छी क्षमता प्रदान करती हैं।
- वास्तविक समय पीसीआर आधारित अभिव्यक्ति विश्लेषण में नीली रावी भैंस नस्ल के MC1R, MITF और KIT जीनों की त्वचा की बायोप्सी में सफेद और सफेद (काले) ऊतकों वाले जानवरों के तीनों जीनों की उच्च अभिव्यक्ति दिखाई दी, KIT अभिव्यक्ति में सबसे अधिक परिवर्तनशील पायी गयी। जीएपीडीएच और आरपीएस 23 को सबसे अधिक स्पष्ट रूप से व्यक्त जीन के रूप में पहचाना गया, जिसे भैंस की त्वचा में जीन अभिव्यक्ति डेटा के सामान्यीकरण के लिए उपयुक्त माना जा सकता है।
- प्रोटॉन परमाणु चुंबकीय अनुनाद स्पेक्ट्रोस्कोपी का उपयोग करके उच्च ऊंचाई (लद्दाखी गोवंश, जर्सी गोवंश, लद्दाखी गधा और चांगथांगी बकरी) के लिए अनुकूलित पशुधन प्रजातियों के सीरम नमूनों का चयापचय प्रोफ़ाइल बनाया गया। सभी नमूनों में कुल 46 मेटाबोलाइट्स की पहचान की गई, जिसमें ग्लूकोज और लैक्टेट सबसे प्रचुर मात्रा में पाए गए।

- देशी, विदेशी और संकर गोवंश में थर्मल तनाव से संबंधित प्रतिक्रियाओं को चिह्नित करने के लिए, तीन समूहों में फेनोमिक और ट्रांसक्रिप्टम डेटा की तुलना की गई। अधिक गर्मी और उमस के मौसम में देशी गायों की तुलना में होलस्टीन फ्रीजियन और करण फ्रीज गायों में शारीरिक तापमान जैसे कि गुदा तापमान, नाड़ी दर, श्वसन दर और त्वचा का तापमान काफी अधिक था। आर्द्र मौसम के दौरान देशी नस्लों की तुलना में, होलस्टीन फ्रीजियन और करण फ्रीज गायों के पीबीएमसी में एपोप्टोसिस और ऑक्सीडेटिव तनाव की दर में पर्याप्त वृद्धि हुई।
- साहीवाल और एचएफ गोवंश के पीबीएमसी के ट्रांसक्रिप्टम विश्लेषण से साहीवाल गोवंश में गर्मी के तनाव के लिए उच्च सेलुलर सहिष्णुता का पता चला। गोवंश और भैंसों के PBMCS में कई हीट रेस्पॉन्सिव जीन और पाथवे की भी पहचान की गई।
- सी57बी एल /6 चूहों में बीसीएम -7 और बीसीएम -9 पेप्टाइड्स के इंटर-पेरिटोनियल इंजेक्शन के प्रभाव का मूल्यांकन करने के लिए एक अध्ययन किया गया। बीसीएम -7 समूह में रक्त शर्करा काफी अधिक पाया गया, जबकि बीसीएम -9 समूह में सीरम इंसुलिन का स्तर अधिक था। लीवर टिशू के ट्रांसक्रिप्टोम विश्लेषण ने कई विभेदित जीनों की पहचान की गई, जो बीसीएम -7 बायोएक्टिव पेप्टाइड के साथ इंजेक्शन वाले चूहों में मधुमेह टाइप -1 के हाइपरग्लाइसीमिया और प्रारंभिक चरणों में भूमिका के लिए अनुमानित किया जा सकता है।
- विदेशी और संकर गोवंश के 100 नमूनों में बड़े पैमाने पर प्रौद्योगिकी का उपयोग करके गोवंश के 16 आर्थिक रूप से महत्वपूर्ण एसएनपी जीनोटाइपिंग द्वारा डीएनए परीक्षण किया गया और प्रत्येक लोसाई में सात हानिकारक और लाभकारी एसएनपी देखे गए थे। इस वर्ष के दौरान विभिन्न सरकारी एजेंसियों के लिए 80 गोवंश और 52 भैंसों के नरों की साइटोजेनेटिक जांच भी की गई।
- देशी पशु आनुवंशिक संसाधन पर नेटवर्क परियोजना के तहत, महत्वपूर्ण पशुधन प्रजातियों की कई आबादी का लक्षणीकरण किया गया, जिसमें गोवंश की तीन आबादी (कथानी, वंदारवी और कम्मा), दो बकरियां (बलांगीर और सोजत बकरी), दो ऊंट (मारवाड़ी और सिंधी) और एक मुर्गी की आबादी (पूंची) शामिल हैं। अंकलेश्वर और कड़कनाथ मुर्गी का संरक्षण अन्य महत्वपूर्ण उपलब्धियाँ थीं। इसके अलावा, कथानी गोवंश, बलांगीर बकरी और तीन ऊंट नस्लों (मारवाड़ी, सिंधी और खराई) के लिए माइक्रोसैटेलाइट मार्करों का उपयोग करके आनुवंशिक लक्षणीकरण वर्णन पूरा किया गया।
- ब्यूरो के अनुसंधान प्रयासों को 29 संस्थान परियोजनाओं, 2 बाह्य वित्त पोषित परियोजनाओं और एक राष्ट्रीय फेलो परियोजना के तहत पूरा किया गया।
- इस वर्ष के दौरान छब्बीस शोध लेख उच्च ख्याति की राष्ट्रीय और अंतर्राष्ट्रीय पत्रिकाओं में प्रकाशित हुए। संस्थान द्वारा चौबीस तकनीकी / लोकप्रिय लेख, दो पुस्तकें और एक प्रशिक्षण संकलन भी प्रकाशित किया गया।
- दिसंबर 2019 में भारतीय पेटेंट कार्यालय द्वारा “A किट फॉर पेरेंटेज वेरिफिकेशन किट: भैंस (बुबलस बुबलिस)” के लिए पेटेंट प्रदान किया गया। परीक्षा के लिए चार नए पेटेंट आवेदन प्रस्तुत किए गए।
- राज्य पशुपालन विभागों के अधिकारियों के लिए एक मॉडल प्रशिक्षण पाठ्यक्रम आयोजित किया गया। ब्यूरो के वैज्ञानिक और प्रशासनिक कर्मचारियों के लिए दो प्रशिक्षण कार्यक्रम भी आयोजित किए गए।
- हरियाणा के कृषि एवं किसान कल्याण विभाग के सहयोग से आईसीएआर-एनबीएजीआर में “किसान

- वैज्ञानिक सहभागिता" कार्यशाला का आयोजन किया गया।
- ब्यूरो के कर्मचारियों ने अपने ज्ञान को उन्नत करने के लिए देश के विभिन्न हिस्सों में प्रशिक्षण पाठ्यक्रमों में भाग लेकर अपने कौशल को बढ़ाया।
- ब्यूरो के वैज्ञानिकों ने स्वदेशी पशु आनुवंशिक संसाधनों के महत्व के बारे में जागरूकता पैदा करने के लिए मेरा गाँव मेरा गौरव कार्यक्रम में सक्रिय रूप से भाग लिया।
- संस्थान की गतिविधियों का प्रदर्शन करने और देशी पशुधन के बारे में किसानों को जागरूक करने के लिए विभिन्न स्थानों पर पर प्रदर्शनी आयोजित की गयी।
- संस्थान अनुसंधान समिति (आईआरसी), अनुसंधान सलाहकार समिति (आरएसी) और नेटवर्क परियोजना की वार्षिक समीक्षा बैठक के दौरान विभिन्न अनुसंधान परियोजनाओं की प्रगति की समीक्षा सुनिश्चित की गई।
- अंतर्राष्ट्रीय जैव विविधता दिवस, संविधान दिवस, अंतर्राष्ट्रीय योग दिवस, स्वतंत्रता दिवस और संस्थान स्थापना दिवस पर ब्यूरो कर्मचारियों की उत्साही भागीदारी ने इन समारोहों को सफलता दिलाई।
- ब्यूरो द्वारा किसान दिवस मनाया गया और स्वदेशी नस्लों के संरक्षण में लगे व्यक्तिगत पशुधन पालकों / समुदायों / संस्थानों को बढ़ावा देने के लिए नस्ल संरक्षण पुरस्कार (2019) समारोह का आयोजन भी किया गया एवं उनको पुरस्कृत किया गया।
- आईसीएआर नॉर्थ जोन स्पोर्ट्स मीट - 2019 में 22 खिलाड़ियों और अधिकारियों की एक टीम ने भाग लिया।
- वर्ष के दौरान कई गणमान्य व्यक्तियों ने संस्थान का दौरा किया, जिसमें स्थानीय सांसद महोदय, ब्राजील का एक प्रतिनिधि मंडल, सचिव डेयर तथा महा निदेशक (भाकृअनुप) एवं उपमहानिदेशक (पशु विज्ञान एवं मत्स्य विज्ञान) प्रमुख रहे।



## INSTITUTE'S PROFILE

ORGANOGRAM



ABOUT BUREAU



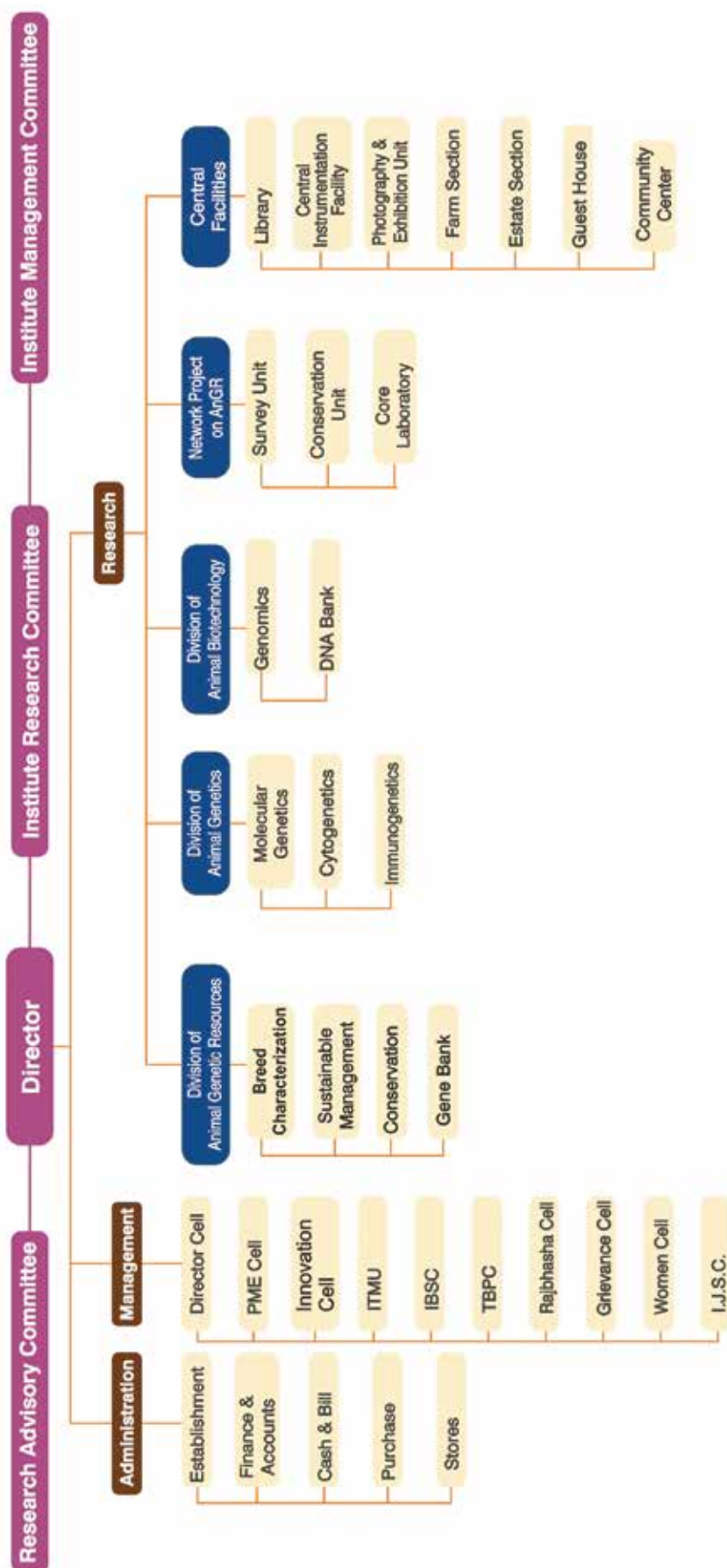
DIVISIONAL PROFILE



FINANCIAL OUTLAY

#### ORGANOGRAM

### ICAR- National Bureau of Animal Genetic Resources







## 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 4th Five Year Plan. During 5th and 6th 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.
- Co-ordination 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.

## DIVISIONAL PROFILE

With reference to the Council's letter No.AS 5/21/2012.IA.I dated 22.07.2013 and in continuation to circular of even number dated 21.08.2013, following divisions were approved and created to achieve the institute's mandate and objectives.

### *Animal Genetic Resource Division*

Animal Genetic Resources Division was created after re-organization of various divisions at National Bureau of Animal Genetic Resources, Karnal. At present Animal Genetic Resources Division have National Gene Bank, Network Project on AnGR, Photography and Exhibition Unit and Core Lab. The division activities are being carried out by 12 scientists. Major activity of the divisions is characterization of various populations through systematic surveys in the field, to record population status, morphometric characterization, body biometry, production and reproduction performance, utility and indigenous traditional knowledge (ITK) for management of animal Genetic resources. Division is also engaged in conservation activities wherein germplasm is stored in National Gene Bank and Somatic Cell lines are also conserved for endangered breeds. The division has a responsibility to formulate strategies for improvement and conservation of the breeds under field conditions. Division is also engaged in development of in-situ conservation models and their implementation in field through various agencies. Core Lab of the division is engaged in genetic characterization of various breeds/population under Network Project on AnGR.

### *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 2013 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 ten principal scientists, one senior scientist, one technical officer, one steno grade III and one skilled supporting staff. During the period under report, scientists from this division worked on ten IRC approved research projects as Principal investigators. In addition to this, one ICAR-AGRI Consortia Research Platform project on Genomics is also running in the division. 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 Animal Biotechnology Division is working under the mandate of "Evaluation of functional genes/biomolecules for enhancing AnGR utilization". Research work under a number of externally funded and institute projects is being carried out in the division with major focus on value addition of our native AnGR using genomic tools. Working on these lines, muscle transcriptome profile of Mandya (Bandur) a

well known sheep for unique meat quality, was assessed and compared to the less desirable, unregistered local sheep population. Genes associated with pashmina production were identified by comparative transcriptome analysis of Changthangi and Barbari goat skin. Under the national fellow project, systematic data on physiological, hematological and biochemical response of native, crossbred and exotic cattle and buffalo breeds across different THI. Genome wide SNPs were identified by generating genotyping-by-sequencing data in cattle and buffalo for phenotype association studies. NMR based metabolome profiling has been also established in serum samples in native and exotic cattle during summer stress. Mice trials were undertaken to investigate the time course effects of milk with different A1/A2 genotypes of beta casein with respect to diabetes and obesity. While exploring genetic diversity across MHC class II locus in *Bos indicus*, crossbred and exotic cattle, unique allelic patterns were identified in indicus cattle at MHC DQ and DR gene loci, potentially associated with disease resistance. Genetic basis of white markings in Nili Ravi buffalo is also being studied through genotype association and differential expression of coat colour genes. Evolutionary dynamics of recombination regulator (PRDM9) has been explored in equines, camels and pigs to understand the fertility traits. The services for testing of A1/A2 allele of beta casein are being provided by the division and a new test for the differentiation of meat samples of cattle, buffalo, pig, camel and small ruminants has also been developed. Being faculty in the Animal Biotechnology division at ICAR-NDRI,

Karnal, scientists of the division are also involved in teaching and student guiding activities. A number of research publications, highest among all the divisions in the international journals of high repute are being routinely published by the division. Further, best publication and poster presentation awards have also been conferred to the scientists/researchers of the division.

### *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

Network project was initiated by ICAR in the VIII plan to characterize livestock and poultry populations at eight different centres. During IX and X plan, twelve new centres were selected for characterization of breeds. Genetic characterization was also added in IX plan by establishing three core laboratories. In-situ and ex-situ conservation activities were also initiated from IX plan onwards. During XI plan, one more core laboratory was established in NEH region and buffalo genomics was also taken up. During XII plan, 17 breeds/populations were undertaken for characterization and 4 at breeds for conservation. However, during 2017-2020 eight new populations have been taken up for characterization and two breeds have been identified for conservation.



## FINANCIAL OUTLAY

### Budget Estimate under Grants & Network Project for the months of April - December, 2019 along with Expenditure

(Rs. in Lakhs)

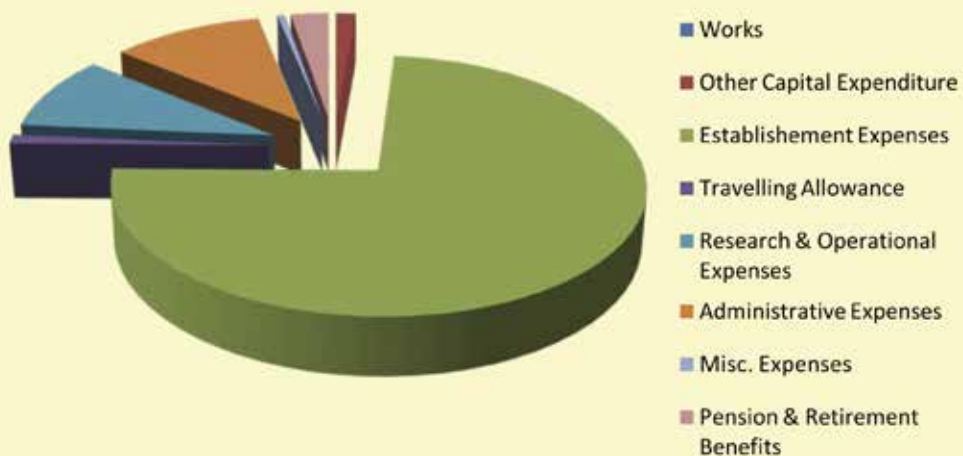
| Sr. No. | Head                                 | Grants         |                | Network Project |               |
|---------|--------------------------------------|----------------|----------------|-----------------|---------------|
|         |                                      | BE             | Exp.           | BE              | Exp.          |
| 1.      | <b>Capital</b>                       |                |                |                 |               |
|         | i) Works                             | 25.00          | 0.00           | 0.00            | 0.00          |
|         | ii) Other capital expenditure        | 30.00          | 16.41          | 0.00            | 0.00          |
|         | <b>Total Capital</b>                 | 55.00          | 16.41          | 0.00            | 0.00          |
| 2.      | <b>Revenue</b>                       |                |                | 130.00          | 96.82         |
|         | i) Establishment expenses            | 1099.92        | 861.62         | 0.00            | 0.00          |
|         | ii) Traveling Allowance              | 15.00          | 13.76          | 0.00            | 0.00          |
|         | iii) Research & Operational expenses | 147.00         | 111.67         | 0.00            | 0.00          |
|         | iv) Administrative Expenses          | 178.00         | 126.07         | 0.00            | 0.00          |
|         | v) Miscellaneous expenses            | 9.00           | 6.18           | 0.00            | 0.00          |
|         | <b>Total Revenue</b>                 | 1448.92        | 1119.30        | 130.00          | 96.82         |
| 3.      | Pension & Retirement benefits        | 34.80          | 31.46          | 0.00            | 0.00          |
|         | <b>Grant Total</b>                   | <b>1483.72</b> | <b>1150.76</b> | <b>130.00</b>   | <b>96.82*</b> |

\* Including releases Rs.95.50/- lakh.

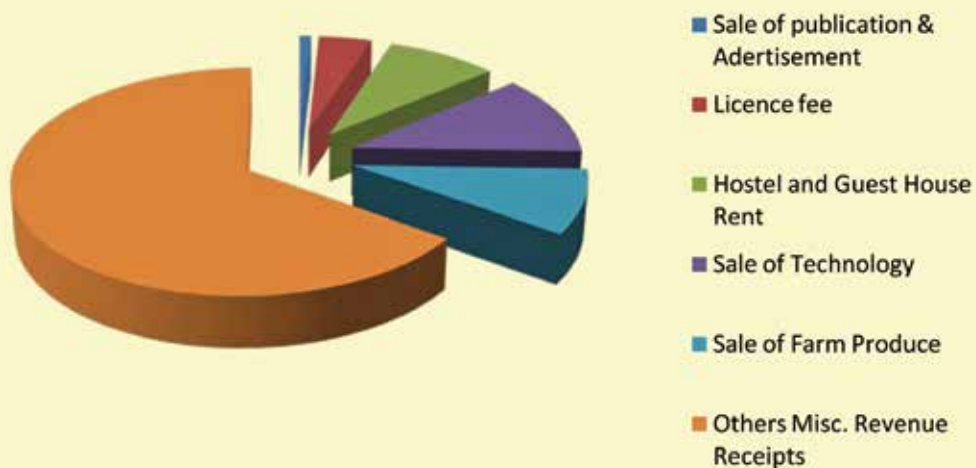
### Revenue Generated for the months April, 2019 to December, 2019

| Sr. No. | Head of Account                     | Amount (Rs.)     |
|---------|-------------------------------------|------------------|
| 1.      | Sale of Publication & Advertisement | 30,925           |
| 2.      | Licence fee                         | 1,45,249         |
| 3.      | Hostel and Guest house rent         | 3,05,971         |
| 4.      | Sale of Technology                  | 4,03,380         |
| 5.      | Sale of farm Produce                | 3,20,307         |
| 6.      | Others Misc. Revenue Receipts       | 22,64,908        |
|         | <b>Total</b>                        | <b>34,70,740</b> |

## Fund Utilization Under Grants



## Revenue Generated







# N B A G R

ANNUAL REPORT 2019





## RESEARCH ACCOMPLISHMENTS



CHARACTERIZATION OF NATIVE AnGR



CONSERVATION OF AnGR



GENETIC DIVERSITY AND GENOMICS



NETWORK PROJECT ON AnGR

### CHARACTERIZATION OF NATIVE AnGR

#### *Cattle population of Kerala*

The cattle population of Kerala was studied by conducting survey in Kottayam, Ernakulum and Trissur districts of Kerala and the information on body biometry, phenotypic characters, reproduction performance, utility and management practices were recorded for Cheruvally, Kuttampuzha and Vilwadi cattle populations. Cheruvally, Kuttampuzha and Vilwadi cows are small in size. Kuttampuzha cattle are also called as Periyar cattle. Periyar cows are maintained under semi-extensive system of management where the animals are allowed to graze in the forest and rubber plantations whereas, Vilwadi cattle are maintained under extensive system of rearing. The coat colour of Kuttampuzha cattle varies from grey-18.35% black-21.25% brownish black-40.15% and mixture-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. 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±1.66, 96.81±0.76, 129.96±1.48, 139.87±2.76, 11.65±0.95, 16.71±0.32, 37.55±0.45, 67.06±1.50 and 84.03±1.96 and for Vilwadi cattle were 98.71±1.58, 93.75±1.12, 125.20±2.26,

134.98±2.63, 18.066±1.27, 16.20±0.18, 35.50±0.44, 65.90±1.01 and 77.09±1.53. In Vilwadi cattle only natural breeding is followed whereas 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. Cheruvally cattle are small to medium in size with coat colour varies from grey-10%, black-17%, brown - 32%, brownish black-26% and mixture-15%. The animals are freely grazing in the rubber plantation and almost under zero input system of management. Breeding is only through natural service, mating used to be inside the rubber plantation during grazing so it is not known which bull has mated. Yearly one calf birth is reported (this may be due that the females are mated in the first heat after calving). The body biometry traits (cm) of Cheruvally cattle are body length-101.640±1.893, height at withers-106.160±1.309, heart girth-144.760±2.476, paunch girth-151.440±2.779, horn length-013.760±0.784, ear length - 016.880±0.313, face length - 037.560±0.686, tail length - 098.520±2.656. These cattle populations produced about 1.2 to 2.5 litres of milk per day under the extensive system of rearing.



*Kuttampuzha cattle*



*Vilwadi Cattle*



*Cheruvally cattle*

### ***Bawri (Garri) cattle of Chambal region (Madhya Pradesh)***

The project was undertaken to characterize the Non-descript cattle in Madhya Pradesh. A unique cattle population “Bawri” (also known as Garri)

was identified in Sheopur and Morena districts of Madhya Pradesh and were found to be different from the existing registered cattle breeds. The farmers keep the animals on migration pattern for fodder and water requirement.



***Bawri (Garri) cattle of Madhya Pradesh***

Shivpuri, Sheopur and Guna districts of Madhya Pradesh had the 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 as Non-descript). Rest of animals was crosses of Jersey and Gir cattle.

### ***Medini cattle of Jharkhand***

Medini cattle are reared mainly for draught purpose. The name is derived from the rulers of the area who patronized local cattle. It is small sized grey coloured animals. Muzzle, eyelids, hooves and tail switch were black. Horns are medium in size and emerge from side of poll laterally upwards. Horn tips are pointed. Face is straight. Hump is medium in males and small in females. Hump is pre-scapular in location. Udder

is round shaped with funnel shaped teats. Average herd size is 3.5 (1-8). Every village had 6 to 8 breeding bulls and natural service is practiced. Average birth and adult weight was  $18.93 \pm 0.14$  kg,  $265.94 \pm 2.68$  kg in males; and  $16.39 \pm 0.54$  kg,  $246.35 \pm 2.15$  kg, in females, respectively. Average age at first calving, service period and calving interval was  $53.56 \pm 0.58$ ,  $129.09 \pm 3.94$  and  $404.72 \pm 5.03$  days, respectively. Daily milk yield ranged from 0.7 to 2.0 kg with lactation length of 5 to 6 months. Bullocks are used for ploughing, threshing, harrowing, carting etc.

Microsatellite marker based within population diversity estimates identified moderate diversity and heterozygote deficiency existing in this population. All the 25 microsatellite loci were polymorphic. 219 alleles with  $8.76 \pm 0.55$  mean number of alleles per locus was recorded. It ranged from 4 (ILSTS11) to 15 (ILSTS34) and was higher than the expected number of alleles ( $3.9 \pm 0.34$ ). Observed heterozygosity was lower than the expected heterozygosity having mean value of  $0.64 \pm 0.04$  and  $0.70 \pm 0.03$ , respectively. Population has heterozygote deficiency as  $F_{IS}$  value was  $0.10 \pm 0.04$ . Abundance of low

frequency ( $<0.10$ ) alleles negated chances of any bottleneck event in the population demography.

### *Jhari cattle of Telengana*

An attempt has been made to characterize and evaluate the Jhari cattle of the state. For characterization of Jhari cattle survey was conducted in 17 villages of 5 districts i.e. Adilabad, Asifabad, Nizamabad, Nirmal and Jahthiyar. Physical characteristics and morphometric traits were recorded on 193 animals of different age and sex. Production and reproduction performance and socio-economic parameters were recorded from 73 farmers of 17 villages. It was observed that Jhari cattle proportion (70 to 80%) was more in Adilabad and Asifabad districts. In Nizamabad districts proportion ranged from 30 to 40%. In Nirmal and Jagthiray districts Jhari cattle proportion was less than 20%. Herd size ranged from 5 to 200. Jhari cattle was reared on extensive system of management i.e. grazing only. Few farmers provided supplement feeds to the bullocks only at home during the working days. Animal houses were open with wooden stick and separated from the owner residence (82%). Jhari cattle were grey or white (90%) in body colour. Body was small, compact and in cylindrical shape. Face was concave and longer as compared to other cattle population which is the differentiating trait of Jhari cattle. Ears were small and horizontal in orientation. Muzzle and eyelids were black. Tail was above the hock with black switch (90%). Legs were longer and strong. Udder was not well developed and mostly bowl shaped. Teats were 6-10 cm long and mostly funnel type. Temperament was docile. Birth weight ranged from 12-18 kg in female and 14-24 kg in male calves. The adult body weight of cows ranged from 150 to 250 kg and of bullocks 200 to 400 kg. 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 cow gives birth to 7-8 calves during her life time. A pair of bullocks may plough one acre of land in 6-8 hours. Bullocks were also used for transportation and load carrying. A total of 51 blood samples of Jhari cattle, 50 of Kamma cattle and 35 of Vandharvi cattle were collected from Kurnool, Jagtiyal and Asifabad districts for genetic characterization. Genetic characterization work is in progress. Jhari cattle are physically distinct from the other cattle populations of the region like Kamma, Vandharvi and Thurupu. Face is the major character for differentiating with other cattle population i.e. longer and convex type. The other differentiating character is horns which are longer and thin at the base as compared to Ongole or its grades. Registration of Jhari cattle as distinct breed is in progress.

### *Native buffalo of Madhya Pradesh*

A unique buffalo population has also been identified in ravine areas of districts of Chambal division especially in Shivpuri and Guna districts. Mostly Gurjars and Dhakhad community were raising these buffaloes in large herds. The coat colour, hair pattern and the physical appearance were different from that of the other identified buffalo populations. These buffaloes are well adapted to in the ravine conditions of hot climate, sparse vegetation and stony terrain and perform well for the milk production. Herd size was about



*Native buffalo of MP*



10-100, and population size may be about 30 thousand.

Gurjar and Kushwaha community raise the Bawri cattle and Yadav community raise the native buffaloes. Data on various physical and morphometric traits on 246 Bawri cattle and 120 native “Dang” buffaloes were recorded.

### *Native sheep population of Andhra Pradesh*

Survey was made in Prakasham district of Andhra Pradesh to characterize lesser known Macherla sheep of Andhra Pradesh. Macherla sheep is famous for mutton production and distributed in the villages adjacent to Krishna River in Guntur, Krishna, Prakasham of AP and Nalgonda district of Telangana state. During survey the body weight and body biometric traits were recorded on 101 adult animals and 52 lambs were recorded for body weight. Total farmers surveyed were 13 belongs to 5 villages. Macherla animals are medium to large in size with coat color mainly white with large black or brown patches in the body, face and legs. More than 99% of females are polled and males are horned. Ears are medium to large in size and leafy. The adult body weight of males was  $53.95 \pm 1.87$  which vary from 38 to 63 kg and the overall adult body weight of ewes was  $41.56 \pm 0.72$  Kg. and varies from 25 to 59 kg. During survey it

was noticed that 70% of males and 52.57% ewes weigh more than 50 kg. and 40 kg. respectively.



*Macherla sheep with lamb*

The overall body length, height, chest girth, face length, face width, ear length and tail length for adult males were  $70.25 \pm 0.93$ ,  $80.00 \pm 1.02$ ,  $89.35 \pm 1.01$ ,  $23.75 \pm 0.32$ ,  $12.55 \pm 0.16$ ,  $15.20 \pm 0.30$  and  $10.15 \pm 0.36$  cm, respectively and corresponding figures for females were  $65.11 \pm 0.33$ ,  $73.15 \pm 0.34$ ,  $82.21 \pm 0.51$ ,  $22.01 \pm 0.12$ ,  $11.16 \pm 0.07$ ,  $15.44 \pm 0.14$  and  $8.90 \pm 0.23$  cm respectively. Body weight of lambs in the age groups of 0-1, 1-3 and 3-6 months ranged between 7 -14, 15-26 and 20 – 33 kg respectively. The age at first lambing in ewes is about 18 months as reported by most of the farmers. Sheep rearing constituted a vital component of livelihood security and economy of the farmers maintaining this sheep population. The survey reveals that the Macherla is uniform population and phenotypically different from other breeds of the region and is famous for mutton production.

### **Adult body weight (Kg) and body biometry(cm) of Macherla sheep**

| Traits  | N      | BW                  | BL                  | Height              | CG                  | PG                  | FL                  | FW                  | EL                  | TL                  |
|---------|--------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| Overall | 101    | 44.01<br>$\pm 0.84$ | 66.13<br>$\pm 0.38$ | 74.50<br>$\pm 0.43$ | 83.62<br>$\pm 0.54$ | 83.39<br>$\pm 0.68$ | 22.36<br>$\pm 0.13$ | 11.44<br>$\pm 0.09$ | 15.40<br>$\pm 0.13$ | 9.15<br>$\pm 0.20$  |
| Sex     |        | **                  | **                  | **                  | **                  | NS                  | **                  | NS                  | NS                  | **                  |
| Male    | 20     | 53.95<br>$\pm 1.87$ | 70.25<br>$\pm 0.93$ | 80.00<br>$\pm 1.02$ | 89.35<br>$\pm 1.01$ | 85.30<br>$\pm 1.68$ | 23.75<br>$\pm 0.32$ | 12.55<br>$\pm 0.16$ | 15.20<br>$\pm 0.30$ | 10.15<br>$\pm 0.36$ |
| Female  | 81     | 41.56<br>$\pm 0.72$ | 65.11<br>$\pm 0.33$ | 73.15<br>$\pm 0.34$ | 82.21<br>$\pm 0.51$ | 82.91<br>$\pm 0.73$ | 22.01<br>$\pm 0.12$ | 11.16<br>$\pm 0.07$ | 15.44<br>$\pm 0.14$ | 8.90<br>$\pm 0.23$  |
| Range   | Male   | 38-63               | 64-77               | 65-86               | 80-95               | 71-101              | 22-25               | 11-14               | 13-18               | 6 - 14              |
|         | Female | 25-59               | 56 - 73             | 65-80               | 70-95               | 63-101              | 19-26               | 9-14                | 10-18               | 4 - 13              |

## *Palamu goat of Jharkhand*

Palamu goat also known as *Medini* is named after its distribution area (Palamu, Latehar and Garhwa) in Jharkhand. This small size goat is reared in Jharkhand state. Average flock size is  $5.36 \pm 0.19$  and varies from 1 to 31 animals. Twinning is common except in first kidding. Head profile is convex, ears are pendulous and horns are straight with backward and upward orientation. Muzzle, eyelids and hooves are black, body is cylindrical, udder is small and pendulous and teats are conical shaped. Age at first mating in males was  $8.32 \pm 0.86$  and in female  $7.22 \pm 1.35$  months.

Twenty three of 25 microsatellite markers amplified successfully. A total of 190 alleles were detected across the 21 SSR markers. Sufficient polymorphism was evident from the allele frequency data. ILSTS82 showed the highest number of observed alleles per locus (20) while RM4 and ILSTS05 showed the lowest (4) with the  $9.14 \pm 1.995$  mean number of alleles. Expected number of alleles varied from 1.487 (ILSTS065) to 7.548 (ILSTS30) with the mean value of  $4.151 \pm 0.906$ . Palamu goat had substantial genetic variation based on its gene diversity in addition to the average number of alleles per locus. The observed and expected heterozygosity values were  $0.637 \pm 0.139$  and  $0.692 \pm 0.151$ , respectively. Observed heterozygosity was lower than expected showing a departure from Hardy-Weinberg Equilibrium (HWE) and possibility of inbreeding. Population has heterozygote

deficiency to the tune of 8.8% ( $F_{IS}$  value=0.088). Population did not suffer from recent genetic bottleneck. The results suggest existence of a distinct goat population harboring sufficient genetic variation for scientific management.

## *Native goats of Andhra Pradesh*

Visits were made in the areas of Andhra Pradesh rich in goat population. Data were recorded on 81 animals belonging to 19 flocks from five villages of East Godavari and Vizianagaram districts. Like that of Telangana state, goats in Andhra Pradesh were also of mixed type. In the East Godavari district most of the animals were of black colour but in the Vizianagaram district population of white goats was more. White goats appeared to be heavier where bucks with longer horns having body weight upto 50 kg were recorded. However, these need to be validated through further exploration in nearby areas. These goats are kept under semi-extensive management, sending them for jungle grazing during day time and kept in open / closed houses during night time. The houses are made with locally available low cost material which is generally wooden logs, bamboos, jute, iron /asbestos sheets etc. Most of the houses are without the electric and water supply but have elevated floor, 5-8 ft above the ground with a wooden ramp made for animals to enter their shelters. The goats are also kept open in the fenced area or tied on the road side. Breeding is through natural service. Goats are reared for meat. They are poor milk yielder giving 0.5 – 1.0 ltr milk per day. The milk is not

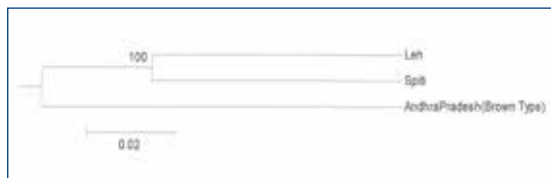




taken out but left for kids. The management for rearing the goats is more or less similar in the Telangana and Andhra Pradesh. Microsatellite based genetic diversity indicated Andhra goats to be a distinct population which is distant from Telangana goats and other neighboring goat breeds.

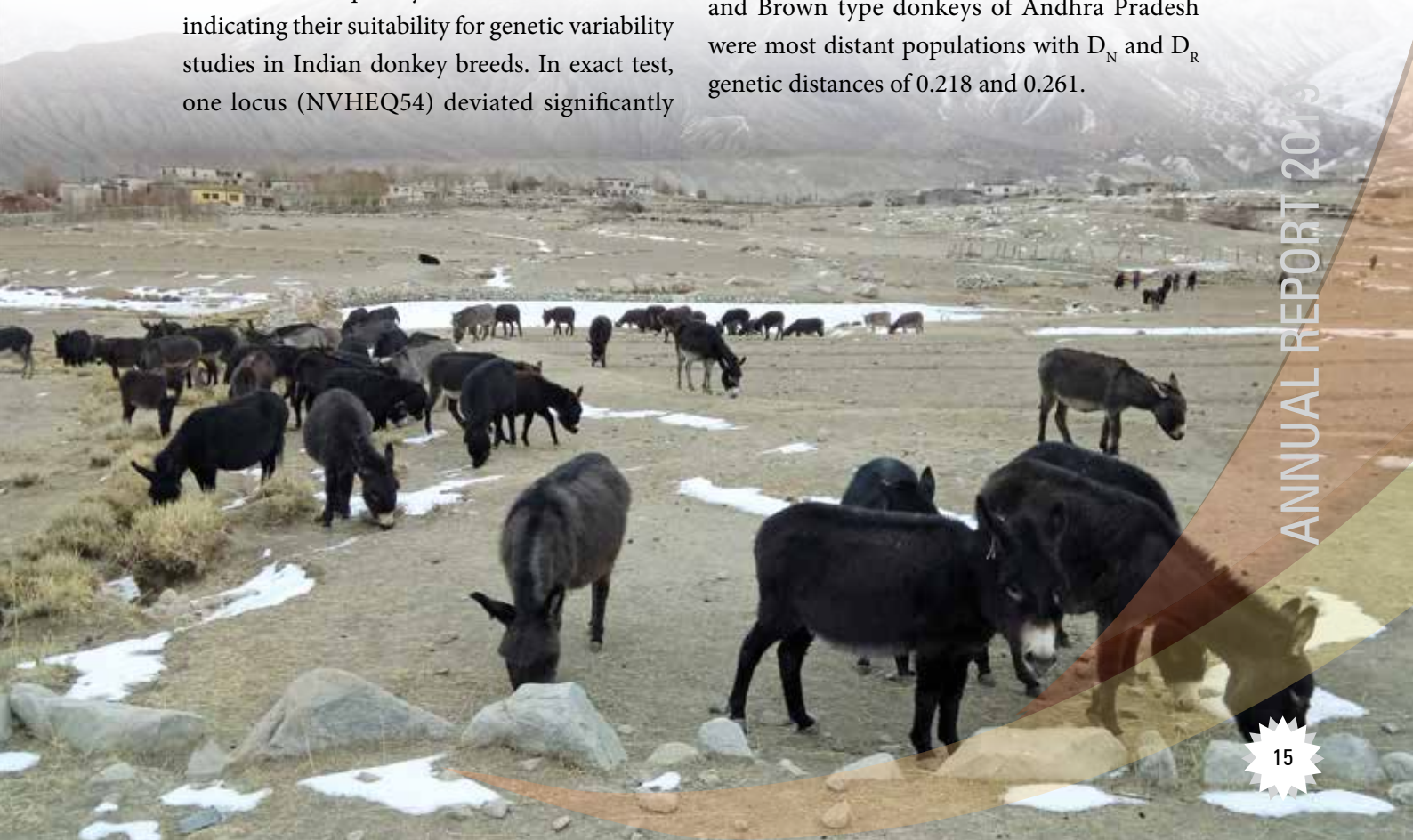
### **Genetic characterization of Ladakhi donkey**

Genomic DNA was isolated from 25 blood samples of Ladakhi donkey and further amplified by PCR using heterologous microsatellite markers of horse origin. Thirteen loci showing >4 alleles used in the final analysis, amplified well, produced unambiguous allele patterns. The observed number of alleles varied from 4 to 9 with a mean of  $5.92 \pm 1.80$ . The effective number of alleles ranged from 1.60 to 5.36 with a mean of  $3.62 \pm 1.06$ . The observed heterozygosity ranged from 0.44 to 0.90 with a mean of  $0.76 \pm 0.13$ . The mean expected heterozygosity was  $0.71 \pm 0.12$ . The mean PIC for all loci assessed from allele frequency data was  $0.67 \pm 0.12$ , indicating their suitability for genetic variability studies in Indian donkey breeds. In exact test, one locus (NVHEQ54) deviated significantly



*NJ dendrogram of Ladakhi (Leh) and other donkeys*

( $P < 0.05$ ) from Hardy-Weinberg equilibrium. The  $F_{IS}$  estimates for individual loci revealed that although ten out of the studied thirteen loci showed heterozygosity excess but at only one loci (COR71) heterozygosity excess was significant ( $P < 0.05$ ). The overall  $F_{IS}$  values of  $-0.076$  were also not significantly different from zero. These donkeys were also evaluated for any recent genetic bottlenecks. The normal 'L' shaped curve of allelic frequency distribution in mode shift test (qualitative test) also pointed towards absence of any recent genetic bottleneck in Ladakhi donkeys. Based on the allele frequency data at eleven common loci, these donkeys were also compared with Spiti donkeys of Himachal Pradesh and Brown type donkeys of Andhra Pradesh. Ladakhi donkeys showed least  $D_N$  and  $D_R$  of 0.115 and 0.139 from Spiti donkeys. Spiti and Brown type donkeys of Andhra Pradesh were most distant populations with  $D_N$  and  $D_R$  genetic distances of 0.218 and 0.261.



## CONSERVATION OF AnGR

### *Conservation of Sahiwal and Haryana cattle at gaushalas*

An attempt has been made to conserve Sahiwal and Haryana cattle breeds at Gaushalas. A total of 453 cows of Haryana & graded and 60 of Sahiwal and graded were identified based on physical characteristics and health soundness in Shri Krishan Gaushala Jundla, Nising and Uplana of Karnal district of Haryana. Identified cows were ear tagged and kept in a separate enclosures at these three Gaushals. State Animal Husbandry Department, Karnal has provided liquid nitrogen containers to all the three Gaushalas and refilling liquid nitrogen every month in containers to these Gaushalas. All the technical support and elite male germplasm for breeding for selected cows were provided by NBAGR, Karnal. The selected cows were given deworming and mineral mixture. Health camps were organised in all the three Gaushalas with the help of State Animal Husbandry Department. In Jundla Gaushala, cows were ultra sono graphed for their reproductive status and accordingly treatment was given. The Controlled Internal Drug Release (CIDAR) treatment was applied to 25 cows (21 Haryana and 4 Sahiwal) and 10 pregnancies

were got confirmed in Jundla Gaushala. A total of 67 calves including 5 of Sahiwal (5 Female) and 62 of Haryana (34 Female +28 male) were born in the Gaushala. In Sahiwal (5), daily milk yield ranged from  $4.5 \pm 1.5$  kg to  $7.25 \pm 1.25$  kg. In Haryana (21), daily milk yield ranged from  $1.55 \pm 0.324$  to  $4.81 \pm 0.56$  kg. Average birth weight in Sahiwal calves was  $18.40 \pm 2.03$  (5) kg and in Haryana calves  $17.97 \pm 0.35$  (45) kg.

### *Ex situ conservation of germplasm*

Germplasm repository at NBAGR is being strengthened by preserving diversified form of germplasm (semen, embryos, DNA, epididymal sperms and somatic cells). The conservation through preservation of semen doses has been in process since the establishment of gene bank however, Conservation through somatic cell was initiated under CRP on Agro-biodiversity recently. Somatic cell bank was strengthened with Jaisalmeri and Bikaneri camel, Halari donkey and Zanskari horse fibroblast cell line from at least five samples each. Somatic cells have been cryo-preserved in 60 vials ( $1 \times 10^6$  cells/ml) for each breed. The germplasm preserved during the year under report is given below:

### **Cryopreserved germplasm at National Gene Bank**

| Germplasm     | Species       | Breed      | Semen doses |
|---------------|---------------|------------|-------------|
| Semen         | Cattle        | Kankrej    | 4850        |
|               |               | Sahiwal    | 6000        |
|               |               | Dangi      | 3000        |
|               |               | Nagori     | 4000        |
|               |               | Rathi      | 100         |
|               | Equine/ Horse | Marwari    | 1000        |
|               |               | Zanskari   | 500         |
| Somatic Cells | Donkey        | Kutchi     | 180 (Vials) |
|               | Camel         | Kharai     | 180 (Vials) |
|               |               | Jaiselmeri | 180 (Vials) |
|               |               | Bikaneri   | 180 (Vials) |
| Total         |               |            | 19990       |

## GENETIC DIVERSITY AND GENOMICS

## Diversity at BoLA MHC locus of Indian cattle (DBT BIO CARE Women Scientist Project)

Genetic diversity at MHC DQ-alpha (DQA) exon 2 of eight indicus and one exotic breeds as well as crossbred Karan Fries cattle was recorded by PCR-RFLP and sequencing. Total 35 and 28 DQA alleles classifying into DQA1 and DQA2 types were identified in field and farm indicus cattle, respectively, documenting novel alleles as well as duplication. Compared to crossbred, indicus cattle showed more genetic diversity and farm indicus were found to be less diverse compared to field animals. In both field and farm animals evidences of ongoing positive selection at Peptide Binding Sites (PBS) and purifying selection at non peptide binding sites of cattle DQA locus also documented. Further phylogenetic analyses of DQA alleles from bovine and other ruminant species revealed presence of trans-species MHC variants, suggesting that evolution in the region has taken place possibly due to common pathogens' pressure, shared by the ruminant species over prolonged periods of time. This study documents high, multiplicative allelic diversity with extreme heterozygosity and duplication at cattle-DQA

locus, which could play significant role by being more advantageous to bind with a larger array of antigens, responsible for the higher adaptive fitness of the Indian native cattle populations.

### Genetic variability in goat MHC class II antigens

Eleven novel gene sequences of the CLA-DRB3.2 gene of the Sangamneri goat breed were obtained and deposited to GenBank (Accessions: MG 986899-903, MH 013230-31, MG 765420, MG 835447, MG 897689, MG 934562). Detailed statistical analysis of the eleven sequences obtained, for the study of genetic polymorphism in the Sangamneri animals revealed presence of 63 SNPs, fifty two parsimony informative sites and the other eleven were singleton variable sites that had two variants. Of these fifty two parsimony informative sites, forty five sites had two variants while 6 parsimony informative sites had three variants i.e. they existed as triple alleles; one parsimony informative site at position 34 of the gene had four variants. Number of haplotypes,  $h$  was sixteen; the haplotype diversity,  $H_d$  was 0.974. The Tajima  $D$  value was 0.03362, which was statistically insignificant

[illegible]

*BoLA DQA allelic variants, representing DQA1 and DQA2 types in Indian cattle*

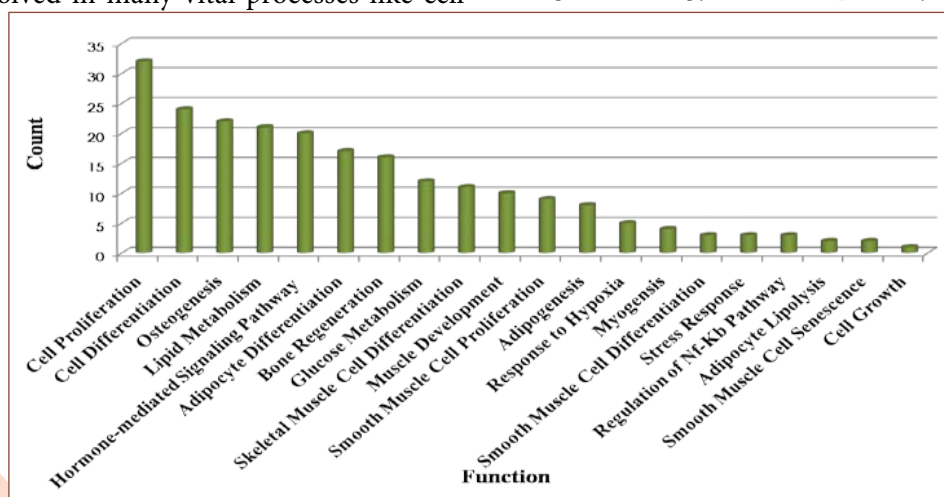


at  $P > 0.10$ . When each of the eleven sequences obtained in the present study was put to SWISS - MODEL analysis, they were all described as being a member of the broader category of MHC Class II antigen proteins. Of the total 63 SNPs observed in the CLA-DRB3.2 gene of the eleven animals of the Sangamneri goat, 50 nucleotide variations were non-synonymous i.e. these nucleotide polymorphisms, led to a change in the amino acid. Only thirteen SNPs were synonymous i.e. the nucleotide variation did not lead to an amino acid change. A positive value of the nonsynonymous (dN) to synonymous substitution (dS) ratio implies a strong positive selection to be occurring on the caprine Class II MHC-DRB3.2 gene locus.

### *Meat (skeletal muscle) transcriptome of Bandur (Mandya) sheep*

Among the meat type sheep breeds in India, Bandur sheep is mainly raised for the organoleptic characteristics of meat, which is highly preferred by consumers. Differences in meat quality at the physico-chemical and mRNA levels between Bandur and local sheep have been established. The role of microRNAs (miRNAs) in regulating hyper-muscling and muscle tenderness in sheep and cattle is well documented. miRNAs are being recognized as a new category of regulatory molecules that are involved in many vital processes like cell

proliferation, differentiation, adipogenesis and apoptosis. The differential expression of miRNAs in Bandur and local sheep was elucidated using RNA sequencing. The cDNA libraries were constructed from skeletal muscle samples of 4 animals each of Bandur and local sheep of similar age, sex reared under similar management conditions. miRNA sequencing was performed on Illumina HiSeq 2000 platform. The total number of reads for each library ranged from 17 to 29 million. The reads were mapped with known human and bovine reference genomes. A total of 100 known, differentially expressed miRNAs with  $p$  value  $\leq 0.05$  were identified. Out of these, 49 miRNAs including let-7 family, mir-206, mir-214, mir-185, and mir-423 were up-regulated while 51 including mir-378, mir-100, mir-133b, mir-10b, and mir-29c were down-regulated in Bandur sheep. A group of myomiRs viz. mir-1, mir-133, and mir-206 that have a great impact on muscle differentiation were highly expressed. A total of 154 genes were predicted as targets of the differentially expressed miRNAs. Gene ontology of the predicted genes revealed that 50, 51 and 32 genes were associated with biological processes, cellular components and molecular processes respectively. The pathways enriched for the predicted genes were cAMP signalling pathway, focal adhesion, mTOR signalling, neurotrophin signalling and chemokine signalling pathway. The gene ontology terms and pathways related to



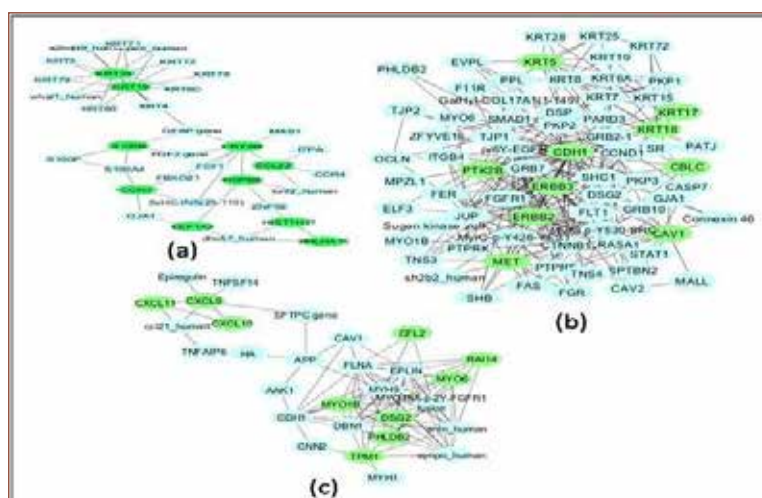
*Top functional terms identified in miRNAs from skeletal muscles of indigenous sheep*

the target genes were relevant for meat quality as they are associated with fat metabolism, muscle tenderness and muscle biosynthesis. The results contribute to a better understanding of miRNA expression in skeletal muscles of sheep breeds with diverse meat quality.

### CRP-genomics-animal component

Sahiwal (*Bos indicus*), is acclaimed worldwide as the best milch cattle breed of the tropics. Unfortunately, it faces threat of genetic erosion by indiscriminate crossbreeding. The present study is an effort to understand the genomic drivers of lactation in Sahiwal. Milk somatic cells were used as source of RNA from Sahiwal cows in early, mid and late lactation stages. Paired end (100bp) RNA sequencing of four biological replicates from each lactation stage was performed on Illumina HiSeq-1000 Platform. Standard bioinformatics software were used for data analysis. Mapping rate against the *Bos taurus* (ARS-UCD1.2) reference assembly was 84.5%. Unique transcripts in early, mid and late lactation were 108, 548 and 99 respectively, while 11377 transcripts were common across all stages. The genes encoding the milk casein and whey proteins showed highest expression in early and

mid lactation, with a declining trend towards the late stage. The enhanced expression of *PLIN2*, *FABP5* and *FABP3* genes in mid lactation suggests enrichment of the PPAR $\alpha$  pathway which is linked to fatty acid metabolism. A gradual decline in the percentage of genes involved in metabolism of proteins, mRNA and insulin synthesis from early to late lactation reflected transition from lactogenesis to involution. Major biological pathways maintained throughout lactation were adaptive immune system, FGF signaling, EGFR signaling, activated TLR4 signaling, NF $\kappa$ B and MAP kinases activation mediated by TLR4 signaling repertoire. Differential expression analysis revealed 547, 1010 and 1313 differentially expressed genes ( $p < 0.05$ ) between early-late, early-mid and mid-late stages, respectively. The topmost regulatory genes identified by network analysis from the differentially expressed genes, were involved mainly in chemokine receptor, GPCR and EGFR1 pathways. The genes and pathways delineated in this study have regulatory implications in cell morphogenesis, lipid droplet formation and protein synthesis in the course of lactation. The study provides an insight into the expression profile of genes influencing milk properties and lactation in Sahiwal cattle.



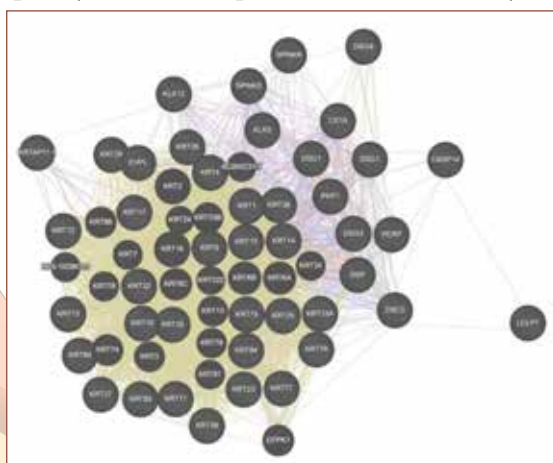
Gene regulatory and protein network of differentially expressed genes across (a) early-late (b) mid-late and (c) early-mid stages of lactation in Sahiwal

### *Skin transcriptome profiling of Changthangi and Barbari goat breeds*

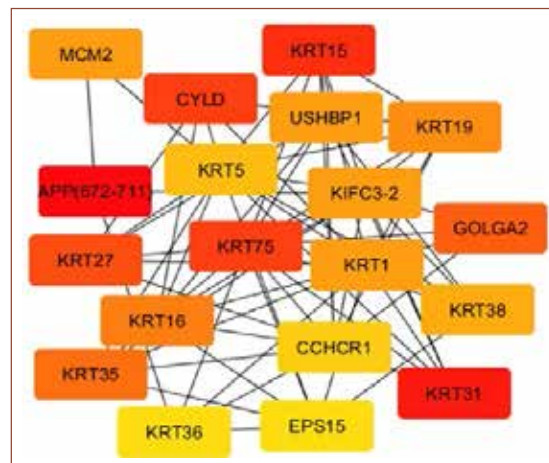
Pashmina, the world's finest natural fiber is derived from Changthangi goats, which are domesticated in Ladakh region, by nomadic pastoralists. It is also known as Cashmere, Kashmir and Pashm in India. Pashmina is derived from secondary hair follicles of goats which undergo cyclic variation as a result of complex epithelial-mesenchymal interactions. These physiological processes involve interactions of numerous signal molecules and signaling pathways which govern hair follicle morphogenesis and mitosis. Therefore, an attempt was made to unravel the gene networks and metabolic pathways that might contribute to fiber development in Changthangi goats. For comparison, Barbari goats which are reared in North Western region of the country for milk and meat purpose were considered as control. Skin samples (4) were collected from each Changthangi and Barbari breed from their native tract. cDNA libraries constructed from these samples were subjected to deep sequencing using Illumina HiSeq 2500 platform. The number of raw reads and processed reads varied from 42.1 to 55.5 million and 40.8 to 53.8 million, respectively for different samples. Mapping with the *Capra hircus* genome yielded 93.24% to 95.85% aligned reads, suggesting good quality of RNA-seq data for further analysis.

Highly expressed genes in both breeds were linked to biological functions such as structural molecule activity, keratin filament binding and RNA binding. A total of 1148 significantly up-regulated and 949 significantly down-regulated genes were identified in Changthangi goats ( $p < 0.05$ ) as compared to Barbari goats. Among these, 525 upregulated and 54 down-regulated genes with a fold change  $> 2$ , were considered for further analysis.

Significant Gene Ontology terms for the genes with higher expression in Changthangi goats included cell differentiation, multicellular organism development, keratinocyte differentiation, hair follicle morphogenesis and establishment of skin barrier. Most of these genes were components of nucleus, cytoplasm, extracellular exosome, intermediate filament, keratin filament and cytoskeleton. Genes with lower expression were integral components of membranes and extracellular matrix and were mainly related to transcription, homophilic cell adhesion via plasma membrane adhesion molecules and cellular response to extracellular stimulus. KEGG enrichment analysis highlighted that the DEGs were associated with pathways involved in *Staphylococcus aureus* infection, estrogen signaling and nicotine addiction. As per reactome pathway database, significantly enriched pathways in the dataset included formation



*Co-expression network of DEGs involved in the keratinization pathway*



*Subnetwork of interactions between the nodes of genes expressed at significantly higher levels in Pashmina producing goats*



of the cornified envelope, keratinization and developmental biology. For the keratinization pathway, a substantial proportion of DEGs (43 genes) showed higher transcript abundance in Changthangi goats. Apart from genes for various keratin proteins, expression of genes for some keratin-associated proteins (KRTAPs) was also observed to be much higher in Changthangi goats (KRTAP7-1, KRTAP11-1 and KRTAP3-1).

### ***Reference based genome assembly of Indian swamp buffalo***

As at present, no genome assembly is available for swamp buffalo, hence, the present investigation was undertaken to construct the genome assembly of Indian swamp buffalo. A total of 21 blood samples from buffaloes of Manipur were collected for karyotyping and Next Generation Sequencing. Karyotyping indicated the swamp nature of these buffaloes.



*Manipur Swamp buffalo*

### ***In-silico and in-vitro analysis of genome-wide SNPs in indigenous and exotic cattle for local adaptation***

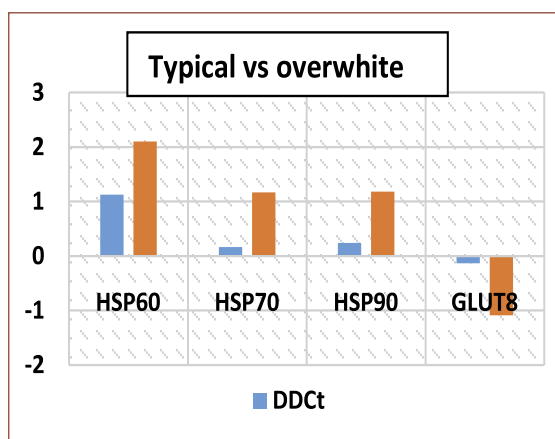
To explore the genetic basis of local adaptation, a total of 46 samples from four native cattle breeds belonging to contrasting landscape and climatic conditions were genotyped using 777 K BovineHD BeadChip (Illumina): Siri & Ladakhi from cold hilly; Kankrej and Hallikar from hot arid and semi-arid regions, respectively. Diversity analysis was carried out using different software

packages including PLINK, ARLEQUIN, STRUCTURE and R. In Ladakhi (72.27%) and Siri (77.98%) cattle, polymorphic SNPs were found to be higher than Hallikar (52.38%) and Kankrej (55.7%) cattle. A total of 1,91,351 SNPs, obtained after initial filtering and LD pruning, were used for estimation of genetic diversity parameters. Maximum heterozygosity was observed in Ladakhi ( $H_o = 0.40$ ) and Siri ( $H_o = 0.37$ ) followed by Kankrej ( $H_o = 0.336$ ) and lowest in Hallikar ( $H_o = 0.330$ ) cattle. Duncan's Multiple Range Test (DMRT) of mean minor allele frequencies (MAF) revealed non-significant ( $p > 0.05$ ) difference between Ladakhi (0.275) and Siri (0.273). Their MAFs were significantly higher ( $p < 0.05$ ) as compared to Kankrej (0.24) and Hallikar (0.23) which also points towards higher heterozygosity and genetic variability in Siri and Ladakhi breeds. Hence, Ladakhi and Siri have a good potential for their future genetic improvement even with a smaller population. PCA analysis showed a separate cluster of Hallikar and Kankrej, while Ladakhi and Siri individuals were spread distinctly. LD-Decay analysis was carried out by pairwise LD measure ( $r^2$ ) using PLINK. The LD decay ranged from 71 kb (Kankrej) to 103 kb (Hallikar) inter-marker distance in hot-adapted breeds and from 218 kb (Siri) to 222 kb (Ladakhi) in cold-adapted breeds. Thus, for genomic selection in these breeds, a tailored SNP array of approximately 42 K SNP for hot-adapted breeds and only 13 K SNP for cold-adapted breeds may be planned. Further analysis of the Samples using R SAMBADA for deciphering the regions of local adaptation is under progress.

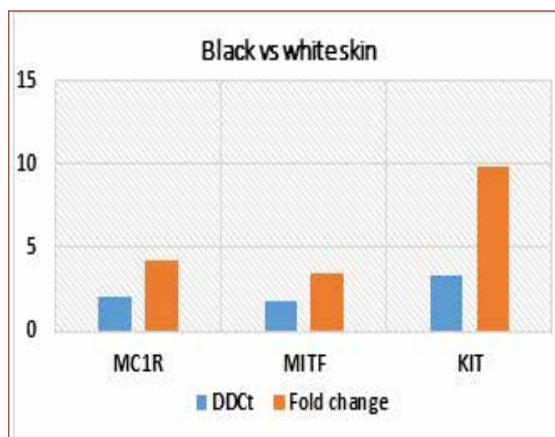
### ***Characterization of coat colour associated genes in Nili Ravi buffalo***

In order to identify most suitable house-keeping genes for the normalization of gene expression data in buffalo skin, seven black and white tissues of buffalo skin tested for the real-time

PCR expression of ten different potential internal control genes. Different algorithms, geNorm, NormFinder and BestKeeper used for data analysis identified GAPDH and RPS23 as the most stably expressed genes, suitable for data normalization.



*Expression changes in terms of fold change of heat shock proteins in PBMCs of typical vs. over white Nili Ravi buffalo*



*Fold changes in expression of skin pigmentation related genes in black and white skin tissues of Nili Ravi buffalo*

Gene expression and physiological parameters investigated in Nili Ravi buffalo under hot and humid, severe stress conditions (THI 88 to 90) and during comfortable winter (THI 56 to 68) season. Though there was no significant variation in external body temperature, respiration, pulse or rectal temperature among typical, over and under white animals within the season, but all the parameters varied significantly between

hot-humid and winter seasons. Gene expression analysis of PBMCs purified from the blood samples during hot-humid season, indicated significant changes (more than two fold) in the expression of HSP60 gene between typical and over white animals and no significant change in the expression of other genes noticed. Skin biopsies collected from over white and under white (black) animals and RNA isolated. Real-time PCR based expression data generated on candidate genes- MC1R, MITF and KIT, showing higher expression of all the three genes in black skin tissues, KIT being the most variable in expression.

### *Establishment of National Bovine Genomic Centre - indigenous breeds*

The blood samples of all the registered breeds of cattle and buffalo were collected from different parts of the country. We collected 1557 samples of cattle belonging to 48 breeds. Similarly blood samples of all the buffalo breeds were also collected. The total number of samples collected from diverse breeds were 2043. A total of 1676 animals belonging to diverse breeds were sequenced at a coverage of 10X yielding 60 GB of data per animal. We followed standard protocol for mapping using best practices of GATK and carried out various operation for the selection of SNPs. The alignment was done on *Bos indicus* genome downloaded from NCBI and for buffalo *Bubalus bubalis* genome was used. 196 SRS parentage markers were also tiled cattle HD DNA chip. The chip thus created has been tested on 192 animals and has given 99.8% call rate. The chip designed has more than 585000 markers and is thus a high density chip. The average distance between the two markers is 4.57 Kb. Similarly a high density chip of *Bubalus*



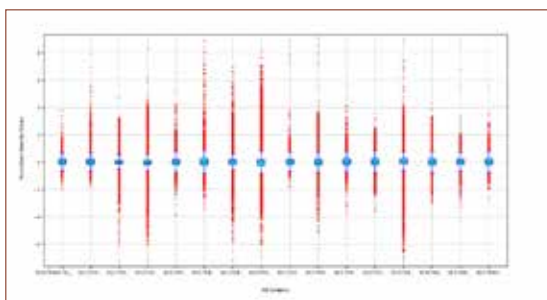
*bubalis* has also been designed and is being analysed for its performance. The phenotype data on milk records is being generated. The data is being collected through CHRS and BAIF. At CHRS Ongole a total of 1326 animals are being recorded under the Project by sixteen milk recorders and enumerators. At CHRS Ajmer 1259 animals are being recorded under the Project. Similarly at BAIF Gujarat 1469 animals are being recorded. At CHRS Rohtak a total of 4114 animals are being recorded and at CHRS Ahmedabad 5839 animals are being recorded making a total of 14006 animals. Blood samples from 4000 animals, who had completed their lactation, were collected and DNA was isolated.

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

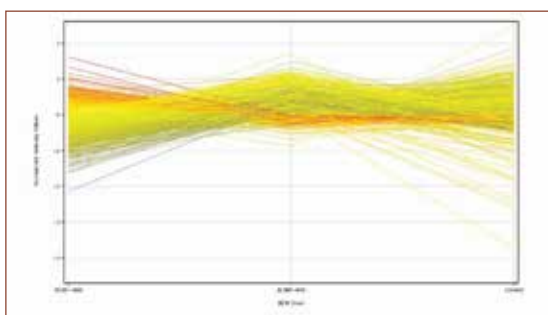
DNA testing by SNP genotyping of 16 economically important loci of cattle – eight of lethal SNPs (BLAD, DUMPS, Citrullinemia, CVM, JH1, HH1, HH3, HH4) and eight of beneficial SNPs for milk traits (DGAT, CSN2, CSN3B, LGB215, ABCG2, GH2141, GH2291, GHR) – was carried out using MassARRAY technology. About 100 Indian HF, HF crosses and Jersey cattle were screened, which revealed the presence of seven harmful and beneficial SNPs each at these loci. Cytogenetic screening of 80 cattle and 52 buffalo males was conducted for various government agencies. Total 7 cattle bulls were also screened for DNA testing for genetic diseases for BLAD, Citrullinemia Factor XI deficiency and DUMPS (HF and HF crosses only). A revenue of Rs 270600/- was received for providing services to the agencies during the year 2019.

#### ***Transcriptome changes in mice liver post BCM milk peptides treatment (NASF project)***

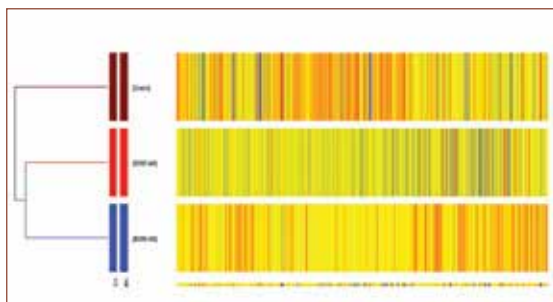
A study has been conducted to compare the transcriptomic changes in liver tissue of C57bl/6 mice injected intra-peritoneally with synthetic BCM-7 and BCM-9 peptides. The experiment comprised of 3 mice groups i.e., control (n=5), BCM-7 (400ug) (n=6) and BCM-9 (400ug) (n=5) treated mice. During the period of 51 days trial, mice were provided with standard chow diet devoid of casein and water ad libitum and maintained at  $21\pm 2^\circ\text{C}$  with 12hr day and night cycle. At the end of trial period, all the animals were sacrificed to collect the liver tissues along with blood samples. Comparison of blood glucose and serum insulin showed significantly ( $P<0.05$ ) higher level of blood glucose in BCM-7 group (179.4 mg/dl) in comparison to BCM-9 (155.7 mg/dl) and control group (163 mg/dl), while significantly ( $P<0.05$ ) higher level of insulin in BCM-9 (1.73 ng/ml) and control group (1.62 ng/ml) in comparison to BCM-7 group (0.81 ng/ml). For generation of



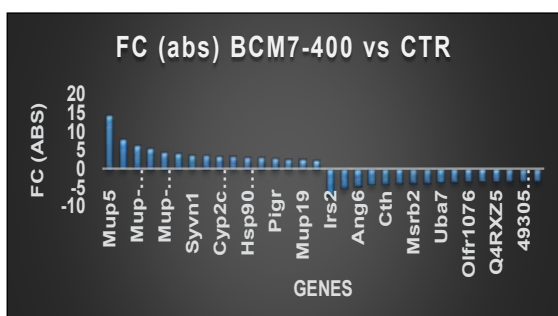
***Box whisker plot showing distribution of normalized intensity values***



***Line plot showing differentially expressed genes (at fold change criteria of  $\geq 2$ ) in liver samples of control, BCM-7 and BCM-9 treated mice***



**Hierarchical clustering showing distinct transcript pattern in liver samples of control, BCM-7 and BCM-9 treated mice**



**Fold change in expression of genes in BCM-7 vs control mice groups**

transcriptome data, Agilent mouse microarrays in 8x 60K format were employed for transcriptome data generation on 16 liver tissue samples. A total of 267 DEGs were identified at  $P < 0.05$ , out of which 117 are up-regulated and 150 are down-regulated. On comparing transcriptome data for mice injected with BCM-7 to control group, the top up-regulated genes on the basis of log fold change were MUP5, MUP21, MUP2, HSPA1B, NAT8 and HSPA1A. However, on comparing transcriptomic signature of liver of mice injected with BCM-9 peptide to control group, the top up-regulated genes were MUP5, CRELD2, MUP2, MUP21, CYP7B1, HSPA1B, NAT8, HSPA1A and GCK. Relative comparison of the transcriptomic signature of liver of mice injected with BCM-7 peptide to BCM-9 injected mice identified CTHRC1, OSR1, FMO3 and N6AMT1 as top up-regulated genes. The most influenced molecular pathways were GnRh receptor mediated, inflammation mediated, apoptosis signaling, cytoskeleton regulation, blood coagulation and angiogenesis indicating

disturbances in normal functioning of cell or commencement of any disease. Additionally, qPCR analysis revealed increased expression of DEGs such as MUP2, MUP21, CRELD2, FMO3, NAT8, CYP7B1 and HSPA1B in mice injected with BCM-7 as compared to BCM-9 peptide advocating the effect of BCM-7 bioactive peptide in hyperglycemia and may be in initial phases of diabetes type-1. This is the first report to evaluate the effect of BCM-7 and BCM-9 peptides on liver tissue.

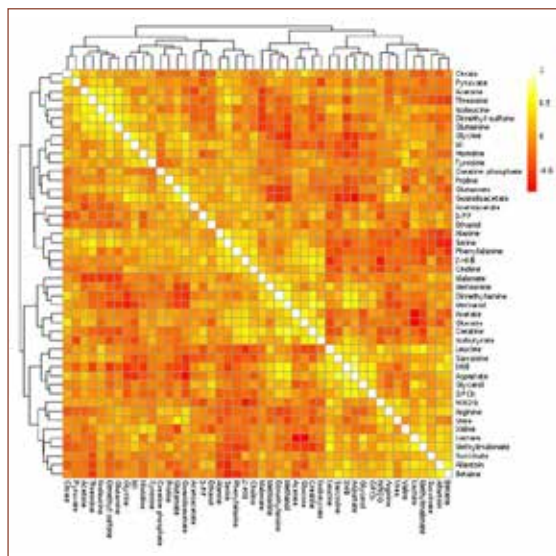
### **Characterization of serum metabolome of native cattle, donkey and goat of Ladakh (National Fellow Project)**

Metabolic profile of serum samples of livestock species adapted to high altitude was evaluated assessing a complementary systems-wide approach to elucidate the influence of such environment on native livestock species. For the study, a total of 33 serum samples collected from native cattle of Ladakh (LAC), Jersey cattle (JYC; maintained in Ladakh for several generations), Ladakhi Donkey (LAD) and Changathngi goat (CHG) were used to generate metabolome data using proton nuclear magnetic resonance ( $^1\text{H-NMR}$ ) spectroscopy. The analysis identified a total of 46 metabolites common in all the samples. The first and second most abundant metabolites in these populations were glucose and lactate. Amongst amino acids, alanine, glycine, valine were most abundant. Some of the least abundant metabolites identified were acetoacetate, Guanidoacetate, Choline and 2-hydroxybutyrate. The quantile normalized and log transformed data was used for principal component analysis (PCA) and partial least-squares discriminant analysis (PLS-DA). Metabolite-metabolite co-relation was calculated using Pearson coefficient co-relation analysis.

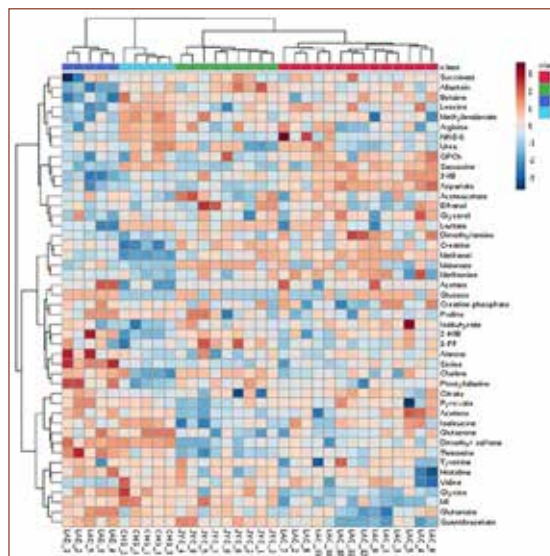
**Concentration of different metabolites identified in serum of Ladakhi cattle, Jersey cattle, Ladakhi donkey and Changathangi goat**

| Metabolites ( $\mu\text{M}$ ) | LAC              | JYC              | LAD               | CHG                |
|-------------------------------|------------------|------------------|-------------------|--------------------|
| Glucose                       | 82.84 $\pm$ 4.95 | 69.33 $\pm$ 2.27 | 147.44 $\pm$ 2.64 | 137.24 $\pm$ 1.81  |
| Lactate                       | 70.64 $\pm$ 6.43 | 82.82 $\pm$ 8.83 | 67.24 $\pm$ 19.48 | 200.40 $\pm$ 13.41 |
| Acetate                       | 46.08 $\pm$ 3.36 | 36.17 $\pm$ 2.60 | 42.34 $\pm$ 2.05  | 32.34 $\pm$ 3.46   |
| Methanol                      | 17.46 $\pm$ 2.09 | 8.22 $\pm$ 0.96  | 7.34 $\pm$ 1.75   | 2.52 $\pm$ 0.06    |
| 3-Hydroxybutarate             | 17.36 $\pm$ 2.03 | 9.91 $\pm$ 0.75  | 5.84 $\pm$ 1.03   | 9.58 $\pm$ 0.82    |
| Urea                          | 12.04 $\pm$ 2.34 | 14.69 $\pm$ 4.03 | 19.54 $\pm$ 3.16  | 29.36 $\pm$ 8.91   |
| Alanine                       | 7.95 $\pm$ 0.44  | 7.41 $\pm$ 0.31  | 17.52 $\pm$ 2.07  | 10.36 $\pm$ 0.86   |
| Glycine                       | 7.23 $\pm$ 0.47  | 10.52 $\pm$ 0.96 | 24.80 $\pm$ 3.89  | 27.38 $\pm$ 1.41   |
| Valine                        | 7.09 $\pm$ 0.77  | 7.29 $\pm$ 0.34  | 7.28 $\pm$ 0.32   | 11.54 $\pm$ 1.17   |
| Citrate                       | 6.44 $\pm$ 0.31  | 5.77 $\pm$ 0.72  | 9.82 $\pm$ 1.11   | 7.36 $\pm$ 0.13    |
| Glutamine                     | 5.52 $\pm$ 0.53  | 5.09 $\pm$ 0.59  | 11.00 $\pm$ 1.56  | 10.00 $\pm$ 1.03   |
| Arginine                      | 4.64 $\pm$ 0.60  | 5.48 $\pm$ 0.78  | 4.52 $\pm$ 0.70   | 8.98 $\pm$ 0.21    |
| Ethanol                       | 4.33 $\pm$ 0.23  | 5.89 $\pm$ 0.51  | 5.46 $\pm$ 0.44   | 5.42 $\pm$ 0.51    |
| Creatine                      | 4.25 $\pm$ 0.30  | 5.97 $\pm$ 0.56  | 4.98 $\pm$ 0.34   | 2.46 $\pm$ 0.26    |
| Proline                       | 4.24 $\pm$ 0.27  | 5.14 $\pm$ 0.53  | 8.08 $\pm$ 1.41   | 7.24 $\pm$ 0.10    |
| Glycerol                      | 4.19 $\pm$ 0.21  | 3.86 $\pm$ 0.18  | 4.18 $\pm$ 0.72   | 4.70 $\pm$ 0.00    |
| Betaine                       | 3.89 $\pm$ 0.38  | 4.73 $\pm$ 0.50  | 2.00 $\pm$ 0.62   | 6.98 $\pm$ 0.91    |
| Serine                        | 3.74 $\pm$ 0.27  | 3.69 $\pm$ 0.15  | 15.28 $\pm$ 2.14  | 4.54 $\pm$ 0.04    |
| Leucine                       | 3.72 $\pm$ 0.35  | 2.74 $\pm$ 0.27  | 2.34 $\pm$ 0.27   | 6.02 $\pm$ 0.12    |
| Isoleucine                    | 3.23 $\pm$ 0.25  | 2.66 $\pm$ 0.26  | 3.46 $\pm$ 0.29   | 4.94 $\pm$ 0.23    |
| Allantoin                     | 2.84 $\pm$ 0.23  | 4.44 $\pm$ 0.81  | 1.10 $\pm$ 0.03   | 4.36 $\pm$ 0.63    |
| Malonate                      | 2.41 $\pm$ 0.55  | 5.04 $\pm$ 0.67  | 2.18 $\pm$ 1.06   | 0.76 $\pm$ 0.10    |
| Glutamate                     | 2.34 $\pm$ 0.33  | 3.18 $\pm$ 0.53  | 6.50 $\pm$ 1.15   | 4.46 $\pm$ 0.53    |
| Pyruvate                      | 2.06 $\pm$ 0.22  | 1.70 $\pm$ 0.23  | 3.78 $\pm$ 0.72   | 3.18 $\pm$ 0.41    |
| Threonine                     | 1.91 $\pm$ 0.15  | 1.23 $\pm$ 0.24  | 5.58 $\pm$ 1.02   | 3.06 $\pm$ 0.37    |
| Histidine                     | 1.75 $\pm$ 0.14  | 2.01 $\pm$ 0.21  | 2.92 $\pm$ 0.30   | 2.74 $\pm$ 0.08    |
| Methylmalonate                | 1.36 $\pm$ 0.13  | 1.58 $\pm$ 0.12  | 1.06 $\pm$ 0.16   | 3.18 $\pm$ 0.16    |
| Tyrosine                      | 1.24 $\pm$ 0.12  | 1.56 $\pm$ 0.13  | 1.60 $\pm$ 0.26   | 2.28 $\pm$ 0.07    |
| Phenylalanine                 | 1.21 $\pm$ 0.05  | 1.49 $\pm$ 0.12  | 2.18 $\pm$ 0.16   | 1.52 $\pm$ 0.12    |
| Aspartate                     | 1.19 $\pm$ 0.05  | 0.59 $\pm$ 0.01  | 0.66 $\pm$ 0.06   | 1.10 $\pm$ 0.09    |
| Methionine                    | 1.14 $\pm$ 0.10  | 0.84 $\pm$ 0.05  | 0.98 $\pm$ 0.08   | 1.06 $\pm$ 0.12    |
| Creatine phosphate            | 1.09 $\pm$ 0.14  | 1.10 $\pm$ 0.17  | 1.46 $\pm$ 0.25   | 1.66 $\pm$ 0.22    |
| Glycerophosphocholine (GPCCh) | 1.03 $\pm$ 0.06  | .77 $\pm$ 0.17   | 0.66 $\pm$ 0.06   | 1.28 $\pm$ 0.25    |
| Acetone                       | 0.96 $\pm$ 0.15  | 0.50 $\pm$ 0.05  | 1.12 $\pm$ 0.02   | 1.22 $\pm$ 0.11    |
| Myo-inositol (MI)             | 0.86 $\pm$ 0.07  | 1.47 $\pm$ 0.06  | 1.48 $\pm$ 0.15   | 1.35 $\pm$ 0.10    |
| Dimethylamine                 | 0.81 $\pm$ 0.11  | 0.52 $\pm$ 0.06  | 0.50 $\pm$ 0.03   | 0.54 $\pm$ 0.05    |
| 3-Phenylpropionate (PP)       | 0.71 $\pm$ 0.06  | 1.11 $\pm$ 0.21  | 0.92 $\pm$ 0.17   | 0.86 $\pm$ 0.14    |
| Isobutyrate                   | 0.62 $\pm$ 0.08  | 0.49 $\pm$ 0.06  | 0.54 $\pm$ 0.09   | 0.48 $\pm$ 0.05    |
| Sarcosine                     | 0.60 $\pm$ 0.06  | 0.16 $\pm$ 0.04  | 0.20 $\pm$ 0.04   | 0.98 $\pm$ 0.07    |
| Dimethyl sulfone              | 0.59 $\pm$ 0.08  | 0.30 $\pm$ 0.07  | 1.92 $\pm$ 0.33   | 2.52 $\pm$ 0.14    |
| N,N-Dimethylglycine (NNDG)    | 0.56 $\pm$ 0.31  | 0.10 $\pm$ 0.00  | 0.12 $\pm$ 0.02   | 0.76 $\pm$ 0.05    |
| Succinate                     | 0.56 $\pm$ 0.04  | .53 $\pm$ 0.05   | 0.52 $\pm$ 0.15   | 0.72 $\pm$ 0.04    |
| Acetoacetate                  | 0.54 $\pm$ 0.08  | 0.74 $\pm$ 0.18  | 0.66 $\pm$ 0.16   | 0.56 $\pm$ 0.07    |
| Guanidoacetate                | 0.39 $\pm$ 0.09  | 1.22 $\pm$ 0.27  | 1.32 $\pm$ 0.29   | 1.12 $\pm$ 0.14    |
| Choline                       | 0.34 $\pm$ 0.04  | 0.48 $\pm$ 0.05  | 0.60 $\pm$ 0.00   | 0.42 $\pm$ 0.12    |
| 2-Hydroxyisobutyrate (HIB)    | 0.29 $\pm$ 0.02  | 0.33 $\pm$ 0.03  | 0.60 $\pm$ 0.21   | 0.36 $\pm$ 0.04    |

LAC: Ladakhi cattle JYC: Jersey cattle; LAD: Ladakhi donkey; CHG: Changathangi goat



*Pearson correlation analysis amongst different metabolites across groups*



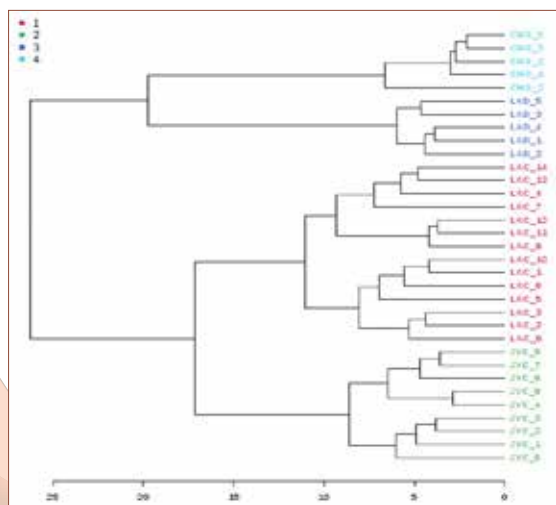
*Hierarchical clustering of all the metabolites in four groups*

The dendrogram analysis using Euclidian distance matrix and Ward clustering algorithm showed separate groupings of individuals of LAC, JSY, LAD and CHG, indicating distinct concentration of different metabolites in the 4 populations.

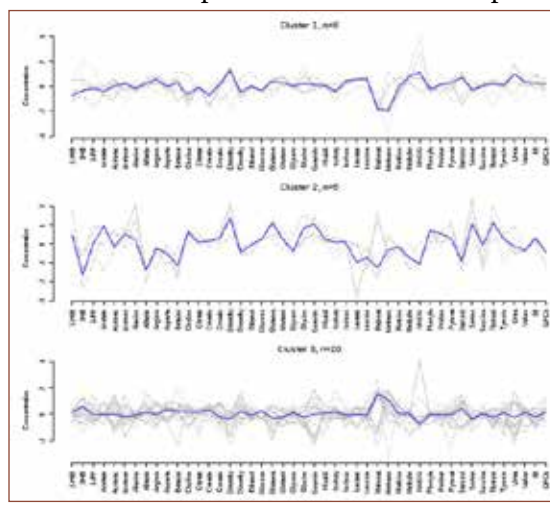
A hierarchical cluster analysis (HCA) was performed using all the metabolites detected in four populations. The analysis revealed clear and separate clustering of all the individuals belonging to Ladakhi cattle, Jersey cattle, Ladakhi donkey and Changathangi goat,

suggesting similar concentrations of different metabolite within each group. Further, K means cluster analysis revealed three separate clusters; Cluster 1 comprised of 8 metabolites, cluster 2 comprised of 5 metabolites while cluster 3 comprised of 20 metabolites.

The sparse PLS-DA (sPLS-DA) algorithm of all the 46 metabolites across 33 serum samples was used to generate 2D score plot. This analysis also showed clear separation of LAC, JSY, LAD and CHG groups. Efforts are underway to generate the metabolome profile of other livestock species

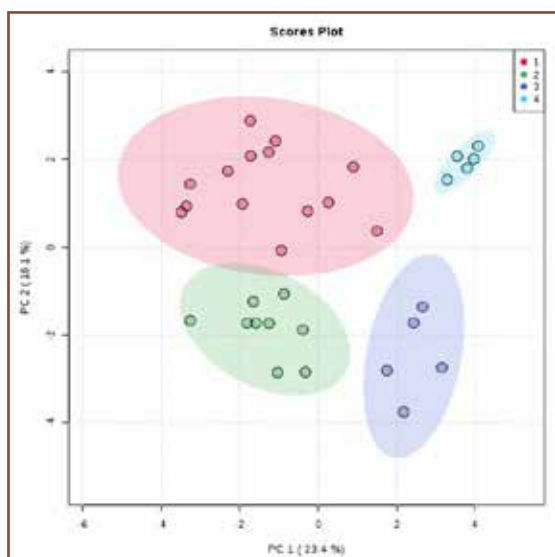


*Dendrogram analysis of individuals based on metabolites concentration*



*K-means clustering of metabolites as per the concentration across four populations*





*2D score plot showing distinct grouping of individuals as per their population*

like yak, double hump camel and Zanskar ponies adapted to high altitude of Leh-Ladakh. Such kind of analysis will help to delineate the metabolites that are making these species to naturally adapt and survive in harsh and hypobaric conditions prevalent in Leh-Ladakh region of our country.

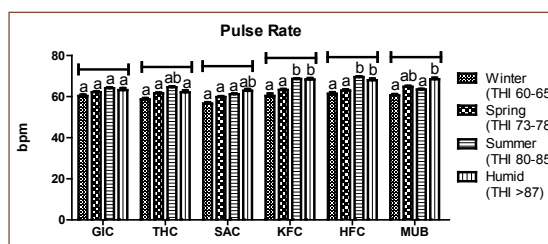
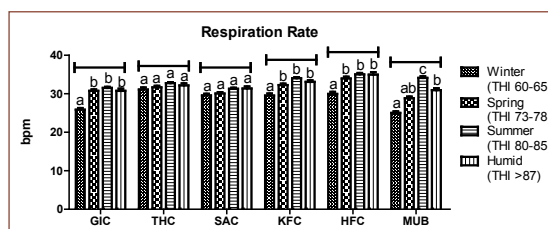
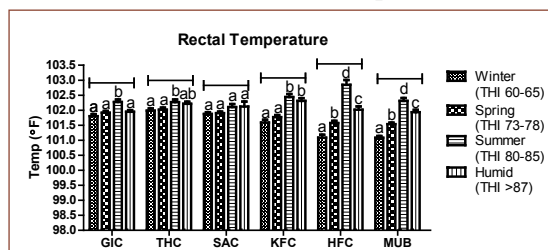
### *Characterizing responses associated with thermal stress in native, exotic and cross-bred cattle*

Phenomic and transcriptomic data related to thermo-physiological, haematological, biochemical, cellular and molecular changes in Indian native (Gir, Tharparkar, Sahiwal), cross bred (Karan Fries) and exotic (Holstein Friesian) cattle in response to seasonal variations (winter, spring, summer and humid season) and different temperature humidity index (THI) was generated. The physiological responses with respect to rectal temperature (RT), pulse rate (PR), respiration rate (RR) and skin temperature (ST) were recorded in 2400 animals during morning and afternoon time points across 4 seasons. The individual parameters showed

significantly ( $p < 0.05$ ) higher values in all the breeds during afternoon period. The values were significantly ( $p < 0.05$ ) high in Holstein Friesian and Karan Fries cows in comparison to native cows during hot summer and humid season.

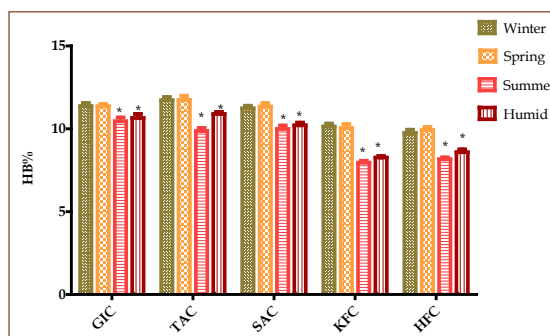
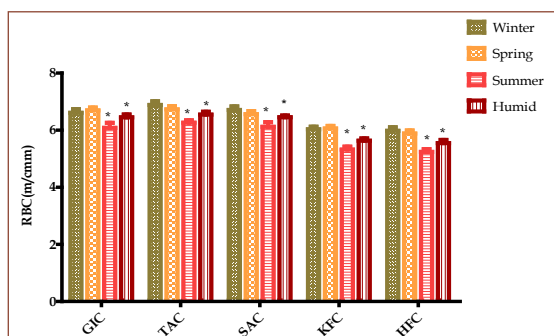
Hematological data of 1200 blood samples revealed maximum reduction in Hb and RBC concentration in Holstein Friesian and Karan Fries cows during hot summer and humid seasons.

WBC count increased significantly ( $p < 0.05$ ) in Holstein Friesian and Karan Fries cows than Gir, Tharparkar and Sahiwal cows during summer. For determining the cellular response at different THI, PBMCs samples were isolated from 170 blood samples collected at different temperature humidity index (THI) i.e., 70, 75, 80, 85 and 90. Parameters *viz.*, cell proliferation, serum level of different heat shock proteins, stress



*Rectal temperature, pulse rate and respiration rate in Gir (GIC), Tharparkar (THC), Sahiwal (SAC), Karan Fries (KFC), Holstein Friesian (HFC) cattle and Murrah (MUB) buffaloes across different THI.*





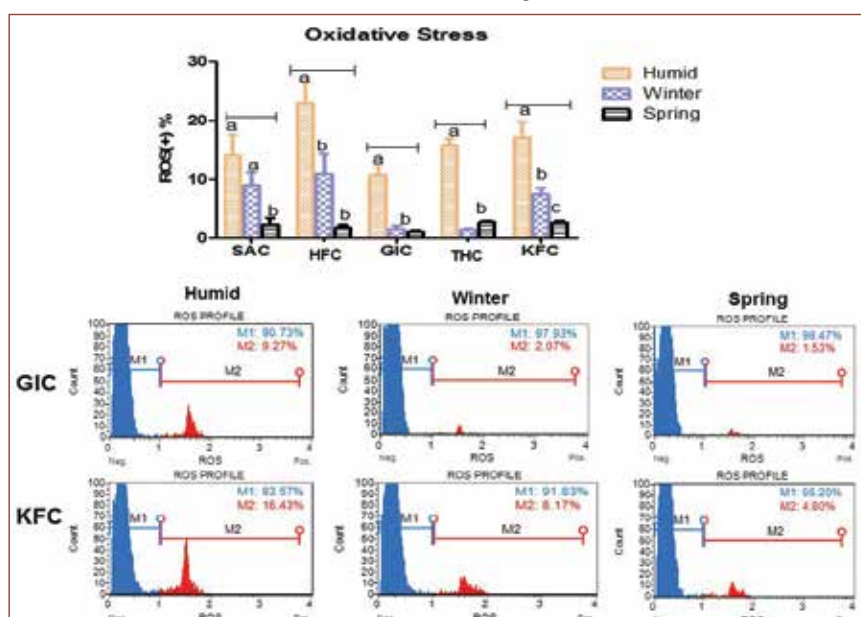
**Hemoglobin and RBC concentration in Gir (GIC), Tharparkar (THC), Sahiwal (SAC), Karan Fries (KFC), Holstein Friesian (HFC) cattle across different seasons**

markers and neutrophil / lymphocyte (N/L) ratio were selected. The cell proliferation data indicated significant ( $p < 0.05$ ) inhibition of cell proliferation in Holstein and Karan Fries PBMCs as compared to Sahiwal cows and Murrah buffaloes at higher THI. Additionally, the serum level of three major chaperons (*HSP70*, *HSP90* and *HSP27*) along with Cortisol and Cytokines (TNF-alpha and IL-6) was measured in 48 heifer animals at THI-85. The analysis revealed that serum concentrations of *HSP27*, *HSP90* and *HSP70* were comparatively higher in Holstein Friesian and Karan Fries cows in comparison to Sahiwal cows and Murrah buffaloes. Similar trend was observed for Cortisol, IL-6 and

TNF-alpha. A substantial increase in the rate of apoptosis and oxidative stress in PBMCs of Holstein Friesian and Karan Fries cows were observed in comparison to native breeds during humid season.

### Comparative transcriptome analysis for heat stress in Sahiwal and HF cattle and Murrah buffaloes

In order to measure the performance ability of a particular breed/animal towards heat stress, it is imperative to determine its thermotolerance ability. In the present investigation, an attempt was made to delineate the transcriptome changes in PBMCs of Sahiwal (*Bos indicus*),



**Cellular oxidative stress in PBMC of different cattle types across season**



Holstein Frisian (*Bos taurus*) cows and Murrah buffaloes (*Bubalus bubalis*) to gain insight into their comparative thermotolerance ability to summer stress. Based on FDR value 0.01, a total of 3907 transcripts were found to be differentially expressed during summer season in comparison to winter season. Further with cut off criteria of signed fold change >2, a total of 1917 DEGs were identified in HF cows, 453 genes in Sahiwal cows, and 1345 genes in Murrah buffaloes. In PBMCs of HF cows; out of 1917 DEGs, 835 genes were up-regulated and 1082 genes were down-regulated whereas in Sahiwal cows; out of 453 genes, 275 genes were up-regulated and 178 genes were down-regulated. In PBMCs of Murrah buffaloes, out of 1345 genes; 578 genes were upregulated and 767 were down regulated.

#### *Heat responsive genes in HF cattle*

Genes that were top most up-regulated included heat shock 70kDa protein 5 (*HSPA5*), insulin induced gene 1 (*INSIG1*), transmembrane protease, serine 4 (*TMPRSS4*), G0/G1switch 2 (*G0S2*) etc. Heat shock proteins such as Heat shock protein 90kDa alpha (cytosolic), class A member 1 (*HSP90AA1*), heat shock 70kDa protein 1A (*HSPA1A*), heat shock 105kDa/110kDa protein 1 (*HSPH1*) were found to be abundantly expressed in HF cows during summer season suggesting the induction of thermoregulatory mechanism. Additionally, increased expression of immune related genes such as C-C chemokine receptor type 1-like (*LOC529196*), C-C motif chemokine receptor 4 (*CCR4*), C-X-C motif chemokine receptor 5 (*CXCR5*), and chemokine (C-C motif) ligand 3 (*CCL3*) were also observed. These chemokines are known to regulate homeostasis and functioning of the immune system during heat stress inducing strong immune response in cattle breeds. Other upregulated immune related

genes were TNF receptor superfamily members and tumor necrosis factor (*TNF*).

#### *Heat responsive genes in Sahiwal cattle*

The genes upregulated in Sahiwal included chemokines, ligands complement factor B (*CFB*), interleukin 1, alpha (*IL1A*), tumor necrosis factor (*TNF*). Other major immune related genes such as Tumor Necrosis Factor (*TNF*), Cathepsin S (*CTSS*), TNF Superfamily Member 9 and 10 (*TNFS9*, *TNFSF10*), TNF Alpha Induced Protein 3 (*TNFAIP3*) were also up-regulated in Sahiwal cows. In addition heat stress also up-regulated the expression of molecular chaperons such as Heat Shock Protein Family A (*Hsp70*) Member 5 (*HSPA5*) and DnaJ Heat Shock Protein Family (*Hsp40*) Member C15 (*DNAJC15*) were over expressed in PBMCs of Sahiwal cattle after stress. These HSPs during heat stress are not only involved in cellular stress response but also have a defense role and participate in antigen processing and presentation process.

#### *Heat responsive genes in buffaloes*

The genes that were highly up-regulated in Murrah buffalo were G0/G1switch 2 (*G0S2*) regulator of G-protein signaling 1 (*RGS1*), CD69 DNA (cytosine-5-)-methyltransferase 3-like (*DNMT3L*) etc. Upregulated genes related to immune and inflammatory response included TNF alpha induced protein 3 (*TNFAIP3*), several chemokine ligands and tumor necrosis factor (*TNF*). Genes such as Serine protease (*HTRA1*), Peptidyl-prolyl cis-trans isomerase F, mitochondrial (*PPIF*), and Heat shock 70 kDa protein 14 (*HSPA14*) play a crucial role in protein folding. Genes like solute carrier family 3 member 2 (*SLC3A2*) upregulated are associated with carbohydrate metabolic process. Other genes upregulated included those associated with cell motility, signal transduction, solute carrier family members important for glucose transport.

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), heat shock 70kDa protein 5 (HSPA5), G0/G1switch 2 (G0S2), tubulin, alpha 3e (TUBA3E) etc.

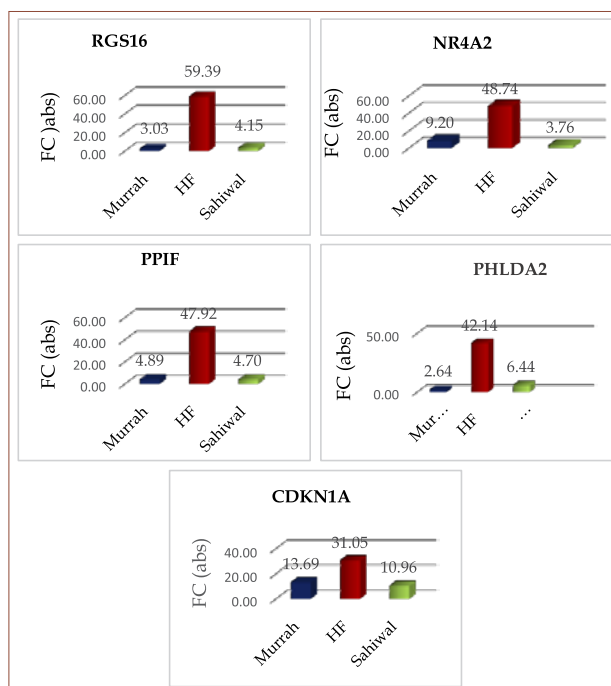
### Most induced genes identified in HF (HFC) *vis a vis* Sahiwal cattle (SAC) and Murrah (MUB) buffalo PBMCs during summer stress

| Gene ID      | Gene        | DescriptiDescription                                | HFC (FC) | SAC (FC) | MUB (FC) |
|--------------|-------------|---|----------|----------|----------|
| A_73_P045601 | RGS16       | regulator of G-protein signaling 16                 | 59.39    | 4.15     | 3.03     |
| A_73_115943  | NR4A2       | nuclear receptor subfamily 4, group A, member 2     | 48.74    | 3.76     | 9.20     |
| A_73_P049561 | PPIF        | peptidylprolyl isomerase F                          | 47.92    | 4.70     | 4.89     |
| A_73_P040961 | PHLDA2      | pleckstrin homology-like domain, family A, member 2 | 42.14    | 6.44     | 2.64     |
| A_73_P069886 | PLK2        | polo-like kinase 2                                  | 35.55    | 9.04     | 22.46    |
| A_73_102040  | CDKN1A      | cyclin-dependent kinase inhibitor 1A                | 31.05    | 10.96    | 13.69    |
| A_73_P168942 | C15H11orf96 | chromosome 15 open reading frame                    | 30.20    | 3.83     | 2.55     |
| A_73_P102796 | CCL4        | chemokine (C-C motif) ligand 4                      | 28.31    | 14.46    | 2.14     |
| A_73_P108101 | IL1A        | interleukin 1, alpha                                | 27.98    | 17.93    | 19.57    |
| A_73_P352131 | HYAL2       | hyaluronoglucosaminidase 2                          | 27.20    | 3.77     | 2.40     |
| A_73_103720  | TMEM88      | transmembrane protein 88                            | 26.74    | 6.16     | 3.65     |
| A_73_108915  | DEPDC7      | DEP domain containing 7                             | 23.82    | 2.22     | 2.96     |
| A_73_110136  | LOC537594   | Rep: LOC537594 protein                              | 22.80    | 5.08     | 5.54     |
| A_73_115064  | HES1        | hairy and enhancer of split 1                       | 22.02    | 5.10     | 6.71     |
| A_73_P102451 | CCL3        | chemokine (C-C motif) ligand 3                      | 18.94    | 9.06     | 11.89    |
| A_73_P112691 | PHACTR1     | phosphatase and actin regulator 1                   | 18.70    | 5.97     | 7.84     |
| A_73_118840  | CFB         | complement factor B                                 | 18.06    | 19.64    | 8.37     |
| A_73_103456  | MAFF        | musculoaponeurotic fibrosarcoma oncogene homolog F  | 16.81    | 15.38    | 23.36    |
| A_73_P033201 | SLC2A1      | solute carrier family 2 member 1                    | 14.28    | 3.04     | 4.84     |
| A_73_109217  | PER1        | period circadian clock 1                            | 13.85    | 4.74     | 4.84     |
| A_73_120639  | BCL2L11     | BCL2-like 11  | 12.69    | 5.72     | 7.81     |

### Pathways in response to summer stress

Efforts were also made to identify the molecular pathways in response to heat stress in individual breeds (Holstein Frisian, Sahiwal cows and Murrah buffaloes) using up-regulated genes

above FC>2. The pathway analysis was carried out for better interpretation of transcriptomic data as it is difficult to extract a unifying biological theme from a large list of individual genes.

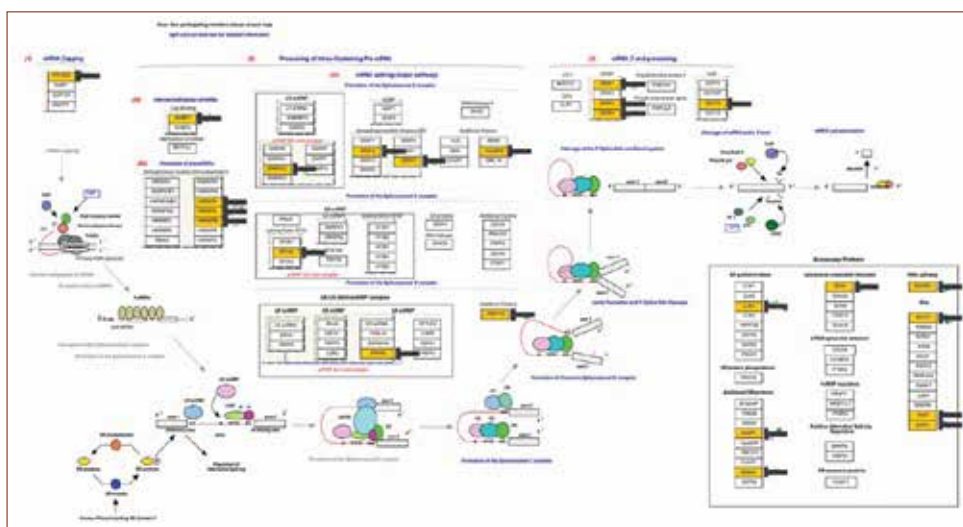


*Most induced genes in HF cattle PBMCs during summer stress*

Some of the important pathways that were commonly expressed in all the three breeds during heat stress included MAPK signaling pathway, chemokine signaling pathway, mRNA processing, apoptosis, TNF signaling pathway, T cell receptor signaling pathway, FoxO signaling pathway and NF-kappa B signaling pathway.

The distinct pattern of transcriptome across indicus and taurine cattle types and buffaloes

might be influencing their cellular tolerance level to heat stress. Overall transcriptome stability of Sahiwal PBMCs (only 453 DEGs) during peak summer and winter seasons suggested it's higher cellular tolerance to summer stress in comparison to HF cows. This study has also helped to identify several heat responsive genes and pathways in PBMCs of cattle and buffaloes.



*Major pathways impacted during heat stress response in HF, Sahiwal cattle and Murrah buffalo*



### NETWORK PROJECT ON AnGR

#### Characterization of Balangir goat

(BAIF Central Research Station, Urulikanchan, Pune):

Systematic survey in three districts of Odisha (Balangir, Bargarh, Sonepur) was carried out. The estimated population of Balangir goat is about two lakh. Average herd size is 8.02 with 49% kids, 28% young stock and 23% adults. Most of the males are castrated at 3 months of age. Goats are black or brown in colour with border on ears. Average weight, at sixth, 3 months and adult was  $2.23 \pm 0.01$ ,  $6.66 \pm 0.02$ ,  $11.42 \pm 0.03$  and  $21.06 \pm 0.03$  kg, respectively. Average age and weight at slaughter was  $17.48 \pm 1.89$  months and  $20.56 \pm 1.15$  kg. Average age at first kidding, kidding interval and kidding rate were 11.09 months,  $218.16 \pm 0.09$  days and 1.94, respectively. Average daily milk yield was 1.1 kg with average lactation length of 59 days.

#### Characterization of Kathani cattle

(BAIF, Development Research Foundation, Urulikanchan)

Data was collected on 9,750 Kathani cattle owners from 118 randomly selected villages distributed in thirteen tehsils of three districts (Chandrapur, Gadchiroli and Gondia) of eastern Maharashtra. Average herd size was 5.30 consisting of breeding females (27%), breeding males (9%), young females and males (13% and 10%, respectively), calves (14%) and 27% bullocks. The breed is mainly used for draught purpose. Animals are mostly white in colour with black muzzle, eyelids, hooves and tail switch. Horns are mostly curved outwards with pointed tips. Forehead is straight. Udder is mostly bowl shaped followed by round. Teats are cylindrical with rounded tips. Breed descriptor has been developed.

#### Performance parameters of Kathani cattle

| Particulars         | Parameters                                | Male                    | Female                   |
|---------------------|---|-------------------------|--------------------------|
| Body weights (Kg.)  | Birth weight                              | $11.94 \pm 0.18$ (84)   | $11.06 \pm 0.19$ (62)    |
|                     | Pre-weaning weight (6 months)             | $60.31 \pm 2.34$ (118)  | $57.44 \pm 2.15$ (104)   |
|                     | 12 month weight                           | $114.97 \pm 5.22$ (54)  | $102.06 \pm 4.42$ (72)   |
|                     | 24 months weight                          | $121.91 \pm 2.71$ (164) | $119.13 \pm 3.36$ (148)  |
|                     | Weight at first calving                   | --                      | $181.93 \pm 3.39$ (136)  |
| Male reproduction   | Age at first ejaculation (months)         | $35.84 \pm 0.31$ (280)  | --                       |
|                     | Age at first mating (months)              | $39.43 \pm 0.24$ (280)  | --                       |
| Female reproduction | Age at first estrus (month)               | --                      | $39.98 \pm 0.06$ (2182)  |
|                     | Estrous cycle duration (days)             | --                      | $20.50 \pm 0.01$ (2182)  |
|                     | Estrus duration (hours)                   | --                      | $18.01 \pm 0.01$ (2182)  |
|                     | Age at first mating (month)               | --                      | $42.84 \pm 0.05$ ((2182) |
|                     | Age at first calving (months)             | --                      | $54.86 \pm 0.05$ (2182)  |
|                     | Average number of services per conception | --                      | $1.48 \pm 0.01$ (2182)   |
|                     | Service period (days)                     | --                      | $203.02 \pm 1.08$ (2182) |
|                     | Calving interval (days)                   | --                      | $486.85 \pm 0.51$ (2182) |
|                     | Daily milk yield (kg)                     | --                      | $0.96 \pm 0.03$ (845)    |
| Dairy performance   | Lactation milk yield (kg)                 | --                      | $136.64 \pm 4.04$ (845)  |
|                     | Fat percentage                            | --                      | 4.10                     |
|                     | Lactation length (days)                   | --                      | $145.76 \pm 1.82$ (845)  |



### Characterization of Marwari and Sindhi camel

(ICAR-NRC on Camel, Bikaner)

**Marwari camel:** Survey was undertaken in Pali, Sirohi, Jodhpur and part of Barmer districts of Rajasthan. Hair sample was analyzed and average fiber diameter was  $43.83 \pm 1.13$  micron. The overall medullation percentage was 68.11 of which 57.01 % was hairy (coarsely medullated) fibers and 11.01 was hetero (partially medullated) fibers. The staple length was 3.59 cm.

**Sindhi camel:** Survey was undertaken in Jaisalmer and Barmer districts of Rajasthan. Hair sample was analyzed and average fiber diameter was  $60.66 \pm 1.47$  micron. The overall medullation percentage was 86.25 of which 80.03 % was hairy (coarsely medullated) fibers and 6.27 was hetero (partially medullated) fibers. The staple length was 2.39 cm.

### Characterization of Poonchi chicken

(Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu)

The farmers rearing Poonchi chicken population are mainly landless or marginal. The farmers used to rear the Poonchi chicken population for meat and egg. Birds are let loose in the day time and kept in wooden house at night and reared under very low inputs. Birds are red/brown/black in colour. Comb is single and mostly red. Adult body weight is  $2.78 \pm 0.25$  kg in males and  $1.90 \pm 0.04$  kg in females. Average age at first egg is 6 months and hatchability is 78% on total egg basis. Average clutch size is  $16.13 \pm 0.46$  with 14 days clutch interval. Average dressing percentage is 71% with bone meat ratio of 3.07. Breed descriptor has been developed.

### Characterization of Sojat goat

(RAJUVAS, Udaipur)

Total 117 farmers of 27 villages were covered and data of 5428 Sojat goats were recorded in Pali, Jodhpur and Nagaur districts of Rajasthan.

Goats are maintained under stall feeding. Goats are large sized, white in colour and dual utility. Average birth and adult weights are 3.73 and 69.94 kg, respectively. Udders are well developed with conical teats. Average daily milk yield is 1.0 kg with 3.29% fat. Average kidding rate is 1.95. Breed descriptor has been developed.

### Characterization of Vandarvi and Kamma cattle populations of Telangana

(WASSAN (NGO), Telangana)

**Kamma cattle:** Around 101 breeders have been identified from 34 villages, 6 mandals, of the study area and registration of the Kamma Cattle Breeders Association is in progress. Two district level meetings were conducted with proposed breeders association at Atmakur mandal, Kurnool district, Andhra Pradesh for discussion over registration of the breeders association and election of the executive committee.

**Vandhera cattle:** Around 119 breeders have been identified from 117 villages, 6 mandals, and 4 districts of Telangana. Biometric traits and physical traits of 700 cattle have been recorded for the purpose of characterization, adopting the format prescribed by the NBAGR.

### Conservation of Ankleshwar chicken

(Poultry Research Station, College of Veterinary Science & A.H., AAU, Anand, Gujarat)

- Farmers have 677 hens and 127 cocks
- 20 Quintal poultry feed was supplied to the beneficiaries in four instalments
- Bamboo baskets were distributed to the beneficiaries for incubation of eggs.

### Outcomes of the projects

- Number of eggs produced : 20,500
- Number of eggs incubated : 6,300
- Number of chicks hatched : 4,706 (74.7%)
- Number of chicks sold : 3,655
- Number of eggs consumed : 8,050
- Number of eggs sold : 6,150

### Tribal sub plan programme on conservation of Kadaknath fowl

(Chhattisgarh Kamdhenu Vishwavidyalaya, Anjora, Durg)

Two tribal villages Gidhali and Bogotolla under Mohala block in Rajnandgaon district (Chhattisgarh) were selected, where 100 tribal women farmers rearing kadaknath chicken were selected as beneficiaries. 1148 chicks and 42 kg of chick feed per family were distributed. On average each family has produce 18 chicks. Mortality is quite high (22.8%). Training and animal health camps were organized in these villages. This programme has added to nutritional security as well as livelihood security of tribal families.

### Diversity estimation of livestock populations

(Core Lab, NBAGR)

Five indigenous livestock populations of three species (cattle, goat and camel) were characterized using a panel of 25 microsatellite markers, specific for each species. Within population diversity estimates for the existing genetic variability as well as population differentiation from the registered breeds was estimated from the genotype data. Non-significant heterozygote excess on the basis of different mutation models as revealed from Wilcoxon rank test, Sign and Standardized differences tests along with mode shift analysis suggested that all the populations

have not experienced serious demographic bottlenecks in the recent past.

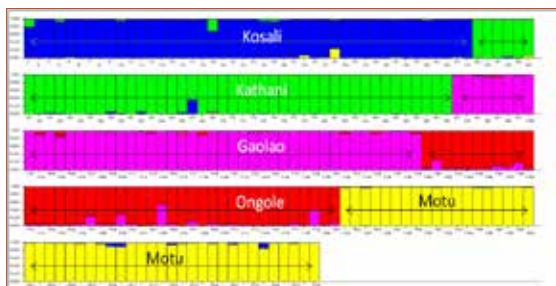
Kathani cattle are distinct from other registered breeds of Indian cattle having morphological similarity and/ or geographic closeness (Kosali, Gaolao, Motu and Ongole) on the basis of molecular differentiation estimated by microsatellite markers. The multi-locus  $F_{ST}$  values of breed differentiation indicated that 19.5% of the total genetic variation was due to unique allelic differences between the breeds, with the remaining 80.5% corresponding to differences among individuals within the breed/ population. The pair-wise  $F_{ST}$  values of breeds ranged between 0.058 to 0.231, thereby revealing the least differentiation between Kathani-Kosali (0.058) and the highest divergence between Kathani-Ongole (0.231). All the five populations separated from each other with 100% bootstrap value in Neighbor joining (NJ) tree constructed on the basis of Nei's genetic distance. The assignment test based on likelihood method with the leave one out procedure assigned 99.56% of the individuals correctly to their respective populations. Bayesian approach illustrated strong genetic structure of the Kathani cattle population with respect to other cattle breeds.

Sindhi, a non-descript camel population distributed along border with Pakistan was explored for genetic variability and its relationship with two registered camel breeds of India- Marwari and Kharai was established. The

### Diversity estimates of populations

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

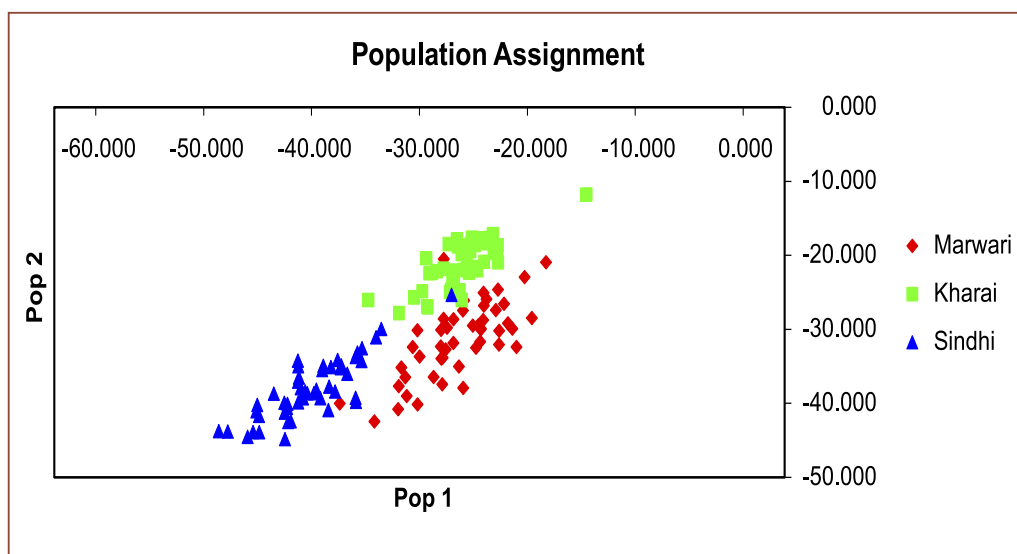
Values are mean ± SE. Na = No. of alleles, Ne = No. of effective alleles; Ho = Observed heterozygosity; He = Expected heterozygosity; F = Fixation index



*Clustering assignment of 228 animals of five Indian cattle populations using STRUCTURE (optimum  $K = 5$ ). Each individual cattle is represented as a thin vertical line that is divided into segments whose size and color correspond to the relative proportion of the genome corresponding to a particular cluster*

standard metrics of genomic diversity detected moderate variability in all the three populations. A total of 303 alleles with a mean of  $8.116 \pm 0.587$  alleles per locus were found in total of 143 animals. Sindhi population had intermediate allelic diversity with  $8.522 \pm 1.063$  alleles per locus. Corresponding values in Marwari and Kharai were  $8.783 \pm 0.962$  and  $7.043 \pm 1.030$ , respectively. Genetic variability within the breeds

was moderate as evidenced by the mean observed heterozygosity of  $0.556 \pm 0.025$ . Sindhi camel population harbors higher genetic variability ( $H_o = 0.594$ ) as compared to the two registered camel breeds (Marwari, 0.543 and Kharai, 0.531). Mean expected heterozygosity under Hardy-Weinberg equilibrium was higher than the observed values across the three camel groups, indicating deviations from assumptions of this model. In fact, average positive  $F$  value of 0.084 to 0.206 reflected heterozygote deficiency in these populations. Differences among populations were medium and accounted for 7.3% of total genetic variability. Distinctness of three camel populations was supported by all the approaches utilized to study genetic relationships such as genetic distances, phylogenetic relationship, correspondence analysis, clustering method based on Bayesian approach and individual assignment.



*Population assignment of Marwari, Kharai and Sindhi camel using log likelihood ratio*

Sindhi camel population was clearly separated from two registered breeds of Indian camel. Results conclude Sindhi to be a separate genepool. Moderate genetic diversity provides an optimistic viewpoint for the survival of severely

declining indigenous camel populations with appropriate planning strategies for conserving the existing genetic variation and to avoid any escalation of inbreeding.





# N B A G R

ANNUAL REPORT 2019





## RESEARCH PROJECTS



ONGOING INSTITUTE PROJECTS



EXTERNAL FUNDED PROJECTS



NATIONAL FELLOW PROJECT

### ONGOING INSTITUTE PROJECTS (as on 01-04-2019)

1. **Project:** Identification of Genetic and phenotypic variation associated with Tick infestation in Indian Cattle.  
**Workers:** Karan Veer Singh and Kamal Jaiswal, BBAU Lucknow. (Jayakumar S up to 3.5.17 and Vikas Vohra up to 29.06.18) -  
**Duration:** April, 2016 to March, 2019, extended up to March, 2020.
2. **Project:** Understanding the molecular basis of characteristic white markings and their inheritance in Nili Ravi buffalo.  
**Workers:** RS Kataria, M Mukesh, Vikas Vohra (NDRI), Sanjay Kumar & KL Mehra-CIRB-Nabha Campus and KP Singh-CIRB-Hisar.  
**Duration:** July, 2018 to June, 2020.
3. **Project:** Characterization of hybrid sterility locus (PRDM9) in Equines, Camels and Pigs.  
**Workers:** Sonika Ahalwat, Rekha Sharma, Reena Arora and Karan Veer Singh  
**Duration:** July, 2018 to June, 2021.
4. **Project:** Phylogenomics of Indian sheep breeds.  
**Workers:** Reena Arora, Sonika Ahlawat and RK Viji  
**Duration:** October, 2019 to September, 2022.
5. **Project:** Identification and Characterization of goat germplasm of Andhra Pradesh and Telangana states.  
**Workers:** NK Verma, RAK Aggarwal, Rekha Sharma and PS Dangi  
**Duration:** October, 2017 to March, 2020.
6. **Project:** Karyotyping and DNA Testing for Screening Genetic Defects in Indian Bovines. (Service project)  
**Workers:** SK Niranjana and Jayakumar S  
**Duration:** April, 2016 to March, 2021.
7. **Project:** Phenotypic and Genetic Characterization of Yak and donkey populations of North trans-Himalayan region of India.  
**Workers:** SK Niranjana, Rahul Behl, Jyotsna Behl, M Iqbal (CAHO, Leh) and Vijay K Bharti (DIHAR, Leh)  
**Duration:** July, 2017 to March, 2020.
8. **Project:** Phenotypic and genetic characterization of Non-descript cattle in Madhya Pradesh.  
**Workers:** Jayakumar S, SK Niranjana, Ajit Pratap Singh (NDVSU, Jabalpur) and DK Yadav (from April, 2019)  
**Duration:** July, 2018 to March, 2020.
9. **Project:** *In-silico* and *in-vitro* analysis of genome-wide SNPs in indigenous and exotic cattle for local adaptation.  
**Workers:** Sanjeev Singh, I Ganguly, SP Dixit, and AK Bhatia  
**Duration:** July, 2018 to June, 2021.
10. **Project:** Study on the Variability and Evolution of Bovine Beta-Defensin Genes.  
**Workers:** Jyotsna Behl, Jayakumar S, Rahul Behl and NK Verma  
**Duration:** July, 2018 to June, 2021.
11. **Project:** Phenotypic and genetic characterization of donkeys of Western Uttar Pradesh.  
**Workers:** Rahul Behl, SK Niranjana, Jyotsna Behl and PK Singh  
**Duration:** April, 2019 to March, 2021.
12. **Project:** Optimisation of Genomic Selection in Livestock Species using Genetic Algorithm.  
**Workers:** Avnish Kumar, Dinesh Kumar Yadav and SP Dixit  
**Duration:** April, 2019 to March, 2021.
13. **Project:** Genomic diversity and Selection signature of Indian native goat breeds.  
**Workers:** Indrajit Ganguly, Sanjeev Singh, SP Dixit and Avnish Kumar

- Duration:** October, 2019 to September, 2020.
14. **Project:** Reference based genome assembly of Indian Swamp buffalo.  
**Workers:** Jayakumar S  
**Duration:** April, 2019 to March, 2020, extended up to March 2021.
  15. **Project:** Conservation of Sahiwal and Haryana cattle at Gaushalas.  
**Workers:** RK Pundir, Arjava Sharma (up to 31.12.2018), PK Singh, AK Mishra and KN Raja  
**Duration:** April, 2015 to March, 2020.
  16. **Project:** Evaluation of livestock policies and programmes for the management of Animal Genetic Resources in Haryana and Punjab states.  
**Workers:** PK Singh, RK Pundir, Arjava Sharma (up to 31.12.2018), HK, Verma (GADVASU) and AK Mishra (from April, 2019)  
**Duration:** July, 2017 to June, 2019, extended up to June, 2020.
  17. **Project:** Characterization and evaluation of lesser known cattle populations (Vandharvi, Zari and Kamma) of Telangana state.  
**Workers:** RK Pundir, PK Singh and PS Dangi and Sabyasachi Das (WASSAN-NGO)  
**Duration:** July, 2017 to June, 2020.
  18. **Project:** Characterization of non-described cattle population of Kerala and Tamil Nadu.  
**Workers:** KN Raja, AK Mishra, R Saravanan (TANVAS) and K Anil Kumar (KANVAS)  
**Duration:** October, 2017 to September, 2020.
  19. **Project:** Identification, characterization and evaluation of mixed indigenous cattle populations of Haryana, Punjab and North-West Rajasthan.  
**Workers:** Anand Jain, DK Yadav and HK Singh (CHRS-Rohtak)  
**Duration:** October, 2017 to March, 2020.
  20. **Project:** Characterization and evaluation of some non-descript buffalo populations of Central and Eastern India.  
**Workers:** 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, Tripura)  
**Duration:** October, 2017 to September, 2020.
  21. **Project:** Phenotypic characterization of some less known sheep populations of Uttarakhand and Andhra Pradesh.  
**Workers:** AK Mishra, KN Raja, Sunil Kumar (Pantnagar) and R Vinoo (Andhra Pradesh)  
**Duration:** July, 2018 to June, 2022.
  22. **Project:** Study of lactation curves in Murrah buffaloes.  
**Workers:** Anand Jain, ID Gupta, HK Singh (CHRS-Rohtak) and Ashish Ranjan (VS-Gaya Bihar, w.e.f. October 2019).  
**Duration:** April, 2019 to September, 2020.
  23. **Project:** Whole genome sequencing of livestock species of India.  
**Workers:** RK Vijh, Sonika Ahlawat, Jyotsna Behl, Rekha Sharma, SK Niranjani, Jayakumar S, Karan Veer Singh, Dige Mahesh Shivanand, Amod Kumar, Soumya Das and Reena Arora.  
**Duration:** October, 2019 to September, 2020.
  24. **Project:** Characterization and documentation of farm Animal Genetic Resources of Mizoram state.  
**Workers:** Monika Sodhi, RS Kataria, SP Dixit, and N Shyamsana Singh (CVS &AH, Aizawl)  
**Duration:** October, 2019 to September, 2020.
  25. **Project:** Characterization of livestock and poultry germplasm in Meghalaya state.  
**Workers:** RK Pundir, Avnish Kumar and I Ganguly  
**Duration:** October, 2019 to September, 2020.



- 26. Project:** Characterization and documentation of livestock and poultry Genetic Resources of Arunachal Pradesh.

**Workers:** SK Niranjana, AK Mishra, MS Dige, Amod Kumar and Jaideep Kumar Singh (KVK, Upper Siang, Geku (AP).

**Duration:** January, 2020 to December, 2020.
- 27. Project:** Network Project on Animal Genetic Resources.

**Workers:** RK Vijh (w.e.f.01.02.2019) Director NBAGR (Project coordinator) and MS Tania (I/c, Network Project)

**Duration:** 1992- Contd.
- 28. Project:** Evaluation of Kadaknath, Desi and broiler chicken meat for Histidine containing dipeptides.
- Workers:** Rekha Sharma, Sonika Ahlawat, MS Tania, Vivek Sharma (NDRI) and Mohan Singh (NDVSVU, Jabalpur)

**Duration:** July, 2018 to June, 2021.
- 29. Project:** Characterization of local goat and cattle populations of Mahakaushal region of Madhya Pradesh and Jharkhand.

**Workers:** MS Tania, PK Vij, RAK Aggarwal, Rekha Sharma, PC Chandran, Amitava Dey, Reena Kamal (ICAR for ER-Patana), Mohan Singh, (NDVSVU, Jabalpur).

**Duration:** July, 2018 to June, 2022.
- 30. Project:** Survey and Documentation of animal genetics resources of North East Region- Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura and Sikkim.

Started from October 2019.

## EXTERNAL FUNDED PROJECTS

- 1. Project:** CRP on Agro-biodiversity Conservation of Animal Genetic Resources.

**Workers:** MS Tania, RAK Aggarwal, PK Vij, and Rekha Sharma

**Duration:** June, 2015 to March, 2017, extended up to March, 2020.
- 2. Project:** ICAR-AGRI Consortia Research Plate form project on Genomics: - Identification of markers for economic traits and transcriptomics study in buffalo and goats.
- Workers:** Reena Arora (PI from April, 2019), RK Vijh, Sonika Ahlawat, Jayakumar S

**Duration:** June, 2015 to March, 2017, extended up to March, 2020.
- 3. Project:** Transcriptome analysis to decipher molecular mechanism related to distinctive morphological phenotypes in Indigenous poultry (CABin) .

**Workers:** RK Vijh and Jayakumar S

## NATIONAL FELLOW PROJECT

- 1. Project:** Genome data mining to unravel molecular basis of thermo tolerance and adaptation to diverse environment in native cattle and buffaloes.

**Worker:** Manishi Mukesh

**Duration:** May, 2011 to May, 2016. Phase II up to 23<sup>rd</sup> May, 2021



## PUBLICATIONS TECHNOLOGIES & AWARDS

RESEARCH ARTICLES



TECHNICAL ARTICLES/BOOK  
CHAPTERS/ INVITED LECTURES



BOOKS AND MONOGRAPHS



PATENTS AND TECHNOLOGIES



AWARDS

## RESEARCH ARTICLES

1. Ahlawat S, Sarova N, Sharma R, Arora R and Tantia MS (2019). Promoter DNA methylation and expression analysis of PIWIL1 gene in purebred and crossbred cattle bulls. *Indian Journal of Animal Sciences*, 89(7):722-727.
2. Ali S, Kuralkar SV, Ingawale M V, Waghmare S P, Manwar S J, Kataria R S and Vohra V. (2019). Phenotypic characterization, management and socio-economic impact of Purnathadi buffaloes. *Indian Journal of Animal Sciences*, 89(10): 1161–1166.
3. Arora R, Kumar N, Sudarshan S, Fairuze MN, Kaur M, Sharma A, Girdhar Y, Sreesujatha RM, Devatkal SK, Ahlawat S, Vijn RK and Manjunatha SS (2019). Transcriptome profiling of longissimus thoracis muscles identifies highly connected differentially expressed genes in meat type sheep of India. *PLoS one*, 14 (6): e0217461.
4. Arora R, Sharma A, Sharma U, Girdhar Y, Kaur M, Kapoor P, Ahlawat S and Vijn RK (2019). Buffalo milk transcriptome: A comparative analysis of early, mid and late lactation. *Scientific Reports*, 9 (1):5993.
5. Behl R, Niranjana S K, Behl J, Ranjan P, Bharti VK and Iqbal M (2019). Comparison of Ladakhi donkeys with three other donkey populations of India based on morphometric attributes. *Indian Veterinary Journal*, 96 (8): 20-22.
6. Deswal S, Singh S, Jeevan C, Ganguly I, Dixit S P and Kumar S (2019). Screening of Y-STR INRA189 polymorphism in Indian breeds of Buffaloes. *Indian J Dairy Science*, 72(4): 449-451.
7. Jeevan C, Ganguly I, Deswal S, Singh S and Dixit S P (2019). Copy number variation of ZNF280BY in *Bos taurus* and *Bos indicus* breeds. *Indian J Dairy Science*, 72(4): 403-407.
8. Kumar DR, Mishra SK, Kumar A, Vineeth MR, Jayakumar S, Sakthivel Selvan A, Karuthadurai T, Chaudhuri P, Kataria RS, Niranjana SK (2019). Major histocompatibility complex (DRB3) gene expression pattern indicates differences in *Brucella abortus* S19 vaccine induced immune response in Karan Fries and Sahiwal cattle. *Indian Journal of Animal Research*, 53 (2), 156-160
9. Kumar DR, Sivalingam J, Mishra SK, Kumar A, Vineeth MR, Chaudhuri P, Kataria RS, Niranjana SK (2019) Differential expression of cytokines in PBMC of *Bos indicus* and *Bos taurus* × *Bos indicus* cattle due to *Brucella abortus* S19 antigen. *Animal Biotechnology*, 1-7.
10. Kumar P, Bharti VK, Mukesh M (2019). Chemometric analysis of antioxidant and mineral elements in colostrum of native and non-native goat breeds to hypoxic conditions at high altitude. *Biology Trace Elementary Research*. doi: 10.1007/s12011-019-01940-y.
11. Kumari N, Loat S, Saini S, Dhilori N, Kumar A and Kataria RS (2019). Role of BoLA-DRB3 genetic diversity against resistance to mastitis in cattle: Review. *Journal of Veterinary Science and Research*, 1:30-36, <https://doi.org/10.36811/jvsr.2019.110004>.
12. Sharma A, Shandilya UK, Sodhi M, Mohanty AK, Jain P, Mukesh M(2019). Evaluation of Milk Colostrum Derived Lactoferrin of Sahiwal (*Bos indicus*) and Karan Fries (Cross-Bred) Cows for Its Anti-Cancerous



- Potential. *International Journal of Molecular Science*, 20(24)
13. Sharma P, Sharma A, Sodhi M, Verma P, Parvesh K, Swami SK, Jast A, Shandilya UK, Mukesh M (2019). Characterizing binding sites of heat responsive microRNAs and their expression pattern in heat stressed PBMCs of native cattle, exotic cattle and riverine buffaloes. *Molecular Biology Reports*. 46(6):6513-6524.
  14. Sharma U, Banerjee P, Joshi J, Kapoor P and Vijn RK (2019). Identification of quantitative trait loci for milk protein percentage in Murrah buffaloes. *Indian Journal of Animal Sciences*, 89(5):528-538.
  15. Shivahre PR, Verma NK, Aggarwal RAK, Sharma R, Dixit SP and Savino N. (2019). Genetic diversity and relationship among North East Hill (NEH) Goats. *Indian Journal of Animal Sciences*, 89(11):1231-1236.
  16. Singh KV, Jayakumar S, SP Dixit and Malik ZS (2019). Molecular characterization and genetic variability of Alpha Casein gene, CSN1S1 in Bikaneri camel (*Camelus dromedarius*) milk. *Indian Journal of Animal Research*, 53(1): 67-70.
  17. Singh KV, SP Dixit, Sharma A, Vohra V, Kant N, Dangi PS and Kumar R (2019). Differentiating characteristics among three new goat populations from Northern India. *Indian Journal of Animal Sciences*, 89(7):746-751.
  18. Singh NP, Vohra V, Das R, Verma U, Tandia MS and Kataria RS (2019). Elucidating the genetic diversity using SSR based markers in Gojri buffalo. *Indian Journal of Animal Sciences* 89(5): 522-527.
  19. Singh PK, Pundir RK, Dangi PS, Desai BG, DJ Bhagat and Shalu Kumar (2019). Physical features, management and performance of newly registered cattle breed of Konkan region of Maharashtra. *Indian Journal of Animal Sciences*, 89(4): 413-418.
  20. Singh R, Gurao A, Rajesh C, Mishra SK, Rani S, Behl A, Kumar V, Kataria RS (2019). Comparative modeling and mutual docking of structurally uncharacterized heat shock protein 70 and heat shock factor-1 proteins in water buffalo. *Veterinary World*, 12(12): 2036-2045. doi: [www.doi.org/10.14202/vetworld.2019.2036-2045](http://www.doi.org/10.14202/vetworld.2019.2036-2045)
  21. Sivalingam J, Niranjana SK, Yadav DK, Singh SP, Singh PK and Singh AP (2019). Physical characteristics of a new cattle population "Bawri" in Chambal region of Madhya Pradesh. *Journal of Livestock Biodiversity*, 9(1) : 49-51.
  22. Vineeth MR, Surya T, Sivalingam J, Kumar A, Niranjana SK, Dixit SP, Singh KV, Tandia MS and Gupta ID (2019). Genome-wide discovery of SNPs in candidate genes related to production and fertility traits in Sahiwal cattle. *Tropical Animal Health and Production* doi.org/10.1007/s11250-019-02180-x.

## TECHNICAL ARTICLES/BOOK CHAPTERS/ INVITED LECTURES

1. नरेश कुमार वर्मा (2019) तेलंगाना राज्य में बकरियों की स्थिति, शरीरिक गुण-माप व प्रबंधन पशुधन प्रकाश अंक 10 :33-35.
2. प्रिंस विवेक, मोनि का सोढ़ी, रणजीत सिंह कटारिया, साकेत कुमार निरंजन, विजय कुमार भारती, प्रवेश कुमारी एवं मनीषी मुकेश (2019) जंसकारी घोड़ा : लद्दाख की दुर्गम परिस्थितियों के लिए एक उत्तम नस्ल, पशुधन प्रकाश अंक 10: 101-104.



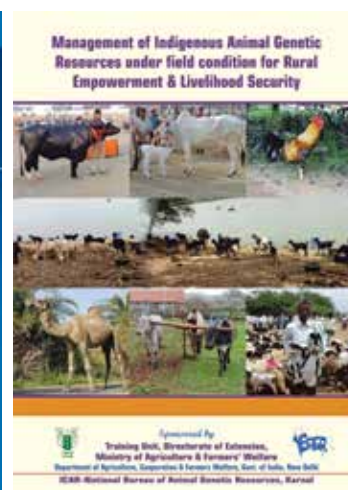
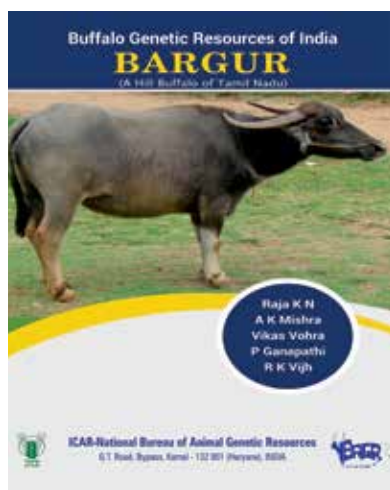
3. Aggarwal, R.A.K. (2019). Role and importance of National Gene Bank for ex-situ conservation of livestock breeds. ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana, India, 79-83pp.
4. Ahlawat, S., Sharma, R., Arora, R. and Tantia, M.S. (2019). Practical aspects of molecular techniques for AnGR characterization. ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana, India, 156-167pp.
5. Arora, R., Kaur, M., Kumar, A., Ahlawat, S., Sharma, R. and Chhabra, P. (2019). Genetic marker based characterization and prioritization of breeds for conservation. ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana, India, 144-155pp.
6. Dixit SP, Singh S and Ganguly I (2019). Perspectives and Challenges of Genomic Selection in sheep. In: National Seminar on "Current Scenario Future Strategies for Augmenting Productivity of Small Ruminants" at Bihar Animal Sciences University, Patna from 14<sup>th</sup> to 16<sup>th</sup> February-2019.
7. Ganguly, I., Raja, K.N. and Singh, S. 2019. Biological Diversity Act and role of National Biodiversity Authority for effective implementation of ABS. In lecture compendium on Management of Indigenous Animal Genetic Resources under field condition for Rural Empowerment & Livelihood Security. ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana, India, 93-99 pp.
8. Kataria, R.S. and Kumari, N. (2019). Genetic basis of disease resistance in indigenous livestock. In lecture compendium on Management of Indigenous Animal Genetic Resources under field condition for Rural Empowerment & Livelihood Security. ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana, India, 168-171pp.
9. Niranjana, S.K., Kumar, A., Jayakumar, S. and Mohan, M. (2019). Chromosome and DNA based genetic diseases in bovines. ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana, India, 138-143pp.
10. Pundir RK. (2019). Conservation and improvement of indigenous cattle and Pandharpuri buffalo, Invited lecture presented in Brain Storming Session held Nov 13, 2019 at MPKV, Rahuri.
11. Pundir RK. (2019). Genetic Improvement in Cattle and Buffalo in India through Progeny Testing Programs. In lecture compendium on Management of Indigenous Animal Genetic Resources under field condition for Rural Empowerment & Livelihood Security. ICAR- NBAGR, Karnal, 105-112.
12. Raja, K.N. and Surya, T. (2019). Assessing impact of national policies and programs on AnGR conservation. In lecture compendium on Management of Indigenous Animal Genetic Resources under field condition for Rural Empowerment & Livelihood Security. ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana, India, 117-127pp.
13. Raja, K.N. and Surya, T. (2019). Phenotypic characters and distribution of indigenous livestock and poultry breeds. In lecture compendium on Management of Indigenous Animal Genetic Resources under field condition for Rural Empowerment & Livelihood Security. ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana, India, 25-53pp.
14. Sharma, R., Ahlawat, S. and Tantia, M.S. (2019). Characterization of livestock



- products: A new outlook for AnGR conservation. In lecture compendium on Management of Indigenous Animal Genetic Resources under field condition for Rural Empowerment & Livelihood Security. ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana, India, 84-88pp.
15. Singh, P.K. and Sharma, L. (2019). National breeding policy and its role in conservation and genetic improvement of livestock. In lecture compendium on Management of Indigenous Animal Genetic Resources under field condition for Rural Empowerment & Livelihood Security. ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana, India, 100-104pp.
16. Singh, S., Ganguly, I., Bhardwaj, S. and Dixit, S.P. (2019). Utilization of genome wide SNPs for genetic improvement of indigenous livestock. In lecture compendium on Management of Indigenous Animal Genetic Resources under field condition for Rural Empowerment & Livelihood Security. ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana, India, 206-213pp.
17. Sodhi, M., Mukesh, M., Niranjana, S.K. and Kataria, R.S. (2019). Uniqueness of indigenous cattle with special reference to A1A2 allele. In lecture compendium on Management of Indigenous Animal Genetic Resources under field condition for Rural Empowerment & Livelihood Security. ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana, India, 214-226pp.
18. Tandia, M.S. and Sharma, R. (2019). Status of conservation programs for effective management of indigenous AnGR in India. In lecture compendium on Management of Indigenous Animal Genetic Resources under field condition for Rural Empowerment & Livelihood Security. ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana, India, 69-74pp.
19. Verma, N.K. (2019). Indian livestock, its characterization and documentation. In lecture compendium on Management of Indigenous Animal Genetic Resources under field condition for Rural Empowerment & Livelihood Security. ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana, India, 14-18pp.
20. Vij, P.K. (2019). Indigenous poultry genetic resources and its role in rural empowerment. In lecture compendium on Management of Indigenous Animal Genetic Resources under field condition for Rural Empowerment & Livelihood Security. ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana, India, 54-62pp.
21. Viji, R.K. and Sharma, U. (2019). Present status and future prospects of genomic selection in cattle and buffalo in India. In lecture compendium on Management of Indigenous Animal Genetic Resources under field condition for Rural Empowerment & Livelihood Security. ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana, India, 1-8pp.
22. Yadav, Dinesh Kumar (2019). Sampling technique and survey methodology for phenotypic characterization of indigenous AnGR. In lecture compendium on Management of Indigenous Animal Genetic Resources under field condition for Rural Empowerment & Livelihood Security. ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana, India, 19-24pp.

## BOOKS AND MONOGRAPHS

1. Raja K N, Mishra A K and Vijn R K. (2019). Management of Indigenous Animal Genetic Resources under field condition for rural empowerment & livelihood security pp: 226. Published by ICAR- NBAGR Karnal.
2. "Advances in Animal Biotechnology" (Springer) by B Singh, G Mal, Sanjeev K. Gautam and Manishi Mukesh ISBN 978-3-030-21308-4, pp562.
3. Raja K N, Mishra A K, Vohra V, Ganapathi P and Vijn R K 2019. Buffalo Genetic Resources of India-Bargur. Published by ICAR- NBAGR Karnal.



## PATENTS AND TECHNOLOGIES

1. First Patent # 327523, Application no: 3775/DEL/2011 on "A Kit for Parentage Verification in Buffaloes (*Bubalus Bubalis*)" was granted by Indian Patent Office in December 2019.
2. Request for examination of the following patent applications was submitted to Indian Patent Office, New Delhi in October 2019:
  - i. Application No. 201611021505 on "Genome wide QTLs for age at first calving in buffaloes".
  - ii. Application No. 201611021506 on "Genome wide QTLs for milk fat percentage, milk protein percentage and total milk fat".
  - iii. Application No. 201611021507 on "Genome wide QTLs for milk yield in buffaloes".
  - iv. Application No. 201611021508 on "Genome wide QTLs for somatic cell counts in buffaloes".





## AWARDS

- Mishra AK, Pundir R K, Singh PK, Raja K N and Sharma A.2019. गऊशालाओं के माध्यम से गाय के नस्लों का संरक्षण, संवर्धन एवं सतत विकास, पशुधन प्रकाश, नवम अंक (2018), Recieved best article published in Institute Hindi magazine Pashuadhan Prakash, by ICAR-NBAGR Karnal.
- Dr RAK Aggarwal (Principal Scientist & Incharge, Gene Bank) was conferred with Dr. P.G. Nair Award – 2019 for scientific contribution in the field of identification, evaluation, characterization, conservation and utilization of livestock and poultry genetic resources of the country.
- संस्थान ने नराकास करनाल के “राजभाषा पुरस्कार” में वर्ष 2018 का द्वितीय पुरस्कार जीता.
- Second Best Poster Award for Save biodiversity-save earth on International Biodiversity Day by Mandeep Kaur, Ashish Kumar, Pooja, Rakesh Kumar, Sonika Ahlawat and Reena Arora on 22.05.2019, organized by ICAR-NBAGR, Karnal.
- First prize for research poster presentation in hindi during Hindi Chetna Maah by Mandeep Kaur, Ashish Kumar, Pooja Chhabra, Rakesh Kumar, Sonika Ahlawat and Reena Arora at ICAR-NBAGR, on 18 September, 2019.
- Best poster award for the poster presented on Genome-wide runs of homozygosity in Indian native cattle” by Anurodh Sharma, Sanjeev Singh, Indrajit Ganguly, Avnish Kumar, S Jayakumar and S P Dixit during the XVI<sup>th</sup> National Symposium on “Animal Genetic Resources for Food and Social Security” at National Bureau of Animal Genetic Resources, Karnal, Haryana during 7-8 February, 2019.
- Best poster award for the research entitled “NMR based metabolome profiling of serum samples in native and exotic cattle during summer stress’ by Prince Vivek, Manish Tiwari, Aman Jast, Monika Sodhi, Parvesh Kumari and Manishi Mueksh during International Conference on Proteomics for System Integrated Bio-Omics, One Health and Food Safety Conference held at ICAR-NDRI from 2-4 Dec.2019.







# N B A G R

ANNUAL REPORT 2019





## CAPACITY BUILDING

TRAINING ORGANIZED



TRAINING ATTENDED



PRESENTATIONS IN SYMPOSIA/SEMINARS/  
TRAININGS



FOREIGN VISITS



MERA GAON MERA GAURAV PROGRAMME



EXHIBITIONS



### TRAINING ORGANIZED

1. A three days training programme on MIS-FMS for all administrative and Finance staff of ICAR-NBAGR, Karnal was organized from 21.08.2019 to 23.08.2019. Sh. Sanjeev Mathur, ACTO and Sh. Pawan Kumar Gupta, AFA&AO coordinated the training programme.
2. A Model Training Course (MTC) on "Management of Indigenous Animal Genetic Resources under field condition for rural empowerment & livelihood security", from 25.11.2019 to 02.12.2019 sponsored by Directorate of Extension, Department of Agriculture, Cooperation & Farmers Welfare (Ministry of Agriculture & Farmers Welfare), Government of India was organized. Dr. A K Mishra Principal Scientist was Course Director and Dr. Raja K N Sr. Scientist was Course coordinator for this training course.



*Valedictory function of Model Training Course*

- Farmer Scientist Interaction: ICAR-NBAGR organized a state level workshop in

collaboration with Department of farmers' Welfare, Haryana. Sh. Ajit Balaji Joshi, Director Department of farmers' Welfare, Haryana acted as chief guest.



*Chief Guest innaugurating Farmer Scientist Interaction*

- A two days in campus training programme on 'Advance Quality Auditors Certificate Training' was organized on 24-25 September, 2019 for the officers of NBAGR. The training was imparted by Dr. DP Singh, An ISO Consultant, from M/S Quality Consultant, Gurugram.



*Participants of ISO training program*

### TRAINING ATTENDED

- Smt. Anita Chanda, Personal Asstt. Attended the Specialized Training Programme on "Enhancing Efficiency and Behavioural Skills" from 20.06.2019 to 25.06.2019.
- Sh. Harvinder Singh, Sr.Tech.Officer (Library) attended National Workshop on "Open Source Library Software KOHA and RFID Training and Certification". From 31.05.2019 to 01.06.2019.

- Sh. Sanjeev Mathur, Asstt. Chief Tech. Officer attended Training-cum-certification program on “Cyber Security and Ethical hacking”.
- Sh. Raj Kumar, Admn. Officer, Sh. Pawan Kumar Gupta, AF&AO, and Sh. Ramesh Behl, AAO attended Sensitization workshop for Head of Administration and Finance Officers.
- Sh. Krishan Lal, SSS, Sh. Ram Sagar, SSS, Sh. Deepak Rai SSS and Sh. Satbir SSS attended a training on Enhancement of Competency and Work Efficiency in Organization on 13-15 February, 2019 at ICAR-NDRI, Karnal.
- Sh. Krishan Lal, SSS, Sh. Ram Sagar, SSS, Sh. Deepak Rai SSS and Sh. Satbir SSS attended Field /exposure visit as an integral part of training on 25th March, 2019 at ICAR-CIRB, Hisar
- Dr. K N Raja, Sr. Scientist, attended a training on Management Development Programme for HRD Nodal Officers of ICAR for Effective Implementation of Training Functions, at NAARM, Hyderabad from 14.03.2019 to 16.03.2019.
- Dr. Saket K Niranjana, Pr. Scientist attended training Programme on Multivariate Analysis Using R. at NAARM, Hyderabad. From 22-11-2019 to 27-11-2019.
- Dr. Dinesh Kumar Yadav, Pr. Scientist attended a training on Management Development Programme on “Impact Assessment of Agricultural and Rural Development Programme” at IIM, Lucknow. From 02.09.2019 to 06.09.2019.

## PRESENTATIONS IN SYMPOSIA/SEMINARS/TRAININGS

Lecture given in Model Training Course on “Management of Indigenous Animal Genetic Resources under field condition for Rural Empowerment & Livelihood Security” held at ICAR- NBAGR Karnal, from 25.11.2019 to 02.12.2019

| Name              | Topic  |
|-------------------|--|
| Dr R K Viji       | Present Status and Future Prospects of Genomic Selection in Cattle and Buffalo in India                  |
| Dr P K Singh      | National Breeding Policy and its role in Conservation and Genetic Improvement of Livestock               |
| Dr R K Pundir     | Genetic Improvement in Cattle and Buffalo in India through Progeny Testing Programs                      |
| Dr Dinesh Kumar   | Sampling Technique and Survey Methodology for Phenotypic Characterization of Indigenous AnGR             |
| Dr P K Vij        | Indigenous Poultry Genetic Resources and its Role in Rural Empowerment                                   |
| Dr Sonika Ahlawat | Practical Aspects of Molecular Techniques for AnGR Characterization                                      |
| Dr Rekha Sharma   | Characterization of Livestock Products: A New Outlook for AnGR Conservation                              |
| Dr RAK Aggarwal   | Role and Importance of National Gene Bank for Ex situ Conservation of Livestock Breeds                   |
| Dr Sanjeev Singh  | Utilization of Genome Wide SNPs for Genetic Improvement of Indigenous Livestock                          |
| Dr N K Verma      | Indian Livestock, its Characterization and Documentation   |
| Dr M S Tania      | Status of Conservation Programs for Effective Management of Indigenous AnGR in India                     |
| Dr Reena Arora    | Genetic Marker Based Characterization and Prioritization of Breeds for Conservation                      |
| Dr R S Kataria    | Genetic Basis of Disease Resistance in Indigenous Livestock  |
| Dr Raja K N       | Phenotypic Characters and Distribution of Indigenous Livestock and Poultry Breeds                        |
| Dr S K Niranjana  | Chromosome and DNA Based Genetic Diseases in Bovines   |
| Dr I Ganguly      | Biological Diversity Act and Role of National Biodiversity Authority for Effective Implementation of ABS |
| Dr S K Niranjana  | Uniqueness of Indigenous Cattle with Special Reference to A1A2 Allele                                    |



- Dr Manishi Mukesh presented a lead paper on “Understanding genome architectures for indigenous livestock species of Ladakh to unravel genetic basis of high altitude adaptation and unique production characteristics” during National Workshop on Physiology of High & Extreme Environment and Special Panel on Extreme Environment & Behavioural Sciences (PEE&BS) organized at DRDO-Defense Institute of Physiology and Allied Sciences, New Delhi 30.10.2019.
- Dr Manishi Mukesh as mentor guided Dr Manoj Singh for the project “Establishing colostrum metabolome signatures of native livestock genetic resources of India: implications for human health” under SERB-DST Scheme from April 2017-March 2019.

## FOREIGN VISITS

- Dr. R.K.Vijh, Director visited IAEA, Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, Vienna International Centre, Vienna, Austria during October 14-18, 2019 to attend Experts’ Consultancy Meeting on “Advances in nuclear and genomic tools to improve livestock productivity: Technology gaps and new approaches for application in developing countries.” Three projects were developed (one each for cattle, buffalo and camel) for implementation of genomic selection in developing countries of Asia, Africa and Southern America.
- Dr. R.S. Kataria, Principal Scientist, visited Papua New Guinea on ‘Technical Cooperation Expert Mission on Animal Sampling, Lab Equipment Set-up and DNA Extraction’ sponsored by International Atomic Energy Agency, Vienna, Austria, 22 to 30 June, 2019 at Papua New Guinea University of Natural Resources and Environment (PNGUNRE), Kokopo, PAPUA NEW GUINEA.



## MERA GAON MERA GAURAV PROGRAMME

Team of scientists visited various villages of Karnal district under Mera Gaon Mera Gaurav in collaboration with veterinary officers of State Animal Husbandry Department and interacted with farmers. Apart from discussing the problems faced by the farmers the lectures on following topics were also delivered to impart the knowledge and also to create the general awareness:

### Topics for general awareness:

- ♦ Importance of indigenous breeds of livestock
- ♦ Common parasitic diseases in livestock, their symptoms and treatment & control.
- ♦ Care of young stock for parasitic diseases in rainy season
- ♦ Livestock management activities
- ♦ Feeding and nutrition of Dairy animals.
- ♦ Repeat breeding and cure in dairy animals.
- ♦ Vaccination schedule to be adopted
- ♦ Preparation of silo pits for storing excess fodder to be used as Silage in lean periods.
- ♦ Rashtriya Swachhta Abhiyan and Beti Bachao Beti Pado
- ♦ Cleanliness, tree plantation and ill effects of stubble burning
- ♦ Awareness on Jal Shakti Abhiyaan
- ♦ Save water by harvesting rain water
- ♦ Common hygiene for reducing the infection and parasite in children
- ♦ Educational programmes and employment opportunity in Agriculture and Animal Husbandry sector.
- ♦ Social responsibility towards community.
- ♦ Save water by harvesting of water in rains
- ♦ Soil health card and management of crop residue
- ♦ Pandit Dindayal Livestock insurance Scheme

Following visits were made to the villages of Karnal district in collaboration with local Vet. Officers of Animal Husbandry Department of Haryana:

- A visit was made on 17<sup>th</sup> August 2019 to Bansa (Jundla), Dist. Karnal with coordinated efforts of Dr Jitender Kumar V.O., Jundla, Karnal. Farmers rearing animals attended the meeting and information related to best animal husbandry practices was shared. Villagers were informed about the water management and conservation practices and its importance. Major problems discussed were how to prevent and cure mastitis as few farmers reported the occurrence of disease in their animals. Information related to good breeding practices was also shared. Some farmers informed about the importance of the infestation of ticks and how to prevent them. Reproductive problems raised by farmers were also discussed. Farmers were given information about the various schemes related to insurance, dairy loan, special schemes for SC, availability of sexed semen, prizes for high yielding indigenous animals also by the concerned V.O.
- गांव सिरसी (मधुबन) में पशुओं के लिए बाँझपन चिकित्सा शिविर में गोवंशीय एवं भैसों का परीक्षण कर उपचार किया गया। इसके बाद एक पशुपालक गोष्ठी का भी आयोजन किया गया, जिसमें 40 से अधिक पशुपालकों ने भाग लिया।
- एक कार्यक्रम राजकीय पशु चिकित्सालय, गांव ऊँचा समाना, करनाल में आयोजित किया गया जहाँ पशुओं के लिए बाँझपन चिकित्सा शिविर में 15 गोवंशीय एवं भैसों का परीक्षण कर उपचार किया गया। राजकीय पशु चिकित्सालय, ऊँचा समाना के पशु चिकित्सक एवं राष्ट्रीय पशु आनुवंशिक संसाधन ब्यूरो के वैज्ञानिकों ने पशुपालकों की पशु स्वास्थ्य, प्रबंधन, पशु बीमा, तथा पशुपालन हेतु ऋण आदि समस्याओं को सुना और समुचित समाधान भी बताया। इस अवसर पर ब्यूरो के वैज्ञानिकों ने पशुओं की स्वच्छता पर विशेष बल दिया



- और पशुपालकों से अपील की जल संरक्षण की अति आवश्यकता है, अतः किसानों को वर्षा के जल के संरक्षण के लिए आगे आना चाहिए, जिससे भूजल स्तर को और अधिक गिरने से बचाया जा सके। किसानों को न कुल पशु स्वास्थ्य पत्र के बारे भी बताया गया।
- An awareness camp was organized on 17 August 2019 in Kaimla village near Gharaunda of Dist. Karnal. Lectures on Jal Bachao Abhiyan, Swachhta Abhiyan and Govt. welfare schemes for farmers and Animal keepers, were delivered by scientists of NBAGR.
  - “मेरा गाँव मेरा गौरव” कार्यक्रम का आयोजन राजकीय पशु चिकित्सालय गाँव डिंगरमाजरा (घरौंडा), जिला करनाल में 26 अगस्त 2019 को किया गया। इस अवसर पर एक पशुपालक गोष्ठी का आयोजन किया गया, जिसमें लगभग 40 पशुपालकों ने भाग लिया। गोष्ठी में पशुपालन विभाग, हरियाणा द्वारा चलाये जा रहे पशुओं से सम्बंधित विविध कार्यक्रम, पंडित दीनदयाल उपाध्याय सामूहिक पशुधन बीमा योजना तथा पशुपालन के लिए ऋण योजना के बारे में बताया। राष्ट्रीय पशु आनुवंशिक संसाधन ब्यूरो के वैज्ञानिकों ने देसी नस्लों के पशुपालने, उनके संवर्धन एवं देसी नस्लों के संरक्षण के फायदों के बारे में विस्तार से बताया।

## EXHIBITIONS

NBAGR participated in the various official functions of state animal husbandry departments & ICAR institutes and exhibited the activities of ICAR-NBAGR to the farmers. The bureau installed the exhibitions on AnGR in the following official functions:

- International summit organised by Animal Husbandry Department, Sonapat, Haryana, 15-17, February, 2019.
- Buffalo fair, organised by Central Institute for Research on Buffalo, Hisar, Haryana, 18<sup>th</sup> February, 2019.
- Dairy Mela at ICAR-NDRI, Karnal, Haryana, 26-28, February, 2019.
- Krishi Unnati Mela at ICAR-IARI, New Delhi, 15-16, March, 2019.
- Pashu Palan Mela at GADVASU, Ludhiana, Punjab, 15-16, March, 2019.
- Seed Day at ICAR-IIWBR, Karnal, Haryana, 5<sup>th</sup> October, 2019.
- Animal show at Karnal organised by Animal Husbandry Department, Haryana, 15<sup>th</sup> November, 2019.





## OTHER ACTIVITIES

IMPORTANT MEETINGS



CELEBRATIONS



SPORTS



DISTINGUISHED VISITORS



### IMPORTANT MEETINGS

#### *IRC Meeting*

The annual Institute Research Committee (IRC) meeting was held on 8, 9<sup>th</sup> and 29<sup>th</sup> April, 2019 wherein final reports of the completed, ongoing projects and 8 new project proposals were discussed and approved. The mid term appraisal of the ongoing research projects was done during second IRC meeting held on October 4, 2019.



#### *QRT Meeting*

QRT meeting was held on 17<sup>th</sup> June, 2019 at NASC Complex, New Delhi.

#### *Network Project Meeting*

XVI Annual Review Meeting of Network Project on Animal Genetic Resources held on June, 25<sup>th</sup>, 2019 at NASC Complex, New Delhi.



#### *IMC Meeting*

Institute Management Committee meeting was held on 30<sup>th</sup> August 2019. Various agenda items were discussed and approved.



#### *RAC Meeting*

A Meeting of Research Advisory Committee (RAC) of NBAGR was held on September 23-24, 2019 under the Chairmanship of Dr. V. K. Taneja, Former Vice Chancellor, GADVASU, Ludhiana. The members, RAC who attended the meeting were Dr. R. K. Sethi, Former Director, CIRB, Hisar (Haryana); Dr. A. K. Rawa, Director, DBT, New Delhi; Dr. R K Vijn, Director (Acting), ICAR-NBAGR; Dr. R. S. Gandhi, Assistant Director General (AP&B), ICAR, New Delhi; Dr. N. K. Ichhponani, Jagraon, Ludhiana (Punjab) and Dr. N. K. Verma, Principal Scientist & In-charge PME Cell, NBAGR as Member Secretary.



*RAC members interacting with the scientists*

## CELEBRATIONS

### *International Biodiversity Day*

NBAGR celebrated “International Biodiversity Day” on 21-22 May, 2019. During this event Dr. S.L. Goswami, Former Vice Chancellor, Banda University of Ag. & Tech. was the Chief Guest and Dr. Arjava Sharma Former Director of NBAGR, Karnal and Dr. M.S. Chauhan, Director, ICAR-CIRG, Mathura were Guests of Honour Dr. R.K. Vijh, Director of ICAR-NBAGR, Karnal presided over the function. The Chief Guest Dr. S.L. Goswami said that all kinds of biodiversity should be judiciously utilized and conserved. He also emphasized on the need of conservation of domestic animal diversity and all the stakeholders should contribute in this noble cause. A total of 18 farmers/Livestock Keepers from 9 states were awarded with Breed Savior Award-2018 in coordination of SEVA, Madurai.



At the occasion, a poster competition on the subject “Save Biodiversity- Save Earth” was also organized for School Students and Research Scholars of ICAR-NBAGR, Karnal, in which 16 students from 6 schools of Karnal and 11 Research Scholars participated. In the school group, Delhi Public School and Pratap Public School (Main Branch) stood First whereas in the Young Scientist group, the poster of Shilpa Turka was ranked First.



### *Constitution Day*

Constitution Day was celebrated on 26<sup>th</sup> November 2019. At this occasion, the Director, NBAGR read out the Preamble of the Constitution of India. A lecture on “Indian Constitution with special reference to rights and duties of Indian citizens was delivered by Ms. Rashmi Singh, Assistant Professor, Pt. CLS Government College, Karnal.



### *International Yoga Day*

International Yoga Day was celebrated on 21<sup>st</sup> June by organizing a Yoga camp in the bureau





premise ICAR-NBAGR for the staff and their family members. The yoga session was attended by 50 persons, including ladies and children.

## *Independence Day*

The bureau staff and their families celebrated Independence Day in the bureau campus. Dr. RK Vijh, Director NBAGR, hoisted the National Flag and addressed the staff. The wards of staff presented a cultural program.



## *सद्भावना दिवस*

सद्भावना दिवस 20 अगस्त, 2019 को सद्भावना दिवस पर शपथ समारोह का आयोजन किया गया।



## *Institute Foundation Day*

NBAGR celebrated its 36<sup>th</sup> Foundation Day on 21<sup>st</sup> September 2019. Awards were given to the best workers in the technical, administrative and supporting staff categories. Dr PG Nair Award 2018 was given to the scientist for outstanding contribution during 2017-2019 on this occasion.



## *Swachh Bharat Mission*

Under Swachh Bharat Mission "Swachhta hi Sewa (स्वच्छता ही सेवा)" Programme was organized from 25.09.2019 to 02.10.2019 wherein bureau staff participated actively in different cleaning activities.



## *Kisan Divas and Breed Conservation 2019 Award Ceremony*

The ICAR- National bureau of Animal genetic Resources Karnal organized the "Kisan Divas and Breed Conservation Award – 2019 Ceremony on 23<sup>rd</sup> December 2019 to promote individual livestock keeper's /communities/ Institutions engaged in indigenous breed conservation.



Under individual category the winners are Shri Jitendra Singh of Fatehabad (Haryana) for conservation of Sahiwal cattle; Shri Radhe Shyam village: Baragaon, District: Karnal for conserving Barbari goat) and Shri Vasrambhai Sondabhai Bharwad, village- Mota Garadiya, District:

Jamnagar (Gujrat) for conservation of Halari donkey. For institutional category Dr. Thiyam Ranadhir Singh, Department of Ani. Sci, Central Agricultural University Imphal, Imphal West (Manipur) received the award for conservation of Manipuri pony.

## SPORTS

A contingent of 22 players and officials participated in ICAR North Zone Sports Meet – 2019 held at ICAR-Indian Institute of Pulse Research, Kanpur during 12-14 Dec. 2019. The contingent participated in Basket Ball, Volley Ball (smashing & shooting), Cycle race, Carom Board and Chess events. The team of Volley ball (Smashing) and Basket Ball reached up to semi-final round.



## DISTINGUISHED VISITORS

- 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.
- A group of 50 progressive farmers from Omkar Sewa Sansthan, Amethi visited on 15.01.2019.
- The students of B.Sc. (Hons) Botany, Delhi University visited on 21.01.2019.
- Under-Graduate and Post-Graduate students from Ramnarain Ruia Autonomous College, Mumbai visited on 02.02.2019.
- Participants of International Training Programme on "Modern Dairy Technology, Management and Cooperatives" of NDRI, Karnal visited on 14.02.2019.
- 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.
- 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.
- A group of 50 B. Sc. Agril. (Hons.) students from Eternal University, Baru Sahib, Himachal Pradesh visited on 26.04.2019.



- A group of 50 B. Sc. Agril. students from College of Agriculture, Kaul Campus, CCSHAU, Kaul visited on 31.08.2019.
- A group of students from Beanstalk World pre and Junior School, Karnal visited on 13.09.2019.
- The participants of Model Training Course on “Advancements in soil, water and plant analysis techniques using sophisticated equipment with respect to salinity and sodicity management” from ICAR-CSSRI, Karnal visited on 20.09.2019.
- A group of 55 B.V.Sc & A.H. students from Post Graduate Institute of Veterinary Education and Research, Jaipur visited on 14.10.2019.
- A group of 25 officers from Directorate of Clinics, KVASU, Pookode, Lakkidi (Wayanad), Kerala visited on 31.10.2019.
- The participants of International Training programme on “Use of Poor Quality Water in Agriculture” from ICAR-CSSRI, Karnal visited on 26.10.2019.
- The students from Vidyanjali Preschool, Karnal visited on 08.11.2019.
- Sh. Sanjay Bhatia, Hon’ble Member Parliament, Karnal visited on 18.12.2019.
- A group of 36 B.V.Sc.&AH students from Tamil Nadu Veterinary and Animal Sciences University, Veterinary College and Research Institute, Orathanadu, Thanjavur visited on 22.12.2019.





## PERSONNEL

STAFF



JOINING/PROMOTION/TRANSFER/RESIGNATION



SUPERANNUATION

## STAFF

### *Scientific Staff*

| Sr. No. | Name of Scientist         | Designation                             |
|---------|---------------------------|---|
| 1.      | Dr. R.K. Vijh             | Principal Scientist & Director (Acting) |
| 2.      | Dr. Anand Jain            | Principal Scientist                     |
| 3.      | Dr. M.S. Tania            | Principal Scientist                     |
| 4.      | Dr. P.K. Vij              | Principal Scientist                     |
| 5.      | Dr. N. K. Verma           | Principal Scientist                     |
| 6.      | Dr. R.A.K. Aggarwal       | Principal Scientist                     |
| 7.      | Dr. P.K. Singh            | Principal Scientist                     |
| 8.      | Dr. R.K. Pundir           | Principal Scientist                     |
| 9.      | Dr. R.S. Kataria          | Principal Scientist                     |
| 10.     | Dr. Anil Kumar Mishra     | Principal Scientist                     |
| 11.     | Dr. Monika Sodhi          | Principal Scientist                     |
| 12.     | Dr. Satpal Dixit          | Principal Scientist                     |
| 13.     | Dr. Jyotsna Behl          | Principal Scientist                     |
| 14.     | Dr. Dinesh Kumar Yadav    | Principal Scientist                     |
| 15.     | Dr. Reena Arora           | Principal Scientist                     |
| 16.     | Dr. Manishi Mukesh        | Principal Scientist & National Fellow   |
| 17.     | Dr. Avnish Kumar          | Principal Scientist                     |
| 18.     | Dr. Rahul Behl            | Principal Scientist                     |
| 19.     | Dr. Rekha Sharma          | Principal Scientist                     |
| 20.     | Dr. Saket Kumar Niranjana | Principal Scientist                     |
| 21.     | Dr. Indrajit Ganguly      | Principal Scientist                     |
| 22.     | Dr. Sanjeev Singh         | Principal Scientist                     |
| 23.     | Dr. Karan Veer Singh      | Senior Scientist                        |
| 24.     | Dr. Raja K.N.             | Senior Scientist                        |
| 25.     | Dr. Jayakumar S.          | Senior Scientist                        |
| 26.     | Dr. Sonika Ahlawat        | Scientist (S.S)                         |
| 27.     | Dr. Dige Mahesh Shivanand | Scientist                               |
| 28.     | Dr. Soumya Dash           | Scientist                               |
| 29.     | Dr. Amod Kumar            | Scientist                               |

## Technical Staff

| Sr. No. | Name of Officer/Official | Designation                                       |
|---------|--------------------------|---|
| 1.      | Dr. P. S. Dangi          | Chief Technical Officer                           |
| 2.      | Sh. S. K. Jain           | Chief Technical Officer                           |
| 3.      | Dr. P. S. Panwar         | Assistant Chief Technical Officer (upto 24.06.19) |
| 4.      | Sh. Sanjeev Mathur       | Assistant Chief Technical Officer                 |
| 5.      | Sh. Harvinder Singh      | Senior Technical Officer                          |
| 6.      | Sh. Naresh Kumar         | Senior Technical Officer                          |
| 7.      | Sh. Satpal               | Technical Officer                                 |
| 8.      | Sh. Jamer Singh          | Technical Officer                                 |
| 9.      | Smt. Pravesh Kumari      | 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         | Technical Officer                                 |
| 15.     | Sh. Balwinder Singh      | Technical Assistant (Driver)                      |

## Administrative Staff

| Sr. No. | Name of Officer/Official | Designation                                      |
|---------|--------------------------|--|
| 1.      | Sh. Raj Kumar            | Administrative Officer                           |
| 2.      | Sh. T.C. Sharma          | Finance & Accounts Officer                       |
| 3.      | Sh. Karambir             | PS to Director                                   |
| 4.      | Sh. Pawan Kumar Gupta    | Assistant Finance & Accounts Officer             |
| 5.      | Sh. Balkar Singh         | Assistant Administrative Officer (upto 04.08.19) |
| 6.      | Sh. Ramesh Behl          | Assistant Administrative Officer                 |
| 7.      | Smt. Anita Chanda        | Personal Assistant                               |
| 8.      | Smt. Amita Kumari        | Personal Assistant                               |
| 9.      | Smt. Indu Bala           | Steno Grade III                                  |
| 10.     | Smt. Shashi Bala         | Assistant  |
| 11.     | Sh. Jita Ram             | Assistant  |
| 12.     | Sh. Yoginder             | Assistant  |
| 13.     | Sh. Satish Kumar         | Assistant  |
| 14.     | Sh. Shiv Chander         | Upper Division Clerk                             |
| 15.     | Smt. Neerja Kaul         | Lower Division Clerk                             |
| 16.     | Sh. Naresh Kumar         | Lower Division Clerk                             |
| 17.     | Sh. Babu Ram             | Lower Division Clerk                             |

## Skilled Support Staff

| Sr. No. | Name of Official | Designation           |
|---------|------------------|-----------------------|
| 1.      | Sh. Krishan Lal  | Skilled Support Staff |
| 2.      | Sh. Ram Sagar    | Skilled Support Staff |
| 3.      | Sh. Deepak       | Skilled Support Staff |
| 4.      | Sh. Satbir       | Skilled Support Staff |



## JOINING/PROMOTION/TRANSFER/RESIGNATION

### Joining

- Dr. R.K. Vijh, Principal Scientist took over acting charge of the post of Director, NBAGR w.e.f. 30.01.2019 (AN).
- Sh. T.C. Sharma, F&AO joined on 11.03.2019 on transfer from ICAR- IIFSR, Modipuram, Meerut.
- Dr. Soumya Dash, Scientist joined on 25.11.2019 on transfer from ICAR-CIRB, Hisar.
- Dr. Amod Kumar, Scientist joined on 29.11.2019 on transfer from ICAR-CIRC, Meerut.
- Dr. Dige Mahesh Shivanand, Scientist joined on 03.12.2019 on transfer from ICAR-CIRG, Mathura.

- Shri Ramesh Behl promoted to the post of Assistant Administrative Officer w.e.f. 07.08.2019 (AN).
- Shri Satish Kumar promoted to the post of Assistant w.e.f. 08.08.2019 (AN).

### Resignation

- Resignation tendered by Dr. P. Kathiravan, Senior Scientist (AGB) from the Council's service accepted w.e.f. 10.09.2011 vide Office Order No. 1-65/05-Estt./2585-86 dated 02.01.2019.
- Technical resignation tendered by Dr. P.S. Panwar, ACTO from the Council's service accepted w.e.f. the afternoon of 24.06.2019 vide Office Order No. 1-80/98-Estt. dated 24.06.2019

### Transfer

- Shri Sunil Kumar, F&AO transferred to CSSRI, Karnal on 06.03.2019.

### Promotion

- Shri Naresh Kumar promoted to the next higher grade of T-6 Senior Technical Officer w.e.f. 16.03.2018.



## SUPERANNUATION

- Shri Balkar Singh, AAO retired voluntarily w.e.f. the forenoon of 4.8.2019.



### हिन्दी बैठकें

- संस्थान में राजभाषा के प्रयोग व प्रचार-प्रसार की समीक्षा के लिए संस्थान राजभाषा कार्यान्वयन समिति की तिमाही हिंदी बैठकों का आयोजन किया जाता है। इस अवधि के दौरान इन बैठकों का आयोजन दिनांक 26-02-2019, 1-07-2019, 28-10-2019 को किया गया।
- पशुधन प्रकाश के संपादक मंडल की बैठक मुख्य संपादक डॉ. मोनिका सोदी, प्रधान वैज्ञानिक की अध्यक्षता में दिनांक 29-07-2019 को आयोजित की गई जिसमें पशुधन प्रकाश पत्रिका के दशम अंक के प्रकाशन संबंधी बिन्दुओं पर चर्चा की गई।

### हिंदी चेतना माह - सितंबर 2019 का आयोजन

प्रत्येक वर्ष की भांति इस वर्ष भी संस्थान में सितम्बर माह को “हिंदी चेतना माह - सितंबर 2019” के रूप में मनाया गया। कार्यक्रम के आयोजन हेतु निदेशक महोदय की स्वीकृति से आयोजन समिति का गठन किया गया जिसके अध्यक्ष डॉ. अनिल कुमार मिश्र; डॉ. रेखा शर्मा; सदस्य तथा श्री सतपाल, सदस्य सचिव बनाये गए। इस अवधि में हिंदी भाषा के प्रचार-प्रसार एवं इसके राजकीय कार्यों में प्रयोग को बल देने के लिए कई प्रेरणात्मक व ज्ञानवर्धक प्रतियोगिताएँ करवाई गईं। इनमें हिंदी निबंध, पत्र लेखन, टिप्पणी/मसौदा लेखन, शब्दार्थ/ अनुवाद, भाषण एवं आशु भाषण प्रतियोगिताएं आयोजित की गईं। वैज्ञानिकों के लिए हिंदी शोध लेख पोस्टर प्रतियोगिता का आयोजन किया गया। सभी प्रतियोगिताओं में विजेता प्रतिभागियों को संस्थान के स्थापना दिवस के सुअवसर पर दिनांक 21-9-19 को नकद पुरस्कारों से सम्मानित किया गया। वैज्ञानिकों सहित स्टाफ सदस्यों ने इसमें बढ़-चढ़कर भाग लिया। संस्थान में आयोजित किये गए हिंदी चेतना माह की विस्तृत रिपोर्ट निम्नानुसार है:

दिनांक 02-9-2019 को “शहर में घुमने वाले बेसहारा गोवंश से अनुभव की जाने वाली कठिनाइयों की तरफ ध्यान आकर्षित



करते हुए इनके पुनर्वास हेतु सुप्रबंध करके इनसे लाभ प्राप्त करने के सुझावों सहित नगर निगम आयुक्त को अनुरोध पत्र” विषय पर एक हिंदी पत्र लेखन प्रतियोगिता का आयोजन किया गया। इस प्रतियोगिता में संस्थान वैज्ञानिकों सहित कुल 18 प्रतिभागियों ने भाग लिया। इस प्रतियोगिता में प्रथम स्थान पर डॉ. सोनिका अहलावत, द्वितीय स्थान पर संयुक्त रूप से श्री राकेश कुमार एवं श्री कर्मबीर मलिक तथा तृतीय स्थान पर श्रीमती अनीता चंदा और प्रोत्साहन पुरस्कार कु. स्वाति रुल्यान ने प्राप्त किया।

दिनांक 04-9-2019 को एक हिंदी निबन्ध लेखन प्रतियोगिता का आयोजन किया गया जिसका विषय “देशी पशुधन-किसानों की आय में वृद्धि का एक बेहतर विकल्प” रखा गया था। इस प्रतियोगिता में संस्थान वैज्ञानिकों सहित कुल 14 प्रतिभागियों ने भाग लिया। इस प्रतियोगिता में प्रथम स्थान पर डॉ. सोनिका अहलावत, द्वितीय स्थान पर श्री कर्मबीर मलिक तथा तृतीय स्थान पर श्री विशाल शर्मा रहे और प्रोत्साहन पुरस्कार श्री अरुण कुमार सिंह ने प्राप्त किया।

दिनांक 06-9-2019 को एक हिंदी में टिप्पणी व मसौदा लेखन प्रतियोगिता का आयोजन किया गया जिसका विषय “संस्थान में पात्र तकनीकी अधिकारी की पदोन्नति हेतु टिप्पणी लिखकर निदेशक महोदय से स्वीकृति प्राप्त करके नामित करवाए गए विशेषज्ञ को तय की गई दिनांक पर आमंत्रित करने हेतु पत्र का मसौदा तैयार करें” रखा गया था। इस प्रतियोगिता में संस्थान वैज्ञानिकों सहित कुल 8 प्रतिभागियों ने भाग लिया। इस प्रतियोगिता में प्रथम स्थान पर श्री कर्मबीर मलिक तथा द्वितीय स्थान पर श्रीमती अनीता चंदा और तृतीय स्थान पर श्रीमती अमिता कुमारी रही एवं प्रोत्साहन पुरस्कार डॉ. रणजीत सिंह कटारिया ने प्राप्त किया।

दिनांक 09-9-2019 को शब्दार्थ एवं अनुवाद प्रतियोगिता का आयोजन किया गया। इस प्रतियोगिता में संस्थान वैज्ञानिकों सहित कुल 15 प्रतिभागियों ने भाग लिया। इस प्रतियोगिता में प्रथम स्थान पर श्रीमती अनीता चंदा द्वितीय स्थान पर श्री प्रिंस विवेक तथा तृतीय स्थान पर श्री विशाल शर्मा रहे और प्रोत्साहन पुरस्कार श्री अरुण कुमार सिंह ने प्राप्त किया।

मौखिक प्रतियोगिताओं की श्रृंखला में दिनांक 12-9-2019 को एक हिंदी भाषण प्रतियोगिता का आयोजन किया गया जिसका विषय “पानी के संकट से लड़ने की तैयारी-जल शक्ति अभियान” रखा गया था। इस प्रतियोगिता में संस्थान वैज्ञानिकों सहित कुल 10 प्रतिभागियों ने भाग लिया। इस प्रतियोगिता में प्रथम स्थान पर डॉ. सोनिका अहलावत, द्वितीय स्थान पर श्रीमती अनीता

चंदा, तृतीय स्थान पर डॉ. करणवीर सिंह रहे और प्रोत्साहन पुरस्कार कु. स्वाति रुल्यान ने प्राप्त किया।

मौखिक प्रतियोगिता के अंतर्गत ही दिनांक 16-9-2019 को एक हिंदी आशु-भाषण प्रतियोगिता का आयोजन किया गया जिसमें छायाचित्रों के क्लिप दिखाकर प्रतिभागियों को विषय के अनुरूप बोलने के लिए कहा गया। प्रतियोगिता में संस्थान वैज्ञानिकों सहित कुल 10 प्रतिभागियों ने भाग लिया। इस प्रतियोगिता में प्रथम स्थान पर डॉ. करणवीर सिंह, द्वितीय स्थान पर श्रीमती अनीता चंदा, तृतीय स्थान पर डॉ. अरुण कुमार रहे और प्रोत्साहन पुरस्कार श्रीमती भारती ने प्राप्त किया।

संस्थान के वैज्ञानिकों को हिंदी भाषा में राजकीय कार्य करने हेतु प्रोत्साहित करने के लिए दिनांक 18-9-2019 को एक हिंदी शोध लेख पोस्टर प्रतियोगिता का आयोजन किया गया जिसमें प्रयोगशाला में पूर्व तीन वर्षों के दौरान किये गए शोध कार्य को आधार बनाया गया था। इस प्रतियोगिता में प्रथम स्थान पर डॉ. मनदीप कौर एवं सहयोगी, द्वितीय स्थान पर संयुक्त रूप से विशाल शर्मा तथा शुभम लोट एवं सहयोगी रहे और प्रोत्साहन पुरस्कार कु. याशिका एवं सहयोगियों ने प्राप्त किया।

वर्ष 2018-19 के दौरान सर्वाधिक हिंदी में कार्य करने वाले कार्मिकों में से उत्कृष्ट हिंदी कार्मिक के चयन की प्रतियोगिता दिनांक 19-9-2019 को करवाई गई थी। निदेशक महोदय द्वारा गठित समिति द्वारा प्रतिभागियों के द्वारा किये गए हिंदी कार्य का मूल्यांकन किया गया। प्राप्त अंकों के आधार पर पर्थ स्थान पर श्री सतीश कुमार, द्वितीय स्थान पर श्री बाबु राम तृतीय स्थान पर श्री नरेश नरवाल रहे और प्रोत्साहन पुरस्कार श्रीमती शशी बाला ने प्राप्त किया।

### राजभाषा पुरस्कार वितरण समारोह

दिनांक 21-9-2019 को संस्थान के स्थापना दिवस समारोह के शुभ अवसर पर विजेताओं को नकद पुरस्कारों से सम्मानित किया गया। इस अवसर पर मुख्य अतिथि के रूप में डॉ. एस.एल. गोस्वामी पूर्व कुलपति बाँदा कृषि एवं प्रौद्योगिकी वि.वि. बाँदा (उ.प्र.) उपस्थित रहे। विशिष्ट अतिथियों में श्री राकेश कुमार कुशवाहा, सचिव नराकास शामिल रहे।

### “पशुधन प्रकाश” के नवम अंक (2018) के पुरस्कार

- प्रथम पुरस्कार : गौशालाओं के माध्यम से गाय की नस्लों का संरक्षण एवं सतत विकास, अनिल कुमार मिश्र, राकेश पुंडीर, प्रमोद कुमार सिंह, के.एन.राजा, आर्जव शर्मा. भाकृअनुप-राष्ट्रीय पशु आनुवंशिक संसाधन ब्यूरो, करनाल।

- द्वितीय पुरस्कार : भारवाहक अश्वजातीय पशु: एक उपेक्षित आनुवंशिक संसाधन
- हिमानी शर्मा, रेखा शर्मा, सोनिका अहलावत एवं एम.एस. टांटिया।
- भाकृअनुप-राष्ट्रीय पशु आनुवंशिक संसाधन ब्यूरो, करनाल।
- तृतीय पुरस्कार : किसानों की आय दुगुनी करने का लक्ष्य: पशुधन की भूमिका
- सत्येन्द्र पाल सिंह एवं रश्मि सिंह, रा.वि.रा. सिंधिया कृषि वि.वि., केवीके, मुरैना।

### वार्षिक हिंदी पत्रिका पशुधन प्रकाश का विमोचन

दिनांक 21-9-2019 को संस्थान के स्थापना दिवस समारोह के शुभ अवसर पर संस्थान की वार्षिक हिंदी पत्रिका “पशुधन प्रकाश” के दसवें अंक (वर्ष-2019) का विमोचन माननीय मुख्य अतिथि के कर कमलों से करवाया गया। इस अवसर पर मुख्य अतिथि डॉ. एस.एल. गोस्वामी, संस्थान निदेशक डॉ. रमेश कुमार विज, पूर्व निदेशक डॉ. आर. सहाय, श्री राकेश कुमार कुशवाहा, सचिव नराकास तथा पत्रिका के संपादक मंडल के सदस्य उपस्थित रहे।



### उपलब्धियाँ

नगर राजभाषा कार्यान्वयन समिति करनाल की 69वीं छमाही बैठक दिनांक 20-6-2019 को वर्ष 2018-19 के दौरान हिंदी में उत्कृष्ट कार्यों के लिए संस्थान को द्वितीय पुरस्कार प्रदान किया गया।

नगर राजभाषा कार्यान्वयन समिति करनाल के द्वारा 15-11-2019 को छमाही बैठक के दौरान श्री सतपाल को वर्ष 2018-19 के दौरान हिंदी में उत्कृष्ट कार्यों के लिए “करनाल राजभाषा गौरव” पुरस्कार से सम्मानित किया गया।





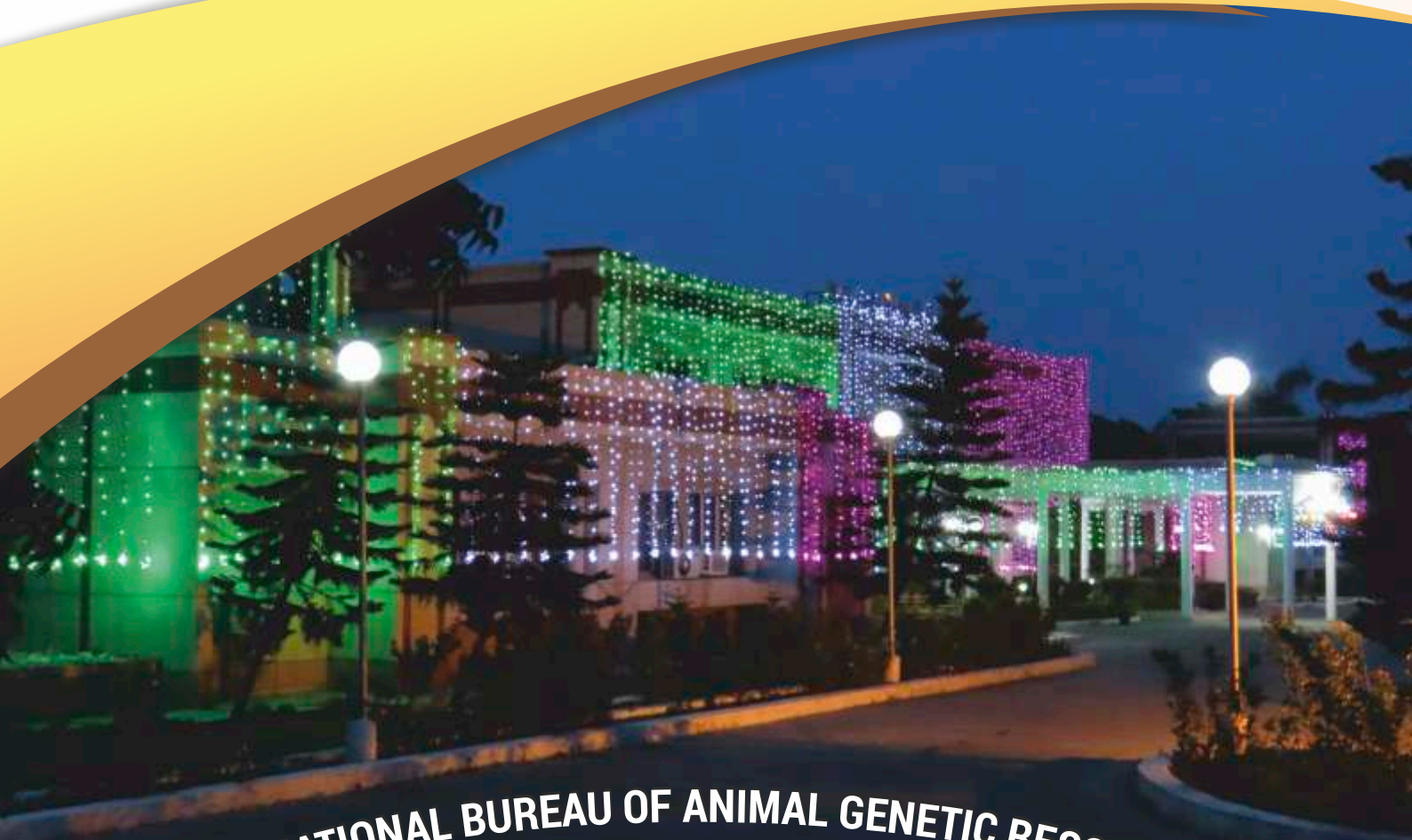
हर कदम, हर डगर  
किसानों का हमसफर  
भारतीय कृषि अनुसंधान परिषद

*Agr*search with a human touch

कुछ सपने पूरे करने हैं, कुछ वादे और निभाना है।  
कदम - कदम चल कर के, कुछ और मंजिलें पाना है ॥  
अभी तो सफर शुरू हुआ है, इन मंजिलों को पाने के लिए,  
मुझे यूँ ही बस चलना है, और बहुत दूर तक जाना है ॥







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

*(An ISO 9001:2015 Certified Institute)*

G.T. Road By-Pass, Near Basant Vihar, Karnal-132 001 (Haryana) India

Phone: 0184-2267918 (O), Fax: 0184-2267654

E-mail: [director.nbagr@icar.gov.in](mailto:director.nbagr@icar.gov.in); [directornbagr@gmail.com](mailto:directornbagr@gmail.com)

Website: [www.nbagr.res.in](http://www.nbagr.res.in)