Annual Report

2017-18

भाकृअनुप
ICAR

ICAR-Central Institute for Research on Buffaloes

Hisar – 125001 (Haryana)

भाकृअनुप • केन्द्रीय भैंस अनुसंधान संस्थान • हिसार
ICAR • CENTRAL INSTITUTE FOR RESEARCH ON BUFFALOES

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Hisar - 125 001 (Haryana) India

The achievements and activities of the Institute from April 2017 to to March 2018 are presented in this report.

Cover Image Concept : ICAR-CIRB encourages adaptive behavioral trait of wallowing in water to maintain physiological homeostasis in buffaloes.

Contents

Sach-Gaurav
with
Surrogate Dam

PREFACE

The ICAR-Central Institute for Research on Buffaloes, is privileged to be addressing the single most important agricultural commodity that is a towering contributor to the national GDP, 'Buffalo - the Black Gold'. In consonance with the immense contributions of the species, the institute geared-up to address the concerns of farmers through accelerated research efforts, wider international recognition, best-ever herd performances and deeper penetration in the stakeholders, thereby attaining a place of pride in the 'buffalo world'. The IX Asian Buffalo Congress delegates; not only from Asian but also from North and South American, European and African countries; witnessed the quality research output of motivated scientists and young researchers emanating out of the well-equipped laboratories laid in serene ambience of the institute. International delegates cherished institute's superior Murrah germplasm, housed in modern and comfortable housing facilities, as well as Champion animals of the farmers – show-casing the superiority of Indian buffalo.

Research in the strategic area of genomic selection was carried forward with genotyping of all bulls under different breeding sets of Network Project on Buffalo Improvement (NPBI) since 1993. Training by internationally acclaimed experts in genomic selection and animal breeding benefitted the faculty and scientists from universities and research institutes. Increased frozen semen stock from progeny tested and test bulls of Murrah, Nili-Ravi, Surti, Jaffarabadi and Pandharpuri breeds is a rare treasure. A new center on Nili-Ravi breed was added at GADVASU, Ludhiana, while existing centers of Murrah and other breeds were further strengthened. For the first time, life-time performance traits of dams were calculated to be used in the selection of the best performers for pedigree selection. Improved germplasm of Murrah and Nili-Ravi breeds was reflected through best-ever wet averages and individual animals crossing standard lactation yields of 4000Kg. The surplus elite Murrah and Nili Ravi bulls and quality frozen semen doses were disseminated for breeding purposes across the country.

Success of cloning was replicated in the field with the birth of a clone of Assamese buffalo at Hi-Tech Sach Dairy, Sirsa. Somatic cells of an Assamese buffalo bull collected from Assam, were transported to CIRB lab over a distance of 2000 KM and a cloned embryo thus developed was transferred to a pure Murrah buffalo at Sirsa - about 100 KM away, leading to the birth of Assamese buffalo male clone calf. At the same time, the first CIRB cloned Murrah calf 'Hisar Gaurav' attained adulthood and started donating high quality semen, that was successfully frozen and used for AI with high conception rates. In addition, the institute got National Agricultural Science Fund (NASF) approval for a project aiming to produce multiple copies of superior buffalo bulls through cloning. Success was also achieved in production of transgenic embryos upto morula and blastocyst stages. New semen cryopreservation cocktails were tested and refined for incorporation in routine semen freezing activities. Research efforts in the field of estrus and pregnancy detection as well as the manipulation of ovarian function continued in the quest for reliable methodologies applicable at field level.

Ruminal microflora alteration with special feed additives helped to reduce methane producing bacterial population without affecting hydrogen sink, thereby improving nutritive efficiency for higher growth and milk production. Patenting, besides third party validation of the technology, are in progress. The institute rendered its expertise to sister ICAR Institute ICAR-IIMR, Hyderabad for assessing nutritional quality of various sorghum cultivars. Nutrition-reproduction interaction, climate change and bioinformatics are some of the other research interests being pursued currently at the institute.

The institute reinforced the connect with stakeholders through extension activities, prominent being ICT applications like E-bhains Gyan Kendra, You-Tube channel, Facebook group and Buffalopedia, which have become hugely

popular among farmers worldwide. Convergence with similarly mandated agencies in outreach programs like Farmer First, MGMG, TSP and FPT remained important in making further inroads deep into the specific rural communities. Showcasing institute technologies and extension advisories through Krishi Melas in different parts of the country helped us reach the remotest farmers from different states. Regular monthly off and on campus trainings helped apprise farmers about scientific buffalo husbandry for greater productivity and profitability. The trainings have become popular amongst farmers from across the country and attended by farmers from other state as well. Towards realizing the target of 'Doubling Farmers' Income', a workshop with progressive farmers, SAUs, Farmers' Commission and line departments helped outline the ground-level priorities, which got reflected in the state policy document.

With this annual report, I shall be completing my tenure of 5 years as Director at the institute and feel contended with the achievements in terms of the numbers and quality of research publications, the increasing numbers of externally funded projects, more post-graduates attracted, outstanding herd performances setting new records every passing year, ushering in greater productivity per unit of land cultivated for green fodder and grains as well as more than doubling the revenue generation that even surpassed the Plan funds allocation. All this would not have been possible without the trustworthy support of the ICAR headquarters, the Hon'ble Director Generals, Deputy Director Generals, ADGs and scientists of the ICAR and my CIRB colleague scientists, technical officers, office and supporting staff as well as research students. The stronger connect and generous faith reposed by the farmers in our activities, made our efforts relentless, tireless and a pleasure to serve both the stakeholders as well as the 'Black Beauty' of this country.

Jai Hind

Inderjeet Singh

Executive Summary

- ICAR-Central Institute for Research on Buffaloes (CIRB) was established in 1985 and its sub-campus was added in December, 1987 at Bir Dosanjh, Nabha, District Patiala, Punjab. The main campus has established a highly pedigreed breeding herd of Murrah while Nili-Ravi buffaloes at sub campus.
- ICAR-CIRB is an ISO 9001:2008 (Certificate No. BN16070/15880) certified institution.
- Achieved highest ever wet average (8.71kg/d; n=115); herd average (5.90kg/d; n=168) and average peak yield (12.74kg; n=140) and second lowest ever AFC (43.58 months; n=67) in Murrah herd.
- First time in the history of CIRB two Murrah buffaloes crossed 4000 kg in lactation. Buffalo no. 4316 and 4462 recorded 4063 kg and 4045 kg, respectively in 305 days.
- Recorded highest ever single day milk yield of 23.4kg (buffalo no. 4462) since inception of the institute. Beside, buffalo no. 4251 produced 22.0 kg (16/02/18) and 4316 yielded 22.1kg (23/03/18) in a single day.
- At Nabha sub-campus, highest ever wet average of 8.52 kg was recorded. Also, highest ever average peak milk yield of 12.70 kg was recorded.
- Herd Life Production (up to 4th and above Lactation) of 34 buffaloes was also estimated for the first time. The average productive days were 1320 and average milk yield per day of herd life was 3.5 litres.
- A total of 54 breeding Murrah bulls and 11 Nili-Ravi breeding bulls were sold to developmental agencies, breeders, panchayats and progressive farmers. 204075 Murrah and 13500 Nili-Ravi semen doses were frozen out of which 126426 Murrah and 3925 Nili-Ravi semen straw were sold in the field for insemination.
- Fifteen bulls of XVI set were test mated and 16 bulls selected for XVII set for test mating under progeny testing.
- 4093 AI using 16 test bulls of XVII set were performed in 10 adopted villages. The conception rate in field was 54.46%. 2229 pregnancies were confirmed and 1593 calving (794 males, 799 females) were recorded. The average age at first calving for 140 daughters was 43.58 months.
- As on 31st March 2018, more than1288 female progenies of XIII to XVI set of different age are standing at various field unit centres for future recordings.
- The overall wet average (8.71 kg), herd average (5.90 kg), 305 days lactation milk (2424 kg), total lactation milk yield (2480 kg), peak yield (12.74 kg) and lactation length (295 days) were achieved in Murrah herd.
- The overall wet average (8.52 kg), herd average (5.84 kg), 305 days lactation milk (2321kg), total lactation milk yield (2363), peak yield (12.70 kg) and lactation length (282 days) were achieved in Nili-Ravi herd.
- The reproductive traits such as service period, calving interval and age at first calving were 167 and 135 days, 478 and 444 days, and 43.58 and 41.15 months for Murrah and Nili-Ravi herds, respectively.
- Hisar Gaurav, first clone bull born at this institute started donating semen at the age of 22 months. Seventeen pregnancies have been established out of 34 AIs in field with cloned bull semen. Growth and physiological status of clone bull are normal.
- Another clone Sach-Gaurav is an assamese buffalo clone produced in field. Donor tail cells were airlifted from Veterinary College, Khanapara, Guwahati and embryo produced was transferred to Murrah buffalo in the field.
- GFP expressed cells were enriched by selective single cells culture method and used as donor cells in handmade cloning and these cells are able to support the generation of transgenic embryos upto morula and blastocyst stage.
- 14 primary somatic cell lines of buffalo including three cell lines from the assamese buffalo were characterized and preserved under liquid nitrogen for long term storage and future applications as a bio-bank.
- Induced pluripotent stem cells were generated from buffalo fetal fibroblasts using transposon system which can survive upto 15 passages in feeder free culture condition. The generated buffalo iPS cells expressed alkaline phosphatase, cell surface antigen, SSEA-1, SSEA-4 and SSEA-5 and

transcription based marker genes and formed embryoid bodies representing three germ layers.

- Fetal fibroblasts transfected with pT2CAGGS-Venus and pCMV-SB100X could be used as donor cells for buffalo cloning and that Venus gene can be used as a marker of foreign genes in buffalo transgenesis.
- Successfully produced healthy in-vitro derived buffalo embryos. Differential staining of hatched blastocysts revealed 34.5% cells representing inner cell mass and rest 65.5% trophectoderm cells.
- Estrus induction rate was highest with progesterone implants as compared to GnRH based protocols. Also, conception rates were highest on fixed time insemination using progesterone implants in anoestrus buffaloes.
- Single prostaglandin injection was good for induction of oestrus as well as conception rates in silent oestrus buffaloes.
- Two third of the buffaloes express 'Doka' with average duration of 4.74+0.23 days of which majority exhibited estrus two days post disappearance of the phenomenon. Also it was observed that 'Doka' is fully exhibited ~5 hours after complete milking. Concentration of PGFM in 'Doka' expressing buffaloes was higher.
- Buffalo sperm viability and post thaw motility were improved by the supplementation of IGF1 @ 250 ng/ml in buffalo bull semen extender.
- Addition of Mifepristone (RU 486) to buffalo semen prevented cholesterol efflux and protect plasma membrane integrity that increased the ability of sperm to withstand stress imposed by cryopreservation.
- A composite feed additive (CFA) reduces methanogenic archaeal population without affecting total bacterial inhabitants with improvement in alternate H2 sink bacterial population in rumen. CFA reduces ammonia emission from rumen thus improves nitrogen utilization efficiency, improvement in digestibility of all the nutrients including dietary fibre and also contribute to environment friendly animal farming. Furthermore, methane concentration in exhaled air was reduced by 75% and 45% in growing buffalo calves and lactating buffaloes, respectively. It is capable of improving growth rate by 10% and feed conversion efficiency by 15% in buffalo calves. It improves milk production (FCM) by 10.42%.
- Supplementation of Eucalyptus and Poplar leaves based feed additive rich in essential oils decreased methane concentration in exhaled air to half as compared to control without affecting nutrients intake and their utilization after three months of feeding.
- Brown midrib sorghum cultivar (SPV-2018) low in fibre and lignin contents showed higher in vitro gas production, DM degradability and VFA production.
- Feeding of the additive blend to growing buffaloes resulted in 14% increase in average daily gain in BW with improvement of feed and protein utilization without affecting feed digestibility or blood biochemical parameters.
- Dietary supplementation of rumen protected methionine, lysine and choline increased nutrient utilization in terms of DM, CP and OM digestibilities.
- Inclusion of chelated copper, manganese and zinc in mineral mixture reduced the requirement of these elements upto half compared to that of their inorganic counterparts.
- Micronutrient (Zn, Cu, Co, Cr, Se, vitamin E, vitamin A, and niacin) supplementation improved production performance of Murrah buffaloes in terms of total milk (18%) and fat corrected milk production in addition to improvement in fat and protein percentage of milk without affecting reproductive performance, blood biochemical and micronutrient profile, except increase in plasma inorganic phosphorus level on the day of parturition.
- Supplementing anionic salt before calving followed by cationic salt postpartum increased dry matter intake during postpartum period and milk fat during initial six weeks.
- Model of convergence was developed by delineating the role of each agency. Participating agencies that could collaborate for sensitizing the farmers on clean milk production were identified along with their roles and expectation from each other.
- Under Farmer First program, three villages were adopted and sixty five honeybee units were established after identifying the feasibility with livestock rearing to increase the farmers' income. Under the program 94 buffaloes were treated for mastitis and 66 AIs were conducted in the adopted villages.
- Under Tribal Sub-Plan, 3 trainings were provided to 311 tribal farmers on buffalo husbandry in three TSP adopted villages of Tehsil Slumber, Distt. Udaipur

(Rajasthan). 500 frozen semen doses were provided to govt. veterinary hospitals. Distributed 80qntls concentrate mixtures and 15 qntls mineral mixture specific to their area. In addition, more than 20qntls seeds of maize, sorghum and moong were distributed.

- A workshop was also conducted on doubling the income of farmers on June 20, 2017 for various stakeholders of agriculture and dairy development like CIRB, CCSHAU Hisar, LUVAS Hisar, HLDB, Nationalized banks, ATMA, DRDA etc. Besides, 60 farmers excelling in the fields of agriculture, dairy, fisheries, horticulture, bee keeping etc. also participated in the event.
- Buffalo mela was organized at the institute on February 04, 2018 in which about 100 elite and prize winning animals participated. The animals included buffalo bulls, lactating and dry buffaloes from all over Haryana and adjoining states.
- Fifteen trainings were organised on improved buffalo husbandry and related aspects covering 1211 farmers and farm women. Ten (08 at main institute, 02 at sub campus and 5 in village) farmers trainings each of 07 days duration were organised on improved buffalo husbandry and related aspects benefitting 692 farmers, youth and women. Five off campus trainings in villages for 519 farmers were organised on scientific nutritional and management practices and improved buffalo farming.
- Five infertility camps were conducted in different villages covering Haryana and Rajasthan treating 115 infertile buffaloes.
- 67 field buffaloes were recorded at the institute premises and a database of 100 farmers was prepared and uploaded on the institute website.
- The institute participated in 9 melas organized in different parts of the country by putting up a stall. Queries of large number of farmers were answered on these occasions.
- Under 'Mera Gaon Mera Gaurav' scheme, 30 villages were adopted by 07 teams covering 06 districts of three states including Haryana, Rajasthan and Punjab. A total of 51 visits were made for goshtis and interface meetings to villages benefiting 2873 farmers.
- Speech of Hon'ble PM Narender Modi in the Krishi Unnati Mela held at IARI, PUSA Campus, New Delhi was broadcasted on March 17, 2018 at the institute in which more than 400 farmers from three different states participated. The function was also graced by Sh. Mahavir Singh Phogat, a National Arjun awardee Wrestler.
- IX Asian buffalo Congress was organized at the institute main campus, Hisar on February 1-4, 2018, participated by 213 delegates (46 foreigners) from across the globe-Sri Lanka, Bangladesh, Nepal, Brazil, Bulgaria, Columbia, Italy, Philippines, Nigeria, Guatemala, USA, UK and India. On the last day a buffalo show with "ramp walk" of prize winning animals of previous years was arranged.
- A training course on “Animal breeding data analysis and genomic prediction” was organized at ICAR-CIRB during November 22-24, 2017 as a capacity building programme of CIRB-ILRI project. 17 participants from SAUs, ICAR institutes and other organizations covering 8 states attended the training.
- Two model training courses sponsored by Directorate of Extension, MoA & FW, New Delhi were organized at the institute on “Modern dairy farm management: production, reproduction, health and nutrition” (26 participants) and “Climate smart buffalo husbandry” (25 participants) on October 9-17 and November 13-20, 2017, respectively.
- Brainstorming workshop on NPBI on “Data tabulation and Presentation” was organized on October 24, 2017 in which PIs of the participating centres attended.
- Training on practical embryology was imparted at the institute from July 24-28, 2017 to a medical professional.
- Organized Interactive meet on “Breed Characters of Nili-Ravi Buffaloes and Its development in Home Tract” on 16th December, 2017 at Ferozepur (Punjab).
- Institute celebrated Agriculture Education Day on December 03, 2017 for promoting the agriculture and allied subjects among the students in one of the adopted villages.
- Thirty research papers from studies carried out at CIRB and 15 research papers from studies carried out by our scientists at other institutes were published in international and national peer reviewed journals. In addition , 8 review papers, 10 books/ compendium/ technical bulletins were also published.
- Two patent applications on 'Novel cryopreservation protocol for improving buffalo sperm post thaw

viability & motility' and 'A composite feed additive for reducing methane emission and improving fibre utilization in ruminants' were submitted.

- Eight Institute funded projects and 4 externally funded projects were completed. Institute has ongoing 17 institute funded (including 4 under NPBI) and 8 externally funded projects. In addition a network project on buffalo improvement with 12 centres across the country covering six different breeds.
- Three Scientists of Institute received awards of scientific societies for quality research and seven awards and recognitions for presentations during conferences, seminar and symposia including one best published paper award.
- Eight Scientists, four technical staff, five administrative staff and seven skilled supporting staff (SSS) were trained at various institutions under capacity building.
- 2 Doctoral students and 11 postgraduate students completed their research work and submitted thesis, while 11 doctoral and 6 postgraduate students are currently pursuing research work at CIRB.
- During the period, 104 hours were dedicated to Swachchh Bharat Mission and work was carried out at 22 different activities by employees. Swachhata pakhwada and cleanliness drive in schools along with sensitization program about the significance of cleanliness, quiz competition, slogan competition and extempore speaking competitions were also organized.
- Agriculture farm at main campus, Hisar produced a total of 30386.30 quintals of green fodder, 1048.90 quintals grains and 537 quintals wheat straw.
- Total green and dry fodder production in subcampus Nabha during the year was 44496 and 3365 quintals, respectively, while grain production was 5077.80 quintals.
- At main campus, 25 acres of saline soil was reclaimed by growing paddy and 24 acres by sowing dhaincha. At sub-campus Nabha, 16 acres land was reclaimed by removing shrubs.
- Two tractors, one each at main campus Hisar and at sub-campus Nabha were purchased to improve the farm efficiency.
- Feed unit prepared about 600 tonnes of concentrate feed for feeding to farm animals. In addition, approx. 15 tonnes of area specific mineral mixture is being prepared annually for farm animals as well as for sale to the farmers for its popularization.
- Revenue generation during the year (2017-18) was Rs. 502.82 Lakh.
- At sub-campus Nabha, milking machine was extended from 8 unit existing cluster to 12 Unit cluster. Also, started preparation of Khoa for sale at sub-campus through Khoa/paneer making machine.

Introduction

ICAR-Central Institute for Research on Buffaloes (CIRB) was established at Hisar in the year 1985 and a sub-campus was added in December, 1987 at Bir Dosanjh, Nabha (district Patiala), Punjab. The institute is mandated to improve buffaloes through identification, conservation and propagation of elite germplasm having high efficiency of production, reproduction and nutrient utilization for sustainable production.

The institute undertakes research and technology application as well as development on all aspects of buffalo production and is also mandated to establish nucleus breeding herds of important buffalo breeds across the country. The Network Project on Buffalo Improvement (NPBI), coordinated by the institute was initiated in 1993, after disbanding the AICRP, for undertaking progeny testing to improve Murrah buffaloes and in the year 2001, its scope was expanded to include other breeds of buffaloes through various centres in different parts of the country as well as to start field progeny testing program. Under this project, genetic improvement of seven important breeds of buffaloes, across 16 centres located in 9 states, is being addressed. ICAR-CIRB has made significant contributions in developing and improving highly pedigreed breeding herds of Murrah and Nili Ravi buffaloes at its main and sub-campus, respectively, apart from dissemination of quality superior germplasm in field throughout the country.

Mandate

- Basic and strategic research for enhancing technology developments on all aspects of buffalo productivity.
- Information repository and dissemination of buffalo product technologies

Staff position as on 31st March 2018

Category	Sanctioned strength	Filled	Vacant
RMP	1	1	0
Scientific	40	29	11
Technical	42	36	6
Administrative	19	13	6
Skilled	73	65	8
Total	175	144	31

Organizational set-up

The institute is one of the 19 Animal Science Institutes amongst 111 Indian Council of Agricultural Research (ICAR) institutes spread across the country. ICAR is a society registered under the Department of Agricultural Research and Education, Government of India in the Ministry of Agriculture and Farmers' Welfare. The institute is headed by the Director, who is administrative head and research manager of the institute. He is advised by a Research Advisory Committee (RAC) consisting of eminent scientists to decide the research agenda / guidelines based on mandate, objectives and perspective plan of the institute. The Institute Research Committee (IRC) meetings, chaired by the Director, take stock of the progress in various research projects being implemented by the scientists,

besides assessing the completed projects and approving new research proposals based on mutual discussions amongst the scientists and experts. The Institute Management Committee (IMC), headed by the Director, decides on important administrative and management matters including funding position, action taken on recommendations of QRT and RAC and approval for higher budget works etc. during the year, RAC, IMC and IRC had regular meetings and provided guidance for further strengthening research and development efforts. Every five years, Quinquennial Review Team (QRT) evaluates the output and outcome of the institute vis-a-vis resources of funds, manpower and facilities available, in order to provide critical appraisal to the Council and the ICAR governing body.

The research activities of the institute are assigned to three subject-matter divisions : i) Animal Nutrition and Feed Technology (AN&FT), ii) Animal Genetics and Breeding (AGB) and iii) Animal Physiology and Reproduction (APR). In addition, a unit for Transfer of Technology and Entrepreneurship (TOTE) takes care of the extension activities. Sub-campus is managed through designation of the senior-most scientist as the Officer-in-Charge for exercising delegated powers. A number of sections like Priority Setting, Monitoring and Evaluation (PME) Cell, Institute Technology Management Unit (ITMU) and Agricultural Knowledge Management Unit (AKMU) have been created and assigned responsibilities for smooth functioning of research activities and technology management of the institute. The scientists are assisted by various levels of technicians and technical officers as well as supporting staff for various experimentations and management of livestock, laboratory and infrastructure resources. Office staff looks after routine administrative and financial matters.

Financial statement/outlay (Rs. in Lakhs)

Head	Sanctioned Budget 2017-18	Expenditure 2017-18
Plan Grants	3044.66	2938.19
Network Project on Buffalo Improvement	579.00	540.61
AICRP on Nutritional and Physiological Intervention...	5.33	5.29
NAIF project	6.36	1.80
NASF project (Synthetic endometrium)	18.13	14.40
NASF project (Lactation stress)	10.17	7.95
CABin project	5.00	0.47
FFP project	23.00	11.85
DST SERB (Semen cryopreservation)	7.41	5.03
DST SERB (Nuclear transfer-cloning)	3.46	2.76
DBT project	21.68	19.43
Zoetis project	10.88	2.70

Revenue generation during 2017-18 (Rs in Lakhs)

Particulars	2017-18
Sale of farm produce	311.05
Sale of other products	4.87
Sale of semen	21.30
Sale of publications	2.92
Application fee for recruitment	0.26
Other fees	3.72
Licence fee of quarters/Guest house rent	6.08
Revenue receipts from schemes	-
Sale/disposal owned assets-surplus	92.38
Misc. income	60.25
Total	502.82

ICAR-Central Institute for Research on Buffaloes

Research Advisory Committee (RAC) → **DIRECTOR** ← **Institute Management Committee**

Main Campus, Hisar

Divisions
- Animal Nutrition and Feed Technology
- Animal Genetics and Breeding
- Animal Physiology and Reproduction

Sections
- TOTE Unit
- PME Cell
- AKMU
- ITM Unit
- Library
- Agriculture farm
- Animal farm
- Feed unit
- Electrical
- Estate
- Guest house
- Landscape
- Workshop
- Security

Administration
- Administrative Officer
  - Cash and bill
  - Central store
  - Establishment
  - Purchase
- Finance & Accounts Officer
  - Audit and Accounts

Network Project on Buffalo Improvement
- Co-ordinating unit
- Main Units
  - Murrah – 6
  - Nili-Ravi – 2
  - Bhadawari – 1
  - Jaffarbadi – 1
  - Surti – 1
  - Pandharpuri – 1
  - Swamp – 1
- Murrah field progeny testing units - 3
- State Agricultural Universities or State Veterinary Universities centres - 7
- Indian Council of Agricultural Research Institutes centres - 9

Sub Campus, Nabha

Officer Incharge
- Laboratory
  - Animal Reproduction
  - Animal Nutrition
  - Animal Breeding
- Others
  - Agriculture farm
  - Workshop
  - Animal Farm
  - Feed Unit
  - Estate & Maintenance
  - Central store
  - Record Cell

Genetic Improvement

The buffalo breeding programme emphasizes the need of an integrated approach involving traditional selection tools combined with biotechnological tools, particularly in light of existing huge gap between availability and the requirement of superior buffalo bulls. To overcome this gap, priority is being given to involve the farmer's buffaloes in the progeny testing programme.

Network Project on Buffalo Improvement

Network Project on Buffalo Improvement (NPBI) was initiated in 1993 with the aim to produce progeny tested bulls for improvement of buffaloes. Seven important buffalo breeds are covered under sixteen centres (funded/non funded/ ICAR/ SAU). The conservation of Bhadawari, Swamp and Nili-Ravi breeds, was undertaken along with breed improvement. In 2001, field progeny testing programme in Murrah buffaloes was initiated with the objective to produce more number of daughters per bull for evaluating sires with more accuracy at CIRB Hisar, NDRI Karnal and GADVASU, Ludhiana.

Genetic improvement of Murrah buffalo

Test mating from XVI set of 15 test bulls (5 from CIRB, 4 from NDRI, 3 from GADVASU and 3 from LUVAS) was completed in June, 2017; thereafter use of 16 test bulls (8 from CIRB, 4 from GADVASU, 2 from NDRI and 2 bulls from field) of XVII set was initiated from July 2017 and will continue till December 2018 at associated centres of Murrah buffaloes for genetic improvement under NPBI.

Progeny test evaluation of XII set bulls (Murrah bulls from January 2010 to June 2011)

S. No.	Bull No.	Location	Date of Birth	Dam No.	Sire No.	Dam's best SLMY (kg)	Sire Index	Rank	Daughters recorded	% superiority
1	2185	GADVASU	23-11-06	1898	1354	3423	2341.35	I	66	0.94
2	183	CCS HAU	03-06-07	1374	1354	2824	2336.77	II	24	0.75
3	2177	GADVASU	06-10-06	1884	1354	3024	2327.51	III	96	0.35
4	5604	NDRI	20-07-05	4020	3108	3222	2327.09	IV	15	0.33
5	2176	GADVASU	02-10-06	2109	1354	2754	2323.32	V	58	0.17
6	5720	NDRI	29-06-06	3543	3930	3011	2322.94	VI	22	0.15
7	Khurana	Rohtak					2313.58	VII	9	-0.25
8	5710	NDRI	23-05-06	5074	5054	2711	2313.12	VIII	22	-0.27
9	R -10	REDHU Farm	15-11-07	042810		5192	2312.62	IX	27	-0.29
10	3598	CIRB	25-07-06	587	1354	2655	2309.22	X	25	-0.44
11	R-11	REDHU Farm	28-11-07	042832		4000	2307.61	XI	23	-0.51
12	220	CCS HAU	20-09-07	1134	1153	2631	22.98.98	XII	11	-0.88

Mean=2319.36; No. of daughters 398

Performance of participating Murrah herds

The herd strength of associated Murrah herds is 1951 from all the NPBI Murrah centres, which includes 774 breedable buffaloes. The weighted average of standard lactation milk yield (305 days or less) in Murrah was reported highest (2487 kg) in 2017-18, since inception of the project and showed an overall improvement of 52.38% since 1992-93 (2.01% per year). Similarly, the weighted average for other performance traits viz. age at first calving and service period were 42.17 month and 161 days, respectively. The weighted wet average of Murrah buffalo was reported highest (8.55 kg) since inception of the project and revealed an overall improvement of 61.62% (2.37% per year). Overall conception rate and calf mortality (0-3 month) reported as 45.83% and 8.88%, respectively. Life time productivity traits viz. herd life, productive life and life time milk yield, were estimated for the first time in buffaloes that completed their fourth or more lactation as 3587 days, 2263 days and 12637 kg, respectively.

Performance traits of Murrah buffaloes at different centers

Traits/Herd Information	Performance of Murrah buffalo at NPBI Centers						Overall
	CIRB, Hisar	ICAR-RC for ER, Patna	NDRI, Karnal	IVRI, Izatnagar	LUVAS, Hisar	GADVASU, Ludhiana	
Herd strength	544	80	522	182	360	263	1951
Breedable buffaloes	285	45	309	96	176	143	774
Conception rate (%)	50.52	42.86	39.60	49.06	47.00	47.45	45.83
SLMY (kg)	2424 (140)	1997 (12)	2387 (96)	2129 (45)	3050 (69)	2707 (54)	2487 (416)
Lactation length (days)	295 (140)	405 (12)	335 (96)	302 (49)	300 (62)	338 (54)	315 (413)
Peak Yield (kg)	12.74 (140)	12.34 (12)	13.0 (96)	10.4 (50)	14.2 (69)	14.73 (54)	13.12 (416)
Age at first calving (months)	43.58 (67)	—	42.29 (35)	37.65 (17)	42.2 (27)	41.3 (25)	42.17 (171)
Service Period (days)	167 (101)	195 (12)	138 (49)	206 (38)	135 (46)	152 (41)	161 (287)
Calving Interval (days)	478 (101)	515 (12)	432 (33)	443 (29)	445 (46)	459 (41)	461 (262)
Wet Average (kg)	8.71	4.30	8.23	5.77	10.3	8.03	8.55
Herd Average (kg)	5.90	2.93	4.21	3.72	7.6	5.25	5.39
Herd Life (days)	3619 (47)	—	3557 (16)	3874 (31)	3130 (12)	3365 (20)	3587(126)
Productive Life (days)	2117 (47)	—	—	2599 (31)	1958 (12)	2270 (20)	2263 (110)
Lifetime Milk Yield (kg)	12771 (47)	—	10561 (16)	12854 (31)	14910 (12)	12284 (20)	12637(126)
Calf Mortality (0-3 month)	7.00 %	7.69 %	15.4 %	6.15 %	3.16 %	8.22 %	8.88 %

Performance of other breeds of buffaloes

Elite herds of Nili-Ravi, Jaffarabadi, Surti, Bhadawari and Pandharpuri breeds of buffaloes have been established in their respective breeding tracts. Nili-Ravi and Bhadawari breed centers are functioning as conservation and improvement units and Jaffarabadi, Pandharpuri and Surti breed centers are concentrating on field progeny testing along with maintaining the herd for young bull production. A breedable herd of 632 (Nili-Ravi-232 at CIRB and 92 at GADVASU, Jaffarabadi-174 at JAU, Pandharpuri-23 at MPKV, Kolhapur, Surti-57 at RAJUVAS, Vallabhnagar and Bhadawari-54 at IGFRI) is being maintained at the above six centers. Overall production and reproduction traits were observed better in Nili-Ravi buffalo at ICAR-CIRB sub-campus, Nabha and GDAVASU, Ludhiana. The herd size of Jaffarabadi buffalo was maintained as per the technical program of NPBI, but comparatively small herd size maintained for Bhadawari, Surti and Pandharpuri breeds.

Performance traits of other breeds of buffaloes at different centers

Traits/Herd Information	Performance of other buffalo breeds at NPBI Centers					
	Nili-Ravi, CIRB sub-campus, Nabha	Nili-Ravi GADVASU, Ludhiana	Bhadawari, IGFRI, Jhansi	Jaffarabadi, JAU, Junagarh	Surti, LRS Vallabhnagar, RAJUVAS	Pandharpuri, MPKV, Kolhapur
Herd Strength	464	142	91	312	115	46
Breedable Buffaloes	232	92	54	174	57	23
Conception Rate (%)	39.75	47.30	59.50	52.68	43.24	43.33
305 days or less lact. milk yield (kg)	2321 (110)	2188 (36)	1403 (19)	1907 (47)	1586 (23)	1536 (7)
Lactation Length (days)	282 (110)	278 (36)	316 (19)	383 (47)	283 (23)	278 (6)
Peak Yield (kg)	12.70 (110)	12.36 (36)	7.69 (19)	11.40 (47)	9.75 (23)	5.98 (7)
Age at first calving (months)	41.15 (49)	42.43 (18)	46.26 (7)	54.05 (21)	50.97 (2)	39.33 (1)
Service Period (days)	135 (95)	180 (34)	190 (15)	217 (48)	131 (23)	85 (6)
Calving Interval (days)	444 (95)	487 (34)	493 (15)	531 (48)	456 (31)	413 (6)
Wet Average (kg)	8.52	7.85	4.16	6.70	5.55	4.72
Herd Average (kg)	5.84	4.20	2.39	3.00	3.43	3.25
Calf Mortality(0-3 month)	5.06%	13.0%	4.10%	4.5%	24.32%	---

Semen production and dissemination

Total 204075 frozen semen doses of Murrah bulls were produced, 57820 semen doses disseminated under NPBI and 126426 doses sold to farmers /NGOs / developmental agencies during 2017-18. The closing balance of frozen semen from Murrah bulls is 564068.

For other breeds of buffalo, a total of 85533 semen doses were produced during 2017-18 and 118877 semen doses were sold/supplied during the report period. Balance stock of frozen semen of buffalo bulls, other than Murrah breed, is 385047doses.

Semen Production and Dissemination: 2017-18 (Murrah bulls)

Centre	Production	Use in NPBI	Sold	Balance
Murrah - ICAR-CIRB, Hisar	136341	43856	76704	441246
Murrah - GADVASU, Ludhiana	32870	5515	35168	114890
Murrah - ICAR-NDRI, Karnal	34864	8449	14554	7932
Total (Murrah)	**204075**	**57820**	**126426**	**564068**
Nili-Ravi CIRB, sub-campus, Nabha	13500	1310	3925	65018
Jaffarabadi, JAU, Junagarh	22365	4040	32770	115267
Bhadawari, IGFRI, Jhansi	15155	4295	200	38548
Surti, LRS Vallabhnagar, RAJUVAS	5801	2266	51	58593
Pandharpuri, MPKV, Kolhapur	28712	47070	22950	107621
Total (other breeds)	**85533**	**58981**	**59896**	**385047**

Field Progeny Testing (FPT)

Three field centers of Murrah buffalo initiated in 2001 at CIRB Hisar, NDRI Karnal and GADVASU Ludhiana to produce more number of daughters (progeny) per bull for increasing accuracy of evaluation and selection of bulls based on daughters' first lactation milk yield. Under field progeny testing program (FPT) semen of test bulls is used for artificial insemination in the field, followed by pregnancy diagnosis, calving records and follow up of progenies till the completion of first lactation for milk records on the basis of monthly test day recording. About 13195 artificial inseminations were carried out in 2017-18 at farmers' door in adopted villages under FPT program to produce daughters from XVI and XVII sets of breeding bulls. Total 6256 female progenies of Murrah buffaloes produced in farmer's herds are standing in field. For other breeds of buffaloes, 9917 AI were carried out.

Field Progeny Testing (AI, PD, CR%, calving, female progeny born and recorded)

Sr. No.	Centre	Artificial insemination (AI)	Pregnancy diagnosis (PD)	Conception rate CR %	Calving	Female calf born	Daughters recorded	Total daughters recorded
1	ICAR-CIRB, Hisar	4093	2229	54.46	1593	799	154	865
2	GADVASU, Ludhiana	6344	2579	40.65	1933	899	186	839
3	ICAR-NDRI, Karnal	2758	1372	50.74	1397	640	119	1046
4	MPKV, Rahori	4286	1976	46.10	1438	635	63	701
5	JAU, Junagadh	2436	1032	42.36	815	365	44	145
6	RAJUVAS, Bikaner	1478	506	34.23	453	188	33	358
	Total	21904	9963	45.48	7589	3526	599	3954

Field Progeny Testing (FPT) of bulls at CIRB, Hisar

In this period 2229 pregnancies were confirmed and 1593 calving (794 males, 799 females) were recorded. In addition 160 progenies, 76 of XIII, 83 of XIV, and 1 of XV set were also calved and monthly test day milk yield were recorded. The average age at first calving for these 160 daughters was 43.03 months. During the year 274 daughters were recorded, out of which 123 daughters completed the lactation, 35 daughters sold before the lactation was completed and recording of 116 daughters are in progress. The physical identification using ear tagging has been done in all female progenies born in the field till March 2018. As on 31st March 2018, 1228 female progenies of XIII to XVI set of different age are standing at various field unit centres for future recordings.

Institute herd performance

Murrah: The overall herd strength of Murrah buffalo as on 31st March 2018 was 536 which includes 126 milch buffaloes, 49 dry, 142 suckling calves (< 1 year), 82 young males and females (1-2 years), 106 heifers (> 2 years) and 31 breeding males (>2 years). Of the total 136341 semen doses frozen during the period 2017-18, 43,856 doses of frozen semen were supplied in network centre and 76,704 frozen semen doses were sold. The highest ever wet average and herd average of 8.71 and 5.90 kg/d, respectively were achieved. The overall standard lactation milk yield (305 days or less) and total lactation milk yield during 2017-2018 was 2424 and 2480 kg, respectively, in 140 buffaloes that completed their lactation. The overall conception rate during January to December 2017 was 50.52 %. The other reproductive traits viz. Age at first calving, service period and calving interval were observed 43.58 months, 167 days and 478 days, respectively. Lifetime productivity traits were estimated for the first time in buffaloes that completed their 4th or more lactations during 2017-18. The lifetime productivity viz. herd life, productive life, lifetime milk yield, milk yield per day of herd life and milk yield per day of productive life were reported: 3619 days, 2117 days, 12771 kg, 3.53 kg and 6.04 kg, respectively.

Performance of CIRB Murrah and Nili-Ravi buffalo herd

Traits	Murrah	Nili-Ravi
Herd Strength	538	464
Breedable buffaloes (≥ 2 yr)	281	232
Conception rate (%)	50.52	39.75
Calf mortality (0-3 m) (%)	6.96	5.05
Overall mortality (%)	4.03	3.66
Wet average (kg/d)	8.71(115)	8.52 (95)
Herd average (kg/d)	5.90(168)	5.84 (142)
Average Peak yield (kg)	12.74±0.23 (140)	12.70±0.28 (110)
Average Lactation length (d)	295±3.62 (140)	282±4.80 (110)
TLMY (kg)	2480±55.06 (140)	2363±60.83 (110)
305dMY (kg)	2424±48.86 (140)	2321±55.25 (110)
Dry period (d)	162±7.54 (101)	157±5.56 (95)
Days open (d)	167±9.83 (101)	135±8.46 (95)
Calving Interval (d)	478±9.87 (101)	444±8.44 (95)
Age at first calving (m)	43.58±0.67 (67)	41.05±0.56 (49)
Herd life (d)	3619	3179
Productive life (d)	2117	1941
Lifetime milk production (kg)	12771	11528
Milk yield/day herd life (kg)	3.53	3.53
Bulls sold (n)	54	11
Milk sold (kg)	310132	247444

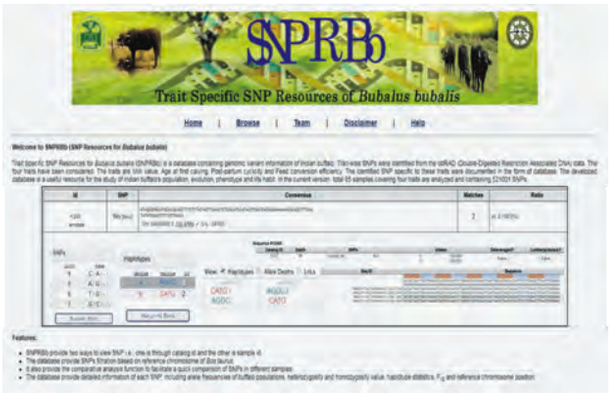
Nili-Ravi: The overall herd strength of Nili-Ravi buffalo as on 31st March 2018 was 464. The overall wet average (8.52 kg),herd average (5.84), 305 days lactation milk yield (2321 kg), total lactation yield (2363 kg), peak yield (12.70 kg) and lactation length (282 days) was achieved. The wet average was recorded highest since inception of the project. The reproductive traits viz., service period (104 days), days open (135 days), calving interval (444 days), dry period (157 days) were achieved during the year 2017-18. The life time productivity (up to 4th lactation) of 34 buffaloes was estimated. The average productive life was 1941 days and average milk yield per day of herd life was 3.53 kg. A total of 13500 semen doses were produced/procured at the sub-campus, Nabha. Out of these, 1310 doses were used at farm for insemination and 3925 doses were sold to field inseminators. Overall calf motility of 5.05% was recorded during this period. The overall conception rate of 39.75% was recorded. Total 147 animals have been sold through public auction and on book value to farmers, universities and various developmental agencies.

Computational identification and modeling of genetic variation in relation to performance traits in buffaloes

SNP identification for higher buffalo productivity using whole genome approach: Trait Specific SNP Resources for *Bubalus bubalis* (SNPRBb) is a database containing genomic variant information of Indian buffalo. Trait-wise single nucleotide polymorphism [SNPs] has been identified from the ddRAD (Double-Digested Restriction Associated DNA) sequencing data. SNP effects are obtained from 80 selectively genotyped high and low performing animals w.r.t. Milk volume, Age at first calving, Post-partum cyclicity and feed conversion efficiency traits. SNPs were identified by refining ddRAD sequencing data, using STACKS pipeline. The identified SNPs are stored in the form of database. The web based access of the data base has been provided by open source technology. Linux, Apache, MySQL and PHP/Perl (LAMP) are used to develop the dynamic web pages for wider accessibility. The features of the SNPRBb-database are :

- It provides two ways of SNP browsing i.e., Catalog or Sample basis;
- Sample wise comparison facilitates the comparative analysis of SNPs.
- Detailed information of each SNP, as allele frequencies of buffalo populations, heterozygosity, homozygosity values and haplotype statistics and effects by functional class and mutation are included.

The CABin (Animal Science) developed database is a useful resource for the study of Indian buffalo's population, evolution, phenotype and life habit.



MicroRNA-related variants associated with corpus luteum tropism in buffalo

- Data obtained from deep sequencing of corpus luteum tissue from different physiological stages w.r.t. corpus luteum tropism was mined *in silico* for the identification of the miRNA-related variants (SSRs & SNPs). The sequences were subjected to BLAST with *Bos taurus* genome and the free energy, stem lop structure and precursor sequences were deduced using Triplet SVM, MFold and Mature Bayes softwares. Five annotated and 176 annotated miRNA were deduced by BLAST2GO for detection of variants (SSRs & SNPs) while comparing with *Bos taurus* genome. In addition, 4 SSRs and 9 SNPs were deduced in the miRNA sequences on the key genes (eukaryotic translation initiation factor 1-like, myocyte enhancer factor 2A, beta casein, T cell receptor gamma cluster, pygopus family PHD finger 1, BOLA class I histocompatibility antigen, plexin D1 and ubiquitin C) confirming their role in governing the corpus luteum tropism in buffalo (*Bubalus bubalis*) during estrous cycle and pregnancy through angiogenesis, cellular transformation, immuno-regulatory functions.

Causes of buffalo calf mortality and its management

Health of calves is of prime importance in dairy industry. Calf mortality in buffalo dairy farming is having great financial implications. Major conditions which cause mortality in buffalo calves are diarrhea, pneumonia and septicemia caused mainly by several bacterial, viral and parasitic agents.

One hundred thirty one (131) village buffalo farms in unorganized sector were surveyed. These were from 12 villages from Haryana including Gangwa, Ladwi, BhuthanKalan, Thuian, Cheemon, RawalwasKalan, DhaniMajua, Hasanga, Dhabi Khurd, Jhalania, Dalher and Ruksana. From Punjab there were 6 villages including Valtoha, Khanpur Barring, Rajgarh, Bajidpur, Bhunsi and HarjouKalan. In addition survey of buffalo calf mortality/ health from two organized farms of CIRB located at Hisar and Nabha was also done. Survey of observations of thirty two (32) veterinarians regarding buffalo calf mortality was also done. The process of survey is ongoing. After the process is complete, analysis will be done.

Twenty eight (28) clinical biosamples including faecal samples, nasal swabs and abscess samples from buffalo calves were subjected to bacterial analysis yielded MDR *E coli* (7), *Klebsiella pneumoniae* (6) and *Salmonella enteritidis* (4). None of the 42 samples from in contact buffalo calves yielded any bacteria of pathogenic significance. The bacterial analysis from clinical samples, samples from in contact animals and post mortem tissues will continue. Further the isolates will be molecularly characterized with respect to various virulence genes.Three hundred twenty two faecal samples of buffaloes from CIRB Nabha and adjoining villages were tested for presence of endoparasites. However all the samples were tested negative as the animals were given anthelminthic treatment.

Buffalo Health

Studies on safety and efficacy of intramammary Ceftiofur hydrochloride (Spectramast® DC) as dry period therapy in buffaloes

The study objective was to evaluate the efficacy of dry animal intramammary antibiotic Ceftiofur hydrochloride formulation (Spectramast DC, Zoetis) on the prevalence of subclinical mastitis (SCM) postpartum. Treatment group received intramammary Spectramast DC, Zoetis (Ceftiofur hydrochloride formulation, 500 mg in 10 ml) and control group was untreated at the time of drying-off. Composite milk samples of buffaloes were taken aseptically before dry-off, and at day 5 and 28 of the subsequent lactation for microbiological examination and somatic cell count (SCC). The overall animal level prevalence of subclinical mastitis at dry-off was 83.89%.The most prevalent udder pathogens isolated from composite milk samples at dry off were coagulase-negative Staphylococcus, representing 41.48 % of all recovered isolates.

Sheep-associated Malignant Catarrhal Fever virus suspected outbreak in buffaloes

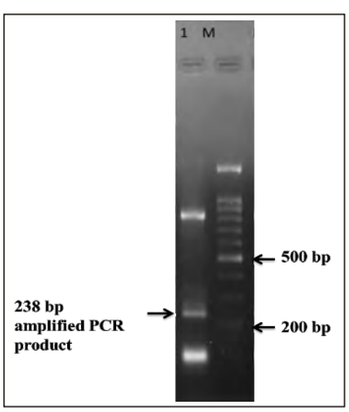
The etiological agent of sheep-associated malignant catarrhal fever is ovine herpesvirus 2 (OvHV/2, subfamily gamma herpesvirinae, family *herpesviridae*). The disease is characterized by pyrexia (106 -107^{0}F), nasal and ocular discharge, corneal oedema and opacity, keratoconjuctivitis, lymphadenopathy and necrotic and erosive lesions of oral mucosa. The reservoir host, domestic sheep, is apparently healthy and not showing clinical signs (asymptomatic)

following infection and transmit the virus to susceptible host through inhalation of aerosol or ingestion. The susceptible host (cattle, buffalo, bison) are dead end hosts and disease is not transmitted from one susceptible host to another.

From 3rd to 28th May 2017, a total of fourteen cases of undiagnosed febrile illness with a 3-day history of high fever (106^{0}F), anorexia and depression followed by corneal opacity in buffaloes with five mortality were reported by farmers of Kungar village in Bhiwani district about 60 kms from Hisar. This village is famous for high yielding Murrah germplasm. Finding of acute febrile illness with typical corneal opacity two to three days after initial pyrexia (106^{0}F) as consistent clinical symptom on examination of most of the cases suggested that malignant catarrhal fever may be a presumptive disease etiology. DNA extracted from buffy coat of EDTA blood samples were tested for OvHV -2 DNA by nested PCR targeting a gene coding viral tegument protein amplifying a 238bp fragment of DNA with nested primer set 556 and 555 (Baxter et al.,1993). The laboratory report supported MCF as a disease etiology in one sample (sample number MCF4/2017). The samples were tested negative on ELISA for trypanosomiasis.

Clinical signs in buffaloes suspected for MCF

a) Erosive mucosal lesions on hard palate and gums below incisors; b) Narrow gray ring at corneoscleral junction with conjunctival and scleral hyperemia, characteristic corneal opacity; c) Necrotic lesions on skin-horn junction of the feet especially at the back of the pastern, crust formation on skin; d) Profuse mucopurulant nasal discharge, discrete local areas of necrosis on dorsum of the tongue and haemorrhagic cheek papillae and asymptomatic migratory mixed flock of sheep and goat.



Lane1 showing desired 238 bp amplified ovine herpesvirus-2 (OvHV-2) tegument encoding gene product by hemi-nested PCR (Baxter et al.1993) from extracted DNA of a MCF suspected buffalo blood sample (MCF4/2017) and Lane 2: 100 bp DNA ladder.

Reproductive Efficiency

For high profitability in large dairy animals, it is desirable that female should have yearly calving and male should produce quality fertile semen with high post-thaw motility. This requires development of technologies which can diagnose reproductive aberrations at an early stage, suitably treat them and also develop technologies which are helpful in multiplication of superior animals using bio-technologies. Climatic change, which is influencing animal physiology by way of stress on the animal, also needs to be looked upon for high productivity of buffaloes.

Cloned Assamese buffalo calf born in the field

A male cloned calf of Assamese buffalo was born on December 22, 2017 through a normal delivery at Sirsa, named as "Sach-Gaurav". The birth weight of the cloned calf was 54.2 kg. The genotype of the calf was confirmed by microsatellite analysis (parentage verification) and chromosome analysis. This achievement has multiple uniqueness and several firsts: 1) World's first cloned buffalo born in the field; 100 km away from the cloning laboratory at Hi-Tech Sach Dairy Farm, Sirsa; 2) India's first cloned Assamese buffalo calf; 3) Cloned embryos were transported for approximately two hours before being transferred into the recipient mothers; 4) Ovaries of Murrah buffaloes were used as a source of recipient oocytes, it proves that one breed of buffalo eggs can reprogram donor cells of other breeds of buffalo; also, Murrah has served as a surrogate mother to support pregnancies of cloned embryos of Assamese buffalo; 5) Singlet method of embryo reconstruction, in which only one recipient oocyte cytoplasm (current method) was used instead of two cytoplasm (standard buffalo cloning method used in India), it's a step towards simplification of buffalo cloning technique; 6) Small tissue of Assamese buffalo was airlifted from College of Veterinary Science, AAU, Khanapara, Guwahati which is 2000 km away from our laboratory, to establish the cultures of donor cells.

Hisar-Gaurav, the first clone of institute started donating good quality semen at the age of 22 months and semen was cryopreserved. Different fertility parameters such as CASA variables and sperm abnormality tests were done on Hisar-Gaurav semen, and its results were normal and compared with the donor bull, 4354. Cloned semen was used for artificial insemination in 15 buffaloes at Institute herd, of which 9 females were found pregnant. These pregnancies are maintained over three months. Also, 17 pregnancies from cloned male semen were established in the field, at Hi-tech Dairy farm, Sirsa.

Poor live birth rates from cloned embryos may be ascribed to the epigenetic reprogramming of somatic donor genome. We studied epigenetic changes in the donor cells (buffalo fibroblasts), which were treated with different concentration of sodium butyrate (NaBu) - a chromatin remodelingHDACi agent. Before drug treatment, the purity and lineage of donor cells were confirmed by determining presence of fibroblast specific protein and gene markers (Vimentin, Tubulin and Cytokeratin) using immuno-staining and PCR. The pure population of buffalo fibroblast cells was treated with 1, 3 and 5 mM of NaBu for 48 h and various observations were taken such as morphological changes, population doubling time and cell proliferation. Treated cells exhibited altered morphology, increased population doubling times and decreased proliferation rate in the dose dependent manner. The epigenetic changes such as acetylation (H3K9ac) and methylation (H3K27me3) were observed using immuno-staining. In all treated groups acetylation (H3K9ac) and methylation (H3K27me3) were significantly increased over the control. These results indicated that treatment of donor cells with NaBu may provide a useful approach to correct epigenetic abnormalities in buffalo cloned embryos.

Simplification of nuclear transfer technique

Semen contains sufficient number of epithelial cells and these cells can be used to produce cloned copies of a meritorious breeding bull. To achieve this, the efficient somatic cell isolation protocol is required to culture cells from ejaculated semen in vitro. Percoll gradient method was used to isolate epithelial cells from the semen of two buffalo breeding bulls. Undiluted semen samples were stored in a 4°C refrigerator for different time periods (0, 4, 12, 24, 72 and 144 h, post semen collection). The cell attachment rates were 100% and 66% for the samples which were stored for

24-h and 72-h, respectively; whereas, 66% for one bull and 33% for other bull for 144-h storage group. Established cells were of an epithelial origin type, which was confirmed by positive expression of cytokeratin-18, an epithelial cell type marker. Cloned blastocyst production rates of semen-derived cells were comparable with that of skin-derived cells. This study indicates that epithelial cells can culture from stored semen and they can also be used as donors to produce cloned embryos of breeding bulls.

Cryopreservation of somatic cells and cloned embryos

Biobanks of cryopreserved gametes and embryos of domestic animals have been utilized to spread desired genotypes, and to conserve the animal germplasm of endangered breeds. In principle, somatic cells can be used for the same purposes, and for reviving of animals the somatic cells must be suitable for animal cloning techniques, such as somatic cell nuclear transfer (SCNT). Somatic cells from three breeds of riverine and swamp type buffaloes were cryopreserved to establish a somatic cell bank. In total, 350 cryovials of 14 different individual animals (25 cryovials per animal) were cryopreserved and informative data such as breed value, origin, and others were documented. Immunostaining of the established cells against vimentin and cytokeratin suggested a commitment to the fibroblast lineage. In addition, microsatellite analysis was performed and documented for unambiguous parentage verification of clones in future. Subsequently, the cryopreserved cells were tested for their suitability as nuclear donors (n=7) using handmade cloning, and the reconstructed embryos were cultured in vitro. The cleavage rates (95.99 ± 2.17 % vs. 82.18 ± 2.50 %) and blastocyst rates (37.73 ± 1.54 vs. 24.31 ± 1.78 %) were higher ($P < 0.05$) for riverine buffalo cells than that of swamp-like buffalo cells, whereas the total cell numbers of blastocysts (258.16 ± 36.25 vs. 198.16 ± 36.25, respectively) were similar. It demonstrates feasibility of biobanking of buffalo somatic cells, and that the cryopreserved cells can be used to produce cloned embryos.

Induced pluripotent stem (iPS) cells through non-viral approaches

Buffalo fetal fibroblasts were reprogramed by non-viral piggyback (PB) transposon mediated transfer of six transcription factors. Briefly, to generate buffalo iPS cells, fetal fibroblasts were isolated from slaughterhouse buffalo fetus (passage 2) and co-electroporated with a piggyBac transposon carrying a multigene cassette consisting of human Oct4, Sox2, Klf4, c-myc, Nanog, and Lin28 (SOKMNL) separated by self-cleaving 2A peptide sequences, driven by a CAGGS promoter and a helper plasmid expressing the pCMV-PB transposase. 12-14 days post electroporation, morphology of fibroblasts started to change to round structures and on day 18 loose aggregates of cells developed. Buffalo iPS cells were generated by the PB mediated delivery of transgenes: SOKMNL and they were maintained in feeder free culture system. Putative iPS cell colonies were cultured, propagated and characterized through morphology and expression of pluripotency markers such as AP, SSEA-1, SSEA-4, SSEA-5 and TRA-1-81 analysed through immunostaining. These cells expressed pluripotent nuclear markers including OCT4, SOX2 and NANOG, KLF4, c-MYC, and LIN28 evaluated through RT-PCR. These cells were expanded using sub-passage and cells were maintained for 15 passages without morphological changes. These cells maintained a high expression of endogenous pluripotent markers and were able to form EBs which showed the expression of three germ layer markers. The current study provides insights into viral-free iPS technology and will facilitate genetic modification of the buffalo genome, and help in the production of transgenic animals using genetically modified iPS cells.

Transgenic animal production using genome editing tool CRISPR/Cas9

Study was conducted to analyse the cattle genome sequence related to beta casein locus and then design the CRISPR/Cas9 system specific for insertion of lysozyme gene using advanced genome editing tools which will further contribute to the production of transgenic bovine embryos. For this three CRISPR guides were designed using CHOP-CHOP algorithm specific to buffalo/ bovine genomes and also homologous recombination vector were designed. To amplify the β-casein sequence, specific primers to buffalo/ bovine β Casein were designed. Primers for amplification of target site optimized and successfully ligated guides in puromycincrispr vector and verification of guide ligation made using REs digestions. Electroporation of guides into cattle fetal fibroblast cells to check their cutting efficiency is being tested. Two Indian scientists completed their project visits to the German laboratory to achieve the project objectives.

Transgenic embryo production

Primary culture of buffalo fetal fibroblast cells was established and subsequently cultured cells were co-

transfected with pT2CAGGS-Venus and pCMV-SB100X at different combination of electroporation conditions. In different combination of volt, time and plasmid concentration, 300 volt, single pulse for 10 ms in 2 mm cuvette and 1.5-2 µg transposons with 200-300ng transposase concentration were found optimum electroporation conditions for expressing Venus fluorescence in cells. After electroporation, the cells were cultured for 2 to 3 days and then Venus expressing cells were picked with the help of pasture pipette under the fluorescence microscope to enrich them through single cell culture method before using as donor cells for HMC. In vitro matured oocytes (22 h) were reconstructed with either transfected or non-transfected buffalo somatic cells by electric fusion followed by activation. The reconstructed, activated embryos were cultured in 400 µL of Research Vitro Cleave medium supplemented with 1% fatty acid-free BSA in 4-well dish, covered with mineral oil and incubated in an incubator (5% CO2 in air) at 38.5 °C for 8 days and the developmental competence was observed. The percentage of cleaved, 4-8 and 8-16 cells stage embryos expressing Venus was not significantly different over the control, but the morula (21.0 vs 53.0%) and blastocysts (10.5 vs 30.6%) yield was low in Venus expressing fibroblast as compared to non-transfected fibroblasts. These results indicate that fetal fibroblasts transfected with pT2CAGGS-Venus and pCMV-SB100X could be used as donor cells for buffalo cloning and that Venus gene can be safely used as a marker of foreign genes in buffalo transgenesis.

Synthetic endometrium to study early embryonic development and uterine health

Immature oocytes collected from buffalo ovaries were subjected to maturation and fertilization in vitro in suitable medium. Cleavage rate was 40.01% on day 2 post-insemination which subsequently led to development of blastocyst stage embryos (10.62%). Total cell number (151.8) and apoptotic index (7.4%) was determined for healthy embryos using Hoechst 33342 and TUNEL assay, respectively. These embryos will be utilized for further studies on endometrium-embryo-pathogen interactions and gene expression.

Bio-signatures of buffalo reproduction for development of diagnostics

Attempts on conjugation of the gold nanoparticles (AuNPs) prepared in colloidal form ("wet chemical method") by reduction of gold salt through a “nucleation” process were made with the anti-progesterone antibodies. The gold nanoparticles prepared were also characterized by dynamic light scattering measurements. The Dynamic Light Scattering measurements showed that the prepared gold nanoparticles are suitable for conjugation experiments. Attempts were also made for *in silico* analysis for interaction between peptide identified from Mx2 protein and the gold nanoparticle surface. Gold nanoparticles were successfully conjugated with the BSA as a representative protein. The in vitro stability of the prepared conjugate was assessed in different concentrations of sodium chloride and other solutions mimicking biological conditions. Attempts on Silver nanoparticles were also made from the wet chemical methods and different biogenic routes.

Lactation stress associated postpartum anestrus SNP array in buffaloes

More than 500 buffaloes were screened at ICAR-CIRB buffalo farm and field for identification of postpartum anestrus animals. The collection of blood was done from heifers and post-partum anestrus animals. A high quality genomic DNA was isolated. A DNA repository of 150 numbers was made with isolated DNA from postpartpum animals and also 100 numbers was added to it from the control DNA samples. Ovarian follicular fluid was successfully aspirated by ultrasonography guided follicular aspiration from more than 7 normal cyclic buffaloes and 8 early post-partum animals and stored at -80°C for RNA isolation. These samples will be used for identifying the differential genes and proteins involved in postpartum lactation stress and their effect on ovarian function in buffaloes. Also, attempts were made to study the genetic polymorphism of HSP70, TLR 4 and IGF-1 genes in relation to anestrous conditions in Murrah buffaloes. Different exonic regions of HSP70, TLR4 and IGF1 were amplified and sequenced for discovery of SNPs. Custom nucleotide sequencing of amplified IGF-1 gene described 4 variable regions between 363 and 422 base pairs and overall 10 variations – 4 in PA, 3 in PPA 1 and 3 in PPA 2 categories. However, restriction enzyme (RE) digestion analysis with HhaI enzyme described a single cut site at 404 position of the 481 bp amplified fragment. TLR-4 gene presented overall 18 variations – 9 in PA (between 190 and 327 base pairs) and likewise 7 in PPA 1 and 2 in PPA 2 categories. RE digestion analysis with *SduI* enzyme confirmed positions 29 and 33 in the 452 base pair amplified fragment while Acc65I enzyme established a cut site at position 320. The Hsp-70

gene on similar analysis found 7 variable regions between 45 and 266 base pairs – 2 in PA, 3 in PPA 1 and 2 in PPA 2 categories which were confirmed by *Mval*and *BamHI*RE enzymes. The present study could provide several putative variations or SNPs but PCR-RFLP results were not conclusive.

DOKA a sign of impending oestrus in buffaloes

A peculiar phenomenon 'DOKA' (Temporary engorgement of Teats) shown by lactating buffaloes prior to commencement of estrus was studied in Murrah buffaloes (n=116) at Animal Farm, CIRB Hisar. 'Doka' is an important sign used by farmers for prediction of estrus in buffaloes. Present study was conducted to know the DOKA occurrence, its duration and relationship with onset of estrus in buffaloes. The study examined physical and morphological changes before, during and after 'Doka'. 'Doka' is widely expressed in lactating buffaloes (~ 66% animals) during mid-lactation for approximately four days prior to onset of estrus. Majority of 'Doka' exhibiting animals (~ 76%) express estrus signs two days after its disappearance. 'Doka' signs were fully exhibited 5 hours after complete milking. Transrectal ultrasonographic scanning suggested that cyclic (Doka) buffaloes have large developing follicles (>11mm) as compared to those not showing 'Doka'. The milk composition during 'Doka' was similar to the milk produced by buffaloes not showing 'Doka'. The endocrinological findings point to normal circulating levels of progesterone and estrogen in 'Doka' animals. However, circulating concentration of PGFM were significantly higher in cyclic buffaloes exhibiting 'Doka' as compared to normal cyclic without 'Doka' and acyclic animals. The present study concluded that animals expressing 'Doka' are cyclic and have normal ultrsonographic and hormonal (progesterone and estrogen) levels except PGFM which show high concentration during this phenomenon expressed over about 4 days.

Climate Change and buffalo farming

Climate change is affecting livestock farming and food production in a complex way - directly affecting food production through increase in frequency of extreme weather conditions and indirectly their production. A number of studies have shown conclusively that climate change has become a major threat to food availability by adversely affecting agricultural productivity and increasing inter-annual variations in yields. Animal and human welfare are interlinked with each other and to climate change as well. New project is designed to assess risks, vulnerabilities, adaptive capacities and mitigation strategies available for addressing climate change risks in important buffalo producing areas of the country.

Buffalo sperm dosage in relation to functional parameters and field fertility outcome

This project was formulated to study the effect of alteration of buffalo sperm dosage on sperm functional parameters and field fertility outcome. The project has been initialized. Around 1000 doses comprising of three sperm dose (20, 16 & 12 million/straw) were distributed for field inseminations.

Nutrition and reproductive interactions (AICRP Project)

For the treatment of anoesrus condition, it has been observed that estrus induction rates were highest with progesterone implants as compared to GnRH based protocols. Furthermore, conception rates were also highest on fixed time insemination using progesterone implants in anoestrus buffaloes. Single prostaglandin injection was good for induction of oestrus as well as conception rates in silent oestrus buffaloes.

Oestrus induction protocols (2017-18)

Protocol	No. of cases/ Induced in heat	Pregnant to first/ Consecutive AI	Not Traceable/ Result Awaited
Ovsynch	14/ 5 (35.7%)	1/2	2/2
Ovsynch-plus	50/27 (54.0%)	5/3	1/18
Crestar	28/25 (89.28%)	11/2	-/-
CIDR	89/80 (89.9%)	28/7	2/32
PG	94/70 (74.5%)	31/5	3/39

Supplementation of IGF-1 in buffalo semen extender to increase semen freezability was also studied. Significant difference was observed between bulls with low (Group I) and high semen freezability (Group II) w.r.t scrotal circumference, sperm concentration, mass activity and individual motility. Also, body weight was correlated with both seminal and serum IGF concentrations and mass activity was correlated with serum IGF concentration in buffalo bulls. Supplementation of IGF1 @250 ng/ml in buffalo bull semen extender improves sperm viability and post thaw motility.

Seminal variables in group I (low semen freezability) and group II (high semen freezability) buffalo bulls

Variables	Group I (n=2)	Group II (n=5)	P Value
Age (Days)	1419.00±217.00	1424.33±131.78	0.98
Body weight (Kg)	965.00±79.00	615.83±30.95	0.002**
Scrotal circumference (cm)	38.50±0.50	31.00±1.51	0.03*
Semen volume (ml)	2.82±0.42	2.83±0.44	0.98
Sperm concentration (Million/ml)	1205.69±58.80	794.48±80.84	0.03*
Total sperms (millions)/ ejaculate	3375.36±340.56	2172.65±305.39	0.08
Mass activity (0-5)	1.850±0.35	2.95±0.20	0.03*
Individual motility (%)	44.64± 4.64	73.25± 1.26	0.000**
IGF in seminal plasma (ng/ml)	49.34±9.17	50.34±6.12	0.98
IGF in serum (ng/ml)	1202.26±50.84	1633.66±60.76	0.04*

Mean value differs (P<0.05) *statistically significant; Mean value differs (P<0.01) **extremely statistically significant

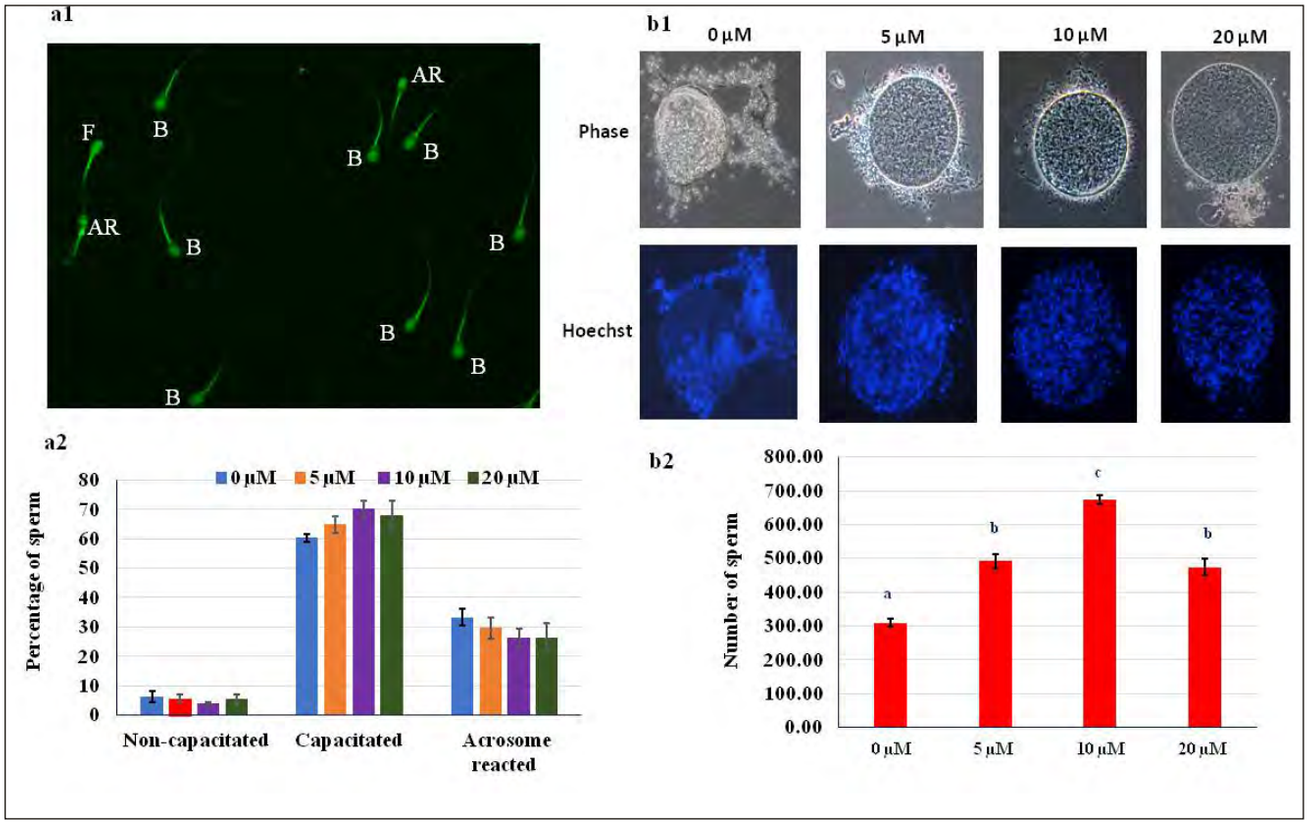
Incubation test : Post thaw motility at different intervals with IGF_1 supplementation at different concentrations

IGF_1 Conc.	0 min	30 min	60 min	90 min	120 min
0 ng/ml	51.90±0.64^{a}	44.76±1.16^{a}	37.14±1.60^{a}	29.52±2.23^{a}	22.62±2.59^{a}
50 ng/ml	52.50±1.33^{ab}	46.88±2.66^{ab}	40.63±3.71^{ab}	34.38±5.12^{ab}	26.88±6.11^{ab}
100 ng/ml	53.13±2.10^{ab}	45.63±2.39^{ab}	38.13±3.39^{a}	31.25±4.50^{ab}	24.38±5.38^{ab}
150 ng/ml	53.33±1.26^{ab}	45.67±1.60^{a}	39.33±2.17^{a}	33.67±2.94^{ab}	27.00±3.64^{ab}
200 ng/ml	53.33±1.66^{ab}	47.50±2.14^{ab}	42.50±3.35^{ab}	36.67±4.94^{ab}	30.00±6.32^{ab}
250 ng/ml	57.50±0.75^{b}	53.75±1.85^{b}	50.42±2.08^{b}	45.00±2.82^{b}	39.17±3.24^{b}
350 ng/ml	54.17±1.53^{ab}	45.83±0.83^{ab}	41.67±1.05^{ab}	33.33±2.47^{ab}	25.00±4.08^{ab}
450 ng/ml	55.00±1.82^{ab}	45.00±1.82^{ab}	40.00±1.82^{ab}	30.83±2.38^{ab}	21.67±2.78^{a}

Values (Means ± SE) in a column having different superscripts are significant (P<0.05)

Species specific semen extender for buffalo semen cryopreservation

High concentration of progesterone in egg yolk induces premature sperm capacitation and RU 486 an antiprogesterone agent, found to neutralize the effect during cryopreservation. To confirm our hypothesis, each ejaculate was divided into four equal fractions and diluted using egg yolk-based extender supplemented with different concentrations of RU 486 (0, 5, 10 and 20 µM) and cryopreserved. We found that RU 486 does not impair the post-thaw sperm kinetics and sperm motility but prevented cholesterol efflux and protect plasma membrane integrity that increased the ability of sperm to withstand stress imposed by cryopreservation. The RU 486 protection of sperm from premature capacitation was confirmed by CTC (chlortetracycline) assay and low expressions of tyrosine phosphorylated proteins (32, 75 and 85 kDa) in sperm. Further, ferric reducing ability of RU 486 suggests its antioxidant activity. Further, it was demonstrated that RU 486 mifepristone treated sperm underwent normal capacitation and tightly attach to zona pellucida indicating its normal fertilizing ability.



Level of serum kisspeptin and its relation to sexual behaviour and semen quality

The objective of the work was to develop weighted score system to evaluate the breeding bulls on the basis of reaction time, sexual aggressiveness, tactile stimulation, penile erection and ejaculatory thrust of buffalo bulls. The other objective was to estimate serum kisspeptin and its relation with testosterone, sexual behaviour and semen quality. Reaction time was positively correlated with tactile stimulation, body weight and negatively correlated with sexual aggressiveness and sperm concentration. Sexually aggressive buffalo bulls had positive correlation with sperm concentration. Ejaculatory thrust was positively correlated with sexual aggressiveness and penile erection. Semen volume was found positively correlated with age. The sperm concentration of first ejaculates is significantly greater than second ejaculate. Testosterone was negatively correlated with reaction time. Kisspeptin concentration was found higher in complete penile erection. Kisspeptin & testosterone concentration are not correlated with sperm concentration.

Feed Utilization

Feed resource utilization and improvement programme focuses on economizing the feeding by maximizing utilization of available feed resources in order to improve the productivity of buffaloes. Research work has been conducted on various aspects of nutrition viz. development of supplementation strategies of critical and limiting nutrients, unravelling diversity of rumen microbes and development of means of rumen manipulation, evaluation of newer feed resources including the unconventional by-products, determination of requirements of nutrients for economic buffalo production, biosafety of feeds etc. Salient achievements on various aspects are presented hereunder.

Effect of stimulants on fibre degradation, methane emission and fungal population

Supplementation of tree leaves rich in Essential Oils (EOs), affect the rumen microbial ecosystem by selective inhibition of specific group of microbes depending on the dose and constituents of essential oils as well as diet of animals. Therefore, a study was conducted to evaluate the effect of supplementation of EOs rich tree leaves (Poplar and Eucalyptus leaves) on enteric methane emission, body weight changes and nutrient utilization in buffalo calves. Eighteen female buffalo calves (10-14 months old, avg. BW 131.70 ± 27.70 kg) were divided into three groups of six each and fed wheat straw based diet with required quantity of standard concentrate mixture and a limited quantity of green fodder. Treatment groups were supplemented with a mixture of dry grounded Eucalyptus and Poplar leaves (25 g each leaves, EOL1; 75g each leaves, EOL2). The average body weight (kg), intake of dry matter (kg/d) of the calves and the digestibility coefficient of various nutrients did not differ significantly among the groups, indicating the level of essential oils rich feed additives did not affect the nutrients intake and their utilization. However, the methane concentration in exhaled air was decreased in EOL-1 and EOL-2 about 47.96% and 56.74% as compared to control after three months of feeding of the feed additives rich in essential oils.

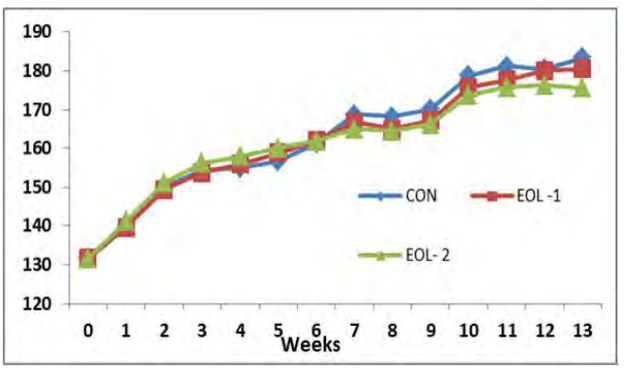


Fig . Body weight changes of buffalo calves

Influence of feeding leaves containing essential oil on in vivo methane production

Group	Methane conc., ppm		SEM	P Value
	Pre-dosing	3 months post-dosing		
CON	0.214 ± 0.09	0.260 ± 0.18	0.09	0.713
EOL-1	0.220 ± 0.08	0.115 ± 0.02	0.06	0.089
EOL-2	0.279 ± 0.05	0.101 ± 0.04	0.08	0.061

In Vitro fermentation kinetics, methanogenesis, and gas production potential of newly developed sorghum (Sorghum Bicolor) cultivars

A study was conducted to evaluate the nutritional quality, in vitro rumen fermentation characteristics, and methane production potential from fodder of sorghum cultivars newly developed by ICAR-IIMR, Hyderabad. Three different types of sorghum cultivars viz. SPV 2018 (brown midrib variety), CSH 24MF (sweet variety) and MP Chari (normal fodder variety) were cultivated in CIRB field, cut at pre-bloom stage and dried to make hay for use as substrate for fermentation study. The in vitro fermentation was carried out by incubating each sorghum cultivar as substrate (200±5mg) in 100 ml calibrated glass syringes following standard in

vitro gas production protocol. Gas production was recorded by displacement of piston at different time intervals for a period of 72h and kinetics of fermentation was studied. Neutral detergent fibre (NDF) and acid detergent lignin (ADL) content was significantly lower in CSH 24MF and SPV 2018 than MP Chari. Total gas production and dry matter degradability was higher (p<0.05) in SPV 2018 followed by CSH 24 MF and MP Chari at 24h of fermentation but they become similar at 72h. Potential gas production (b, ml/g DM) remained lower (p<0.05) with increased (p<0.05) fractional rate of gas production (c, rate/h) in SPV 2018 cultivar than CSH 24MF and MP Chari. The methane production (ml/g digestible DM) remained similar at any time of sampling. The enzyme estimation demonstrated increased (p<0.05) activities of xylanase, beta glucosidase and acetyle esterase in SPV 2018 followed by CSH 24 MF and MP Chari. Quantification of rumen microbial population in fermentation medium by qRT-PCR demonstrated increased number of total bacteria with lowered methanogenic archaeal population in SPV 2018 followed by CSH 24 MF and MP Chari. Therefore, brown midrib sorghum cultivar (SPV-2018) may be preferred over others because of their low fibre and lignin contents with higher gas production, DM degradability and VFA production for large scale fodder production and better feed efficiency.

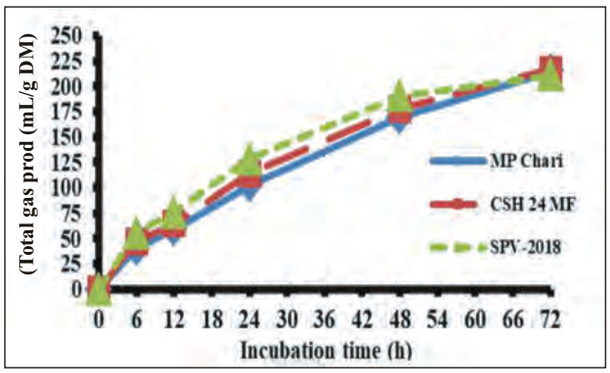


Fig. : In vitro **gas production of different sorghum fodder cultivars**

In vitro **fermentation kinetics of different sorghum fodder cultivars**

Attributes	Gas Production (ml/g DM)					Gas production Constants	
	6h	12h	24h	48h	72h	b (ml/g DM)	c (rate/h)
MP Chari	39.76^{a}	58.77^{a}	101.98^{a}	169.39	214.33	288.77^{b}	0.019^{a}
CSH 24 MF	47.04^{ab}	64.48^{a}	113.27^{ab}	177.77	216.10	255.66^{ab}	0.025^{a}
SPV 2018	55.40^{b}	76.18^{b}	128.13^{b}	190.41	211.22	229.33^{a}	0.036^{b}
SEM	4.60	4.68	0.009	8.55	1.94	16.29	0.005
P value	0.021	0.001	7.37	0.235	0.212	0.005	0.003

Rate and extent of gas production was determined for each feed by fitting gas production data to the nonlinear equation Y= b(1 − e−ct) (Orskov and Mcdonald,1979), where y is the volume of gas produced at time t, b the potential gas production (ml g−1 DM), and c the fractional rate of gas production. Parameters b and c were estimated by an iterative least square method using a non-linear regression procedure of the SPSS.

Hyper-ammonia producing bacteria from rumen of buffaloes and their inhibition

Investigations were carried out to determine predominant hyperammonia producing bacteria (HAB), to isolate and characterize HAB and to screen and select suitable additive for inhibition of HAB in rumen of buffaloes. Study employing high throughput sequencing of amplicons of 16S rRNA gene from metagenomic DNA recovered from enrichment culture of HABs of buffalo rumen indicated that at phylum level Proteobacteria (61.1 to 68.2%) was the most predominant HAB followed by Unclassified bacteria (24-29%). At genus level, among sequences with valid genus name Acidaminococcus was most predominant. Other genera detected include Candidatus, Carsonella, Allisonella, Oscillobacter, Bacteroides, Proteus, Fusobacterium, Pyramidobacter, Paraeggerthella, Denitrobacterium, Succinoclasticum and Acidaminococcus. Twenty isolates of HAB were isolated from rumen of buffaloes and they had very high rate of ammonia production (upto 200 times higher than that reported earlier) and had low16S rRNA gene similarity to cultured bacteria indicating that many more culturable HABs exist than that is known so far. In vitro studies with rumen fluid of buffalo indicated that most of the plant based additives tested (origanum oil, clove oil, lemon grass oil, eugenol, saponins, reetha extracts, bargad leaf extracts, etc.) tend to affect feed digestibility significantly at

dose level required for meaningful reduction in ammonia production. However, a combination of additives was found to reduce ammonia production significantly without affecting feed digestibility. On feeding the additive blend to adult fistulated buffaloes there were 55% reduction in ammonia level in rumen fluid which was much higher than that observed (17%) in in vitro studies. Further, there was no reduction in VFA production or total bacterial population or important fibrolytic enzymes. Feeding of the additive blend to growing buffaloes resulted in 14% increase in average daily gain in BW with a trend (P<0.10) in improvement of feed and protein utilization efficiency with no change in feed digestibility or blood biochemical parameters suggesting that these additives can be safely used for improving performance of buffaloes.

Supplementation of galactogogue herbal mixture

Enhancement of milk production from optimally fed buffaloes is challenging task and in present project, galactogogue herbal ingredients will be screened and evaluated on the basis of their chemical composition. Proximate analysis of five different herbal ingredients was done. Analysis of minerals contents is in progress. Further methanol extracts of the ingredients has been prepared for the determination of total phenols, total flavonol, and for their antioxidants properties.

In vitro **fermentation kinetics of different sorghum fodder cultivars**

S. No.	Ingredients	Dry Matter	Crude Protein (%)	Ether extract (%)	Crude fibre (%)	Ash (%)
1	Fenugreek seeds (Methi)	90.39±0.42	27.65±2.45	6.22±0.65	15.24±0.21	3.925±0.12
2	Cumin seeds (Jeera)	93.58±4.43	20.04±3.52	12.18±0.51	18.95±1.13	5.215±0.19
3	Jivanti roots	91.67±2.99	2.99±0.25	3.09±0.24	14.38±0.18	3.425±0.64
4	Shatavari roots	86.93±3.49	7.25±0.51	0.80±0.06	7.675±0.43	2.91±0.25
5	Fennel seeds (Saunf)	90.7±0.18	18.34±1.02	10.47±0.14	12.95±0.17	9.31±0.07

Supplementation of protected limiting amino acids to transition buffalo

The study was carried out to see the effect of dietary supplementation of rumen protected methionine (RPM), lysine (RPL) and choline (RPC) on the performance of transition Murrah buffaloes. A feeding trial was conducted involving twenty buffaloes at third trimester of pregnancy, divided randomly into four groups of five animals each on the basis of average body weight and previous lactation milk yield. The buffaloes were put on the experiment for 180 days i.e. 90 days pre partum and 90 days post-partum. In control group (G1), buffaloes were fed wheat straw, chaffed green fodder and compounded concentrate mixture as per ICAR (2013). In group G2, buffaloes were fed control diet supplemented with 7g RPM and 15g RPL; group G3 buffaloes were fed control diet supplemented with 50g RPC and group G4 buffaloes were fed control diet supplemented with 7g RPM, 15g RPL and 50g RPC. Dietary supplementation of rumen protected methionine, lysine and choline had no effect on average DM intake, body weight and body condition score (BCS) of buffaloes. Increased utilization in terms of digestibility % of DM, CP and OM was noticed in rumen protected methionine, lysine and choline supplemented group in comparison to control group animals. Results of the milk composition showed that supplementation of rumen protected methionine, lysine and choline in group G4 increased the contents of fat, protein, lactose and total solids significantly (P<0.05) whereas only fat content was increased significantly (P<0.05) due to rumen protected methionine and lysine supplementation in group G2 buffaloes. Similarly improvement (P<0.05) in 4% FCM, SCM, ECM and milk energy in supplemented buffaloes without any significant effect on milk yield per day. Haemato- biochemical results showed that rumen protected choline supplementation in group G3 significantly (P<0.05) decreased serum cholesterol, triglycerides and urea on both 45 and 90 days postpartum and decreased VLDL level on 45 days postpartum. Rumen protected methionine, lysine and choline in group G4 significantly (P<0.05) lowered serum cholesterol and triglycerides level on both 45 and 90 days postpartum; serum VLDL on 45 days and serum urea level on 90 days postpartum. Results of PHA-P assay showed that treatment mean values for skin fold thickness (%) were found to be comparable in all the groups (G1, G2, G3 and G4). However, at 24 hour of sensitization against PHA-P, the average values for skin fold thickness was significantly (P<0.05) higher in groups G2 and G4 in comparison with groups G1 and G3. The transcriptome analysis is in progress

Studies on development and supplementation of chelated minerals in buffaloes

Due to limited availability of trace minerals through their inorganic sources efforts were made to develop methods for chelation of trace elements copper, manganese and zinc with an amino acid glycine. Reducing the dose of these organic chelated minerals up-to the level of half (50-75%) of the inorganic one had no adverse effects in a long-term study on buffalo calves either on blood levels of minerals, blood biochemical parameters, the total antioxidant status including immune status and chelated minerals were able to compensate the demand of their counterpart inorganic sources. Even though levels of antioxidant enzymes remained higher ($P<0.05$) in the chelated mineral groups as compared to their control calves fed higher amounts of inorganic trace elements. Fecal excretion of all these three elements was also reduced ($P<0.05$) in the chelated elements fed groups, which remains indicative of environmental friendly nature of the product developed.

Critical micronutrient supplement for peri-parturient buffaloes

A study was undertaken to evaluate the effect of critical micronutrient supplementation during the peri-parturient period on production and reproduction status of Murrah buffaloes. Twenty-two healthy Murrah buffaloes in an advanced stage of gestation (average 53 days prior to their expected date of parturition) were divided into two equal groups i.e. control and treatment respectively. Buffaloes of both the groups were maintained on farm's standard feeding practices as per their requirement. Additional micronutrient supplementation was carried out once in a week in buffaloes of treatment group having Zn, Cu, Co, Cr, Se, vitamin E, vitamin A, and niacin. Supplementation of critical micronutrient improved production performance of Murrah buffaloes in terms of total milk (18%) and fat corrected milk ($P<0.05$) production in addition to improvement in fat and protein percentage ($P<0.05$) of milk. Critical micronutrient supplementation did not affect blood biochemical and micronutrient profile, except for an improvement ($P<0.05$) in plasma inorganic phosphorus level in the treatment group on the day of parturition. Reproductive performance of buffaloes remained unaffected due to weekly supplementation of critical micronutrients in the ration.

Assessment of feeding practices of Banni buffaloes under traditional husbandry practices

The data and information collected through survey and interview of Maldharis in four villages namely Bhirandiyara, Hodka, Hodka-Sethwad and Hodka-Erandewali revealed that average herd size is 94 buffaloes (ranged between 20 to 300). The Milk production parameters were: Wet average 6.35 kg & Herd average 4.61 kg and milk fat 6.73%. As many as 39 grasses samples, six concentrate mixture samples and four soil samples were collected to know the nutrient status of the feed being offered to these animals and suggest the ameliorative measures. All the four soil samples were deficient in Zn and three soil samples were deficient in Fe. The analysis of feed and fodder sample is in progress. The Banni buffaloes are maintained on extensive grazing feeding system. The behavioural parameters of Banni buffaloes were also recorded. The buffaloes go for night grazing without any buffalo boy and follow a typical grazing behaviour. In each herd four-five buffaloes act as group leader are tied a bell in the neck and rest of the buffaloes follow them on the sound of the bell while going and coming from grazing. The banni buffaloes also exhibit a strong mother instinct and it is this strong instinct towards their calves which brings them back to their shelter. An unknown person can go near to a buffalo or can touch in the presence of owner or buffalo boy but in absence of owner, buffaloes became aggressive and furious. While feeding concentrate, buffalo remain calm and wait for their turn to be fed. When a buffalo is in heat and bull is along with this buffalo, then other buffaloes do not interfere.

Cation- anion salt feeding to buffaloes during transition period

The acid-base balance of animals is dependent upon the balance between anions and cations in the blood and can affect their performance. The DCAD level in a diet of transition buffaloes and effect of feeding cation anion salt during transition period on feed intake, milk production, common metabolic disorders, Ca and Mg conc. in plasma were studied. Twenty buffaloes were divided into two groups of ten each on the basis of equal previous lactation milk yield. Treatment group was supplemented with 90g anaion (-749.16 mEq) salt/animal/day starting approximately 21 days before calving till calving and then same animals were fed 150g cation (+1473.36 mEq) salt/animal/day. There was significant ($P<0.01$) increase in dry matter intake in treatment group (2.65 vs. 2.37 Kg DMI/100kg B.wt.) during postpartum period. After calving there was significant ($P<0.01$) increase in plasma calcium (10.42 vs. 8.33 mg/dl) and in milk fat (6.83 vs. 6.24 %) during initial 6 weeks in treatment group. Milk yield increased (9.01 vs. 8.13 kg/day) during initial thirteen weeks.

Transfer of Technology

Institute is engaged in extension activities for propagation of knowledge on buffalo breeding, feeding, reproduction, health and management to the farmers through regular visits by the scientists/technical personnel to adopted villages, organizing trainings, demonstrations, lectures, calf rallies and treatment camps etc. The Institute is also working on Field Progeny Testing Programme in 10 villages around Hisar under Network Project on Buffalo Improvement, besides same extension research aspects.

Clean milk production

A pilot study was conducted in village Dhiktana and Sarsod, Distt. Hisar to understand existing practices pertaining to clean milk production. The study revealed that 46 percent respondents were having Kaccha floor in their sheds. It was also found that 68 percent respondents also felt that Kaccha floor was more comfortable for the animals. As far as cleaning of the sheds where animal died was concerned it was seen that 32 percent cleaned the floor by scrubbing the area where animal died. About 52 percent respondents reported that method of full hand milking was preferred while 52 percent were of the view that full hand milking was better than thumb pressure. About 70 percent respondents informed that maximum cases of mastitis were there in either third or fourth lactation.

Convergence for dairy development

Eminent persons in the field of agriculture and animal husbandry have emphasized for the need of convergence between different agencies working for dairy development. At present, the agencies are working in isolation and they converge only on few occasions for a particular purpose. There is a need to develop parameters for convergence and also to study nature and extent of convergence between different agencies. Model of convergence was developed by delineating the role of each agency. Participating agencies who could collaborate for sensitizing the farmers on clean milk production were identified along with their roles and expectation from each other. Thus, action plan along with responsibilities of each agency will be developed which will be agreed upon for testing the model of convergence developed.

ICAR-CIRB Scientists in trainings organised for tribal farmers

Participation of rural youth in farming

The project aimed to ascertain the level of participation of rural youth in different farming activities, examine the youth migration behaviour, exploring the attitude and aspirations of rural youth towards farming, assessing the perception of parents about the future of their children in farming and recommending the opportunities for generating remunerative livelihood opportunities for rural youth of Hisar. As per activity plan, a bilingual interview schedule for data collection was developed and data collection and analysis from 90 rural parents completed.

The results showed that majority of the parents (46.7%) as respondents belonged between 51-57 years age category and revealed poor education status. About 63% respondents (parents) had Agriculture as their main occupation followed by Agriculture and animal husbandry (14.4%). About 40% respondents fell under 1-2 ha land holding category (Small farmers) with an average herd size of 4.8 animal heads. As far as information source utilization was concerned, veterinary doctor and Veterinary Field assistants were the major sources for receiving animal husbandry information and got highest mean score followed by bank personnel and village Extension officer. About 83% of the respondents (parents) had no leadership position and the rest were mainly the members of the dairy cooperative (14.4%) followed by associations. Television was the major

mass media source being utilized by majority of the respondents based on their mean score (2.60) followed by newspaper and radio. Respondents (parents) were classified as per their educational, occupational, economic, social and career aspiration for their children.

Social aspirations were also found almost same of parents towards their children and youth towards themselves, both wished to be respectable as their major social aspiration. Career aspirations revealed by parents towards their children were different than their children for themselves. 26.6% youth wanted to be an entrepreneur, followed to be a soldier in army and then teacher whereas parents wished that their son should go in teaching line followed by soldier in army as a carrier. About 14 % parents wanted that their children should opt for entrepreneur as a career. A policy implication was prepared under title "lucrative farming to rein rural youth migration: A survey report". The findings led to recommendations to make the agriculture as lucrative and profitable occupation as outcome of the study for harnessing the huge potential of rural youth in farming of Haryana and of those in similar situations. The study concluded that profitable agriculture is crucial for attracting and retaining youth in agriculture.

Tribal Sub Plan

The Tribal Sub-Plan (TSP) was adopted as a strategy for the socio-economic upliftment of tribal population. Since 2015, the Institute has adopted four villages under this program in the Kherar Gram Panchayat, Tehsil Salumber, District Udaipur, Rajasthan. These tribal villages viz. Bhainson ka Namala, Tulsiyon ka Namla, Roba and Chatpur have a good number of buffaloes. Efforts were made along with Rajasthan State Department of Animal Husbandry to improve local buffalo breeds. Previously, the institute provided 1500 doses of superior Murrah frozen semen for distribution in the field and four Nilli Ravi bulls for natural service. The elite animals distributed have performed well and are in great demand for breed improvement. These farmers are setting example for others by enhanced income generation for sustainable livelihood in the tribal areas. During 2017-18, 500 doses semen were provided to the government veterinary hospital, Kherar Gram Panchayat, to cater to the farmers' needs. The calves born out of inseminations from the semen provided are born and are being reared in these villages. The calves born have got good acceptance from the villagers. Three training programmes were organized in TSP area. Draught tolerant high yielding varieties seeds for Maize, Moong and Sorghum sourced from National Seed Corporation (NSC) were provided to 218 tribal farmers in the adopted tribal villages (10 qtls maize seed, 9.20 qtls sorghum seed, 2.4 qtls moong seed). Distributed 80qtls concentrate mixture, 15qtls min mix and 30 steel kassi in villages adopted under TSP. The tribal farmers were also introduced to improved crop agricultural practices through use of improved farming implements. The tribal farmers were given demonstrations on following technologies for improving producing and efficient use of resources:

I. Breed improvement through use of AI

ii. Ration balancing

iii. Use of Mineral mixture for optimum production

iv. Hay and silage for fodder conservation

In addition, campaign on cleanliness, personal hygiene and health among tribal people was undertaken in all the four adopted villages. Following were specifically focussed during this initiative:

- Explaining importance of cleanliness, especially among school children
- Vaccination of children and animals – benefits, Govt. initiatives and related aspects
- "Swach Bharat Abhiyan" for cleanliness in the community places like panchyat bhawan, homes, around the animal farms and around villages.

Distributions of items to tribal women farmers for improved productivity of livestock.

Area Specific Mineral Mixture - demonstration

Interacting with tribal people for explaining importance of cleanliness and personal hygiene

Diversified Farming through Livestock and Agriculture

Farmer FIRST Project (FFP) was initiated with the objective of increasing productivity and round the year employment opportunity through scientific livestock production system (Buffalo and indigenous cattle) and honey bee farming to augment the farmers' income under diversification of agriculture farming system through Horticulture. Three villages viz. Dhansu, Kharkhadi and Khokha were adopted under the project for undertaking activities. Farmer's meetings and trainings were organized in villages. Assessed the feasibility of apiculture establishments along with livestock rearing through scientists-farmers interface. Established sixty five honey bee units (majority women farmers) and honey extraction was undertaken in the months of December 2017, January and February 2018. For udder health and control of mastitis in elite buffaloes 94 buffaloes were treated for mastitis, 66 AI carried out for improved buffaloes germplasm production, at farmers door. Following training/programs organized in the villages for

- Capacity building in apiculture by hands on training
- Procurement of hive assembly and management
- Honey management in winter and summer season
- Honey Extraction and value added products processing

FARMERS TRAINING

Total 15 trainings were organized in the institute during 2017-18 with the participation of 1078 farmers and 133 women. Lectures of bank officials, state department of animal husbandry, bee keeping and other enterprises were arranged with the help of experts. Training calendar for the whole year was prepared and put on the website of the institute which was strictly adhered to. Training programs were also organized in the villages on the special request of village Panchayats. In this training there were 154 participants. This training war organized in convergence mode as scientists of KVK, Bank officials, veterinarians of SDAH along with representatives of cooperatives also participated and jointly conducted this program.

Farmer's group trainings in villages (Package of practices for buffalo husbandry)

Date	Village	Participants
Aprl 29 - May 02, 2017	Sadalpur, Adampur	154
August 17-19, 2017	Ladwi, Hisar	121
August 18-21, 2017	Kharkari Makhwan (Bhiwani)	100
November 17-20,2017	Biran, Rajasthan	55
March 14-17, 2018	Chaudhrywas, Hisar	89

Trainings under tribal sub plan (Climate smart livestock rearing and farmers welfare and upliftment)

March 28, 2018	Chatpur (tribal vill.), Udaipur, Rajasthan	84
March 29, 2018	Roba & Tulsiyon ka Namla (tribal vill.), Udaipur, Rajasthan	195
March 30, 2018	Bhaisonka Namla (tribal vill.), Udaipur, Rajasthan	32

CIRB Hisar training (Scientific management of buffaloes)

June17-23, 2017	79
July15-21, 2017	77
September 10-16, 2017	60
September 13-19 ,2017	72
October 21-27, 2017	87
October 26-28,2017	48
December 15-21, 2017	90
February 21-24, 2018 (+ Nabha)	5
February 16-22, 2018	76
March17-23, 2018	98

OTHER EXTENSION ACTIVITES

Buffalo show

Buffalo Mela was organized at the Institute premises on February 04, 2018 in which about 100 elite animals and prize winning animals of 2015-16 and 2016-17 participated. The animals included buffalo bulls, lactating and dry buffaloes from all over Haryana and adjoining states. Many private companies also participated and put up their stalls.

Animal Infertility treatment camps & Kishan gosthis

Five infertility camps were conducted during this year at various villages viz. Bhatod (Rajasthan), Chaudhariwali, Kungar Bhaini, Malapur (Hisar), Thuiyan (Fatehabad). A total of 115 infertile buffaloes were treated for infertility problems (Anestrus, Repeat breeding and delayed puberty).

Demonstration of urea treatment of paddy straw

A demonstration of urea treatment of paddy straw for better use as animal feed was made to the farmers who visited the institute on March 17, 2018. The activity was carried out by Dr. SS Dahiya, Dr. PC Lailer and Dr. ML Sharma in the feed unit premises.

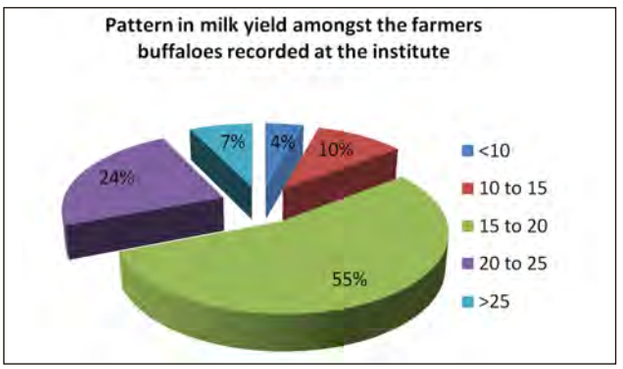
Participation in melas

The institute also participated in 9 melas which were organized in different parts of the country. This activity was coordinated by making arrangements regarding institute's participation by booking the stalls, preparing exhibits and literature for the benefit of the farmers.

Date	Place
22-23 Sept, 2017	PAU, Ludhiana, Punjab
28-29 Oct, 2017	Motihari, Bhiar
27-29 Oct, 2017	Pashumela Jhajjar, Haryana
23-25 Nov, 2017	National dairy Mela NDRI, Karnal, Haryana
1-5 Dec, 2017	National Livestock Championship, Patiala, Punjab
16-19 Mar, 2018	Krishi Unnati Mela, IARI , New Delhi
24-26 Mar, 2018	Agri Leadership summit, Rohtak, Haryana
27-28 Mar, 2018	Kisan Mela CCSHAU, Hisar, Haryana
23-24 Mar, 2018	Pashupalan Mela, GADVASU, Ludhiana, Punjab

Milk recording competition of famers' buffaloes

Milk recordings of 66 buffaloes belonging to farmers of Haryana & Punjab were done at the institutes' premises this year as compared to 33 and 34 in the years 2015-16 and 2016-17, respectively. Out of these,5 buffaloes yielded more than 25 kg milk and 21 yielded more than 20 kg per day. While 55% of the buffaloes yielded between 15-20 kg milk.



Mera Gaon Mera Gaurav Programme

Various activities under MGMG were organized viz. village visit, trainings, soil sampling, field demonstrations, infertility treatment and health camps.

Name of activity under MGMG	Activities conducted	Farmers participated
Visit to village by teams	51	2587
Interface meeting/ Goshthis	56	2873
Trainings organized and special days	12	1081
Demonstrations conducted	36	875
Advisories (No.)	-	1432
Literature support provided	18	3467
Awareness created	-	2999
Input support provided	03	51

Distinguished Visitors

- Sh. Om Parkash Dhankar, Agric. Minister, Govt. of Haryana
- Dr. Harsh Kumar Bhanwala, Chairman National Bank for Agriculture and Rural Development (NABARD)
- Dr Jimmy Smith, Director General, International Livestock Research Institute (ILRI)
- Dr. Major General R.M. Kharb Ex. Chairman, Animal Welfare Board of India
- Dr. AK Srivastava, Chairman
- Dr. JK Jena, DDG (AS & Fisheries)
- Dr. AK Singh, DDG (Extension), ICAR
- Dr. K Pradhan, Ex-VC, OUAT, Bhubaneshwar
- Dr H Rahman, Regional Representative South Asia Head, ILRI
- Dr. Arun Kumar Joshi, Asia Regional Representative, CIMMYT
- Dr. S Honappagol, Commissioner DAHD, New Delhi
- Dr. SK Ranjhan, Ex-FAO Consultant
  Dr. Antonio Borghese, Gen. Sec. IBF, Riome
- Dr. KP Singh, VC, CCSHAU, Hisar
- Dr Gurdial Singh, VC, LUVAS
- Dr. Rameshwar Singh, VC, BASU, Patna
- Dr. AS Nanda, VC, GADVASU, Ludhiana
- Dr. Ramesh Yadav, Chairman, Haryana Kisan Aayog
- Dr. R.S. Dalal, Secretary, Haryana Kisan Aayog
- Dr. R.S. Balyan, Member, Haryana Kisan Aayog
- Dr. R.S. Hudda, Director, CCS HAU
- Sh. RP Singh, GB member, ICAR
- Sh. Mahavir Singh Phogat, Dronacharya Awardee
- Dr. BS Prakash, ADG (AN&P), ICAR
- Dr. RS Gandhi, ADG (AG&B), ICAR
- Dr. VPS Chahal, ADG (Extension), ICAR
- Dr. MS Chauhan, Director CIRG, Makhdoom
- Dr. Arjava Sharma, Director NBAGR, Karnal
- Dr. Virender Singh, MD HLDB, Panchkula
- Maj. Gen. (Dr.) RM Kharb, AVSM (Retd.)
- Dr. MP Yadav, Ex-Director IVRI, Bareilly
- Dr. PK Uppal, Ex-Director NRCE, Hisar
- Dr. SK Agarwal, Ex-Director, CIRG, Makhdoom

Technologies Developed

ICAR-CIRB has developed numerous technologies for improved buffalo production over past several years. The technologies developed are economically viable, simple, user friendly and have wide applications in field. Important proven technologies of the Institute are listed as follows:

1. Production, maintenance and dissemination of superior germplasm

Institute maintains highly pedigreed herds of Murrah and Nili-Ravi buffaloes aimed at breed improvement through selective breeding particularly for the production of superior breeding bulls and bull mothers. 564068 doses of frozen semen from test bulls and progeny tested bulls are available for Murrah breed improvement. Since inception 896 Murrah and 316 Nili Ravi bulls of high genetic merit have been supplied to various developmental agencies and village panchayats in different States for improvement of production performance of buffalo genetic resources. During year 2017-18, total 54 breeding Murrah bulls were sold to various developmental agencies, breeders, panchayats and farmers, while Nili-Ravi bulls were sold primarily to Punjab State Animal Husbandry Department for frozen semen production and natural mating in breeding tract of the breed. During the period from April 2017 to March 2018, 136341 frozen semen doses were produced, 43856 doses supplied and 76704 doses sold for Murrah. 4093 A.I. were done in ten adopted villages. The conception rate in the field was worked out to be 54.46%. In this period, 2229 pregnancies were confirmed and 1593 calving (794 males, 799 females) were recorded for the purpose of bull evaluation.

2. Phenotypic marker for breed identification

Tongue colour could be an important phenotypic marker for breed identification. Tongue colour pattern revealed that pink colour in Nili-Ravi and black tongue colour in Murrah buffalo are governed by incomplete dominance of genes. The mix type or gray or spotted colour of tongue might be due to the incomplete dominance gene interaction, which dilutes the basic colour of tongue. The findings on tongue colour conclude that pure bred Nili-Ravi buffaloes have pink colour of tongue and pure Murrah animals have black tongue as an added breed characteristic. The mixed tongue colour (pink and black), grey, pink in Murrah graded and black tongue colour in Nili Ravi graded animals indicates inter-mixing in these breeds.

3. 'KALRUMPSCALE' for predicting milk production potential

This is a uniquely designed device to measure body conformations proved 'good' for milk production. This has a novel design which is mounted on rump surface area of buffalo to measure vertical and horizontal angles with all possible linear measurements under 3D orientation.This device is very useful for predicting milk production potential in buffaloes.

4. Semen production, sale and revenue generation

A total of 136341 semen doses were produced during the year and it was highest ever. The significant increase in production of semen doses was due to better monitoring of semen production activities throughout the year and generation of alternative manpower for each activity. A total of 76704 doses of semen were sold in field for germplasm dissemination. Revenue of Rs 21.35 Lakhs was generated by sale of semen doses and by earnings from semen freezing of field bulls. The revenue generation was also highest ever.

5. Scrotal circumference for bull selection

Larger testis found to produce more semen. Scrotal circumference (SC) of males is highly correlated with age and body weight and it can, therefore, be used for pre-selection of breeding bulls at an early age. According to this study, mean SC value was 35.23 ± 3.00 cm for mature Murrah bull (>600 Kg). It is recommended that, bull having scrotal circumference < 29 cm should not be used for breeding programme, while males with SC of over 41 cm (Mean +2 S.D.) should qualify as the best option.

6. Improved protocol for semen cryopreservation

Novel cryopreservation protocol for buffalo sperm was developed by altering the freezing rates in 3-step cryopreservation protocol. Using this protocol, significant improvement in post-thaw sperm motility and kinetics parameters (average path velocity, straight line velocity, sperm elongation, total, progressive & rapid motility), sperm live percent, plasma membrane and acrosome integrity was obtained. Patent has been applied for the technology.

7. Sericin for improved semen freezing

Sericin is a water-soluble globular protein (a protein hydrolysate) derived from silkworm Bombyxmori. Supplementation of 0.25-0.5% sericin in semen extender improved frozen-thawed semen quality through protecting sperm from oxidative stress.

8. Ready to use buffalo semen extender

Egg yolk is most commonly used semen extender for semen cryopreservation. There are some limitations of egg yolk based semen extender like wide variability of egg yolk composition, risk of microbial contamination, presence of high-density lipoproteins, calcium and steroids hormones. To solve the above stated problems, active ingredient of egg yolk was extracted and unwanted substances were removed from the egg yolk. Important additives were added and compared with raw egg yolk based extender and found that customized extender showed better performance in terms of sperm motility and freezability compared to egg yolk based extender.

9. Molecular markers for MAS

Seminal acidic fluid protein gene, known to govern fertilization efficiency through sperm stability in cattle bulls has been partially sequenced in 35 Murrah bulls, recorded for high and low field conception rates. SNP genotyping and sequencing revealed nucleotide polymorphism across exon 4-5. Four haplotypes were identified from sequence analysis. Relation between occurrence of SNPs and mean sperm motility and other estimated semen quality parameters by CASA were analysed for high and low conception rate bulls. Identified SNPs are suggestive markers for bulls screening w.r.t. conception rate.

10. Embryo transfer technology

Embryo transfer technology is a specialized technique for attaining the maximum number of embryos from a genetically superior animal in the shortest time possible. In this regard, ICAR-CIRB, established the superovulatory protocols for buffaloes and successfully produced 36 calves of superior animals. One calf was also born at the farmers doorstep using this technology. Large scale production of embryos is the need of hour for cloning, germplasm preservation, transgenesis, sexing, fertility testing and embryonic developmental studies. Procedures have been standardized and implemented regularly for the preservation and rapid multiplication of genetically superior characters of sire by making embryos available for somatic cell nuclear transfer.

11. Superovulation protocol for buffaloes at random stage of cycle

For multiple embryo production nearly 30-40 days are required for treatment planning and embryo recovery from donors. A protocol was developed that require only 12-17 days for programming, superovulation, insemination and embryo recovery thereby reducing programming to embryo recovery period by 50% as against conventional protocol. Protocol consists of examination of donors and administration of progesterone implant to all donors having a well-developed CL on day 0 of examination. Five days FSH treatment is initiated any day between 2-5 of implant. Implant is removed and prostaglandin injection is given on day 4 of super-ovulatory FSH treatment. Buffaloes are inseminated thrice at 12 h intervals, starting at 48h after Crestar removal. Embryo recovery is made on day 5/6 post-insemination.

12. Cloned male calf for semen production

Using cloning technology, it is possible to make multiple copies of an outstanding bull in the shortest possible time that could mitigate demand of proven semen. ICAR-CIRB produced Murrah superior cloned male 'Hisar-Gaurav' in 2015. Cloned bull started donating semen at the age of 22 months and is having good motility in fresh (70-85%) as well as post-thaw (50-55%) semen. Physiological and biochemical profile of semen/seminal plasma and sperm abnormalities was found normal even upto 120 min in heat test at 38.0 °C. Use of this semen for artificial insemination has shown encouraging results as 9 out of 15 inseminated buffaloes are pregnant in institute farm and 17 out of 34 animals are pregnant in field.

13. Cryopreservation of somatic cell lines from superior animals

Total 14 primary somatic cell lines were established and cryopreserved from adult elite buffaloes, which includes 4 from champion bulls. These primary cell lines were characterized using expression of cytoskeleton markers including vimentin for fibroblast origin type and cytokeratin for epithelial origin type. Cryopreserved cell lines would be viable genetic material for long term maintenance of elite germplasm, which have wide range of applications including cloning

even after death of animal, induced pluripotent stem cells production and unlimited DNA/RNA/protein source for any research purpose.

14. Ultrasonography for monitoring ovarian activity

The non-invasive technique of ultrasonographic scanning was used for diagnosis of ovarian activity in peri-pubertal heifers, parous buffaloes and anoestrus/ cystic animals. The technique is very useful for detecting cyclic status of animals on single ultrasound examination as well as infertility diagnosis. The technique is nearly 95% accurate as compared to twice examination per rectal or progesterone assay carried out at 10 days interval for cyclic status detection. With the use of this technique, time of ovulation following estrus induction and synchronization therapy can be predicted very precisely to allow fixed time insemination without the need for estrus detection.

15. Ovsynch plus protocol for estrus induction

Anestrus condition in buffaloes lengthen calving interval and reduce net calf crop. A protocol named as Ovsynch Plus has been developed to bring buffaloes in heat. Protocol consists of an injection of PMSG (400 IU) on Day 0, GnRH injection on Day 3, an injection of PGF on Day 10 followed by fixed time insemination at day 12 along with second GnRH injection. The major advantage of this protocol is that this protocol is superior to Ovsynch protocol with conception rate close to 35% and resumption of cyclicity in more number of buffaloes after treatment.

16. Pregnancy diagnosis and fetal age determination

Pregnancy can be diagnosed as early as 26 days post insemination using ultrasound scanning of genitelia. A standard chart was developed for crown-rump length of buffalo fetus on different days post insemination for determining the age of fetus in pregnant buffaloes. The exact date of mating could be predicted very precisely using this chart and it helps in better management.

17. Fetal sex determination

Ultrasonography guided fetal sex determination technology has been standardized. Based on location of the genital tubercle, an accurate diagnosis can be made at 55 day of gestation in buffaloes as against 50 days reported in cattle. The technique is useful in progeny testing as well as for production of breeding bulls in bull mother farms. Farmers can also check the fetal sex to help them in sale/ purchase of dams.

18. Dry Colostrum

Prevalent field practice of feeding of colostrum after long awaited placenta -expulsion remains one of the major causes of low calf survival rates in buffaloes. Higher calf mortality is a loss of quality germplasm which affects heifer- replacement or bull development of profitable buffalo breeds. Drying of colostrum to achieve ready to feed powder form, without loss of its immunity property has been developed by spray drying of colostrum. Surplus colostrum was salvaged at farm and transported to spray drying machine in cold chain. Drying was done under controlled temperature and air pressure to ensure nutrient quality of colostrum. Dry colostrum powder is a 'supplementary diet' for calf health and survival. Weaned calves, kept segregated from dams can be fed on this powder for four days by reconstitution of powder and bottle feeding. Dry colostrum feeding resulted in reduced mortality and faster growth rate by 20-22%.

19. Designer calf starter

The critical deficient limiting amino acids i.e. methionine and lysine had an important role to play in balancing of amino acids for efficient utilization of feed protein (CP). The designer calf starter can be prepared with the addition of lysine and methionine reducing cake i.e with reduced CP content (21 and 20%, respectively) and fed to three groups of six male calves (age 30 to 45 days and 58.40 kg mean body weight) each for a period of three months. Higher growth rate (11 and 20%, respectively) with increased efficiency of feed utilization (14.6 and 22.7%, respectively) leads to savings on the cost of feed per kg weight gain (15.3 and 25.5%, respectively) in CS2 and CS3 fed groups as compared to CS1 without affecting the digestibility of organic nutrients.

20. Antioxidants in survival and growth of neonates

Advanced pregnant (270 to 280 days' gestation) buffaloes, administered two doses of antioxidant micronutrients, consisting of vit A (Palmitate), vit D and vit E (dl- alpha 3 Tocopherol acetate) at 15 days intervals, secreted 25-80% more IgG protein in colostrum than control buffaloes. Calves born to treated buffaloes were also supplemented with mineral mixture @ 5 g/calf/day, colostrum feeding @ 10% of birth weight, concentrate mixture starting 10 to 15 days after birth and green fodder offered after 3 weeks, in order to achieve high growth rate and survival. These calves

gained 10% higher body weight and had 30% better immunity as compared to non-supplemented calves.

21. Feeding standards for different categories

Feeding standards have been developed for different categories of buffaloes, viz. growing males, growing heifers, breeding bulls, lactating buffaloes and pregnant buffaloes by taking into account the nutrient requirement for growth and production as well as gestation. Required inputs for ICAR (2013) feeding standards were provided by the institute.

22. Feed restriction for heifers

Feed efficiency has an important role in economics of feeding ruminants. A technology was developed for buffalo heifers of about 18 – 24 months for improving the feed utilization. As compared to the normal feeding practise of equal proportion (50:50) of concentrate and roughage (wheat straw) *ad lib*, targeted group was fed as per nutrient requirement with restriction of dry matter up to 2.18% of the body weights. Restricted feeding was helpful in saving 20% of wheat straw (~635 g per animal per day) as compared to the control, without compromising the growth rate (~750 g/day). Technology was also helpful in reducing the feed and fibre intake with simultaneous enhancement in neutral detergent fibre digestibility as well as reduction in the cost of feeding of buffalo heifers.

23. Critical micronutrient supplement for peri-parturient buffaloes

Peri-parturient period is a critical period in the life of dairy animals and nutritional interventions are desired to counteract the stress during the period, which leads to animal's reduced performance. Additional supplementation of especially designed micro-nutrient to targeted peri-parturient buffaloes needs to be fed once in a week only from 8 weeks pre-partum to 8 weeks post-partum. The supplement includes trace minerals Zn, Cu, Co, Cr, Se with vitamin E, A and niacin and was helpful in improving production performance of Murrah buffaloes in terms of total milk (18%) and fat corrected milk production.

24. Urea molasses mineral blocks (UMMB)

Urea molasses mineral blocks are prepared in the same way as Uromol, except the addition of mineral mixture, salt and binder. By ad lib feeding of these blocks along with other feed ingredients, about 20 percent of the conventional concentrate mixture can be saved.

25. Feed additive for methane mitigation

A composite feed additive was developed for reducing methane emission and improvement in fibre utilization by ruminants. The feed additive can reduce methane emission by 75% (by reducing number of methanogenic archaea in rumen) and simultaneously promote growth of alternate hydrogen utilizers like sulphate reducing bacteria. Its beneficial effects are not affected by microbial adaptation/resistance over time. The feed additive does not affect number of useful microbes in rumen (bacteria and fungi) and stimulate rumen ecosystem by increasing microbial fibrolytic activity. Thus there is increased fibre digestion and reduced rate of ammonia production in rumen. Overall the feed conversion efficiency increased by 15% and production performance (growth rate) increased by 10%. Patent has been applied for this novel technology.

26. Superior isolates of anaerobic fungus

Superior isolates of anaerobic fungus were isolated and evaluated for ability to increase in vitro digestibility of straw by buffalo rumen microflora. Such isolates have the potential to be used as feed additives. Among 165 isolates studied, the isolate Neocallimastix sp. CF 17 showed the highest CMCase and xylanase activity in pure culture medium containing straw. Growing buffaloes fed with encapsulated culture of the fungus resulted in 20 % increase in growth rate. Supplementation could not reach up the significant level. The inclusion level of these mixed enzymes is around 1 kg/ton of concentrate. The cost of commercial enzymes i.e. xylase and cellulose vary between Rs 200 to 250/kg and are usually used in huge quantities in textile industry (cellulose) and paper industry (xylanse).

27. Enzyme supplementation

Fibrolytic enzyme supplementation can be used as feed ingredient in the concentrate mixture of calves to increase the growth rate and nutrient utilization. Mixed supplementation of xylase and cellulose (cellulase and xylanase @ 6000 and 15000IU / Kg DM of substrate) in the diet of growing calves, resulted in increased digestibility of DM, OM and CF digestibility. It resulted in significantly higher growth rate in supplemented group (486.42±25.28 g/d) as compared to control group (411.23±17.85 g/d). Its supplementation also increased the DMI/d in treatment group or in other words it increased the appetite. Supplemented group calves get more energy per unit of fodder with higher DMI.

28. Area-specific mineral mixture

Surveys of feeding practices carried out in Haryana revealed deficiencies of essential minerals like calcium, phosphorus, zinc, copper and manganese. On the basis of analysis of mineral intake vs requirement, an area specific mineral mixture (ASMM) was developed. With the supplementation of this mineral mixture in the ration of anestrus buffaloes, seventy per cent buffaloes conceived within a period of 4 weeks. The mineral mixture improves feed intake, milk production and reproductive efficiency. Institute has been preparing and selling mineral mixture to the farmers for encouraging adoption of this technology. The technology for preparation of ASMM has been licensed to a private firm. Area specific mineral mixture for the adopted villages in Udaipur district of Rajasthan under Tribal Sub Plan (TSP) was also developed and distributed.

29. Chelated trace minerals with enhanced bioavailability

Due to limited availability of trace minerals through their inorganic sources for ruminants, source of trace minerals with higher availability is today's need. Different methods for chelation of trace elements copper, manganese and zinc were developed using smallest amino acid glycine as an organic molecule. Inclusion of chelated copper, manganese and zinc in mineral mixture reduced the required supplemental amount of those elements up-to-half of the amount given through their inorganic sulphate sources in buffaloes. No adverse effects were seen after a long term study on the growth performance, blood parameters, antioxidant status and immune status. Higher levels of plasma antioxidant enzymes in the chelated mineral fed buffaloes remained indicative of their higher bio-availability for animals. Reduced faecal excretion of these elements was also an added advantage and indicative of environmental friendly nature of the product developed.

30. Management of Thermal stress

Heat stress results from the animals' inability to dissipate sufficient heat to maintain homeothermy. Microclimate modifications together with supplementation of niacin @ 6 g/day/animal, yeast @10 g/day/animal and mustard oil @150 g/day/animal lead to enhanced milk production of lactating buffaloes by reducing thermal stress . It is also advisable to feed partially mixed wet ration (sanni), but moisture content should not exceed 50% in total ration.

31. Induction of lactation

Farmers are commonly facing the problems of conception failure, anestrous, cystic ovaries, abortions and repeat breeding. Such farmers can benefit by inducing infertile animals into lactation using hormonal therapy. Estradiol-17β and progesterone @ 0.1 mg/kg body weight/day is given for seven days. In brief, on the day of treatment, 1 ml of each hormone solution is administered subcutaneously in the morning and evening at 12 hourly intervals for seven consecutive days. Thereafter, on day 17, 19 and 21; 10 ml Largectil injection are also given intramuscularly. Udder massage is given between 15th and 21st day of treatment for 15 minutes in morning and evening daily. Milking is started on 21stday of treatment. The milk becomes normal in physical and chemical properties within 10-15 days of the start of milking and the amount of milk yield increases with time.

Patents filed

- Kumar R, Jerome A, Kumar P, Monika Saini, Kumar D, Sharma RK, Singh I. Provisional Patent filed on "Process for Improving Riverine Buffalo sperm viability and uses thereof" (IP36395/SS; Indian Patent Application No 201711039431 dated 6 Nov.2017).
- Dey A, Paul SS, Dahiya SS, Balhara AK, Jerome A, Punia BS, Mery YC. Complete patent filed on composite feed additive for reducing methane emission and improving fibre utilization in ruminants. (IP36394/SS; Indian Patent Application No. 201711046302 dated 22 Dec. 2017).

Awards & Recognitions

Dr. Inderjeet Singh was conferred "Distinguished Scientist Award" of the Indian Society for Buffalo Development (ISBD) for his meritorious achievements and commendable contribution to buffalo research and development during the inaugural session of the IX Asian Buffalo Congress on "Climate resilient buffalo production for sustainable livelihood" on February 1, 2018. Dr. Harsh Kumar Bhanwala, Chief Guest, Hon'ble chairman, NABARD presented the citation and shawl.

Dr. Avijit Dey was conferred **Distinguished Scientist Award 2015-16** by the Society of Bioresource and Stress Management for during 3rd International Conference, Nov 8-11, 2017 at Jaipur, Rajasthan.

Dharmendra Kumar received **Prof. G. P. Talwar Middle Career Scientist Award** from ISSRF during the World Congress on "Reproductive health with emphasis on family planning and assisted reproductive technology & 28th annual meeting of the ISSRF.

Best Paper Awards

Prasad M, Ranjan K, Brar B, Shah I, Lalmbe U, Manimegalai J, Vashisht B, Gaury M, Kumar P, **Khurana SK**, Prasad G, Rawat J, Yadav V, Kumar S and Rao R. 2017. Virus-Host Interactions: New Insights and Advances in Drug Development Against Viral Pathogens. *Current Drug Metabolism,*18, 942-970.

Phulia SK, Pratibha, Sharma RK, Balhara AK, Sunesh, Bharadwaj A and Inderjeet Singh In: IX Asian Buffalo Congress on *"Climate Resilient Buffalo Production for Sustainable Livelihood"* in Physiology theme.

Rekha Yadav, Hema Tripathi, P Kumar, N Kumar and N Ramesh In: IX Asian Buffalo Congress on *"Climate Resilient Buffalo Production for Sustainable Livelihood"* in Socio-economic theme.

Dharmendra Kumar, Taruna Anand, Naresh Selokar and PS Yadav In: IX Asian Buffalo Congress on *"Climate Resilient Buffalo Production for Sustainable Livelihood"* in Biotechnology theme.

Attri K, Dey A, Bharadwaj A and Dahiya SS In: IX Asian Buffalo Congress on *"Climate Resilient Buffalo Production for Sustainable Livelihood"* in Climate Change theme.

VB Dixit, Hema Tripathi and I Singh In: National Conference at PITSAU Hyderabad held on April 22-24, 2017.

Best poster presentation Award

Singh RK, Dey A and Singh M. In: International Conference on gender issues and socio-economic perspectives for sustainable rural development (GIRD-2017) held at CCSHAU, Hisar, India from October 23-25, 2017.

Post-award travel grant of Best teacher award of ICAR was used by Dr. Hema Tripathi to deliver lecture on "Extension methodologies-livestock Extension information delivery systems in India" at LUVAS Hisar, GADVASU Ludhiana , RAJUVAS Bikaner, CoV&AS Udaipur, BASU, Patna Institute of Agriculture Sciences, BHU, Varanasi, CoVS, Khanapara and CAU Sikkim.

Congress/Workshops Meets Organised

9th Asian Buffalo Congress

The 9th Asian Buffalo Congress was inaugurated by Dr Harsh Bhanwal, Chairman NABARD as the Chief Guest on Feb. 1, 2018. The Congress was attended by 213 delegates (46 foreigners) from thirteen countries across the globe – Sri Lanka, Bangladesh, Nepal, Brazil, Bulgaria, Columbia, Italy, Philippines, Nigeria, Guatemala, USA, UK and India. Considering the importance of future market of buffalo milk and meat, India is expected to hold big share of profit in global market. Dr S.S. Honnappagol, AHC, GoI explained efforts towards strengthening the AI Centres through Rashtriya Gokul Mission to increase AI coverage in buffalo in country. Dr JK Jena, DDG (AS), ICAR introduced the animal science activities undertaken nationwide and emphasized impact of climate change on productivity of animals and suggested to consider technology development in view of combating with conditions arising from this change to achieve sufficiency in nutritional security with quality and safety concerns. Dr Harsh Bhanwal, Hon'ble Chairman NABARD emphasized doubling farmer's income is likely to be achieved only if livestock production is adopted simultaneously with crop farming. Adoption of climate resilient technologies to propagate total production was emphasized, especially, for marginal and small holding farmers. He addressed importance of integrated farming using climate smart technologies. In view of scarcely available water resources, he pointed out that less water consuming technologies are the need of the day to sustain agriculture and livelihood in country. On the last day of congress, a buffalo show was organised in order to showcase our best germplasm to the dignitaries and foreign delegates attending the event. The buffalo show was inaugurated by Hon.ble Agriculture Minister of Haryana, Sh. OP Dhankar. Dr. Ramesh Yadav Chairman, Hayana Kisan Ayog, Dr. AK Srivastava, Chairman ASRB, Dr. A.K. Singh, DDG (Extension) ICAR and Vice Chancellors Dr. K.P. Singh, CCS HAU, Dr. Gurudial Singal, LUVAS and Dr. Rameshwar Singh, BASU, were amongst the distinguished guests.

Workshop on increasing the income of farmers

A workshop was also conducted on increasing the income of farmers based on the experiences of progressive farmers on 20th June, 2017. Dr RK Yadav Chairman Hayana Kisan Aayog was the chief guest on the occasion while Dr KP Singh Vice-Chancellor CCSHAU, Hisar and Chairman of the ICAR State level committee for 'Doubling Farmers Income' chaired the proceedings. Different stakeholders of Agricultural and dairy development participated i.e. representatives of CIRB SDAH, SD Agriculture, fisheries, Horticulture, CCSHAU, LUVAS, HLDB, LEAD Bank, ATMA, DRDA. Besides 60 farmers excelling the fields of agriculture, dairy, fisheries, horticulture and bee keeping also participated. Recommendations emerged from the workshop were finally included int he report of farmers commission and other policy making bodies, particularly in the document prepared by the State Level committee of ICAR for DFI .

Network Project on Buffalo Improvement (NPBI)

15th Annual Review Meet of ICAR-Network Project on Buffalo Improvement (NPBI) was held on 21-22, July, 2017 at ICAR-RCER, Patna. The meeting was chaired by Dr. J K Jena, DDG (AS), ICAR-New Delhi and Dr. Rameshwar Singh, Vice Chancellor Bihar Veterinary University; Patna was the guest of honour during the inaugural session. The annual review meet was co-chaired by Dr. RS Gandhi ADG (AB&P) ICAR-New Delhi, in the presence of Dr. Inderjeet Singh, Director ICAR-CIRB & Project Coordinator, NPBI and Dr. Vineet Bhasin, Principal Scientist (AG&B) ICAR-New Delhi.

Dr Bhati, Director ICAR-RCER also expressed his views in inaugural session.

Brainstorming Workshop on NPBI-Data Tabulation and Presentation was organised on October 24, 2017 at ICAR-CIRB, Hisar. An Interactive Meet of all the Principal Investigators of Murrah Centres (LUVAS, GADVASU, NDRI, IVRI, CIRB) was held on February 27, 2018 to discuss various issues related to project and inclusion of genomics selection in breeding programme. Dr KP Singh and Dr A Bharadwaj were the coordinators.

Training Course on "Animal breeding data analysis and genomic prediction"

A training course on "Animal breeding data analysis and genomic prediction" was organized under CIRB-ILRI project during November 20 to 24, 2017 for capacity building on genomic selection. Dr Arjava Sharma, Director, NBAGR Karnal inaugurated the course. Course was jointly conducted by scientists of CIRB and ILRI Nairobi. Course outline was designed and delivered by the guest faculty from Nairobi, Kenya, Dr Raphael Mrode and INRA, France, Dr Vincent Joseph. Dr KP Singh and Dr P Sikka were the coordinators of the training. Seveneen participants from different SAUs, ICAR institutes and other organizations covering eight states participated in the training. Dr Gurdial Singh, Vice Chancellor, LUVAS, Hisar graced the valedictory function and distributed certificates to trainees.

QRT meeting of AICRP (NIANP, Bangalore)

QRT review meeting of AICRP on 'Nutritional and physiological interventions for enhancing reproductive performance in animals' and outreach project on 'Estimation

of methane emission under different feeding systems and development of mitigation strategies' was conducted at ICAR-CIRB on December 26-27, 2017. The meeting was chaired by Dr. MP Yadav and attended by Dr SK Agarwal, Dr. DT Pal and Dr. Inderjeet Singh alongwith PIs of different centres *viz*. Dr. RK Sharma (CIRB Hisar), Dr AJ Dhami (AAU Anand), Dr PR Pandya, (AAU), Dr MJ Aware (BAIF) and Dr Manju Wadhwa (GADVASU).

Modern dairy farm management - MTC

A model training course on "Modern dairy farm management: production, reproduction, health and nutrition" was held at the institute from October 9-17, 2017. Twenty six participants from Assam, Chhattisgarh, Haryana, Maharashtra, Punjab and Uttar Pradesh attended the training. Dr. Virender Singh, MD Haryana Livestock Development Board awarded certificates to the participants on successful completion of the training program. The training was coordinated by Dr. Ashok Boora and Dr. A Bharadwaj.

Maj. Gen. (Dr.) R.M. Kharb, AVSM (Retd.), Ex-Chairman, Animal Welfare Board of India with Director CIRB and participants.

Climate Smart Buffalo Husbandry-MTC

A model training course on "Climate smart buffalo husbandry" was organized from November 13-20, 2017. This program was designed to acquaint the field functionaries especially the field veterinarians with the impact of climate change and ways of mitigation. This program also sensitized the participants about various 'green technologies' available for higher production in dairy animals. There were 25 participants from six states viz. Chhattisgarh, Haryana, Madhya Pradesh, Orissa, Punjab and Uttar Pradesh. Total of 38 lectures were conducted covering various aspects of climate change vis-à-vis livestock production systems. The training was co-ordinated by Dr. AK Balhara and Dr. SK Phulia.

Trainings for professional

Training on practical embryology for medical/professionals was organized at the institute from July 24-28, 2017. The course was organized by Dr PS Yadav (Course Director),Dr. D Kumar and Dr. Pradeep Kumar (Course Coordinators). The training was attended by Dr. Cherry Bansal, MBBS, M.D, PhD (Pathology). The training was imparted on various aspects of reproductive biotechnology including semen cryopreservation.

Interactive meet on breed characters of Nili-Ravi buffaloes

An Interactive meet on ""Nili-Ravi – The Pride of Punjab: Current status and development"" was organised at Ferozepur (Punjab) on December 16, 2017 in collaboration with Animal Husbandry Department, Govt. of Punjab (AHD, GoP). The meet was attended by a total of 74-participants including 14 resource persons from the institute, AHD GoP, Punjab Dairy Development Board, NGOs and private partners; 30 veterinary officers and 30 farmers from Punjab and Narwana (Haryana). The meet was organized by Dr. KP Singh, Dr. Sanjay Kumar, Dr. Mustafa H. Jan and Dr. KL Mehrara. This interactive meeting was the follow-up of a workshop on "Redefining the phenotypic characters of Nili-Ravi Buffalo" held in october 2016 at Nabha . This interactive meet, like the previous workshop, was conceived to dispel the wrong impressions that have settled in farmers about characteristic features of Nili-Ravi buffaloes that only the Panch-Kalyani character is a defining feature. It was recommended to establish 'Nili-Ravi Buffalo Breeders' Association' on similar lines as other breeders' associations to register, conserve and propagate superior Nili Ravi germplasm.

Important Committees

Institute Management Committee (IMC)

26th meeting of Institute Management Committee (IMC) of ICAR-CIRB was held on December 23, 2017 at the main campus. During the meeting, proceedings of previous IMC was confirmed and then action taken report on the proceedings was presented. IMC expressed satisfaction over the action taken. Grievance committee of the institute was constituted. IMC appreciated the efforts of the scientists and exhorted them to take up research on issues of direct concern to the farmers aimed at solving the problems being faced by them in buffalo husbandry. It expressed its satisfaction on the progress of infrastructure development and hoped the same will be utilized to the optimal level. It also found the working atmosphere at the institute congenial to further progress.

Composition of IMC

Dr. Inderjeet Singh (Chairman)

Members

Dr. RS Sheokand, LUVAS
Dr. (Mrs) P. Sikka, ICAR-CIRB
Dr. Rajendra Kumar, ICAR-NRCE
Dr. Ajay Kumar Dang, ICAR-NDRI
Dr. RS Kataria, ICAR-NBAGR
Director (AHD Haryana)
Director (AHD Punjab)

Member Secretary

Sh. Rishi Ram, Admin. Officer

Research Advisory Committee (RAC)

The XXI RAC meeting was held on November 29-30, 2017 under the chairmanship of Dr K Pradhan, Former VC, OUAT Bhubaneswar. Chairman in his opening remarks stressed that scientists should have a few focused projects, prioritize the research and complete the projects in time as resources are limited. Director presented the achievements and priority programs of the institute. He apprised the RAC with the progress and the future activities being taken up by the institute. Significant improvement in the performance of animal farm, agriculture farm, landscaping, and renovation of old sheds for comfortable animal housing along with the research output of good quality was observed by the Committee. After thorough discussion, RAC recommended to carry out research on buffalo genomics, methane mitigation & fibre utilization and suggested that greater emphasis be given to prepare for climate change challenge. Further, it suggested to take up impact analysis of socioeconomic with buffalo at centre stage of diversified integrated agriculture and efforts should be made to increase the income of farmers.

Composition of RAC

Dr. K Pradhan, Former VC, OUAT Bhubaneswar (Chairman)

Members

Dr. Rameshwar Singh, VC, Bihar Ani. Sci. University, Patna
Dr. B.S. Prakash, ADG (AN & P), ICAR N Delhi
Dr. BG Mukhopadhya, Ret Chief GM, NABARD
Dr. KR Trivedi, Advisor, NDDB, Anand
Dr. D.K. Sadana, Former Pr. Sci., NBAGR, Karnal
Dr. Vineet Bhasin, Principal Scientist, ICAR HQ, N Delhi
Dr. Inderjeet Singh, Director, CIRB

Member Secretary

Dr. R.K. Sharma, Principal Scientist, I/C Head APR

Institute Research Committee (IRC)

Annual IRC meeting was conducted on May 29-30, 2017. The RPPs submitted by various PIs were got evaluated by the subject matter experts. IRC meeting was held on June 16-17, 2017 again for the external projects and those projects which could not be discussed on May 29-30, 2017 due to paucity of time. Mid-term review of IRC projects was held on November 27, 2017 in order to monitor the progress of the projects. Further, a supplementary IRC for the monitoring of various projects was also conducted on February 28, 2018 to review new projects.

Composition of PMC

Dr. Inderjeet Singh (Chairman)

Members

Dr. S S Dahiya
Dr. (Mrs) P. Sikka
Dr. V.B. Dixit
Dr. K.P. Singh
Dr. S.S. Paul
Dr. Dharmendra Kumar

Member Secretary

Dr. Navneet Saxena

Project Monitoring & Evaluation Committee (PMC)

Two meetings of PMC were conducted viz. on May 10, 2017 and May 17, 2017. The committee finalized the names of experts for the evaluation of projects. Also committee identified current researchable issues contemplating recommendations of the Institutes' Research Advisory Committee. Important research areas identified were.

- Buffalo genomics and biotechnology including sex pre-selection.
- Climate change and its impact on buffalo production and reproduction.
- Economics of milk production, calf rearing, heifer management including feeding management of high yielding buffaloes e.g. using TMR, group feeding behaviour.
- Integrated farming at village level/model village/livelihood security and socio-economic aspects of buffalo farming.

Major Events

VIGILANCE AWARENESS WEEK

Institute observed the period from 30th October to 4th November 2017 as "Vigilance Awareness Week". A integrity pledge was administered by the Director CIRB to all officials of the Institute on 30th October, 2017. Director sensitized the staff for maintaining highest standards of integrity, transparency and good governance. He also emphasised about the zero tolerance towards corruption, honest discharge of duties and importance of public participation in eradicating corruption. All employees were advised to take e-pledge as a citizen and record it through the website https://pledge.cvc.nic.in. Leaflet on "Vigilance Awareness - General Conduct" and "Do's and Don'ts" were distributed among the employees and the same was also uploaded on the institute's website. Different posters related to anti-corruption were displayed at prime location in the office.

AGRICULTURAL EDUCATION DAY

Agricultural education day in in Government School, KheriMakhwan on 3 December 2017. Nearly 150 students and staff (Dr. SS Dahiya, Dr. VB Dixit, Dr.HemaTripathi and Dr PS Yadav) of ICAR-CIRB participated in this event

हिन्दी सप्ताह

संस्थान में दिनांक 14 से 21 सितम्बर तक हिन्दी सप्ताह का आयोजन किया गया इस अवसर पर संस्थान के कर्मचारियों के बच्चों के लिए तथा संस्थान एवं अन्य केन्द्रों के कर्मचारियों के लिए हिन्दी की निबन्ध प्रतियोगिता परिच्छेद अनुवाद (अंग्रेजी से हिन्दी), हिन्दी शब्दानुवाद (अंग्रेजी से हिन्दी), हिन्दी निबंध प्रतियोगिता एवं हिन्दी टंकण प्रतियोगिता का आयोजन किया गया। हिन्दी सप्ताह का समापन समारोह दिनांक 21 सितम्बर को आयोजित किया गया जिसमें रोहतक आकाशवाणी केन्द्र के वरिष्ठ उद्घोषक डॉ सम्पूर्ण की गौरवमय उपस्थिति में पुरस्कार वितरण किया गया। समापन समारोह के दौरान मुख्य अतिथि द्वारा हिन्दी में वर्ष के दौरान सर्वाधिक कार्य करने हेतु संस्थान में कार्यरत श्रीमती सुशीला देवी, श्री धरमपाल, प्रधान वैज्ञानिक श्रीमती हेमा त्रिपाठी तथा श्री दिनेश कुमार को भी नगद पुरस्कार से सम्मानित किया गया।

Young entrepreneurs from Jammu & Kashmir on Sadhbavna Mission by Romeo Force, Indian Army at CIRB, sub-campus, Nabha on February 28, 2018

International Yoga Day 21st June, 2017

Constitution Day (Samvidhan Divas) 26th November 2017

CIRB employees participating in cleanliness drive

Agriculture Education Day 3 Dec. 2017

Director, CIRB hoisting the National flag on Independence Day.

Republic Day Celebration

Broadcast of PM Modi Speech on Krishi Unati Mela with chief guest Mahavir Phogat 17th March 2018

New Year Celebration on 1st Jan. 2018

Success Stories

Semen Collection from Field Bulls

To support the ongoing buffalo genetic improvement program in the country, there is a need to produce quality frozen semen from genetically superior Murrah bulls at large scale. Progressive farmers do own genetically superior bulls but owing to their use in natural service,such high-end genetic germplasm remains scantly utilized. To utilize genetic potential of field bullsand to maintain larger genetic variability, ICAR-CIRB Hisar undertook a novel exercise in conservation and propagation of such superior Murrah bulls through semen collection.

Phase-I

Semen collection at farmers' door was started in June 2008 of a National Champion Murrah bull named 'Gholu' from village Didwadi, Panipat District, Haryana. This created awareness among ownersto get semen of their prized bulls preserved. In this way, CIRB collected approximately 55,000 doses of frozen semen from 30 champion bulls under this program.

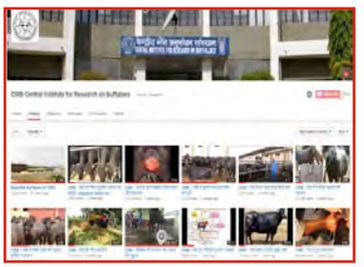
Phase-II

The limitation of the Phase-I was lack of authenticated records of mothers and their milk yields. To overcome this limitation, the milk yield of the dam authenticated by government agencieswas taken as the criterion of selection of bull, which was then verified to be son of the same recorded high yielding buffalo through DNA testing for parentage verification.This has not only created awareness for milk recording but also for parentage verification of the private bulls' whose semen is being marketed. Recently, five bulls (Sikander, Dara, Dhanna, Heera, Kohinoor) were selected for the program, with dam yields of as high as 26.57 kg. More than 30,000 frozen semen doses from these bulls have been produced so far.

ICT initiatives for reaching farmers across the globe

Over the last few decades, Information and Communication Technology (ICT) has offered immense opportunities to strengthen agricultural extension system all over the world and now e-Learning has been recognised as a very important tool for dissemination of information in agriculture.

Making use of the ICT, the institute developed an information repository on all aspects of buffalo through a web-page 'Buffalopedia', which was launched in March 2013. This knowledge dissemination platform has only text based information on different aspects of buffalo farming. It has attracted 100 million page reviews by March 2018.A huge number of followers of Buffalopedia (~35%) are outside India, indicating popularity of buffalo farming across the globe.



The 'YouTube' is highly popular amongst educated youth for resourcing information on varied aspects of daily life requirements, including animal husbandry. In July 2014, ICAR-CIRB launched 'CIRB-Central Institute for Research on Buffaloes' channel on YouTube to impart virtual training on buffalo farming through e-lessons designed in the form of advisories, package of practices, things to do etc. YouTube channel has received overwhelming response from internet users – a fact proven by over 10 million views – over 90% on mobile phones and nearly 15% accessed from abroad. While the average view time is about 2 minutes in India, in non- Hindi areas like China, average view time is more than 11 minutes. So far, most of the videos are in Hindi language, but translation into some other Indian languages is in progress.

Facebook has become an important social platform for exchange of information, news and views. ICAR-CIRB made use of this platform to disseminate and share information on a day-to-day basis with two-way interaction through posting views, information, pictures, videos, news, comments etc. in a Facebook group 'ICAR-Central Institute for Research on Buffaloes', started in 2011, with more than 50,000 members from over 90 countries of the world, sharing approximately 150,000 posts, comments and reactions during a four week period.

Infrastructure

Land : At main campus, the Institute owns over 781 acres of land. Out of total land available, 30% is irrigated and restis rainfed/barren. 25 acres of saline soil was reclaimed by growing paddy and 24 Acres by sowing dhaincha. At sub campus, Nabha, 16 acre land was improved by removing dried and uprooted trees and shrubs, 33 acre dhaincha was sown for green manuring and 40 acre land was improved by spreading farm yard manure/compost. At sub-campus Nabha the institute 516 acres of land, out of which Total of 438.5 acre cultivable land is divided into 4 blocks for agricultural operations with canal and tube well irrigation facility.

Agriculture Farm: During the year, total area sown was 247 acres in Kharif season and 237 acres in Rabi season. Agriculture farm at main campus, Hisar produced a total of 30386.30 quintals of green fodder, 1048.9 quintals grains and 537.6 quintals wheat straw. At sub-campus Nabha, the total green and dry fodder production during the year was 44496 and 3365 quintals, respectively, while grain production was 5077.8 quintals. Pakka irrigation channel of 300 meters was constructed in the main campus for efficient use of irrigation water. More than two thousand Neem trees were planted on sides of road and irrigation channel.

Animal Farm : Animal farm related activities are undertaken in old sheds inherited from the erstwhile Bull Progeny Testing Farm of the Haryana State Govt. which includes 10 covered sheds for indoor housing of 40 adult buffaloes each, having attached calf pens for followers and open paddocks for loose housing. Experimental animals are housed in two of these sheds for research in nutrition division. In addition, two sheds repaired recently can house 40 to 50 young stocks while individual and group housing sheds with physiology division are also primarily meant for keeping animals allotted to various experiments. Construction of automated shed for housing 200 animals has been completed. Procurement of compatible equipment for effective integrated functioning of the whole unit is under process. A suitable wallowing facility has been constructed. Milking machine extended from existing 8 unit cluster to 12 unit cluster at Sub-campus Nabha Animal farm. In the premises of modern animal shed at the main campus, a biogas plant of 200 cubic meter capacity alongwith 30kVA DG set for electricity generation has been installed.

Farm Machinery and workshop: Institute has a workshop to support agriculture, animal farm and landscape sections. The workshop is sufficiently equipped to undertake mechanical/repairing jobs. Farm workshop at the main campus has nine tractors including one new addition. Major implements/attachments to these tractors are fodder harvesters, disc plough, MB plough, cultivator, straw making reaper, zero tillage seed drill machine, chaff cutter, harrow and a laser leveller. A tractor driven rain gun system for irrigation was also installed. One tractor was also purchased for sub-campus Nabha.

Feed Unit: Feed unit is engaged in preparation of concentrate feed by formulating feed for different categories of animals. Feed unit prepared about 600 tonnes of concentrate feed. In addition, approx. 15 tonnes of area specific mineral mixture is prepared annually for farm animals as well as for sale for its popularization. Feed processing unit and attached grain/cake store cover an area of about 4500 square feet together with an open drying place of about 1500 sq. ft. This unit is equipped with automatic feed grinder cum mixer of capacity (10Q/hr) with lifts for grinding and mixing of concentrate mixture. Facilities for feed processing also exist at sub campus.

Agriculture Knowledge Management Unit (AKMU): Institute AKMU provides cyberoam protected internet and E-mail connectivity to all scientists/officers. It also looks after the work related to installation and maintenance of computers, peripherals, network equipment etc. Maintenance and updation of institute website, biometric

system, CCTVs, EPABX Cyberroam are the other activities carried out by this unit. Computer and internet facilities are also given 24 hours for student. Dedicated lease line of 4 mbps was installed at sub-campus Nabha to facilitate the scientist and other staff members of the Sub-campus.

Library: An air-conditioned library facility with the sitting capacity of 20 persons, owns 1230 books on various disciplines viz. livestock production management, nutrition, physiology, genetics, breeding, biotechnology, analytical techniques etc. Good collection of journals for the last three decades as bound volumes is also available. The library also subscribes newspapers, periodicals and magazines to keep the staff updated about the happenings. Photocopying facility is also available in the library. CIRB library is member of CeRA (consortium for e-resources in Agriculture), under which the institute gets access to full text online journals, 24x7.

Electrical section: Electrical section of the institute is responsible for providing round the clock electric supply to the institute laboratories with 11 KV sub- station comprising of 500 KVA transformer, OCB, ACB, LT panels and two DG sets of 250 and 110 KVa capacities for power backup. Electrical section attends electric maintenance of different labs, guest house, residential units, repairing and servicing of air conditioners, geysers, electric motors, street lights, underground LT cables and HT and LT overhead lines of the agriculture farm of the institute. Electrical section aids the operation and maintenance of audio-visual facility of the institute.

Estate Section : Estate Section of this institute is responsible for construction, modification and repairs works in all the residential, office building, animal shed and water channels in the agriculture farm. Estate section ensures water supply and sewage disposal to the whole campus. Day to day maintenance activities including cleaning of roads, building and pathways in the campus are also assigned to this section, besides inventory of building assets.

Landscaping : This section looks after greens at the campus including gardens, roadside maintenance and colony parks. Tree plantation, pruning of trees, removal of horticulture wastes, plantation/landscaping at campus, creation & maintenance of nurseries of saplings of trees, shrubs & seedbeds of ground covers & seasonal flowers are the responsibilities of this section . The institute campus bears a neat and green look.

Guest house : Institute guest house has fourteen well furnished rooms for accommodating 28 guests at a time. It has separate reception with attached well-furnished lounge and dining hall to cater to the requirements of visitors as well as get together for institute fraternity. During 2017-18 revenue of Rs 2,04,660 has been generated with occupancy of 690 guests for 1478 days.

Semen Freezing Lab : Semen freezing laboratory is an important constituent of the institute and is equipped with ultramodern facilities like CASA, fluorescent and DIC microscope and biofreezer for cryopreservation of Murrah buffalo bull's semen. The lab is engaged in cryopreservation, maintenance and distribution of frozen semen from genetically superior Murrah bulls. The lab has a stock of more than four lakh doses of frozen semen from about 230 breeding bulls out of which more than sixty thousand doses are of progeny tested bulls. Frozen semen doses prepared from farmers' superior bulls are also available with the institute and these are available for buffalo improvement programme. The performance of the semen freezing lab further excelled this year as compared to the previous year in terms of production , sale and revenue generation

Central Laboratory : A central laboratory facility has been developed at ICAR-CIRB after merging of laboratories from Animal Physiology and Reproduction (APR) & Animal Nutrition & Feed Technology (ANFT) divisions that provides optimum conditions for scientific research, experiments, and measurements. The CLF facilitates interdisciplinary research by supporting the use and accessibility of lab hardware and software. Central laboratory facility is open to every eligible person, scientists and students. In this laboratory, all the necessary facilities are available related to biochemistry, proteomics, genomics and other '-omics' research. Available instruments include picodrop, gel documntation system, thermal cycler (PCR), gel electrophoresis systems, IEF system for 2DGE, ELISA Reader, refrigerated centrifuge, laminar flow, shaking incubator, TFF system, freezers and analysis softwares etc.

Publications

PUBLICATIONS

A) Research articles (Work done at CIRB)

Balaraju BL, Tripathi H, Yadav J. 2017. Reasons for decreasing indigenous cattle population and interventions in its conservation - A perceptual study of field veterinarians in Karnataka. International Journal of Livestock Research **77 (12):**213-223.

Buragohain L, Nanda T, Ghosh A, Ghosh M, Kumar R, Kumar S, Gupta SS, Bharali A, Mohanty AK, Singh I, Balhara AK. 2017. Identification of serum protein markers for early diagnosis of pregnancy in buffalo. Animal Science Journal **88(8):**1189-1197.

Choudhary KK, Bharadwaj A, Sharma RK, Jerome A, Khanna S. 2017. Relationship of temperament with oestrous behaviour, resumption of ovarian cyclicity and milk yield in post-partum Murrah buffaloes. Reproduction in Domestic Animals **52 (6):**962-968.

Dey A, Paul SS, Dahiya SS, Punia BS. 2018. Effects of vegetable oils supplementation on *in vitro* rumen fermentation, volatile fatty acid composition and methane production in buffaloes. Buffalo Bulletin **37 (1):**37-44.

Dixit VB, Bharadwaj A, Duhan A, Tripathi H, Singh S. 2017. Contribution of phenotypic characters in deciding the price of different categories of buffaloes. Indian Journal of Dairy Sciences **70 (4):**479-481.

Dixit VB, Bhardwaj A, Singh KP, Tripathi H, Duhan A. 2017. Farmers' perception about impact of sale of buffaloes on dairy development index and socio-economic conditions in Haryana. Indian Journal of Extension Education **53 (3):**50-53.

Jakhar V, Vinayak AK, Singh KP. 2017. Effect of non-genetic factors on performance traits of Murrah buffaloes. International Journal of Current Microbiology & Applied Sciences **11:**4248-4255.

Jerome A, Srivastava SK, Sharma RK, Phulia SK. 2017. Efficacy of progesterone implants on induction of cyclicity in anestrous buffaloes. The Indian Journal of Animal Sciences **87 (7):** 819–823.

Jerome A, Srivastava SK, Sharma RK, Sarkar SK, Kumar R. 2017. Follicular dynamics, hormonal and biochemical profile across seasons in buffaloes. The Indian Journal of Animal Sciences **87 (7):** 824–828.

Jerome A, Thirumaran SMK, Kala SN. 2017. Repertoire of non-coding RNAs in corpus luteum of pregnancy in buffalo. Veterinary World **10 (9):**1377-1382.

Jerome A, Thirumaran SMK, Kala SN. 2017. Identification of microRNAs in corpus luteum of pregnancy in buffalo (*Bubalus bubalis*) by deep sequencing. Iranian Journal of Veterinary Research **18 (4):**287-290.

Karuppanasamy K, Sharma RK, Phulia SK, Jerome A, Kavya KM, Ghuman SPS, Kumar H, Singh I, Krishnaswamy N. 2017. Ovulatory and fertility response using modified Heatsynch and Ovsynch protocols in the anovular Murrah buffalo (*Bubalus bubalis*). Theriogenology **95:**83-88.

Katiyar GK, Sharma RK, Mudgal V, Jerome A, Phulia SK, Singh I. 2017. Fertility response in post-partum buffaloes following bypass nutrient supplementation. The Indian Journal of Animal Sciences **87 (8):** 960–964.

Kavya KM, Sharma R K, Jerome A, Phulia SK, Singh I. 2017. Anti-Müllerian hormone and antral follicular count in early and delayed pubertal Murrah buffalo heifers. Livestock Science **198:**89-92.

Kumar D, Sharma P, Vijayalakshmy K, Selokar NL, Kumar P, Rajendran R, Yadav PS. 2018. Generation of Venus fluorochrome expressing transgenic handmade cloned buffalo embryos using Sleeping Beauty transposon. Tissue & Cell **51:**49-55.

Kumar R, Ghosh M, Kumar N, Balhara AK, Gupta M, Sharma RK, Singh I. 2017. Polymorphism in 52 untranslated region of heat shock protein 70 gene as marker of post partum anoestrus in Murrah buffaloes. Reproduction in Domestic Animals **52:**505-512.

Paul SS, Bu D, Xu J, Hyde KD, Yu Z. 2018. A phylogenetic census of global diversity of gut anaerobic fungi and a new taxonomic framework. Fungal Diversity **89:**253-266.

Paul SS, Dey A, Baro D, Punia BS. 2017. Comparative community structure of archaea in rumen of buffaloes and cattle. Journal of the Science of Food and Agriculture **97:**3284-3293.

Rathore R, Sharma RK, Phulia SK, Mudgal V, Jerome A, Ghuman SPS, Singh I. 2017. Comparative efficacy of oestrus synchronization protocols in buffalo (*Bubalus bubalis*). Tropical Animal Health and Production **49:**1377-1382.

Sehgal JP, Dey A, Kant S. 2018. Developing feeding module for increasing milk production in Murrah buffaloes (*Bubalus bubalis*). Buffalo Bulletin **37(1):**45-50.

Sharma P, Yadav AS, Selokar NL, Kumar D, Dhaka SS, Yadav PS. 2018. Epigenetic status of buffalo fibroblasts treated with sodium butyrate a chromatin remodeling agent. Tissue & Cell **50:**51-58.

Sharma RK, Phulia SK, Jerome A, Singh I. 2017. Ovsynch Plus protocol improves ovarian response in anovular Murrah buffaloes in low breeding season. Reproduction in Domestic Animals **52:**1030-1035.

Singh RK, Dey A, Punia BS, Paul SS, Singh M, Kumar R. 2017. Supplementing blends of plant secondary metabolites as phytobiotics for modulation of *in vitro* methanogenesis, and rumen fermentation in buffalo. Bulletin of Environment, Pharmacology and Life Sciences **6 (1):** 444-447.

Singh RK, Dey A, Singh M, Punia BS, Paul SS. 2018. Efficacy of Reetha (Sapindus mukorosii) fruit extracts in modulating *in vitro* rumen fermentation and methanogenesis in buffalo. International Journal of Current Microbiology & Applied Sciences **Spl. Issue 7:**4666-4672.

Tripathi H, Janmoni S. 2017. Psychological work load and drudgery in livestock rearing: A gender analysis. Journal of Community Mobilization and Sustainable Development **11:**127- 132.

Tripathi H, Tripathi BN, Dixit VB. 2017. Prevalence of self-reported occupational health hazards and preventive measures followed by male and female workers in livestock rearing in Uttar Pradesh: A study of rural India. International Journal of Livestock Research **7 (3):**149-164.

Verma R, Singh I, Balhara AK, Nayan V, Sharma RK, Chaudhiry V. 2018. Correlation between extremes age at first calving with their productive and reproductive performances in Indian Murrah buffaloes (*Bubalus bubalis*). Indian Journal of Animal Research. Doi-10.18805/ijar.B-3371. pp 1-7.

Yadav J, Tripathi H. 2017. Availability, approachability and use of livestock informative services of Animal husbandry department by women farmers in Uttar Pradesh. Ruminant Science **45 (2)** 271-276.

Yadav J, Tripathi H, Balaraju BL, Yadav R. 2017. Constraints in availing the livestock extension services under state department of Animal Husbandry as perceived by women livestock farmers. Indian Journal of Extension Education **53(2):**51-53.

Yadav R, Sagar MP, Tripathi H, Kumar P, Balaraju BL. 2017. Performance appraisal of women self help groups (W-SHGS) at village level in Rewari district of Haryana. SSRG International Journal of Humanities and Social Science **4 (5):**51-53.

B) Research articles (Work done by CIRB Scientists at other institutes)

Agrawal H, Selokar NL, Saini M, Singh MK, Chauhan MS, Palta P, Singla SK, Manik RS. 2018. Epigenetic alteration of donor cells with histone deacetylase inhibitor m-Carboxycinnamic acid bishydroxymide improves the *in vitro* developmental competence of buffalo (*Bubalus bubalis*) cloned embryos. Cellular reprogramming **20:**76-88.

Bhardwaj A, Nayan V. 2016. Molecular characterization, modeling, *in silico* analysis of equine pituitary gonadotropin alpha subunit and docking interaction studies with ganirelix. *In silico* Pharmacology **5(1):**5.

Dedar RK, Vaid RK, Anand T, Singh J, Virmani N, Khurana SK, Kumar S. 2017. Rhodococcus equi diarrhea and suppurative pneumonia in Marwari filly: a case report. Veterinary Practitioner **18(2)** 245-248.

Dey A, Samajdar T. 2017. Evaluation of production performance of cows supplemented with rice bean fodder fed straw based diet in small holder's production system. Indian Veterinary Journal **94 (11):**33-35.

Dubey PK, Dubey S, Mishra SK, Arora R, Patel J, Singh KP, Kathiravan, Mishra BP, Kataria RS. 2017. PCR-SSCP analysis of MDGI gene and its association with milk production traits in river buffalo (*Bubalus bubalis*). Research in Veterinary Science **115:**307-309.

Landge S, Tripathi H, Banthiya V. 2017. Self-reported risks associated in Veterinary profession Indian Journal of Extension Education **53(4):** 132-135.

Mandal AB, Kulkarni R, Rokade JJ, Bhanja SK, Singh R. 2017. Effect of dietary addition of Amla (*Emblica officinalis*) on performance and HSP70 gene expression in coloured broiler chicken during extreme summer. Journal of Animal Research **7(2)** 233- 241.

Narnaware SD, Kumar S, Dahiya SS, Patil NV. 2017. Concurrent infection of Coccidiosis and Haemonchosis in a dromedary camel calf from Rajasthan, India. Journal of Camel Practice and Research **24 (3):** 225-228.

Nayan V, Onteru SK, Singh D. 2018. Mangifera indica flower extract mediated biogenic green gold nanoparticles: Efficient nanocatalyst for reduction of 4 nitrophenol. Environmental Progress & Sustainable Energy **37:**283-294.

Rani S, Singh Y, Gulati B, Khurana S. 2017. Occurrence of enterohaemorrhagic Escherichia coli in buffalo meat. Journal of Experimental Biology and Agricultural Sciences **5 (2):**208-214.

Saini M, Selokar NL, Agrawal H, Singla SK, Chauhan MS, Manik RS, Palta P. 2017. Treatment of donor cells and reconstructed embryos with a combination of Trichostatin-A and 5-aza-2'-Deoxycytidine improves the developmental competence and quality of buffalo embryos produced by handmade cloning and alters their epigenetic status and gene expression. Cellular reprogramming **19:**208-215.

Selvam RM, Onteru SK, Nayan V, Sivakumar M, Singh D, Archunan G. 2017. Exploration of Luteinizing hormone in Murrah buffalo (*Bubalus bubalis*) urine: Extended surge window opens door for estrus prediction. General and Comparative Endocrinology **251:**121-126.

Singh R, Mandal AB, Biswas A. 2017. Efficacy of propionic, benzoic and tartaric acids in preventing biosynthesis of aflatoxins in poultry feed. Animal Nutrition and Feed Technology **17:**157-164.

Singha H, Malik P, Saini S, Khurana SK, Elschner MC, Mertens K, Barth SA, Tripathi BN, Singh RK. 2017. Draft genome sequences of two clinical isolates of Burkholderia mallei obtained from nasal swabs of glanderous equines in India. Genome Announcements **5:**e00063-00017.

Thilakar P, Tripathi H, Sasidhar PVK, Senthil Kumar G. Demand and supply projections of Indian veterinary manpower International Journal of Science, Environment and Technology **5(2):**1737-1744.

C) Review articles

Balhara AK, Nayan V, Dey A, Singh KP, Dahiya SS, Singh I. 2017. Climate change and buffalo farming in major milk producing states of India – Present status and need for addressing concerns. The Indian Journal of Animal Sciences**87(4):**403-411.

Dhama K, Karthik K, Khandia R, Munjal A, Tiwari R, Rana R, Khurana SK, Sana U, Khan RU, Alagawany M, Farag MR, Dadar M, Joshi SK. 2018. Medicinal and therapeutic potential of herbs and plant metabolites/extracts countering viral pathogens-Current knowledge and future prospects. Current Drug Metabolism **19:**236-263.

Prasad M, Lambe U, Ranjan K, Patil S, Brar B, Devi B, Panigrahi S, Prasad G, Khurana S, Dhama K, Misri J. 2018. An insight in biomarkers for colorectal cancer. Journal of Gastroenterology, Liver & Pancreatic Diseases**3(1):**1010.

Prasad M, Lambe UP, Brar B, Shah I, J M, Ranjan K, Rao R, Kumar S, Mahant S, Khurana SK, Iqbal HMN, Dhama K, Misri J, Prasad G. 2018. Nanotherapeutics: An insight into healthcare and multi-dimensional applications in medical sector of the modern world. Biomedicine & Pharmacotherapy **97:**1521-1537.

Prasad M, Ranjan K, Brar B, Shah I, Lalmbe U, Manimegalai J, Vashisht B, Gaury M, Kumar P, Khurana SK, Prasad G, Rawat J, Yadav V, Kumar S, Rao R. 2017. Virus-host interactions: new insights and advances in drug development against viral pathogens. Current Drug Metabolism **18:**942-970.

Singh RK, Dey A, Singh M, Kumar R. 2017. Plant bio-active compounds as feed additive for reducing methane emission from livestock- a review. Bulletin of Environmental Pharmacology&Life Sciences **6 (5):**50-53.

Verma R, Singh I, Shukla SK, Chaudhiry V, Kumar S, Nayan V, Balhara AK. 2017. Artificial induction of lactation and milk yields in dry barren (Infertile) cows and buffaloes: An overview. Journal of Experimental Zoology India **20 (1):**1291-1297.

Vijayalakshmy K, Ninan J, Kumar D, Virmani M, Selokar NL, Yadav PS. 2018. Potential application of stem cells in livestock production. International Journal of Current Microbiology & Applied Sciences **7(3):**67-77.

D) Lead papers/Invited lectures

Balhara AK, Deeksha, Phulia SK, Sharma RK, Singh I. 2018. Buffalo physiology and climate change in India IX Asian Buffalo Congress (ABC) 2018 on climate resilient buffalo production for sustainable livelihood, from February 1-4, 2018 at ICAR-CIRB.

Dey A, Misra SS, Dahiya SS, Balhara AK, Kumar K, Das AK, Singh RK, Attri K, Imaz JA. 2017. Essential Oils as Phytogenic Feed Additive: Potential Benefits on Environment, Livestock Health and Production, The third international conference on bio-resource and stress management, 2017, from November 8-11, 2017at Jaipur, Rajasthan.

Nayan V. 2017. Computational immunoreagent design and *in silico* pharmacology: recent trends and future prospects for livestock production and health, International conference of society for bioinformatics and biological sciences (SBBS) on recent trends In bioinformatics and biotechnology for sustainable development (SBBS-ICRTBBSD 2017) fron October 12-13, 2017 at Faculty of Veterinary Sciences and Animal Husbandry (SKUAST), Jammu.

Sharma RK, Phulia SK, Mudgal V, Kumar P, Jerome A, Singh I. 2018. Reproduction status and outcome of nutritional and hormonal interventions in buffaloes, IX Asian Buffalo Congress (ABC) 2018 on climate resilient buffalo production for sustainable livelihood, from February 1-4, 2018 at ICAR-CIRB.

Singh KP. 2018. Genetic improvement of buffaloes in network mode, IX Asian Buffalo Congress (ABC) 2018 on climate resilient buffalo production for sustainable livelihood, from February 1-4, 2018 at ICAR-CIRB.

Tripathi H. 2017. Integrated farming Systems, X livestock Championship technical session on Fisheries and Shrimp farming and Expo on December 4, 2017 at Patiala, Punjab.

Tripathi H, Dixit VB, Nukala R, Yadav R. 2018. Revisiting and strengthening Livestock extension delivery Systems in India, IX Asian Buffalo Congress (ABC) 2018 on climate resilient buffalo production for sustainable livelihood, from February 1-4, 2018 at ICAR-CIRB.

Tripathi H, Dixit VB, Singh I. 2017. Enhancing the livestock productivity and production- Focus on agricultural extension, National conference on revisiting agriculture extension strategies for enhancing convergence, from April 24, 2017 at PJTSAU, Hyderabad.

VB Dixit, Tripathi H, Singh I.2017.Extension needs and strategies for sustainable buffalo production at 2nd National Conference of Society for Veterinary & Animal Husbandry Extension (SVAHE) on technological interventions for sustainable livestock production, from 10-12 April, 2017 at SKUAST Jammu.

Yadav PS, Selokar NL. 2017 Genome editing-application in animals, Annual Conference Society of Animal Physiologists of India, from December 21-22, 2017 at Bider, Karnatka.

E) Books /Compendium/Technical Bulletin/Manual

Balhara AK, Phulia SK, Sunesh, Nayan V, Jerome A. 2017. Climate smart buffalo husbandry. Model training course (MTC) sponsored by directorate of extension, dept. of agriculture, cooperation and farmers' welfare, ministry of agriculture and farmers' welfare, govt. of India from November 13-20, 2017 at ICAR-CIRB, Hisar, Haryana.

Boora A, Yadav S, Bharadwaj A. 2017. Modern dairy farm management production, reproduction, health and nutrition. Model training course (MTC) sponsored by directorate of extension, dept. of agriculture, cooperation and farmers' welfare, ministry of agriculture and farmers' welfare, govt. of India from October 9- 16, 2017 at ICAR- CIRB, Hisar, Haryana, ICAR- CIRB, Hisar.

Khurana SK, Dey A, Nayan V, Balhara AK, Balhara S, Jan MH, Singh RK, Singh M, Deeksha, Sarangi A, Panghal S, Kumar S. 2018. Souvenir: IX Asian Buffalo Congress 2018 on climate resilient buffalo production for sustainable livelihood, from February 1-4, 2018 at ICAR-CIRB,Hisar, Haryana.

Khurana SK, Dey A, Nayan V, Balhara AK, Balhara S, Jan MH, Singh RK, Singh M, Deeksha, Sarangi A, Panghal S, Kumar S. 2018. Book of Abstracts: IX Asian Buffalo Congress 2018 on climate resilient buffalo production for sustainable livelihood, from February 1-4, 2018 at ICAR-CIRB,Hisar, Haryana.

Kumar B, Sharma RK, Islam R, Avasthe RKA. 2017. User manual on Basics of Ultrasonography and image interpretation of various physiological and pathological conditions in bovines, ICAR- national Organic Farming Research Institute Tadong, Gangtok, Sikkim, technical bulletin: ICAR-NOFRI/TB/2017/01.

Mandal A, Khatta VK, Biswas A, Sihag S, Singh R. 2018. Analytical techniques in animal nutrition, Satish Serial Publishing House, Delhi.

Marshall K, Mrode R, Sikka P, Singh KP, Singh I, Bharadwaj A. 2017. Incorporation of genomic selection into the Murrah buffalo breeding program. ILRI Manual No. 27, Research Program on Livestock.

Roy KS, Selvaraju S, Sharma RK, Mehta JS, Dhami AJ, Biswas RK, Kulasekar KK, Gowda NKS, Ravindra JP, Gupta R, Prakash BS, Bhatta R. 2018. Ovsynch and Heatsynch: Economic and Efficient strategies for estrus synchronization and fertility improvement in livestock, Technical folder No.34, AICRP 2018.

Singh KP, Sikka P.2017.Training course on animal breeding data analysis and genomic predictions organized by ICAR-CIRB in collaboration with ILRI, Nairobi, Kenya from November 20-25, 2017 at ICAR-CIRB, Hisar, Haryana.

Tripathi H, Saxena N, Balhara AK, Hasan MJ, Rajkumar. 2017. Annual Report 2016-17 (English and Hindi editions). ICAR-CIRB.

Mahanta SK, Koli P, Singh KK, Das MM, Misra AK, Rokde SN, Singh S, Maity SB, Kushwaha BP, Nayak S. 2017. Feeding strategies in relation to climate resilient forage and livestock production, ICAR-Indian Grassland and Fodder Research Institute, Jhansi, Uttar Pradesh.

F) Book Chapters

a) **In Model Training Course on 'Modern dairy farm management, production, reproduction, health and nutrition' (Eds. Boora A, Yadav S and Bharadwaj A)**

Balhara AK, Sharma RK, Phulia SK, Singh I. 2017. Thermal Stress-Effects on Production & Reproduction. pp 153-158.

Bharadwaj A, Khanna S. 2017. Buffalo herd management and farm records. pp. 145-152.

Khurana SK, Boora A, Yadav S, Sikka P. 2017. An Overview of Zoonotic Diseases: Prevention and Control. pp . 64-68

Khurana SK, Boora A, Yadav S. 2017. Impact of Global Warming on Emerging Infectious Diseases: Present Scenario and Future Outlook. pp. 54-60.

Sharma RK, Phulia SK, Jerome A, Balhara AK. 2017. Diagnostics use of ultrasonography in reproduction. pp 87-93.

Sharma RK, Phulia SK, Jerome A, Singh I. 2017. Application of hormone therapies for summer anestrus in buffaloes. pp 94-97.

Sikka P, Singh KP, Bharadwaj A, Singh I. 2017. Genomic selection in dairy cattle: Integration of DNA testing into breeding. pp 111-120.

Singh KP. 2017. Buffalo genetic resources of India and selection for improvement in production performance of dairy buffaloes. pp 58-63.

Singh RK, Singh M, Dey A, Dahiya SS. 2017. Factor influencing mineral requirements under changing environmental conditions. pp 87-88.

Yadav S, Boora A, Khurana SK. 2017. Mastitis and therapeutic management. pp 107-110.

b) In Model Training Course on 'Climate smart buffalo husbandry' (Eds. Balhara AK, Phulia SK, Sunesh, Nayan V and Jerome A)

Balhara AK, Singh S, Singh I. 2017. Concept of climate smart livestock. pp 8-11.

Balhara AK, Sunesh, Phulia SK. 2017. Impact of Climate Change on livestock production – an overview. pp 12-15.

Dey A, Singh RK, Attri K, Dahiya SS. 2017. Methane abatement from livestock: recent development of feeding strategies. pp. 16-22.

Jerome A, Sharma RK, Phulia SK. 2017. Thermal stress- Effects on production and reproduction in Dairy animals. pp 61-62.

Nayan V, Panghal S, Bhardwaj A, Balhara AK, Phulia SK, Sharma RK. Genomic technologies for climate resilient livestock production. pp 68-71.

Phulia SK, Balhara AK, Sharma RK, Nayan V, Singh M. 2017. Strategies for offsetting effect of adverse weather on buffalo reproduction. pp 103-107.

Phulia SK, Jerome A, Sharma RK, Balhara AK. 2017. Using infertile buffaloes for milk production - Induced lactation method. pp 72.

Phulia SK, Sharma RK, Balhara AK. 2017. Hygienic milk production, milking techniques in dairy animals. pp 89-93.

Singh KP, Boora A. 2017. Buffalo genetic resources and adaptation strategies to climate change: Farmers creativities. pp 23-27.

Singh R. 2018. Quality control of animal feed. pp 119-123.

c) Book Chapters in other Books/Compendiums

Balhara AK, Dey A, Singh I. 2018. Climate resilient buffalo production system for food security, Souvenir of IX Asian Buffalo Congress, from February 1-4, 2018 at ICAR-CIRB.

Dey A, Balhara AK, Dahiya SS. 2018. Essential oils as feed additive: potential applications on methane mitigation and livestock production, Souvenir of IX Asian Buffalo Congress, from February 1-4, 2018 at ICAR-CIRB.

Kumar D. 2018. Editorial note. *In* Lohiya NK, Kumar D (ed.), Animal Model: Tool for Study of Fertility, Reproductive Health and Translational Medicine, Indian Society for the Study of Reproduction and Fertility (ISSRF) Newsletter.Vol. 21, pp 5-6.

Kumar D, Selokar NL, Kumar P, Yadav PS. 2017. Transgenic embryo production technology. *In* Balhara AK, Phulia SK, Sunesh, Nayan V, Jerome A (ed.), Climate Smart Buffalo Husbandry Model Training Course (MTC) sponsored by Directorate of Extension, Ministry of Agriculture and Farmer Welfare, Govt of India from November 13-20, 2017 at ICAR-CIRB, Hisar. pp 50-53.

Kumar D, Selokar NL, Sharma P, Yadav PS. 2017. Induced pluripotent stem cells for veterinary applications. *In* Singh I, Yadav PS, Sharma RK, Balhara AK (ed.), Buffalo Production using Reproductive Biotechnology, compendium of training for ASEAN countries ICAR-CIRB, Hisar. pp 103-109.

Kumar P, Kumar D, Jasmer, Pawaria S, Suman. 2017. Semen cryopreservation technique-Present and future. *In* Zama M, Taggar RK, Kumar D, Chakraborty D, Mahajan V (ed.), Biotechnology and bioinformatics in animal and veterinary sciences. pp 95-110.

Kumar P, Kumar D, Pawaria S, Vijayalakshmy K. 2017. The art and science in frozen semen technology and artificial insemination. *In* Singh I, Yadav PS, Sharma RK, Balhara AK (ed.), Buffalo Production using Reproductive Biotechnology, compendium of training for ASEAN countries, ICAR-CIRB, Hisar. pp 32-41.

Kumar P, Srivastava N, Pande M, Prasad JK, Sirohi AS. 2017. Evaluating Sperm Cell Viability and Membrane Integrity. *In* Srivastava N, Pande M (ed.), Protocols in semen biology (comparing assays) Springer, Singapore. pp 57-71.

Nayan V. 2017. Computational immunoreagent design and *in silico* pharmacology: recent trends and future prospects for livestock production and health. *In* Zama M, Taggar RK, Kumar D, Chakraborty D, Mahajan V (ed.), Biotechnology and bioinformatics in animal and veterinary sciences. pp 17-25.

Selokar NL, Kues WA, Kumar D, Rajendran R, Saini M, Yadav PS. 2018. Uses of CRISPR-Cas to produce the livestock models: Prospects for India. *In* Lohiya NK, Kumar D (ed.), Animal Model : Tool for Study of Fertility, Reproductive Health and Translational Medicine, Indian Society for the Study of Reproduction and Fertility (ISSRF) Newsletter.Vol. 21, pp 17-20.

Sharma RK, Jerome A, Phulia SK, Balhara AK, Singh I. 2017. Reproduction management in buffaloes. *In* Singh I, Yadav PS, Sharma RK, Balhara AK (ed.), Climate smart buffalo husbandry Model Training Course (MTC) sponsored by Directorate of Extension, Ministry of Agriculture and Farmer Welfare, Govt of India from November 13-20, 2017 at ICAR-CIRB, Hisar. pp 63-67.

Sharma RK, Jerome A, Phulia SK, Singh I. 2017. Reproductive Biotechnologies in Buffaloes: An Overview. *In* Chandra V, Chauhan VS, Sarkar M, Singh G (ed.), Upstream reproductive technologies for augmentation of livestock production, vol. ICAR-IVRI, Izatnagar. pp 115-123.

Sharma RK, Phulia SK, Jerome A, Balhara AK, Singh I. 2017. Ovarian cyclicity resumption and ultrasound for reproductive management in large animals, Advance training on ultrasonography for diagnosis and management of Infertility in farm animals, Tribal Sub Plan ICAR-RC for North Eastern Hill Region, Umiam Meghalaya. pp 7-11.

Tripathi H, Dahiya SS, Dixit VB, Singh I. 2018. Glimpses of ICAR-CIRB p. 1-6, Souvenir of IX Asian Buffalo Congress, from February 1-4, 2018 at ICAR-CIRB.

G) Abstract papers in Conferences/ Seminars/ Workshops/ Trainings

Balaraju BL, Tripathi H, Janmoni S, Akand AK. 2017. Reasons for reducing indigenous cattle population and suggested interventions in their conservation: A perceptual study of field veterinarians in Karnataka, 2nd National conference of society for veterinary & animal husbandry extension (SVAHE) on technological interventions for sustainable livestock production, from April 10-12, 2017 at SKUAST Jammu. pp 134.

Dey A, Paul SS, Dahiya SS, Punia BS. 2017. Efficacy of Sunflower and Cottonseed Oils in Modulating *In-vitro* Rumen Fermentation and Methane Production in Buffalo (*Bubalus bubalis*), 3rd International Conference of Bioresource and Stress Management, from Nov 8-11, 2017 at Jaipur, Rajasthan. pp 203.

Kumar K, Dey A, Rose M. 2017. Potential of Feed Additives rich in Essential Oils in Modulating *In vitro* Rumen Fermentation and Methanogenesis in Buffalo. *ibid*. pp 204.

Ghorui SK, Kumar S. 2018. Cystic Echinococcosis of camel and sheep in Raasthan: Partial characterization of cystic fluid and germinal membrane proteins,XXVII National Congress of Veterinary Parasitology and National Symposium on "Technologies for sustainable parasite control and redressal of detection methods directed for upliftment of rural economy" from February 12 - 14, 2018 at College of Veterinary and Animal Sciences, RAJUVAS, Navania, Vallabhnagar, Udaipur, Rajasthan. pp 119.

Ghorui SK, Kumar S, Singh R. 2018. KDNA genetic signatures obtained by LSSP-PCR analysis of Trypanosoma evansi isolated from camel. *ibid*. pp 41.

Ghorui SK, Kumar S, Singh R, Patil NV. 2018. Changes in the serum profiles of lipids and cholesterol in camel naturally infected with Trypanosomiasis. *ibid*. pp 42.

Ghorui SK, Kumar S, Singh R, Patil NV. 2018. Molecular diagnosis of drug resistance of *Trypanosoma evansi* in camel. *ibid*. pp 119.

Mudgal V, Saxena N, Kumar K, Dahiya SS, Punia BS, Sharma ML. 2018. Sources and Levels of Dietary Zn, Cu, and Mn affecting Growth Performance, Feed Efficiency and Excretion of Minerals in growing Murrah Buffalo (*Bubalus bubalis*) Calves, International Conference on Bio and Nano Technologies for sustainable agriculture, food, health, Energy, and Industry, from February 21-23, 2018at GJUST, Hisar. pp 229.

Nukala R, Tripathi H, Yadav R.2018.Massive Open Online Courses (Moocs) for Agricultural Education and Development: What's and Why's!, National seminar on ICT application in changing face of agriculture, BAU, Jharkand.pp 97.

Prasad M, Brar B, Ranjan K, Ikbal L, Lambe U, Harimohan, Khurana SK. 2017. Molecular and nano-technological tools for GIT viruses National Seminar on 'Opportunities and Challenges of Translational Research in the Frontier Areas of Animal Biotechnology and V Annual convention of SVSBT, from September 22-23, 2017 at Bhubneswer, Orissa.pp 77-81.

Prasad M, Brar B, Ranjan K, Khurana SK, Misri J, Prasad G. 2017. Emergence of new viral diseases through animals: An Insight in molecular diagnosis Virocon 2017 from December 7-9, 2017 at Mangalore.

Singh RK, Dey A, Singh M. 2017. Nutraceutical approach to minimize antibiotics residue and enhancing food and nutritional security, International Conference on gender issues and socio-economic perspectives for sustainable rural development (GIRD-2017) from October 23-25, 2017) at CCS-HAU, Hisar, India. pp 61.

Singh RK, Singh M, Dey A, Sharma RK. 2017. Influences of tannins in modulation of ruminal environment of livestock and contributions towards rural economical development. *ibid*. pp 165.

Vijayalakshmy K, Kumar D, Virmani M, Kumar P, Pawaria S, Selokar NL, Sharma P, Rasika R, Yadav PS. 2018. Transcriptome ananlysis of buffalo bull spermatozoa for identification of fertility associated genes., World Congress on Reproductive Health & 28th Annual Meeting of ISSRF, from February 23-25, 2018 at Hyderabad. pp 155.

Yadav PS, Kumar P, Selokar NL, Kumar D, Sharma RK. 2017. Sperm dynamics of cloned buffalo male, Annual Conference Society of Animal Physiologists of India from December 21-22, 2017 at Bider, Karnatka.pp

Yadav R, Sagar M, Tripathi H. 2017. Enhancement of socio economic status of dairy based rural women by SHG approach In Proceedings of ISEE seminar from November 28-30, 2017 at RVSKVV Gwalior. pp 96.

Yadav R, Tripathi H, Kumar P, Kumar N, Nukala R. 2018. Marketing pattern of milk and milk products in Murrah breeding tract of Haryana, 7th IVEF National conference on shaping livestock extension advisory services for doubling farmers income, Shivamogga.pp 32-33.

Yadav R, Tripathi H, Kumar P, Kumar N, Nukala R. 2018. Animal marketing pattern in Murrah breeding tract of Haryana: A perceptual study of buffalo owners, National seminar on ICT application in changing face of agriculture, BAU, Ranchi.pp47.

Yadav R, Tripathi H, Kumar P, Kumar N, Nukala R. 2018. Information seeking behaviour of buffalo farmers in Murrah breeding tract of Haryana: A perceptual study, 17th Indian Science Communication Congress (ISCC 2017) Communicating India's Scientific Wisdom: Changing Paradigms, New Delhi.

Abstracts in IX Asian Buffalo Congress on climate resilient buffalo production for sustainable livelihood, from February 1-4, 2018 at ICAR-CIRB.

Attri K, Dey A, Bharadwaj A, Dahiya SS. 2018. Response of lactating buffaloes (*Bubalus bubalis*) supplemented with mixed feed additives on feed utilization, milk yield and methane production. pp 104-105.

Bhardwaj A, Nayan V. 2018. Ganirelix interaction with gonadotropin alpha: *in silico* insights towards drug-target interactions and implications for assisted reproduction in buffaloes. pp 96-97.

Boora A, Yadav S, Singh KP, Balhara AK, Lailer PC, Phulia SK. 2018. Buffalo production in tribal area of Rajasthan-Constraints and opportunities. pp 167.

Chanu YM, Paul SS, Dey A, Dahiya SS. 2018. Isolation and characterization of hyper-ammonia producing bacteria in the rumen of buffaloes. pp 78-79.

Chaturvedi KK, Rai A, Mishra DC, Rao AR, Budhlakoti N, Sunita, Jyotika, Jerome A, Singh I, Sikka P. 2018. SNPRBb: Trait specific SNP database of *Bubalus bubalis*. pp 91.

Chaudhary M, Sikka AK, P SK, Pander BL. 2018. Selection indices for various performance traits of Murrah buffaloes. pp 121.

Chaudhary M, Sikka AK, Singh KP, Pander BL. 2018. Lifetime performance traits of Nili-Ravi buffaloes. pp 120.

Dey A, Kumar R, Jerome A, Phulia SK, Sikka P. 2018. Silage preparation: a technology for sustainable buffalo production during lean periods. pp 80.

Dey A, Paul SS, Umakanth AV, Bhat BV, Lailer PC, Punia BS. 2018. *In vitro* fermentation kinetics, methanogenesis, enzyme activities and gas production potential of newly developed sorghum (Sorghum bicolor) cultivars in buffalo. pp 68-69.

Dixit VB, Tripathi H, Singh S. 2018. Modes of convergence for buffalo development in Haryana. pp 162-163.

Jan MH, Kumar S, Tripathy MK, Mehrara KL, Singh I. 2018. Transferability of white marking patterns from parents to offsprings in Nili-Ravi Buffaloes. pp 112.

Jerome A, Jyotika, Rao AR, Chaturvedi KK, Sikka P. 2018. *In silico* identification of variants associated with corpus luteum tropism in buffaloes (*Bubalus bubalis*). pp 41.

Jyani V, Mudgal V, Gupta M, Sharma RK, Bharadwaj A, Phulia SK. 2018. Effect of weekly micro-nutrient supplementation during peri-parturient period on performance of Murrah buffaloes. pp 72.

Khurana SK, Yadav S, Boora A. 2018. Impact of climate change and global warming on vector borne diseases. pp 103.

Kumar A, Kushwaha BP. 2018. Climatic vulnerability and buffalo distribution in India. pp 106-107.

Kumar D, Anand T, Selokar N, Yadav P. 2018. Generation and characterization of transposon mediated reprogramming of buffalo fetal fibroblasts to induced pluripotent stem cells. pp 92.

Kumar K, Dey A, Rose M. 2018. Influence of phytogenic feed additives rich in essential oils on feed intake, growth, nutrient utilization and methane production in Murrah buffalo (*bubalus bubalis*) calves. pp 103-104.

Kumar S, Jan MH, Mehrara KL, Singh S, Singh I. Recent trends in productive and reproductive performance in Nili-Ravi Buffaloes. pp 28.

Kushwaha BP, Singh S, Maity SB, Misra AK, Singh KK, Singh I. 2018. In-situ conservation of Bhadawari buffaloes. pp 111.

Lailer PC, Singh KP, Boora A. 2018. Buffalo production system in Arid zone Jodhpur. pp 171.

Lailer PC, Singh KP, Dey A, Dahiya SS, Mudgal V. 2018. Buffalo herds in Banni in Kachchh: a source of livelihood for landless MaldharisLow in-put buffalo production system in Banni area of Kachchh, Gujarat. pp 166.

Mudgal V, Saxena N, Kumar K, Dahiya SS, Punia BS, Sharma ML. 2018. Effect of supplementing chelated zinc, copper and manganese on performance of Murrah buffalo calves. pp 73.

Mudgal V, Singh KP, Boora A, Lailer PC, Phulia SK, Singh I. 2018. Feeding pattern of buffaloes in tribal villages of Udaipur district of Rajasthan and development of area specific mineral mixture. pp 37.

Nath A, Sikka P, Jerome A, Balhara AK, Paul SS, Balhara S, Singh I. 2018. Inferring relationship of blood parameters with average daily gain as phenotype determinant for feed conversion efficiency in buffalo heifers. pp 81.

Nayan V, Bhardwaj A, Panghal S, Balhara AK, Phulia SK, Sharma RK, Singh D. 2018. Curious case of computational immunoreagent design, green chemistry and nanomaterials per se: opening new vistas for augmenting buffalo reproduction. pp 13.

Nukala R, Tripathi H, Yadav R. 2018. Need of massive open online courses (MOOCs) for entrepreneurship development in buffalo production system. pp 164-165.

Patel RN, Lailer PC, Dalal J, Vipin, Bharadwaj S, Sarangi A. 2018. Effect of anion salt in feed intake of Murrah Buffaloes. pp 84.

Paul SS, Sikka P, Jerome A, Dwijesh M, Chaturvedi KK, Nath A, Keerti, Rao AR, Singh I. Identification of genetic variation underlying differential feed conversion efficiency by double digestion RAD Analysis in Murrah Heifers.pp 72.

Phulia SK, Pratibha, Sharma RK, Balhara AK, Sunesh, Bharadwaj A, Singh I. 2018. Incidence of Doka behaviour in lactating Murrah buffaloes. pp 16.

Ratika K, Dahiya SS, Dey A, Kumar R. 2018. Blood biochemical profile and lipid peroxidation of buffalo calves on dietary supplementation of rumen protected nutrients to their dams, . pp 83.

Ratika K, Dahiya SS, Dey A, Singh RK, Balhara AK, Nayan V. 2018. Effects of diets supplemented with methionine, lysine and choline on milk yield and composition of Murrah buffaloes, . pp 75.

Saxena N, Sharma ML, Singh SP, Mudgal V, Dey A, Kumar R. 2018. Evaluation of herbal anthelmintic mixture in-vivo under field condition. pp 79.

Sharma P, Yadav AS, Selokar NL, Kumar D, Khanna S, Yadav PS. 2018. Sodium butyrate, a chromatin remodeling agent, alters epigenetic ststus of buffalo fibroblasts. pp 94.

Sikka P, Paul SS, Jerome A, Mishra D, Chaturvedi KK, Nath A, Yadav K, Rao AR, Singh I. 2018. Identification of genetic variation underlying differential feed conversion efficiency by double digestion RAD analysis in Murrah heifers. pp 72.

Singh KP, Lailer PC, Dey A, Dahiya SS, Mudgal V. 2018. Low in-put buffalo production system in Banni area of Kachchh, Gujarat. pp 34-35.

Singh KP, Singh S, Mehrara KL, Boora A, Singh I. 2018. Diversity in Phenotypic Characters of Nili-Ravi Buffaloes. pp 119.

Singh M, Balhara AK, Singh RK, Ghosh M, Nayan V. 2018. Salivary proteomic analysis for identification of growth related biomarkers in Murrah buffalo calves. pp 17-18.

Singh P, Phulia SK, Sharma RK, Balhara AK, Sunesh, Jerome A, Singh I. 2018. Endocrinological changes during 'Doka' exhibiting lactating Murrah Buffalo. pp 19.

Singh RK, Dey A, Singh M, Punia BS, Dahiya SS, Paul SS. 2018. Influences of active phyto-chemicals on methane emission and blood bio-chemical parameters on Murrah buffalo calves. pp 106.

Singh RK, Singh M, Dey A, Pal RP, Dahiya SS, Ratika K. 2018. Influencing of health promoting conjugated linoleic acid in milk and meat of buffalo; a review. pp 129-130.

Singh S, Tripathi H, Dixit VB, Kumar A, Singh I. 2018. Challenges, threats, opportunities of livestock championships with special reference to buffaloes. pp 163-164.

Sunesh, Balhara AK, Sikka P, Singh I. 2018. Buffalopedia- a web portal on scientific buffalo production. pp 164.

Tripathi H, Dixit VB, Singh S, Singh I. 2018. Searching rural youth interest in agriculture: A case of Haryana, India. pp 170

Tripathy MK, Jan MH, Kumar S, Mehrara KL, Singh S, Singh I. 2018. Effect of degree of skin whiteness on productive and reproductive performance in Nili-Ravi Buffaloes. pp 53.

Verma D, Lailer PC, Balhara AK, Dahiya SS, Mudgal V, Chandra S. 2018. Effect of different feeding ingredients under field condition on reproductive performance and its validation in high yielding Murrah buffaloes at farm level. pp 27.

Verma R, Panghal S, Balhara AK, Nayan V, Phulia SK, Sharma RK. 2018. Genetic polymorphism of IGF-1, TLR 4, and HSP70 in anestrous Murrah buffaloes. pp 50.

Verma R, Singh I, Balhara AK, Nayan V, Sharma RK, Phulia SK. 2018. Global Gene expression in Murrah buffaloes during extremes of age at first calving. pp 42-43.

Yadav PS, Kumar P, Selokar NL, Kumar D, Kumar R, Sharma RK. 2018. Successful pregnancy from clone bull Hisar-Gaurav frozen semen. pp 93.

Yadav R, Tripathi H, Kumar P, Kuma N, Nukala R. 2018. Productive and reproductive traits of buffaloes in Murrah breeding tract of Haryana. pp169.

Yadav R, Tripathi H, Kumar P, Kumar N, Nukala R. 2018. Constraints perceived by the buffalo owners while breeding services from State department of animal husbandry in Murrah buffalo breeding tract of Haryana. pp 161-162.

Yadav S, Boora A, Singh KP, Devi P, Singh I. 2018. A randomized controlled open label study of safety and efficacy of intramammary ceftiofur commercial preparation as dry period therapy in buffaloes. pp 147.

Yadav S, Boora A, Singh KP, Khurana SK, Singh S, Singh I. 2018. A study of pattern in calf mortality at an organized Murrah buffalo herd in India: a 24 year review.pp 141.

H) Popular article

Balaraju BL, Tripathi H, Manjunatha L. 2017. An update of indigenous cattle breeds of India. Pashubandhan 6(7):1-4.

Singh R, Biswas A, Mandal AB. 2018. Impact of ochratoxin on poultry production. Poultry Punch 34 (4):66-70.

हेमा त्रिपाठी, सतबीर सिंह दहिया, सज्जन सिंह, वी.बी. दीक्षित एवं इन्द्रजीत सिंह (2017). भैंस पालन से आय सृजन के अवसर, खेती, पृ.: 3-6.

I) Extension Leaflet/pamphlet/posters etc.

Singh KP, Dahiya SS, Balhara S, Boora A. 2017. Nili-Ravi Buffalo: Punjab Gorav. ICAR-CIRB, Hisar, pp 1-8.

सतवीर सिंह दहिया, अविजित डे, पी.सी. लैलर, सुनेश बल्हारा (2017). सम्पूर्ण आहारपिंड। (In Hindi), ICAR-CIRB publication, Hisar, Haryana.

Dey A, Dahiya SS, Lailer PC, Singh I. 2017. Bhainso ke liye santulit Aahar (Balanced feed for buffalo rearing) (In Hindi), ICAR-CIRB publication, Hisar, Haryana.

हेमा त्रिपाठी, सतवीर सिंह दहिया, अश्विनी कुमार पाण्डेय, विश्व भारती दीक्षित एवं इन्द्रजीत सिंह (2017). ब्याने से पूर्व, ब्याने के दौरान एवं ब्याने के बाद पशुओं की देखभाल।

हेमा त्रिपाठी, सतवीर सिंह दहिया, विश्व भारती दीक्षित एवं इन्द्रजीत सिंह (2017). चूँ करें स्वच्छ दुग्ध उत्पादन।

हेमा त्रिपाठी, धर्मेन्द्र, वी.बी. दीक्षित एवं इन्द्रजीत सिंह (2018) जल जीवन का अनमोल रतन इसे बचाने का करो जतन।

हेमा त्रिपाठी, धर्मेन्द्र, वी.बी. दीक्षित एवं इन्द्रजीत सिंह (2018) कितनी भी हो मजबूरी पोलीथीन से बनाएं दूरी।

हेमा त्रिपाठी, धर्मेन्द्र, वी.बी. दीक्षित एवं इन्द्रजीत सिंह (2018) व्यक्तिगत स्वच्छता: स्वच्छता से स्वास्थ्य व स्वास्थ्य से जीवन बने।

हेमा त्रिपाठी, धर्मेन्द्र, वी.बी. दीक्षित एवं इन्द्रजीत सिंह (2018) स्वच्छ भारत की शुरूआत: स्वच्छ गाँव।

हेमा त्रिपाठी, धर्मेन्द्र, वी.बी. दीक्षित एवं इन्द्रजीत सिंह (2018) पेड़ बचाओ, धरती बचाओ।

J) e-Publication (ePoster)

Bhardwaj A, Nayan V.2018. Ganirelix interaction with gonadotropin alpha: *in silico* insights towards drug-target interactions and implications for assisted reproduction in buffaloes, available at https://www.eposters.net/poster/ganirelix-interaction-with-gonadotropin-alpha-in-silico-insights-towards-drug-target-interactions.

Dahiya SS, Dey A, Lailer PC. 2017. Complete feed block: a solution for animal feeding and management (https://www.scribd.com/document/351691867/Complete-Feed-Block-A-Solution-for-Animal-Feeding-and-Management-SS-Dahiya-Avijit-Dey-and-PC-Lailer-2017).

Dey A. 2017. Feeding strategies for milch buffaloes, https://www.slideshare.net/avijitcirb/dudharu-bhains-o-ka-poshan-feeding-strategies-for-milch-buffaloes.

K) Blog

Tripathi H, Dixit VB, Singh I. 2017. Doubling the income by 2022: views of progressive farmers at CIRB. Agricultural Extension in South Asia (AESA) Aesa Blog **52 (17)**

Database

Boora A, Yadav S, Singh I. 2018. Database of top 100 farmer's buffaloes, Recognition and economic empowermrnt of farmers thhrough identification, conservation and propagation of farmer's best buffaloes : An initiative by ICAR-CIRB since 2015, vol. pp 1-27, ICAR-CIRB, Hisar.

Chaturvedi KK, Mishra DC, Rao AR, Budhlakoti N, Sunita, Bhati J, Rai A, Sikka P, Paul SS, Singh KP, Jerome A and Singh I. 2018. SNPRBb: Trait specific SNP resource on *Bubalus bubalis* for DATABASE.

Research carried out at ICAR-CIRB published in peer reviewed journal - **Fungal Diversity**
[Impact Factor :14.078 (2017-18) ; NAAS Rating (2018) : 19.47]

Research Projects

Institute (IRC approved) Projects

Completed: 8	
No.	**Project Title**(Duration) **PI,** Co PIs
1	Cloning for conservation and multiplication of superior buffalo germplasm (Sep 2010-May 2017) **PS Yadav,** D Kumar, RK Sharma, EM Sadeesh, N Selokar, S Khanna
	Sub Project-1 Cryopreservation of somatic cells and cloned embryos for providing the future reproductive opportunities in buffalo (Apr 2015-May 2017) **N Selokar**, PS Yadav, RK Sharma, D Kumar
	Sub Project-2 Optimization of conditions for efficient gene transfer into buffalo somatic cells for transgenic embryo production (Nov 2015-May 2017) D Kumar, N Selokar, PS Yadav
2	Effect of stimulants on fibre degradation, methane emission and fungal population in buffaloes(Apr 2012-May 2017) **A Dey**, SS Dahiya, BS Punia, PC Lailer, N Saxena, SS Paul
3	An integrated investigation of microbial communities involved in methane production and fibre digestion improvement of reproductive efficiency(Apr 2014-Jun 2017) **SS Paul**, A Dey, BS Punia, A Jerome, P Sikka
4	Studies on development and supplementation of chelated minerals in buffaloes (Apr 2013-Sep 2017) **V Mudgal**, N Saxena, SS Dahiya, BS Punia, K Kumar, ML Sharma
5	Scientific validation of 'Doka' in buffaloes for improvement of reproductive performance under field and farm conditions (Nov 2013-Oct 2017) **SK Phulia**, RK Sharma, AK Balhara, I Singh, Sunesh, PC Lailer, A Bharadwaj
6	Evaluation of sorghum cultivars on growth rate and feed utilization in buffalo (Apr 2015-Dec 2017) **A Dey**, PC Lailer, SS Paul, BS Punia
7	Factors influencing participation of rural youth in farming an exploratory study for approval (Nov 2015-Mar 2018) **H Tripathi**, VB Dixit, Sajjan Singh
8	Optimization of interspecies somatic cell nuclear transfer technique for production of horse cloned embryos (Oct 2015-Mar 2018) **N Selokar**, D Kumar, PS Yadav ;NRCE - TR Talluri, SK Ravi, T Anand
Ongoing	
1	Identification of genetic variants in genes related to oxidative status in relation to fertility in Murrah Bulls (Jul 2013-Oct 2018) **P Sikka**, P Kumar
2	Identification of SNPs in genes related to meat production and their association with meat parameters in buffaloes (*Bubalus bubalis*) (Oct 2010-Mar 2018) **AK Pandey/P Sikka,** SS Dahiya
3	E-BhainsVigyan Kendra(Nov 2013-Dec 2018) **Sunesh**, AK Balhara, SK Phulia, PC Lailer, P Sikka
4	Convergence for dairy development - a synergistic approach(Dec 2015-Jan 2019) **VB Dixit**, H Tripathi, Sajjan Singh
5	Development of diagnostic platforms for sensing candidate bio-signatures of buffalo reproduction (Nov 2015-Oct 2018) **V Nayan**, AK Balhara, RK Sharma;NRCE - A Bhardwaj
6	Manipulation of follicular wave pattern to increase conception rate in buffaloes (Aug 2016-Jul 2019) **MH Jan**, Sanjay Kumar, KL Mehrara
7	Causes of buffalo calf mortality and its management (Nov 2017-May 2020) **SK Khurana**, A Boora, S Yadav, S Kumar
8	Development and supplementation of nano-minerals in buffalo(Sept 2017-Aug 2020) **V Mudgal**, N Saxena, S SDahiya
9	Climate Change and buffalo farming in India: risk assessment and vulnerability - adaptation studies for enhancing the resilience (Jun2017-May 2020) **AK Balhara**, SK Phulia, RK Sharma, A Boora, PC Lailer, A Dey, V Nayan, S Balhara
10	Challenges of high yielding buffaloes: Identification and their management (Jul 2017-Jun 2020) **A Boora**, S Yadav
11	Understanding production performance and assessment of feeding practices of Banni buffaloes under traditional extensive production system (Aug 2017-Mar2019) **SS Dahiya**, KP Singh, A Dey, PC Lailer, V Mudgal

12	Effect of supplementation of galactogogue herbal mixture to lactating buffaloes on production performance and blood biochemistry (Aug 2017-Mar 2020) **N Saxena**, P Sikka, V Mudgal, ML Sharma, K Kumar
13	Buffalo sperm dosages in relation to its functional parameters and field fertility outcome (Mar 2018-Apr 2020) **S Singh**, P Kumar, Jerome A , RK Sharma
14	Aflatoxicosis in buffaloes(Pilot Study) **Ram Singh**
Under Network Project on Buffalo Improvement	
1	Genetic improvement of Murrah buffaloes (CIRB, Hisar Centre) (July 1991-Contd) **KP Singh**, A Bharadwaj, P Kumar, S Khanna
2	Genetic improvement of Nili Ravi buffaloes (CIRB Sub-Campus Nabha Centre) (April 1990-Contd) **R Singh/S Kumar**, MH Jan, KL Mehrara, R Mehta
3	Genetic improvement of Bhadawari buffaloes (IGFRI Centre) (2001- Contd) **BP Kushwaha**;IGFRI - SB Maity, Sultan Singh
4	Progeny testing of bulls under field conditions (FPT) (2001-Contd) **A Bharadwaj**, VB Dixit, H Tripathi

Externally Funded Projects

Completed: 8

No.	Project Title (Duration) PI, Co PIs
1	Computational identification and modeling of genetic variation in relation to performance traits (NABG – CABiN Scheme) – CIRB Centre (Jun 2015-Jun 2017) **P Sikka**, K P Singh, S Balhara, SS Paul, A Jerome, AK Balhara, Varij Nayan
2	Generation of induced pluripotent stem (iPS) cells from buffalo fetal fibroblasts through non-viral approaches (Feb 2016-Mar2018) **D Kumar**, N Selokar, PS Yadav;NRCE - T Anand, BC Bera, N Virmani
3	An open label study to assess the efficacy of 'Spectramast' in the therapy and control of clinical and sub-clinical mastitis in buffaloes (Contract research Project - Zoetis) (Sep 2015-Mar 2017) **A Boora**, KP Singh, Sarita

On-going

No.	Project Title (Duration) PI, Co PIs
1	National Agricultural Innovation Fund (Institute technology management unit (ITMU) (Apr 2008-Contd)**VB Dixit/SK Khurana**, P Sikka, V Mudgal, A K Balhara, S K Phulia
2	Nutritional and physiological interventions for enhancing reproductive performance in animals (AICRP) (Nov 2014-Mar2020) **RK Sharma**, SK Phulia, V Mudgal, Jerome A, P Kumar
3	Lactation stress associated postpartum anoestrus SNP array in Buffaloes (NASF) – CIRB Centre (Jul 2015-Jun 2018) **RK Sharma**, Varij Nayan ; IOB - T Keshava Prasad
4	Simplification of nuclear transfer technique for the production of elite buffalo bulls (SERB) (Oct 2015-Sep 2018) **N Selokar/ D Kumar**
5	Studies on antagonists/inhibitors of signalling molecules to prevent cry capacitation and development of species specific semen extender for buffalo semen cryopreservation (SERB) (Oct 2015-Sep 2018) **P Kumar**
6	Genomic techniques to profile and improve productivity and resilience in buffalo (ICAR-ILRI collaborative Project) (Apr 2016 - Mar18) **P Sikka**, I Singh , A Bharadwaj, AK Pandey, KP Singh ; ILRI- Karen Marshall, Raphael Marode
7	Diversified farming through livestock and agriculture - Farmers First Programme(Oct 2016-Mar2020) **KP Singh**, A Boora, Sajjan Singh; CCSHAU - Bharat Singh, Sunita Yadav, Satpal; IARI - ManjeetSingh
8	Integration of mastitis resistance gene (Lysozyme) into the beta-casein locus of buffalo/ bovine genomes using CRISPR/cas9 (DST-DAAD) (Feb 2017- Jan 2019) **PS Yadav**, D Kumar, N Selokar
9	Synthetic endometrium: A novel model to study early embryonic development and uterine health in ruminants (NASF) - CIRB Centre (Feb 2017-Dec 2020) **D Kumar**

Conferences/Workshops Attended

Event	Attended by
17th Indian Veterinary Congress and XXI IAAVR symposium on newer generation vaccines, diagnostics for improvement of health and productivity vis a vis genomic interventions for societal benefits on April 8-9, 2017 held at IVRI, Izatnagar, Uttar Pradesh	H Tripathi
Enhancing the livestock productivity and production- Focus on Agricultural Extension at National Conference on Revisiting Agriculture Extension strategies for enhancing productivity on April 22-24, 2017 held at PJTSAU, Hyderabad, Telangana	H Tripathi
Participated in meeting on Way Forward in Buffalo and Cattle Genomic Selection on April 27, 2017 held at ICAR, New Delhi	P Sikka
Indo German Project Visit from August 23-September 10, 2017 at Germany	PS Yadav
Workshop on National workshop on developing a roadmap for Agricultural knowledge management in India on September 27-28, 2017 held at DKMA, ICAR, New Delhi	H Tripathi
International conference of society for bioinformatics and biological sciences (SBBS) on Recent Trends In Bioinformatics and Biotechnology for Sustainable Development on October 12, 2017 held at Faculty of Veterinary Sciences and Animal Husbandry (SKUAST), Jammu	Varij Nayan
Brainstorming workshop on "NPBI Data Tabulation and Presentation" on October 24, 2017 held at CIRB, Hisar	I Singh, KP Singh, A Bhardwaj, S Kumar, MH Jan, R Mehta
International Conference on gender issues and socio economic perspectives for Sustainable rural development on October 23-25, 2017 held at GIRD, CCS HAU, Hisar	H Tripathi
III International Conference on Bioresource and Stress Management at SIAM on November 8-11, 2017 held at Jaipur, Rajasthan	A Dey
Training on “Animal breeding data analysis and genomics prediction” on November 20-24, 2017 held at ICAR-CIRB, Hisar, Haryana	KP Singh, P Sikka, BP Kushwaha
Review meeting of CAB in Project on November 27-28, 2017 held at IASRI, New Delhi	P Sikka
Bill and Melinda Gates Foundation stakeholder’s meeting on December 08, 2017 held at ICAR-NDRI, Karnal, Haryana	Varij Nayan, AK Balhara
FFP zonal meeting organized on December 17, 2017 held at ATARI, Jodhpur, Rajasthan	KP Singh
Workshop on “Crop Residue Management” organized by NABARD, on December 21, 2017 held at Chandigarh	A Dey
Annual Conference Society of Animal Physiologists of India on December 21-22, 2017 held at Bidar, Karnataka	PS Yadav
Advancement in bovine reproduction biotechnologies to increase breeding efficiencies’ on February 13, 2018 held at Gurugram, Haryana	P Kumar, Jerome A
International Conference on Bio and Nano-Technologies for sustainable agriculture, food, health, Energy, and Industry on February 21-23, 2018 held at GJUST, Hisar, Haryana	V Mudgal
World Congress on Reproductive Health with Emphasis on Family Planning and Assisted Reproductive Technology & 28th Annual Meeting of the ISSRF on February 23-25, 2018 held at Hyderabad, Telangana	D Kumar
Earth hour campaign for biodiversity conservation March 24, 2018 ICAR-CIRB, Hisar, Haryana	RK Sharma, AK Balhara
IX Asian Buffalo Congress (ABC- 2018) February 01-04, 2018 ICAR-CIRB Hisar, Haryana	I Singh, SS Dahiya, P Sikka, VB Dixit, Hema Tripathi, A Bharadwaj, KP Singh, SN Kala, Ashok Kumar, Sunesh Balhara, PC Lailer, N Saxena, Ram Singh, A Dey, V Mudgal, SS Paul, PS Yadav, RK Sharma, Sajjan Singh, SK Phulia, V Nayan, AK Balhara, D Kumar, Jerome A, Pradeep Kumar, Naresh Selokar, BP Kushwaha, Sarita Yadav, Sanjay Kumar, MH Jan, S Khanna, AKS Tomar, BP Singh, R Parkash, SS Malik, K Kumar, Raj Kumar, Ram Chander, Rajesh Kumar, KL Mehrara

Capacity Building

Name	Subject Area	Place and Period
Scientists		
Dr. S Singh	MDP on Leadership Development	ICAR-NAARM, Hyderabad, June 13-24, 2017
Dr. PS Yadav	Improving e-Governance in Agriculture	MANAGE, Hyderabad,13-15 Nov., 2017
Dr. V Mudgal	Advances in Applications of Nanotechnology	ICAR-CIRCOT, Mumbai, Sept. 11-15, 2017
Dr. V Nayan	Nanotechnological Approaches in Pest and Disease Management	ICAR-NBAIR, Bengaluru, Nov.15-24, 2017
Dr. P Kumar	Bioinformatics tools & their application in biological research	ICAR-NRCE, Hisar, Sept. 5-7, 2017
Dr. D Kumar	Training Programme on Application of Bioinformatics in Agricultural Research and Education	ICAR-NAARM, Hyderabad, Sept. 14-23, 2017
Dr. H Tripathi	Competency Enhancement Programme for Effective Implementation of Training Functions by HRD Nodal Officers of ICAR	ICAR-NAARM, Hyderabad, Feb. 15-17, 2018
Dr. N Selokar	National Workshop on Revisiting FOCARS: Reflections and Feedback of Trained Scientists	ICAR-NAARM, Hyderabad, March 15-16, 2018
Technical Officers		
Sh. BP Singh Sh. Raj Kumar	Competence enhancement program for Technical Officers of ICAR	ICAR-NAARM, Hyderabad, Sept. 13-22, 2017
Sh. Raj Kumar	Training workshop on Video and Computer Based Materials Production	ICAR-IASRI, New Delhi, Sept. 4-9, 2017
Dr. AK Saini	Farm Management	ICAR-IIFSR, Modipuram Oct. 24-28, 2017
Administrative Staff		
Sh. Ram Avtar Sh. Raj Kumar Sh. Narender Kumar Sh. Sunil Kumar	Government e-Marketplace (GeM), e-tendering & e-procurement	Director General of Supply & Disposal Department of Commerce, New Delhi, May 04, 2017
Sh. Rishi Ram	Establishment and Financial Matters for US/SAOs/SF&AOs of ICAR	ICAR-NAARM, Hyderabad, Aug. 17-23, 2017
Sh. Rishi Ram, Sh. Ram Avtar	Procurement & PFMS	ICAR–CPRI, Shimla, Sept. 11-13, 2017
Skilled Supporting Staff		
Sh. Raj Kumar Sh. Satbir Singh Sh. Mahabir Singh Sh. Rajender Singh Sh. Balwant Smt. Sarla Rani Sh. Jaikumar	In-House Training On "To improve skills and efficiency of Skilled Supporting Staff" March 7-9, 2018, organized by HRD unit, ICAR-CIRB (Coordinators: Dr. SK Khurana, Dr. V Mudgal, Dr. Jerome A)	

Budget allocated: Rs. 2.5 lakhs ; Budget utilized :Rs. 2.5 lakhs

Research Students

S.No.	Name of the Scholar	Degree	University	Year	Guide/Co-guide	Title of the thesis
Completed						
1	Chander Mohan	Ph D	IGNOU, New Delhi	2012-17	N Saxena	Identification of active ingredients against GI parasites in extracts of indigenously known herbs
2	Papori Sharma	PhD	LUVAS, Hisar	2014-17	P S Yadav	Studies on epigenetic characteristics of somatic cells in water buffaloes
3	Rashmi	MVSc	NDRI, Karnal	2015-17	AK Balhara	Genetic polymorphism of Serpine2, IGF-1, TLR4 and HSP70 genes in anestrusmurrah buffaloes
4	Pratibha Singh	MVSc	NDRI, Karnal	2015-17	S K Phulia	Behavioural, Morphology and Endocrinological studies during DOKA in Buffaloes
5	Diwakar	MVSc	NDRI, Karnal	2015-17	PC Lailer	Feeding management of high yielding buffaloes under field condition and its validation at farm
6	Krishan Kumar	MVSc	LUVAS, Hisar	2015-17	Avijit Dey	Effects of Feed Additives Rich in Essential Oils on Rumen Fermentation, Methanogenesis and Nutrient Utilization in Buffalo
7	Vikramjeet Singh	MVSc	LUVAS, Hisar	2015-17	Avijit Dey	Relationship of Residual Feed Intake With Rumen Fermentation and Blood Biochemical Profile in Growing Buffalo Calves
8	Kavita	MVSc	LUVAS, Hisar	2015-17	AK Balhara	Efficacy of melatonin with Ovsynch protocol for induction of estrus in anestrusMurrah buffalo heifers during summer season
9	Vikas Jyani	MVSc	LUVAS, Hisar	2015-17	V Mudgal	Effect of critical micronutrient supplementation during peri-parturient period on production and reproduction status of buffaloes
10	Deepak Kumar	MTech	NDRI, Karnal	2015-16	D Kumar	Transposon mediated reprogramming of buffalo fibroblasts to generate induced pluripotent stem cells
11	Vijayalakshmi	MVSc	LUVAS, Hisar	2016-17	D Kumar	Transcriptome analysis of buffalo bull spermatozoa for identification of fertility associated gene(s)
12	Ananth. K	MVSc	LUVAS, Hisar	2016-17	D Kumar	Production of cloned embryos using somatic cells from Swamp buffalo and oocytes from Riverine buffalo
13	Lokesh Kumar	MVSc	LUVAS, Hisar	2017-18	S K Phulia	Evaluation of efficacy of different treatment protocol of estrus induction in buffaloes under field conditions
Pursuing						
1	Kh. Ratika	PhD	NDRI, Karnal	2014 -17	SS Dahiya	Performance of transition buffaloes fed diets supplemented with rumen protected methionine, lysine and choline
2	Y. Mery Chanu	PhD	NDRI, Karnal	2014 -17	SS Paul	Hyper ammonia producing bacteria from rumen of buffaloes and evaluation of additives for their inhibition
3	Rekha Yadav	PhD	IVRI, Izatnagar	2015-18	H Tripathi	Effectiveness of breeding services by state department of animal husbandry in Murrah breeding tract of Haryana-A perceptual study

S.No.	Name of the Scholar	Degree	University	Year	Guide/Co-guide	Title of the thesis
4	Jasmer	PhD	LUVAS, Hisar	2015-18	Pardeep Kumar	Studies on minimization of cyocapacitation of buffalo *(Bubalus bubalis)* sperm during cryopreservation
5	Archana Sarangi	PhD	NDRI, Karnal	2016-19	AK Balhara	Identification and confirmation of early pregnancy associated urinary metabolites in murrah buffalo
6	Mala Singh	PhD	NDRI, Karnal	2016-19	S K Phulia	Proteomic evaluation of uterine and vaginal cytology during early pregnancy in buffaloes
7	Ram Kumar Singh	PhD	NDRI, Karnal	2016-19	SS Dahiya	Modulation of Buffalo Milk Conjugated Linoleic Acid Content through Dietary Supplementation of Plant Secondary Metabolites
8	Puja Tamboli	PhD	NDRI	2016-19	A Bharadwaj	Association of age at first calving and first lactation traits on lifetime productivity in buffaloes
9	Deeksha	PhD	LUVAS,Hisar	2016-19	AK Balhara	Evaluation of infrared thermography for monitoring of udder health in buffaloes
10	Muhamad Abubakar	PhD	LUVAS, Hisar	2017-19	PS Yadav	Effect of telomerase activator on telomere length and telomerase activity of somatic cells and cloned embryos in buffalo
11	N Ramesh	PhD	IVRI, Izatnagar	2017-20	H Tripathi	Multi-dimensional study on usage of antibiotics in livestock and poultry farming
12	Kiran Attri	MVSc	NDRI, Karnal	2016-18	A Dey	Evaluation of composite feed additive on milk production, Methane emission and nutrient utilization in buffaloes
13	Ram Narayan Patel	MVSc	NDRI, Karnal	2016-18	PC Lailer	Effect of feeding cation-anion salt during transition period in buffaloes
14	Jyoti Shakya	MVSc	NDRI, Karnal	2016-18	I Singh	Effect of enzyme mix supplement on buffalo milk production, composition and feed digestibility
15	Sonam Bhardwaj	MVSc	NDRI, Karnal	2016-18	PC Lailer	Studies on level of serum kisspeptin and its relationship with sexual behavior and semen quality
16	Vipin	MVSc	IVRI, Izatnagar	2016-18	V Mudgal	Effect of vitamin A and E supplementation during peri-paturient period on performance of Murrah buffalo
17	Sandeep Chikkara	MVSc	LUVAS, Hisar	2016-18	SS Dahiya	Effect of replacement of GNC with Guar Korma on rumen fermentation pattern and growth performance in buffaloes

Personnel

General Administration

Dr. Inderjeet Singh	Director
Sh. Rishi Ram	AO (11.04.2017 to 23.12.2017)
Sh. Ram Avtar Parashar,	FAO (Relieve on 23.12.2017)
Sh. Raj Kumar	AAO (Relieve on 23.12.2017)
Sh. Joginder Singh	Private Secretary
Sh. Rajesh Kumar	Assistant Administrative Officer
Sh. Viksit Kumar	Assistant
Sh. GirdhariLal	Assistant
Sh. Abdul Majid	Assistant
Sh. Ashok Kumar	UDC
Smt. Indira Devi	UDC
Sh. Satbir Singh	UDC
Sh. Dharam Pal	LDC
Sh. Sunil Kumar	LDC
Sh. Mahabir Singh	LDC

Animal Genetics & Breeding Division

Dr. (Mrs.) Poonam Sikka	Principal Scientist & Head I/c
Dr. Anurag Bharadwaj	Principal Scientist
Dr. AK Pandey	Principal Scientist (till 21/06/2017)
Dr. KP Singh	Principal Scientist
Dr. SK Khurana	Principal Scientist
Dr. SN Kala	Senior Scientist
Dr. Ashok Kumar	Scientist
Mrs. Sunesh Balhara	Scientist (On study leave)
Sh. AKS Tomar	ACTO
Sh. Ram Chander	T.O

Animal Nutrition & Feed Technology Division

Dr. Satbir Singh Dahiya	Principal Scientist & Head I/c
Dr. Puran Chand Lailer	Principal Scientist
Dr. Navneet Saxena	Principal Scientist
Dr. SS Paul	Principal Scientist (till 16/06/2017)
Dr. Ram Singh	Principal Scientist
Dr. Avijit Dey	Senior Scientist
Dr. Vishal Mudgal	Senior Scientist
Dr. ML Sharma	ACTO
Sh. Krishna Kumar	ACTO

Animal Physiology & Reproduction Division

Dr. Prem Singh Yadav	Principal Scientist
Dr. Rakesh Kumar Sharma	Principal Scientist & Head I/c
Dr. Sajjan Singh	Principal Scientist
Dr. Sushil Kumar Phulia	Principal Scientist
Dr. Varij Nayan	Scientist
Dr. Ashok Kumar	Scientist
Dr. Dharmendra Kumar	Scientist
Dr. Jerome Andonissamy	Scientist
Dr. Pradeep Kumar	Scientist
Dr. Sadeesh EM	Scientist (till 18/04/17)
Dr. Selokar Naresh Lalaji	Scientist
Sh. Jagdeep Singh	Technician
Sh. Asharfi Shah	Technician

Transfer of Technology and Entrepreneurship

Dr. VB Dixit	Principal Scientist & Incharge
Dr. (Mrs) Hema Tripathi	Principal Scientist
Dr. ML Sharma	ACTO
Sh. Gopal Dutt Tiwari	Technician

Network Project on Buffalo Improvement

Dr. Inderjeet Singh	Project Coordinator
Dr. KP Singh	Principal Scientist &Incharge
Dr. BP Kushwaha	Principal Scientist (Posted at IGFRI, Jhansi)
Dr. Sarita Yadav	Scientist (Joined on 04.12.2017 after availing study leave)
Sh. Ram Chander	TO

Prioritizing Monitoring & Evaluation Cell

Dr. Navneet Saxena	Principal Scientist
Dr. Dharmendra Kumar	Scientist
Sh. Raj Kumar	ACTO

PRO

Dr. Ashok Kumar Balhara	Scientist

HRD Cell

Dr. (Mrs)Hema Tripathi	Principal Scientist
Dr. Jerome A	Scientist

AKMU & Library

Dr. Avijit Dey	Senior Scientist
Sh. Raj Kumar	ACTO

CPIO/APIO

Dr. RK Sharma	Principal Scientist & CPIO
Sh. Rajesh Kumar	AAO & APIO

Hindi Section

Dr. Vishal Mudgal	Senior Scientist & Hindi Officer
Sh. Dharam Pal	LDC

Vigilance Officer

Dr. Anurag Bharadwaj	Principal Scientist

Agricultural Farm

Dr. PS Yadav	Principal Scientist & Overall Incharge
Sh. Surender Singh Malik	ACTO & Incharge
Sh. SantLal	TO (Driver)
Sh. Kuldeep Singh	TO (Driver)
Sh. Satpal	TO (Driver)
Sh. Satish Kumar	Technician

Workshop Section

Dr. PS Yadav	Principal Scientist & Overall Incharge
Sh. Baljeet Singh	TO & I/c Workshop Section
Sh. Bhim Raj	TO (Driver)
Sh. Ram Kumar	STA (Driver)

Estate Section

Dr. SK Phulia	Principal Scientist & Incharge
Sh. Brij Pal Singh	ACTO

Electrical Section

Dr. SK Phulia	Principal Scientist &Incharge
Sh. Rajesh Parkash	ACTO
Sh. Gopal Singh	TO

Landscape Section & Guest House

Sh. AKS Tomer	ACTO & Incharge

Animal Farm Section

Dr. A. Bharadwaj	Principal Scientist & Overall Incharge
Dr. Sudhir Khanna	Chief Technical Officer &Incharge
Dr. Satish Kakkar	CTO
Dr. Rajesh Kumar	Technical Assistant
Sh. Joginder Singh	Technician

Internal Security

Sh. Ram Chander	TO

CIRB Sub-Campus Nabha

Scientific

Dr. Ram Singh	Principal Scientist & Officer Incharge (20.03.2017 to 26.9.2017)
Dr. Sanjay Kumar	Scientist & Officer Incharge (w.e.f. 27.9.2017)
Dr. Mustafa Hassan Jan	Scientist

Technical

Dr. KL Mehrara	CTO & I/c BPM
Sh. Virendra Singh	CTO & I/c Workshop
Sh. Jagdish Prasad	CTO & I/c Agriculture
Sh. Rajiv Mehta	ACTO & I/c Feed Unit
Dr. TP Singh	ACTO & I/c Estate and Maint.
Dr. RS Pippal	STO & I/c Security
Dr. Ashwani Saini	STO & I/c Library
Sh. Daljit Singh	TO
Sh. Balwinder Singh	TO
Sh. Mohan Singh	TO (Driver)
Sh. Nishan Singh	Technician
Sh. Santokh Singh	Technician
Sh. Dalbara Singh	Technician

Administration

Sh. Narender Kumar	AAO
Sh. Tejinder Singh	UDC

Joining

- Dr. SK Khurana, Principal Scientist joined on 01.04.2017 on transfer from ICAR - NRCE, Hisar.
- Sh. Rishi Ram, Administrative Officer joined on 11.04.2017 on transfer from ICAR – CIRC, Meerut
- Dr. Sanjay Kumar, Scientist joined on 27.04.2017 at Sub-Campus,Nabha on transfer from ICAR-NRCC, Bikaner
- Sh. Sadhu Ram S/o Sh. Rajmal, SSS joined on 16.08.2017
- Sh. Jarnail Singh S/o Sh. Sher Singh, SSS joined on 16.08.2017
- Sh. Om Parkash S/o Sh. BhajanLal, SSS joined on 24.07.2015
- Sh. Rati Ram S/o Sh. Mangal Ram, SSS joined on 16.08.2017
- Sh. Jaswant Singh S/o Sh. Magher Singh, SSS joined on 11.8.2017
- Sh. Shri Nath S/o Sh. Ram Jugan, SSS joined on 11.8.2017
- Sh. Rajesh S/o Sh. Swarth, SSS joined on 11.8.2017
- Sh. Mukhtiar Singh S/o Sh. Joginder Singh, SSS joined on 11.8.2017
- Sh. Virendra Singh 29.9.2017 on completion of deputation to DAC, GoI.

Promotion

- Sh.Surender Singh, ACTO, promoted to the next higher grade of CTO w.e.f. 17.01.2016
- Sh. Raj Kumar, STO, promoted to the next higher grade of ACTO w.e.f. 01.01.2016
- Sh. Rajesh Kumar, Asstt. Promoted to the next higher grade of AAO w.e.f. 5.8.2017
- Dr.Varij Nayan, Scientist, promoted to the next higher grade of RGP Rs.8000/- (Sr. Scientist) w.e.f. 17.11.2016
- Dr. Ashok Kumar Balhara, Scientist promoted to the next higher grade of RGP Rs.8000/- (Sr. Scientist) w.e.f. 08.1.2017
- Dr.Sadeesh EM, Scientist promoted to the next higher grade of RGP Rs.7000/- (Scientist) w.e.f. 01.05.2015 (Presently posted at NDRI, Karnal)
- Dr.Shaitan Singh, STO, promoted to the next higher grade of ACTO w.e.f. 01.01.2017
- Dr. Rajesh Kumar, TA, promoted to the next higher grade of STA w.e.f. 24.11.2016

Retirements

- Sh. IS Kundu, AAO retired on 30.04.2017
- Sh. Rameshwar, Casual Labourer on 30.04.2017
- Sh. Mahabir Singh, STA compulsory retired on 23.05.2017
- Dr.Shaitan Singh, ACTO retired on 31.08.2017
- Sh. Jagpal, CLTS retired on 28.02.2018
- Sh. Neenu, SSS, CIRB, Sub-Campus retired on 28.02.2018
- Dr. SN Kala, Sr. Scientist retired on 31.03.2018

Transfer

- Dr. Sadeesh EM, Scientist transferred to ICAR – NDRI, Karnal on 19.04.2017
- Dr. SS Paul, Principal Scientist transferred to ICAR – DPR, Hyderabad on 17.06.2017.
- Dr. AK Pandey, Principal Scientist transferred to ICAR – IVRI, Izatnagar on 22.6.2017.
- Sh. Rishi Ram, AO on promotion transferred to ICAR-IISR, Lucknow as Senior AO on 23.12.2017
- Sh. Ram Avtar Parashar, FAO on promotion transferred to ICAR-CPCRI, Kasargod as Senior FAO on 23.12.2017.
- Sh. Raj Kumar, AAO on promotion transferred to ICAR-NBAGR, Karnal as Administrative Officer on 23.12.2017

Sad Demise

Sh. Balraj Singh, SSS expired on 14.7.2017.



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