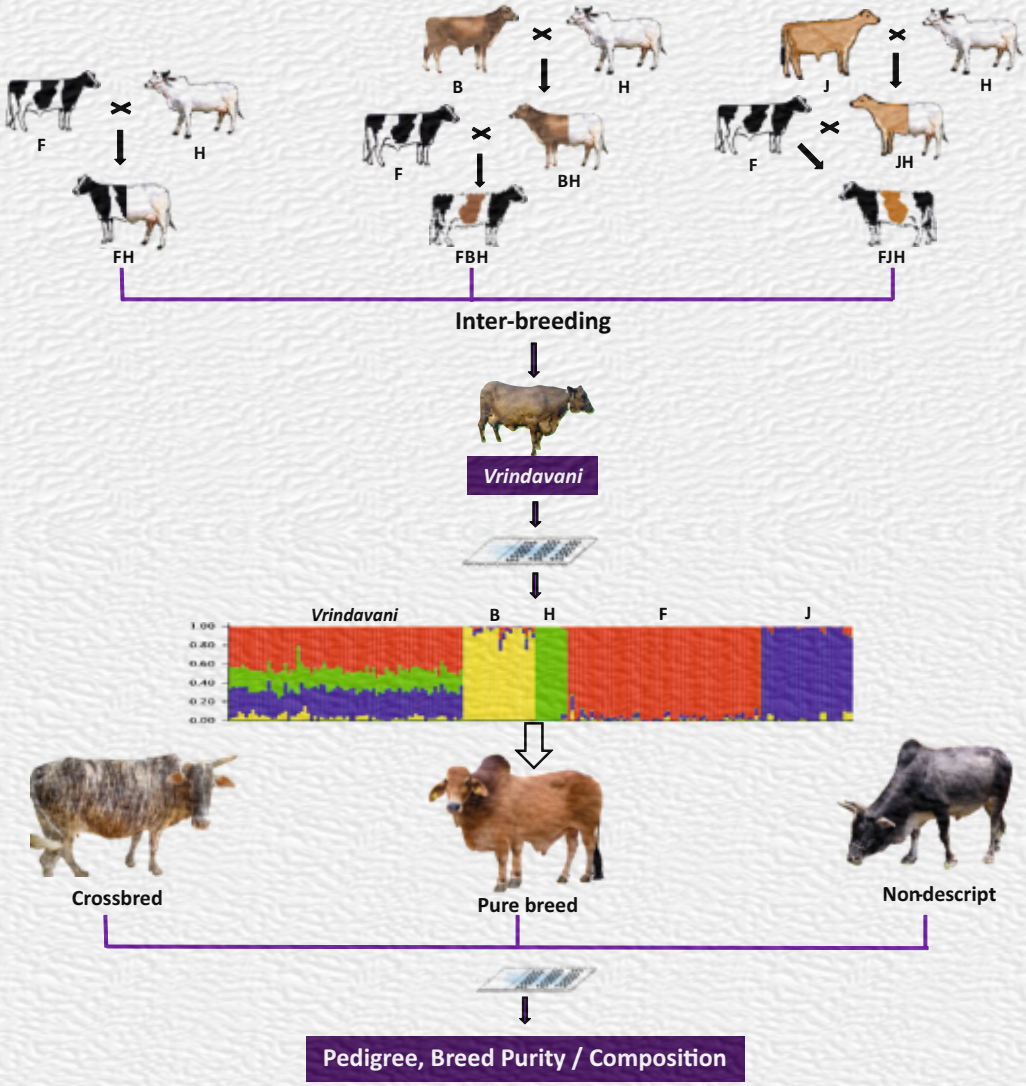
Annual Report
2017-18



ICAR-INDIAN VETERINARY RESEARCH INSTITUTE
(ISO 9001:2008 Certified)
Izatnagar-243 122 (U.P.), India
www.ivri.nic.in

ICAR-IVRI

ANNUAL REPORT

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We resolve to safeguard the livestock wealth of the country ...

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About the cover page:

The synthetic crossbred cattle strain depicted schematically on the cover page, was derived by the inter-se mating of different half-breds and three-breed crosses up to 7 generations. Finally, the FH, FBH and FJH crosses were used in the breeding plan to develop the synthetic strain. This synthetic population of crossbred cattle strain with an expected exotic inheritance of 50-75% and Hariana inheritance between 25-50% was named "Vrindavani" in the year 2006. The precise genetic composition of the Vrindavani could be determined using a 50K SNP BeadChip, with an average ancestry of 42.60, 19.75, 10.60 and 27.01% inheritance levels from Holstein Friesian, Jersey, Brown Swiss and Hariana breeds, respectively. This approach will find application for estimating the breed purity/composition of any unknown/purebred/non-descript cattle population.

Abbreviations used:

F - Holstein Friesian; B - Brown Swiss; J – Jersey; H – Hariana; FH - Holstein Friesian+Hariana; BH - Brown Swiss+Hariana; JH - Jersey+Hariana; FBH - (1/2 Holstein Friesian +1/4 Brown Swiss + 1/4 Hariana); FJH - (1/2 Holstein Friesian + 1/4 Jersey + 1/4 Hariana)

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FOREWORD

Livestock is an integral component of agriculture in India and help to improve food and nutritional security, generate income, employment, act as a cushion against crop failure, and contribute to foreign exchange through export of livestock products. The livestock sector is both expanding and adapting to changing economic, technological, and environmental factors. In this context, the institute has been serving as the national hub for research to develop important veterinary diagnostics, vaccines and biological products for successful control and management of major livestock and poultry diseases and raise the productivity of the livestock species. In addition, the institute contributes to the development of trained human resource through quality education at the post-graduation level.

The ICAR-IVRI, since its establishment in 1889, has been a torch-bearer for advanced scientific and technological research, education and extension activities in Veterinary Science in India. Since its inception, the institute has laid a balanced emphasis on the pursuit of basic, applied, and translational research in veterinary science. Frontier areas of research include development of new generation vaccines, nanotechnology-based diagnostics and biosensors, host-pathogen interaction, advanced clinical research and therapeutics including ethno-veterinary medicine, antimicrobial peptides, clinical applications of stem cells; rumen microbiology, genetic studies on livestock health and production, augmentation of reproductive efficiency, cancer biology etc.

The institute actively pursues a policy of true academic freedom in all the areas of its activities. The faculty, numbering about 236, is active in a broad spectrum of research and maintains a high annual publication output. Serving as a national centre for excellence in R&D in veterinary science, the institute has handled 163 research projects, including 79 institute-funded and 84 externally-funded projects during the year. The faculty of the Institute continues to attract a large number of research projects funded by various agencies, including the ICAR; Department of Science and Technology (DST); Department of Biotechnology (DBT); DBT-BBSRC; Dept of Health Research, Ministry of Health and Family Welfare; CSIR; ICMR; CZA, Ministry of Environment and Forests; UPCAR; Ministry of food Processing and Industries etc.

The research accomplishments of the scientists and students are reflected in 405 quality research papers besides several books, invited paper/lectures, training manual/compendia, monographs and extension bulletins. It is noteworthy to mention that the scientists of the institute have been publishing in international journals of repute and this has brought more visibility to the research output. Research publication trend analysis revealed that since 2013-14, the total impact factor from research publications in peer reviewed journals has jumped from 231.56 to 350.

In pursuance to the identified thrust areas of research, and targets set by the GoS and the Council; the institute continued research to develop Thermo-tolerant FMD vaccine and other new generation vaccines with long duration immunity, combination vaccines to save cost of vaccination and diagnosis, etc. The products ready for transfer include: the Subviral particle-based vaccine against Gumboro diseases of poultry (the first recombinant vaccine for livestock/poultry in the country to reach to the farmers in very near future), improved PPR diagnostic kit, serodiagnostic kits for bluetongue disease of sheep and Japanese encephalitis of pigs.

Institute-industry interface meetings were organized to popularize the developed technologies and their transfer to interested manufacturers in the country. The Institute has been encouraging its faculty and students to protect their intellectual property, and convert the results of some of their scientific investigations to practice via technology transfer and entrepreneurship development. During this reporting period, the institute generated revenue to the tune of Rs. 92.25 lakh from sale of technologies and royalties accrued from technologies transferred in the preceding years. The Institute IPR portfolio includes grant of two patents, one design registration, four copy rights and filing of one new patent during the reporting period.

On the basis of All India Entrance Examination, 181 students (98 M.V.Sc. and 83 Ph.D.) were admitted to post-graduate programmes of the Deemed University during the academic year and currently, a total of 243 M.V.Sc. and 406 Ph.D. students are on roll. The

Division of Physiology & Climatology as well as Division of Nutrition – functioning as Centres for Advanced Faculty Training recognized by ICAR –contributed to the capacity building of faculties in the SAUs and Veterinary Universities. The institute also conducted several in-house training to upgrade the skills of scientists, students and all categories of technical and administrative staff. The institute also strengthened its linkages with various SAUs/Veterinary universities such as Assam Agricultural University (Jorhat), Kamdhenu University (Gandhinagar, Gujarat), Chhattishgarh Kamdhenu University (Durg), Rajasthan University of Veterinary & Animal Sciences (Bikaner), Maharashtra Animal & Fishery Sciences University (Nagpur), and Bihar Agriculture Sciences University (Patna). This is expected to raise the standard of higher education across the NARS system. The post graduate students are being encouraged to take up twinning PG program at reputed foreign universities for advanced research exposures.

The farmer welfare schemes of the government were implemented through organizing *Sankalp Se Siddhi*, *Sansad Adarsha Gram Yojana* and *Farm Women Day*. Several other important extension activities were carried out at the headquarter, campuses and regional stations of the institute in the form of *Kisan Melas*, exhibitions, animal health and infertility camps, soil health camps, awareness camps on hygiene and zoonoses, *Jai Kisan Jai Vigyan* week and *Mera Gaon Mera Gaurav* programme, etc. Further, the institute has organized training courses to farmers/farmwomen in *Precision Livestock Farming*, *Dairy and Animal Husbandry* and *Unnat Pashupalan*. Rural youth were trained and assisted for establishing entrepreneurship Tribal families were assisted for establishment of piggery, poultry and goatry. More than 2000 farm families benefitted under the Tribal sub-plan program (TSP) being implemented in Karnataka, West Bengal, Uttarakhand, Himachal Pradesh and Maharashtra. A number of mobile apps are being developed and some have been released for use by the stakeholders. The use of such user-friendly apps will certainly enhance the spread of developed technologies among the farming community.

The faculty members have been conferred with national awards and honors, viz., ICAR-Bharat Ratna Dr C. Subramaniam award, Hari Om Ashram Trust award, ICMR-Young Biomedical Scientist award in recognition of their contributions and the high level of academic excellence.

I am honoured to present the ICAR-IVRI Annual Report of 2017-2018 which documents the research efforts made and the significant accomplishments during the period. The volume of high quality work reported goes to the credit of the intellectual activities of the faculty members and the students, to the support of the skilled support staff, technical and administrative personnel, and to financial support from various funding agencies. As I complete my fourth year as Director of this institution, I place on record my personal gratitude to the Hon'ble policy makers Shri Radha Mohan Singh Ji, Hon'ble President ICAR; Dr Trilochan Mohapatra, Hon'ble Secretary DARE and DG, ICAR; Chhabilendra Roul, Hon'ble Special Secretary (DARE) & Secretary (ICAR); Dr Joykrushna Jena, DDG (AS), and Dr Ashok Kumar, ADG (AH), ICAR, New Delhi. I sincerely thank ADG (ANP), ADG (AP&B) and whole staff of the Animal Science Division of ICAR as well as Hon'ble FA (DARE), Director (Finance), and staff of Finance Division of ICAR. I sincerely and gratefully acknowledge the collective support and cooperation received from all my colleagues at IVRI. We the IVRIans, pledge to sharply focus our efforts for the welfare of the farmers and livestock owners which has been our endeavour for the past 128 years and continue to serve the country in the coming years too.

Jai Hind

(R K Singh)

CONTENTS

2017-18

VISION

Harness veterinary and animal science research and education for sustainable growth in the livestock sector so as to ensure food and income security.

MISSION

Research and development in veterinary and animal science to promote livestock and poultry health and production, generate human resources, develop and transfer technologies to ensure sustainable livestock production systems.

MANDATE

- Basic and strategic research for improvement of animal health for enhanced productivity
- Human resource development, imparting under-graducate and post graduate education
- Dissemination of livestock production and health technologies

1.0 Executive Summary

Animal Health

Vaccine development

- FMD (trivalent) vaccine with novel adjuvants provided complete protection in calves when tested 28 day post vaccination by homologous virus challenge with FMDV serotype O.
- A thermostable mutant (F98Y) virus-like particle (VLP) induced specific antibody titres as determined by LPBE and found comparable to cell culture antigen. F98Y capsid antigen may be used as an alternate antigen in LPBE as it avoids handling infective virus.
- FMD virus passaged in the presence of nucleoside analogue ribavirin showed two specific amino acid changes in RdRp gene. Mutation G62S resulted in lower fidelity of RNA dependent RNA polymerase.
- FMD virus was rescued from eight of the twelve codon deoptimised constructs (deoptimised at different segments of non-structural proteins genes of FMDV Asia 1) and characterised. Sequence analysis of these viruses passaged in BHK-21 cells showed genetic stability.
- Serological potency models based on SNT and LPBE for FMD virus serotype A was developed as *in vitro* alternative for challenge method in FMD vaccine quality testing.
- Vaccine worth attributes such as adaptability to suspension BHK-21 cells, growth kinetics, BEI-inactivation kinetics, genetic and antigenic stability of thermostable mutant of FMD virus serotype O was studied and found to be similar to parent vaccine virus.
- Lapinized classical fever virus (pCSFV–GFP) produced using reverse genetics has been rescued in PK-15 cell line.
- Combination vaccines of Thermo-adapted (Ta) PPR and goatpox, and Ta PPR and sheeppox vaccines were prepared.
- Bacterial ghosts and outer membrane vesicles of *Pasteurella multocida* have been characterized, and it will be evaluated as novel delivery system and adjuvant along with FMDV antigens.
- Proof-of-concept study on the Hemorrhagic septicaemia vaccine formulations prepared using novel adjuvants was evaluated *in vivo*. The HS vaccine formulations using different concentrations of *Pasteurella multocida* antigen viz., 2.5 mg and 0.5 mg with novel adjuvants was found efficacious in cattle.
- The modified S19 strain (S19Δper) of *Brucella abortus* was found to be highly attenuated eliciting strong immunological response.
- One of the anaerobic sensor FNR genes of *Salmonella* Typhimurium responsible for colonization in the intestine was deleted and *in vitro* growth kinetics of the mutant was found comparable with respect to the wild type.
- cctA gene of *Clostridium chauvoei* was inactivated and the mutant was characterized by PCR and haemolytic assay.
- Immunization of mice with irradiated *Trypanosoma evansi* at 450 Gy and 480 Gy produced predominantly IgG2a type antibody response post-immunisation (PI), while in mice immunized with *T. evansi* irradiated at 500 Gy, the predominant antibody response PI was of IgG2b type.
- Immunization with a cocktail of *Eimeria tenella* rIMP+rSO7+rGAM22 conferred significant protection in chickens in terms of weight gain, lesion scores and oocyst output following homologous oocyst challenge in broiler chickens.
- Ferritin2 (FER2) and Tropomyosin (TPM) of *Hyalomma antolicum* were cloned, expressed and characterized as recombinant proteins for use as potential vaccine candidates against ticks.

Diagnostic development

- An improved sandwich ELISA kit (IVRI-M antigen capture ELISA kit) for bluetongue diseases of sheep has been developed, validated and the kit released.
- A Lateral flow assay (LFA) device has been developed which can be used for detection of both PPRV antigen as well as antibody using same device (dual usability device).
- Competitive ELISA developed for detection of CSFV antibodies in pigs with 99.22% specificity and 96.70% sensitivity as compared to IDEXX ELISA Kit.
- Recombinant protein based iELISA has been developed for detection of rotavirus D (RVD) infection.

- Hybridomas against FMD virus non-structural protein 3AB was produced. Development of monoclonal antibody based blocking ELISA for specific detection of FMDV non-structural protein (NSP) antibodies in all FMD-susceptible species is in progress.
- Serotype specific monoclonal antibodies specific to FMDV serotype Asia 1 were produced. The MAbs are neutralizing and specific to 146S of FMDV Asia 1.
- Developed a recombinant protein based indirect ELISA for detection of Porcine Circo Virus 2 (PCV2) antibodies in pigs.
- Indirect IgM ELISA was standardized to know the active infection of Japanese encephalitis virus in swine.
- Dipstick IgG ELISA was standardized as an on-site test for sero-diagnosis of JE in swine with relative sensitivity and specificity of 100% and 92.9 %, respectively.
- Indirect IgG ELISA was standardized for sero-diagnosis of JE virus in equines.
- ELISA using LPS of *Brucella* has been standardised and inter-laboratory validation within Institute and at four other outside institutions has been completed.
- Latex Agglutination Test (LAT) and indirect ELISA employing synthetic peptides of LLO for serodiagnosis of listeriosis in caprine and bovine species was developed and evaluated.
- Latex Agglutination Test (LAT) using polyclonal IgY antibodies against recombinant LLO and synthetic peptides of LLO for direct detection of *L. monocytogenes* in foods and clinical samples from enrichment broth was developed.
- Latex Agglutination Test (LAT) employing synthetic peptides of *Com1* and *Ybgf* have been standardized for serodiagnosis of Coxiellosis in bovines.
- A diagnostic ELISA was standardized using a cocktail of recombinant SAG-1 and SAG-3 proteins with the sensitivity and specificity of 91.60% and 79.48%, respectively.
- Standardized PCR and LAMP assays for *Salmonella* spp., verotoxigenic *E. coli, S. aureus, Clostridium perfringens* and *Clostridium botulinum* type A & B.
- Multiplex PCR for the detection of *tet*B, *sul*2 and *str*A was optimized and found to be promising for rapid screening of these antimicrobial resistance genes in isolates of *Pasteurella multocida*.
- Standardized species specific (cattle, buffalo and pig) paper based LAMP and LAMP-LFA strip, and multiplex PCR assay for simultaneous detection of species origin of tissue from cattle, buffalo, pig, sheep and goat.

Characterization of pathogens

- Intraocular inoculation of swine origin JEV in mouse model induced typical clinical signs and neuropathological lesions.
- Mice infected with JEV through intra-peritoneal route showed increased levels of cytokines (TNF-α, MCP-1, INF- γ, IL-10) between 3 to 5th DPI.
- LD_{50} for swine origin JEV by intra-peritoneal route was calculated to be $10^{2.5}$/0.1 ml.
- Experimental studies on bluetongue virus serotype-2 in sheep after intradermal inoculation revealed pathomorphological changes in lungs, trachea and spleen, decrease in hematological parameters with increased serum biochemical values and altered kinetics of CD4+ and CD8+ T cell sub populations at different days.
- A field isolate of Canine distemper virus (*CDV (Dog)/Bly/Ind/2018*) of canine origin has been isolated and adapted in Vero cells for further attenuation through serial passage (up to 10th passage label). The virus has been characterized at antigenic and genomic level.
- Complete genome sequencing of Sheeppox virus -Romanian Fanar and Indigenous Sheeppox virus -Jaipur isolates were done using next generation sequencing.
- A total of 696 fecal samples from children (158), piglets (261) and calves (277) were screened for group A rotavirus from western coastal parts of India (Karnataka, Kerala, Goa and Maharashtra) of which, 31, 12 and 9 samples from human, bovine and porcine species, respectively, were found positive. The most prevalent genotypes found were G1P[8], G12P[11] in humans while G3P[11] & G6P[11] in bovine and G4P[6] in porcine from Maharashtra and Goa.
- Cultural isolation of *Campylobacter* spp. was 11.64% (51) from a total of 438 samples from different sources. *C. coli* was the predominant species isolated (31/51).
- A total of 111 *Campylobacter* isolates from different sources were evaluated for their biofilm forming ability and sensitivity to disinfectants. Phenol, sodium hypochlorite and benzalkonium chloride were effective, as they completely inhibited the biofilm formed by *Campylobacter* isolates.
- *Campylobacter* isolates (111) were genotyped by *fla*A typing and ERIC-PCR assay. *Fla*A typing generated 6 genotypes while the ERIC-PCR assay generated a total of 10 genotypes and showed a good discriminatory power (D value) of a 0.88-0.90. Dendrogram analysis showed that the human isolates shared high identity with animal origin isolates (chicken,

quail and poultry skin) irrespective of origin of the isolates (Bareilly and Pantnagar).
- Whole genome sequencing of 2 isolates each of *E. coli* and *Pasteurella multocida* revealed genomic diversity.
- Antimicrobial profiling of 430 Indian isolates of *P. multocida* revealed gentamicin, amoxycillin/clavulanic acid and cefoperazone to be highly effective against the isolates tested.
- MLVA-16 analysis of 80 *Brucella* field isolates revealed that the isolates from human and animals grouped together.
- Antibiotic sensitivity testing of 80 *Brucella* field isolates revealed that only a few isolates were sensitive to tetracycline and streptomycin. Majority of the isolates showed resistance to rifampicin and co-trimoxazole, respectively.
- Screening of novel known SNP analysis of gyrB gene in 10 representative *M. bovis* isolates from eastern India indicated variation in locus 756, 1410 and 1450.
- The C3 binding region and antigenic epitope of GAPDH from *Haemonchus contortus* was identified in fragment D comprising 95 residues (77 to 171) which stimulated host peripheral blood mononuclear cells *in vitro*.
- A reference multi-acaricide resistant tick strain has been characterized and established.
- Screening of 27 wild animal carcasses/muscles revealed presence of *Trichinella* sp. in 5 leopards and one tiger sample.
- Molecular characterization of different *Trichinella* isolates collected from wild animals revealed circulation of *T. britovi*, *T. spiralis* and *T. nelsoni* or *T. nelson*-like genotypes in India.

Disease monitoring and surveillance

- Out of 600 tissue samples from respiratory tract, 84 positive were found positive for NDV, 23 for IBV, 6 for AIV-A, 8 for FAV and 12 for ILTV genome. Three isolates of NDV, 4 of IBV and 3 of ILTV were isolated in embryonated chicken egg.
- Phylogenetic analysis of NDV isolates revealed involvement of 3 different genotypes (VI, VII, XIII), IB isolates revealed the involvement of Mass strain and nephropathogenic strain and ILTV showed closeness with CH04 isolate of Switzerland.
- Japanese encephalitis virus was detected in 6/20 mosquitoe pools tested by TaqMan RT-PCR.
- Mosquito pools collected from animal sheds were subjected to NGS. Data analysis revealed presence of Nege virus, Biggie virus, Dianke virus, Merida virus, Shuange Chryso like virus, Culex rhabdo virus, *Wuchereria bancrofti*, Malaria parasite, etc.
- Out of 459 serum samples from Uttarakhand (228), Himachal Pradesh (111), Jammu and Kashmir (47), and Delhi (73) showed SRLV seropositivity of 17.98%, 2.7%, 14.89% and 6.85%, respectively.
- Hospital-based occurrence of canine parvovirus was found to be 63% of canine gastrointestinal cases.
- Out of 137 animals tested (103 by DTH; 137 by serum-ELISA & 35 by milk-ELISA), prevalence of Johne's disease in bovines was found to be less (6.8%) by DTH compared to ELISA (Serum: 11.7%; Milk: 22.9%).
- Three fecal samples from organized cattle farm turned positive to both IS900 insertion sequence and ISMap02 PCR and identified as 'Bison' type strains by restriction enzyme analysis of IS1311.
- In pig-cum-fish integrated farming under field conditions, zoonotic bacteria viz. *Clostridium perfringens* A was detected in 16.7% (n=24) of pig slurry followed by Enterotoxigenic and Shigatoxic *Escherichia coli* (8.33% each).
- Single or multiple pathogens were detected in 79 out of 450 lung samples which included 28 cases of *P. multocida*, 17 cases of BHV-1, 11 cases of *M. hemolytica*, 7 cases each of BPI3 and BVDV, 5 cases of BCV and 1 case of BRSV.
- Investigation of 33 cases of abortions in cattle (31) and buffalo (2) revealed presence of *Brucella spp.* (11), and non-specific microbes (*E. coli*, *E. Fergusonii*, *Aeromonas*, *Bestiarum*, *Acinebacter schindleri*) in 18 aborted foetus.
- Of 372 bovine milk samples screened from Assam and Haryana, ESBL producing *Enterobacteriaceae* and MRSA were detected in 13.44% and 2.68% samples, respectively with gene blaCTX-M as predominant ESBL gene followed by blaSHV and blaTEM gene.
- Total 874 samples were screened for parasitic infestation and found that *Haemonchus contortus* and *Teladorsagia circumcincta* were predominant parasites. However, *Oesophagostomum* sp., *Bunostomum trigonocephalum* and *Trichostrongylus* sp. were also found prevalent.
- In wildlife species, the important conditions diagnosed were canine distemper in lion and leopard; Rota viral infection in sloth bears; tuberculosis in sloth bears, Nilgai, spotted deer and Himalayan griffon, systemic aspergillosis in Himalayan griffons,

verminous pneumonia due to *Protostrongylus* sp. in Himalayan blue sheep, *Mulleries* sp. in musk deer and *Trichinella* sp. infestation in tiger and leopard.

Therapeutics

- Three antimicrobial peptides (AMPs) of 12-15 amino acids of mammalian origin were synthesized and screened against multi-drug resistant *Enteroaggregative E. coli* (MDR-EAEC) strains (n=3) to determine their Minimum Inhibitory Concentrations (MICs), Minimum Bactericidal Concentration (MBCs) and *in vitro* stability.
- The MIC values (µM) of AMP-1, AMP-2 and AMP-3 against MDR-EAEC strains were observed to be 32.0, 4.0 and 32.0; while the MBC values (µM) were found to be 64.0, 4.0 and 32.0, respectively.
- *In vitro* testing of three inhibitor molecules *viz*., catechin, silymarin, taxifolin for their ability to inhibit lethal toxin formation of *Bacillus anthracis* revealed that silymarin at concentration of 10 µM was more effective than taxifolin.
- Ribavirin at 50 mg/kg body prevented the clinical disease in adult mice and death in case of suckling mice induced by FMDV A serotype.
- Endoplasmic stress induced autophagy plays an important role during the replication of FMDV in cell culture and inhibition of autophagy restricts FMDV replication.
- Dietary supplementation of ω-3 PUFA rich fish oil @ 156 mg EPA and DHA per kg body weight for 10 weeks inhibited the endometrial PGF2α production during the luteolytic/maternal recognition window following estrus induction.
- Curcumin and bilirubin combination showed marked synergism in wound healing and by isobolograph combination ED_{50} was 0.06% [0.02% (B) + 0.04% (C)].
- Kaempferol showed endothelium-independent relaxation through the involvement of BKCa channels, sGC, protein kinase A (PKA) pathways in rat isolated pulmonary artery.
- Casein kinase 2 was identified as a novel pathway of oxytocin signaling in late pregnant mouse uterus.
- Lysophosphatidic acid acts as a luteotropic factor during the estrus cycle in non-pregnant buffalo uterus by enhancing PGE_2 to $PGF_{2\alpha}$ ratio and modulates the mRNA expression of genes that facilitate the establishment and maintenance of pregnancy in early pregnant buffalo uterus.
- Administration of betulinic acid (BA) and ursolic acid (UA) to rats (30, 60 and 120 mg/kg) for 28 days did not significantly affect the body weight gain and different organ weight as compared to control rats.
- Ceftriaxone and chitosan mixed at different ratio from 1:1-1:10 with binder glutaraldehyde or tripolyphosphate (TPP) for good yield has been standardized. However, encapsulation efficiency was low.
- Bacosine (*Bacopa monnieri*) and alizarin (*Rubia tinctorium*) were found to be cytotoxic, inhibited expression and activity of MMP-9 and MMP-11 in mouse mammary cancer cell line. Bacosine and alizarin showed apoptotic and necrotic activities, respectively.
- IgY extraction from egg yolk by different methods was standardized and chloroform-PEG method was found to be more suitable.

Clinical research

- Six months cryopreserved xenogenic composite graft of tendons found to be effective for repair of tendon gap defects.
- Six months cryopreserved xenogenic composite graft of bone were evaluated *in vitro* and *in vivo* for healing of bone gap defects and found to be effective for repair.
- Metallic CESF, M-seal circular ESF, Stack intramedullary pinning and Acrylic cast were found suitable for fracture fixation in ruminants.
- Hybrid locking plating technique produced excellent bone healing in dog.
- A plate-interlocking nail construct for the repair of diaphyseal femur fractures in dogs was designed and evaluated in clinical cases.
- Conventional and Doppler echocardiographic evaluation was carried out in 102 dogs suspected for cardiac abnormalities out of which 35 were found to have confirmed primary cardiac abnormalities.
- A strong correlation was found between renal resistive index and systolic function parameter and diastolic function parameter.
- Early and late stages of Kerato-Conjunctivitis Sicca (KCS) had significantly high expression of Caspase 3 (89.33%) and INFγ (85.04%) than the control.
- Bioengineered caprine forestomach matrix fabricated with cell adhesion molecules were able to reduce the healing time by 25 to 30% when compared with autograft.
- NaOH (8% Conc.) as decontaminant, was considerably effective in reducing total bacterial count (TBC) from 1.9 X 10^4 cfu/gm to 1 x 10^4 cfu/gm in per unit floor area of pig farm initially washed with plain water.

- ORP-EVM 18 treatment (EC50-200 mg/kg orally) significantly restored impaired kidney function.
- Dogs (n=325) with signs and symptoms of gastritis showed that hepatitis (40/140), renal failure (26/80, Haemoprotozoa infection (07/50), GI parasitism (10/40) and pyometra (8/15) contributed to development of secondary gastritis.
- Nano-structured hybrid polymer of Catechin consistently increased *in vitro* antioxidant property, improved bioavailability and has potential for use as a hepatoprotectant.
- Structured catechin hydrate nanoparticles using Na-alginate polymer may be a boon to treat compromised liver condition.
- Safety testing of tolfenamic acid was conducted in Himalayan griffons and found to cause reversible increase in uric acid levels at 6 h and 12 h interval. Plasma tolfenamic acid concentration was at peak at 2 h interval and declined to undetectable levels at 96 h post treatment. The birds remained active and healthy.
- Bioactive meshes, coated with mesenchymal stem cells and its conditioned media were prepared and the stem cells were extracted successfully from mesh scaffold. Cryopreservation protocol for MSCs-augmented mesh scaffold was standardized.
- Canine induced pluripotent stem cells (ciPSCs) were generated by reprogramming of adipose tissue-derived mesenchymal stem cells and were propagated efficiently on functionalized carbon nanotube scaffold.
- Saponins were extracted for *in vitro* cytotoxicity studies from fruits of *Asparagus adscendens*, seed coat of *Sapindus mukorossi*, leaves, flowers and stem of *Silene inflata* and leaves of *Chlorophytum spp.*
- The supplementation of vitamin E, Se, Cu and Zn along with the extra energy during peri-parturient period is expedient in amelioration of production stress and efficacious transition of crossbred cow.
- Kisspeptin (Kiss1-Kp) and its receptor (Kiss1r) expressed differentially at protein and transcripts level in the anterior and medio-basal hypothalamic area to regulate the GnRH release in different stages of estrous cycle in buffalo. The extra-hypothalamic presence of kisspeptin and its receptors in corpus luteum and its association with luteal steroidogenesis was established.
- The dynamics of expression of BMP and FGF systems in buffalo placenta indicate that the BMP and FGF may play significant role in modulating placental function by promoting angiogenesis, cell survivability and steroid genesis in water buffaloes.
- MDCK cell lines stably transfected with the recombinant plasmids encoding transcript variants of luminal renal urate transporter MRP4 in domestic chicken (*Gallus domesticus*) as well as vulture (*Gyps himalayensis*) were established and characterized. Results indicated that urate transport is not inhibited at MRP4 channel in the presence of 200 μM diclofenac. MRP4 appears to be functional as diclofenac efflux transporter in both chicken and vulture.

Animal Production

Nutritional and physiological research

- Dietary co-supplementation of JA-derived prebiotics and polyphenols brings about a synergistic effect much like a symbiotic on gut health in dogs.
- Supplementation of lutein and 20 mg/kg DM improved immune and antioxidant status and the ability of captive India leopards to combat stress.
- Supplementation of nano-Zn at the level of 20 and 40 ppm exhibited beneficial effects on immune response, hormonal profile, antioxidant status and reproductive traits of goat kids.
- Supplementation of nano-selenium was superior than inorganic selenium in exerting beneficial effects on clinico-nutritional attributes of rats exposed to endotoxin.
- Eight rumen bacteria from buffalo were isolated, characterized and identified and culture submitted to VTCC, NIANP, Bengaluru.

Genetic studies on livestock

- Admixture levels (breed composition) in *Vrindavani* cattle (n=24) were estimated using Bovine 50K SNP BeadChip and the proportion of inheritance of Holstein Friesian, Jersey, Brown Swiss and Hariana, in these cattle was ascertained to be 42.60, 19.75, 10.6 and 27.01 %, respectively. Principal Component Analysis (PCA) could successfully be used to predict the structure and ancestry proportions in *Vrindavani* cattle.
- The pedigree data on sire and dam on 154 *Vrindavani* cattle was collected, tabulated and digitised for ready reference of the cattle farm. Inbreeding coefficients were calculated and digitised which ranged from 0 to 32 % in all the animals studied. These were categorized as acceptable (<5 %), moderate (5-10 %) and high (>10%) inbreeding groups. The mean inbreeding coefficients of acceptable, moderate and high inbreeding groups were

0.0216a±0.0014 (96), 0.0729b±0.0025 (38) and 0.2043c±0.0165 (20), respectively.

- The differentially expressed miRNAs in the PBMCs of crossbred pigs (62.5 to 75 % Landrace inheritance) in response to CSF vaccination on 7 and 21 days of post vaccination were identified. Out of predicted DE miRNAs, it was found that 40 and 35 DE miRNAs were common from miRNA seq and mRNA seq data on different time intervals. Two set of target genes, CD86 and TNFAIP3 (target gene of ssc-miR-146a-3p); TLR4 and IFIT1 (target gene of ssc-miR-1343) were validated by qRT-PCR and were also found to be in concordance with the results of mRNA Seq analysis.
- Mineral constituents of milk in different bovine species and breed were estimated and compared. The Ca, Cu, fat and protein were found significantly higher in Murrah buffalo followed by Tharparkar cattle and crossbred cattle. However, Mn and Zn were higher in Tharparkar cattle followed by Murrah buffalo and crossbred cattle. Tharparkar milk was also rich in Na and K followed by crossbred cattle and Murrah buffalo.
- Genotyping for A1/A2 loci of β-Casein gene was carried out in a population comprising of 429 Frieswal, 235 *Vrindavani* and 50 Tharparkar cattle housed at different locations. All the three genotypes viz. A1A1, A1A2 and A2A2 were observed in Frieswal and *Vrindavani* whereas A1A1 was not observed in Tharparkar cattle.
- The effect of A1/A2 β–Casein genotype in Frieswal cattle had significant effect on several production traits. Results revealed that genotype had significant effect ($P \leq 0.05$) on Total milk yield in kg, Milk yield at 300 days in kg, Lactation length in days and Peak Yield.
- Data on fitness/ economic traits viz. birth weight, weaning weight, adult body weight, litter size at birth, litter size at weaning, generation interval etc were recorded in base foundation parental stock (P generation) in mice and their offspring born as a result of full sib mating to develop an inbred strain. The average birth weight was found to be 1.68±0.01g and the mean litter size at birth was 9.46±0.08. The mean adult body weight of male (35.26±0.41g) was significantly ($P \leq 0.01$) different from the female (31.19±0.39g).
- FecB mutation was screened in a population of 432 Kendrapada sheep from their natural breeding tract and its association with litter size was found out. This indicated that effect of genotype on litter size was highly significant and one copy of the FecB allele increased litter size from 1.0 to 2.0. Further, 173 breedable animals with FecBBB genotype were also identified.
- The 5’ and 3’ regulatory regions of Uromodulin gene from Black Bengal goat were PCR amplified using proof-reading DNA polymerase and were characterized by means of NGS.
- Plasmid-based transgene expression vector targeting expression of transgene in the urine utilizing 5' and 3' regulatory regions of kidney-specific uromodulin gene from goat was constructed.

Livestock products technology

- Dye based quality indicator sensors to assess the freshness, change in quality and temperature abuse conditions of chicken meat stored at different temperatures was developed.
- A survey conducted in and around NCR and Bareilly, revealed that the taste, nutritional value and brand name of meat products are the most sought after features and *Seekh Kebab* is the most preferred convenience meat product in the NCR.
- Comparison of various food grade wrapping films *viz.* LDPE, LLDPE, HDPE and PVC in tray sealing packaging system for fresh meat (chicken and mutton) and meat products revealed that HDPE is a superior film for both refrigerated and frozen storage.
- Standardized processing of fermented milk powder enriched with antioxidants from sprouted legumes and application of crude extract of curd as antimicrobial and antioxidant agent in paneer and raw meat preservation.
- Antimicrobial activity increased in digested milk of indigenous cattle against *Shigella flexneri*, and remained same in undigested and digested milk against *Bacillus cereus*.
- Higher amount of saturated fatty acids were detected in indigenous cattle and local goat milk, whereas polyunsaturated fatty acids were present in lower or undetectable limits.
- Lactic acid producing bacteria were isolated from the milk of hill cattle.

Extension

- A total of six training programmes on *Unnat Pashupalan, Dudharu Pashu Prabandhan, Vaigyanic Pashudhan Prabandhan, Vaigyanic Pashupalan* were organized during the period. These programmes were sponsored by ATMA, Champawat (UKD); Bhojpur (Bihar); Pakur (Jharkhand); HELP NGO, Dehradun

(UKD); SAMETI, Lucknow (U.P.). A total of 110 farmers/farmwomen and 21 extension professionals of ATMA were trained.

- Two interface meets were organized at IGFRI, Jhansi and Navsari Agriculture University, Gujarat which were attended by a total of 200 and 114 participants (Veterinary officers, SMS of KVKs, Personnel of Dairy development department, scientists and professors) respectively.
- One *Kisan mela* was organized at IVRI Campus, Mukteswar on 28th Feb. 2017 wherein a total of 250 farmers/farmwomen participated.
- The institute exhibition stall was put up in a total of 17 *Kisan Mela*/Animal fairs which include ICFMD, Bhubaneshwar; Motihari, Bihar; Varanasi, Mathura, Sahjahanpur, Kanpur, Moradabad and Bareilly in Uttar Pradesh and GBPUA&T, Pantnagar, Uttarakhand.
- The institute participated in a total of six *Vrihad Pashu Aarogya Shivir* (Animal Health camps) organized in various districts of UP and Bihar.
- Division of Extension Education successfully conducted a training program on "Changing Paradigms in Agricultural Extension: New Demands Need New Capacities" in collaboration with MANAGE, Hyderabad which was attended by 24 participants from 7 States.
- A year-long program, "Mentoring Rural Youth" continued by the Extension Education Division, wherein, 100 potential rural youth were trained and mentored on various agricultural/livestock/poultry farming systems to promote agripreneurship among youth.
- Extension Education Division significantly contributed to the nation-wide exercise, "Coordination Committee meeting of Uttar Pradesh on Doubling Farmers' income by March 2022"; second meeting held at IVRI on 04th April, 2017.
- Under the TSP programme, various activities were organized by the IVRI campus, Bengaluru; IVRI Campus, Mukteswar; ERS, Kolkata; IVRI-TEC, Pune and IVRI Regional Station, Palampur. The major activities included 15 trainings/*Gosthies*, 365 demonstrations (including input distribution) of various technologies/ package of practices and livestock/ birds for livelihood generation, 23 health camps/exhibition and two exposure visits benefitting a total of 1427 tribal farmers/ farmwomen *viz*., 455 Mahadev Koli and Kokna, 135 Soliga, 530 Tharu, 48 Himachali tribal, 263 Santhal and Lodha tribal families. Under the NEH programme, IVRI-ERS, Kolkata organized animal health camps and awareness programmes and distributed piglets in the Lakhimpur, Baksa, Kokrajhar and Chirang of Assam, thereby benefitting 85 farmers of Ahom community.
- A total of 173 queries were answered through the Kisan Call Center and IVRI helpline services.
- A total of 23685 visitors visited ATIC, out of which 19213 visitors came for technology product procurement, 498 visitors for consultancy and 3974 visitors for exposure visits (83 groups). The visitors mainly included livestock owners/ farmers, students, and entrepreneurs and distinguished visitors. During visits the visitors were shown dairy farm, poly-clinic, piggery farm, feed unit, Krishi Vigyan Kendra and various research divisions of the Institute. The visitors included 1798 School children: 1059 farmers, 50 field Vets, 224 Other Professionals, 813 College students (UG/PG scholars), and 30 Academicians from various Agriculture and Veterinary universities.
- TEC, Pune conducted 14 animal health camps in different villages of Maharashtra State wherein a total of 1,865 animals belonging to 547 livestock farmers were treated for various ailments.
- Under TSP programme, 10 tribal farm women were given a unit of four female goats and a male goat each in Gawandh tribal village of Nashik district for improving the livelihood security.
- One interface meet (with the state veterinary officers and staff of Vanbandhu College of Veterinary Sciences, Navsari, Gujarat) and three *Kisan Goshties* were conducted at different parts of Maharashtra. Six training programmes (including two on Goat Farming for 103 farm men and women under TSP) and five workshops/seminars were also organized.
- Different user friendly IVRI technologies (such as UMMB block, Feed block making machine, Foldable animal restraining device, Fetal extractor, Device for retention of prolapse and External skeletal fixation devices) were evaluated in the field level. *Jai-Gopal* vermiculture unit was established at TEC, IVRI, Pune.
- A survey was conducted among 217 veterinary officers from different regions of Maharastra to ascertain the frequently used antibiotics in different clinical conditions and factors responsible for their misuse leading to development of AMR.

- IVRI Regional Station Palampur distributed 40 crossbred milch goats and 4 bucks to tribal families under TSP activity.

Education

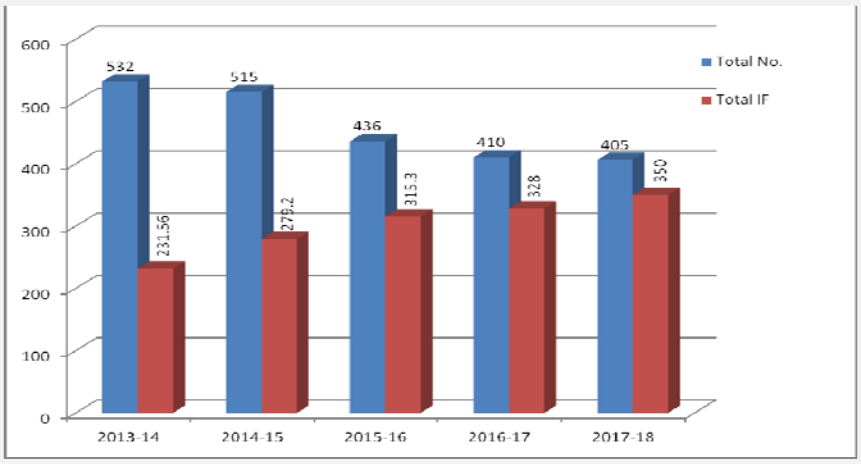
- On the basis of All India Entrance Examination, 181 students (98 M.V.Sc. and 83 Ph.D.) were admitted to post-graduate programs during the academic year.
- Four officers from RVC were enrolled to the National Diploma in Equine Husbandry, Medicine and Surgery (NDEHMS).
- Six specialized short-term training courses were conducted in different disciplines to provide the recent advances and hands-on training to students and in-service candidates.
- Centre for Advanced Agricultural Science and Technology (CAAST) is a lead platform of ICAR under the National Agricultural Higher Education Program (NAHEP) funded by the World Bank. The IVRI DU has successfully bagged an Advanced Centre for Livestock Health under the CAAST.

Publication and Presentations

- During the current year (2017-18) a total of 405 research papers were published in Indian (234) and foreign (171) journals of repute with total NAAS score of 2352.8 and TR Impact Factor of 349.86 A detailed analysis of the research publications of IVRI from 2013-14 to 2017-18 revealed that the institute is steadily improving impact factor of publications. Scientists of the Institute are increasingly publishing in international journals with high impact factor. The percentage increase of impact factor compared to 2013-14 was 51%.
- The other major publications of the institute include Books (9), Book Chapters (45), Annual Reports (2), Popular/Technical Articles (53), and Invited Papers/Lectures in training (187), Research Abstracts (271), GenBank Submissions (299), Training Manual/Compendia (22), Monographs (15), News Letter (2) and Extension Bulletins (25).
- Mass media presentations made during the year include Radio/TV Talks (22) and Press Releases/Newspaper Coverage (27).

Other Achievements

- Developed National Brucella Repository wherein 80 field isolates has been preserved.
- Seven technologies *viz*., Live attenuated Classical Swine Fever vaccine, PPR vaccine, Goat Pox vaccine, Vero cell-based Sheep Pox vaccine, *Jai Gopal* vermiculture, Vegetable incorporated meat products and Premium chicken soup were licensed to 13 Govt. Deptts/commercial houses/entrepreneurs earning a revenue of Rs. 92,25,179.
- The institute was granted two patents and has filed one new patent.
- The institute was granted one design and four copyrights.
- A total of 3,812 mice, 3,065 rats and 354 guinea pigs and 47 rabbits were produced during the year 2017-18.
- A total of 28,226 frozen semen straws from *Vrindavani* (14,192 straws), Tharparkar (1,625 straws), Sahiwal (3,573) and buffalo (8,836) bulls were produced.



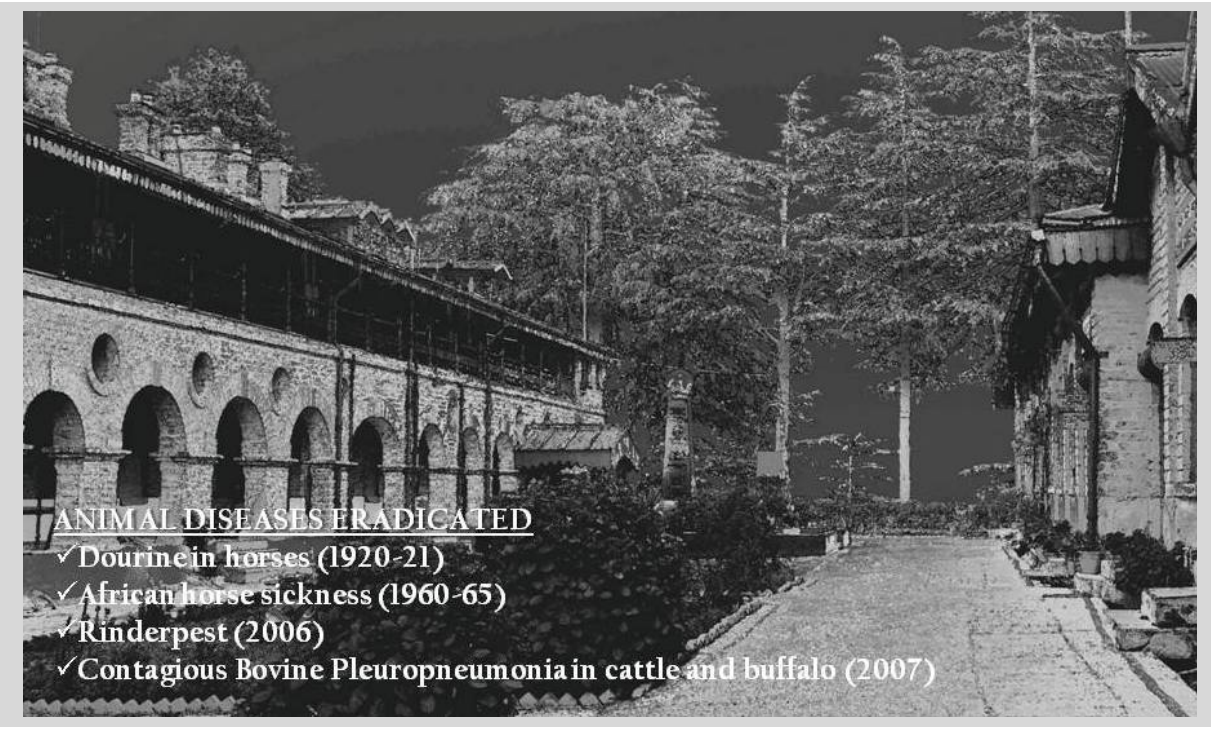
The changing trend of research publications with international impact factor published during 2013-18

2.0 Introduction

MILESTONES

The major historical landmarks in the genesis, growth and development of this national institute are:

1889 Foundation of Imperial Bacteriological Laboratory (IBL) at Pune, Maharashtra
1890 Appointment of Dr Alfred Lingard, a noted medical scientist, as Incharge IBL
1893 Shifting of the IBL to Mukteswar, Kumaon Hills of Uttar Pradesh (now in Uttarakhand)
1897 Historical visit of renowned bacteriologists, Dr. Robert Koch, Dr. R. Pfeiffer and Dr. G. Gaffky
1899 Production of first batch of anti-rinderpest serum
1901 Establishment of a sub-center at Kargaina, Bareilly (U.P.)
1913 Establishment of Izatnagar campus
1925 Institute renamed as Imperial Institute of Veterinary Research
1930 Institute renamed as Imperial Veterinary Serum Institute
1936 Institute renamed as Imperial Veterinary Research Institute
1940 Development of vaccine against Ranikhet disease of poultry
1947 Headquarters shifted from Mukteswar to Izatnagar and the institute renamed as Indian Veterinary Research Institute (IVRI) under Govt. of India
1958 Establishment of a Postgraduate College of Animal Sciences at Mukteswar, affiliated to Agra University
1959 Establishment of Regional Station at Palampur (Himachal Pradesh)
1966 Transfer of administrative control to Indian Council of Agricultural Research and recognition as a National Institute
1970 Establishment of a Regional Station at Kolkata (formerly Calcutta)
1971 Establishment of IVRI Campus at Bangalore (Now Bengaluru)
1973 Development of irradiated lung worm vaccine and establishment of Vaccine Production Centre at Srinagar
1982 Establishment of Germplasm Centre at Izatnagar
1983 Conferment of Deemed University status by University Grants Commission to IVRI, Izatnagar
1986 Establishment of National Biotechnology Centre (NBC) at Izatnagar
1986 Establishment of a Centre for Animal Disease Research and Diagnosis (CADRAD) at Izatnagar
1998 Establishment of High Security Animal Disease Laboratory at Bhopal
2000 Dedication of High Security Animal Disease Laboratory to the Nation
2001 Development of competitive-ELISA diagnostic kit for Rinderpest, approved by OIE and validated by IAH, Pirbright, UK.
2001 P2 facility for FMD vaccine quality control created at Animal Experimental Station, Yelahanka, IVRI, Bengaluru
2001 Conferment of Sardar Patel Outstanding ICAR Institution Award
2002 Development of live modified PPR vaccine
2004 Establishment of Kisan Call Centre at Izatnagar
2004 Inauguration of University-cum-Administrative Block at Izatnagar
2004 Dedication of Polyclinic to the Nation
2005 Award of ISO 9001: 2000 Certificate by International Certificate Services Asia to CADRAD
2006 India achieved the Rinderpest free status
2009 Recognition of HSADL as OIE approved Referal Lab for HPAI diagnosis; the third such lab in Asia and seventh in the world
2009 Establishment of SPF Animal Facility at HSADL, Bhopal
2009 Establishment of Zonal Technology Management - Business Planning and Development Unit (North Zone)
2010 Conferment of Sardar Patel Outstanding ICAR Institution Award for the year 2009
2012 Erection of commemorative pillar at Mukteswar to mark the successful global eradication of rinderpest
2013 Commemorative Centenary Pillar erected at Izatnagar Campus
2014 Development and commercialization of Sheeppox vaccine using indigenous strain
2015 Establishment of Training and Education Centre at Pune
2015 Initiation of under-graduate (BVSc & AH) programme at IVRI Deemed University
2016 ISO 9001:2008 certification for Quality Management system
2016 Release of IVRI signature



Dr Alfred Lingard, a distinguished medical bacteriologist was appointed in 1890 as in-charge of the laboratory. Within a short period of two years the seriousness and danger of handling the micro-organisms of infectious diseases and pathological materials in the densely populated city of Pune was realized and consequently, the laboratory was shifted in 1893 to an isolated site amidst the dense conifer forest of Mukteswar in Kumaon hills of the Himalayas situated at about 1500 m above the mean sea level in United Province. Dr. Lingard had studied bacteriology in Germany and was instrumental for the historical visit of three renowned bacteriologists, Drs. Robert Koch, Pfeiffer and Gaffky to Mukteswar in 1897 to advise on methods for the prevention and control of rinderpest. The work for production of the anti-rinderpest serum started in the same year and the first batch was produced in 1899. During the next five years from 1901 to 1906, the Institute started production of antisera against anthrax, haemorrhagic septicaemia and tetanus, a vaccine against black quarter and a diagnostic against equine glanders. A sub-centre was established at Kargaina near Bareilly on 1901 for conducting some experiments in the plains. The land available at Kargaina was inadequate for further expansion of the work and therefore the Izatnagar campus was started in 306 ha of land in 1913. The name of Imperial Bacteriological Laboratory was changed to the Imperial Institute of Veterinary Research in 1925 and again renamed as Imperial Veterinary Research Institute in 1936. At the dawn of independence of the country on 15th August, 1947, the institute was renamed as Indian Veterinary Research Institute. The administrative control of the institute was transferred to Indian Council of Agricultural Research in 1966 and it got the recognition as a national Institute.

A new campus of IVRI was created at Bangalore (1971), besides regional stations at Kolkata (1970), Palampur (1967) and Srinagar (1973). In 1998 High Security Animal Disease Laboratory at Bhopal was established which later in 2009 was recognized as OIE approved referral laboratory for diagnosis of HPAI and later converted into a separate institute. The institute has been further expanded by the establishment of Training and Education Center at Pune, Maharashtra in 2015.

The institute has contributed immensely for enhancement of livestock production through control of economically important diseases and eradication of some of them, most notably eradication of rinderpest, CBPP, African horse sickness and dourine. Important vaccines against economically important diseases include rinderpest (GTV vaccine), hemorrhagic septicaemia, anthrax, PPR, sheeppox, goatpox and New Castle disease of poultry. The institute has also developed a number of user friendly and advanced diagnostics for livestock and poultry diseases.

Besides research on animal health, the institute contributed to productivity enhancement through genetic improvement of indigenous livestock and development of better cost effective nutritional

interventions. Value addition of livestock products and research to enhance shelf-life of livestock products and innovative technologies to monitor quality of livestock products during storage had helped the livestock producers and entrepreneurs. The Institute also acts as a nodal referral centre for veterinary type cultures, disease diagnosis, biological, immuno-diagnostics and also recognized as DCGI Laboratory for quality testing of all veterinary vaccines and diagnostics being used in the country.

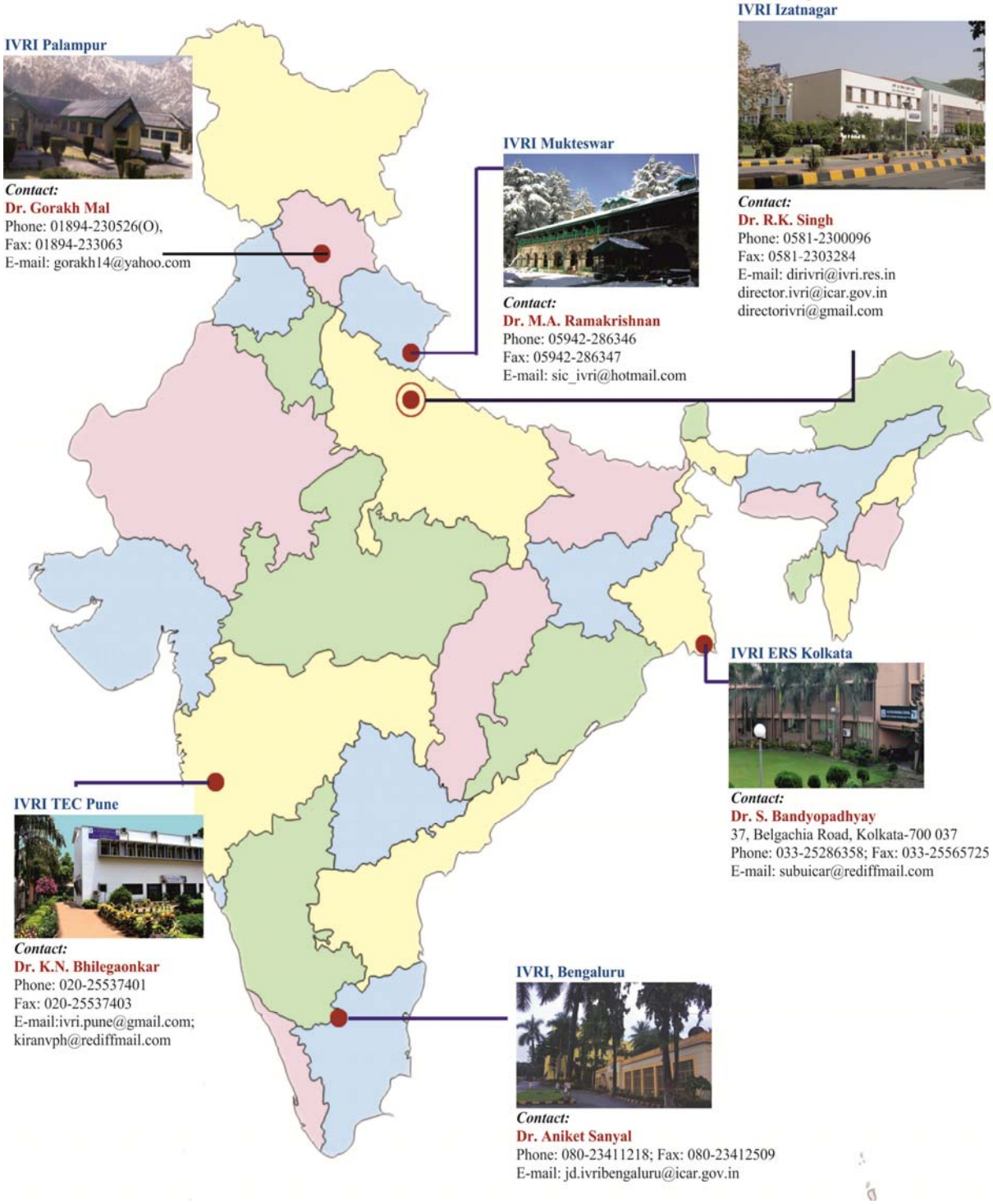
It continues to strive hard to further boost the livestock economy of the country through research to develop new generation vaccines for livestock and poultry, advanced and user friendly diagnostics for animal diseases, provide diagnostic services to various stakeholders including wildlife organizations, monitoring and surveillance of diseases in the country, development of low cost therapeutic agents based on indigenous herbal preparations and stem cell based therapies. The institute has successfully transferred many of these technologies to various commercial manufacturers and entrepreneurs in the country and has disseminated these technologies to end users through its extension services using conventional and latest information and communications tools. The institute has a dedicated unit to promote entrepreneurs and commercialize the technologies. During last five years, more than 30 technologies were transferred to various stakeholders including commercial houses. The significant achievements of the institute has been recognized through various awards, most notably the 'Sardar Patel Outstanding ICAR Institution Award', twice, in 2001 and 2009.

The ICAR-IVRI has also been actively involved in teaching and training veterinary professionals in the country. Post-graduate teaching and training for field veterinarians, civil and army personnel started as early as 1900. Regular post-graduate and refresher courses were organized since 1922 and the institute started awarding Diploma for the Associateship of IVRI in 1943 as a part of post-graduate teaching programme leading to establishment of a P.G. College of Animal Sciences in 1958. In the beginning, it was affiliated to the Agra University and subsequently to Rohilkhand University. The Deemed University status was conferred by UGC in 1983. The IVRI-Deemed University with its reputation for quality education offers Master's degree in 22 disciplines and Doctoral degree in 19 disciplines. The undergraduate degree programme (BVSc & AH) has also been initiated from 2015 with an intake capacity of 20 students. The university has MoU with several Central and State Agriculture Universities for extending its expertise in higher education in Veterinary and Animal Sciences.

The Referral Veterinary Polyclinic and Teaching Veterinary Clinical Complex (TVCC) offers treatment services to livestock and pets, and the facility provides an excellent platform for teaching students and trainees. The TVCC is being further strengthened by expanding the infrastructure, and building a new block equipped with state-of-the-art equipments. Super-specialty laboratories for veterinary ophthalmology and dental surgery have also been established. The wildlife centre of the institute imparts education and training on wildlife health and management and provides consultancy services to various wildlife sanctuaries, zoos and various state and central organizations involved in wildlife conservation. The institute has also established National Animal Science & Veterinary Educational Museum and a mini zoo for educational and recreational purposes.

Branch Laboratory of IBL (1901) at Kargaina, Bareilly (UP)

ICAR-Indian Veterinary Research Institute



ORGANIZATIONAL SET-UP

ICAR-INDIAN VETERINARY RESEARCH INSTITUTE (DEEMED TO BE UNIVERSITY)

DIRECTOR

ADMINISTRATION

IZATNAGAR CAMPUS (HEADQUARTERS)

- Joint Director CADRAD
- Joint Director Ext. Education
- Joint Director Academic
- Joint Director Research
- Joint Director (Admn.)
- CAO
- Comptroller
- Registrar

OTHER CAMPUSES/REGIONAL STATIONS

- Joint Director Bengaluru
- Station I/C Mukteswar
- Station I/C Palampur
- Station I/C Kolkata
- Station I/C Pune

DIVISIONS

- PME Cell
- HRD Cell
- ITMU
- ZTMC

RESEARCH, TEACHING & EXTENSION

Health

- Bacteriology & Mycology
- Biological Products
- Biological Standardization
- Epidemiology
- Immunology*
- Medicine
- Parasitology
- Pathology
- Pharmacology & Toxicology
- Surgery
- Vet. Biotechnology
- Veterinary Public Health
- Virology

Production

- Animal Genetics
- Animal Nutrition
- Animal Reproduction
- Livestock Production & Management*
- Livestock Products Technology
- Physiology & Climatology
- Temperate Animal Husbandry

Basic and Social Sciences

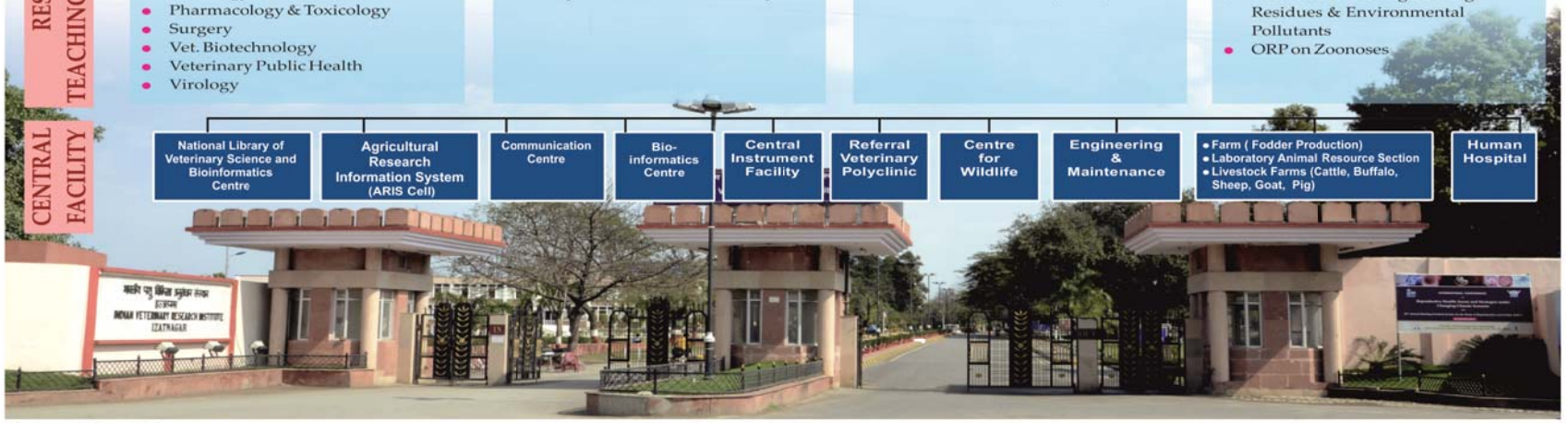
- Biochemistry
- Extension Education
  - Krishi Vigyan Kendra
  - Kisan Call Centre
- Livestock Economics, Statistics & Information Technology
- Agricultural Technology Information Centre (ATIC)

Network Programme

- AINP on Bluetongue
- AINP on Gastrointestinal Parasitism
- AINP on Neonatal Mortality
- AINP on Diagnostic Imaging & Management of Surgical Conditions in Animals
- ORP on Ethnoveterinary Medicine
- ORP on Monitoring of Drug Residues & Environmental Pollutants
- ORP on Zoonoses

CENTRAL FACILITY

- National Library of Veterinary Science and Bioinformatics Centre
- Agricultural Research Information System (ARIS Cell)
- Communication Centre
- Bio-informatics Centre
- Central Instrument Facility
- Referral Veterinary Polyclinic
- Centre for Wildlife
- Engineering & Maintenance
- Farm (Fodder Production)
- Laboratory Animal Resource Section
- Livestock Farms (Cattle, Buffalo, Sheep, Goat, Pig)
- Human Hospital



* Sections, ** Camp Mukteswar

REVENUE GENERATION DURING 2017-18

(Rupees in lakhs)

(A) Revenue Generation	Izantnagar*	Mukteswar	Bengaluru	Total
1. Sale of Dairy Products	223.45	0.00	0.00	223.45
2. Sale of Vaccines	11.25	0.00	0.00	11.25
3. Income from Service Rendered	21.65	0.00	18.00	39.65
4. Income from Publications	0.16	0.00	0.00	0.16
5. Sale of Animals	3.64	0.00	1.30	4.94
6. Other Misc. Receipts	488.88	72.36	20.11	581.35
Total	**749.03**	**72.36**	**39.41**	**860.80**

*Including Izatnagar HQ, ERS Kolkata, Regional Station, Palampur and TEC, Pune

SUMMARY OF EXPENDITURE 2017-18

(Rupees in lakhs)

(B) Summary of Expenditure:	Izantnagar*	Mukteswar	Bengaluru	Total
Govt. Grant (Non Plan+ Plan) Merged by ICAR:				
1. Estt. Charges including LSPC	10688.03	1150.97	682.27	12521.27
2. T.A.	52.96	9.41	3.97	66.34
3. Assets Acquired				
a) Equipment	53.75	0.75	1.33	55.83
b) Books & Journals	0.44	0.96	1.00	2.40
c) Others	731.56	73.28	6.87	811.71
4. Feed & Upkeep of Animals	184.92	7.38	20.11	212.41
5. Chemicals & Glassware	260.25	78.74	34.61	373.60
6. Scholarship/Fellowship	323.45	0.00	0.00	323.45
7. Other Misc. Contingent Expr.	17839.45	921.46	320.49	19081.40
8. Works – Repair & Maintenance	165.46	18.85	10.00	194.41
Total	**30300.27**	**2261.80**	**1080.75**	**33642.82**

*Including Izatnagar HQ, ERS Kolkata, Regional Station, Palampur and TEC, Pune

SCHEME-WISE EXPENDITURE DURING 2017-18

(Rupees in lakhs)

S.No.	Summary of Expenditure	Izatnagar	Mukteswar	Bengaluru	Total
A.	Govt. Grant (Non Plan + Plan)	30300.27	2261.80	1080.75	**33642.82**
B.	Govt. Grant Schemes (Non Plan + Plan)				
a.	All India Network Programme (as Coordinating Centre)				
1.	AINP on Gastro-intestinal Parasitism	53.39	-	-	53.39
2.	AINP on Bluetongue	55.84	5.42	-	61.26
3.	AINP on Neonatal Mortality in Farm Animals	86.70	-	-	86.70
4.	AINP on Diagnostic Imaging and Management of Surgical Conditions in Animals	252.19	-	-	252.19
b.	Outreach Programme (as Coordinating Centre)				
1.	ORP on Zoonotic Diseases	156.80	-	-	156.80
2.	ORP on Ethno-veterinary Medicine	75.97	-	-	75.97
3.	ORP on Monitoring of Drug Residues and Environmental Pollutants	97.33	-	-	97.33
c.	All India Coordinated Research Projects (as Collaborating Centre)				
1.	AICRP on Pigs (Izatnagar centre)	34.23	-	-	34.23
2.	AICRP on Pigs (ERS, Kolkata centre)	12.07	-	-	12.07
3.	AICRP on ADMAS (Izatnagar centre)	4.17	-	-	4.17
4.	AICRP on ADMAS (ERS, Kolkata centre)	2.40	-	-	2.40
5.	AICRP on Nutritional and Physiological approaches for enhancing reproductive performance in cattle and buffalo	4.71	-	-	4.71
6.	AICRP on Himalayan Goat Unit	0.00	8.55	0.00	8.55
d.	Consortia Research Platform				
1.	CRP on Vaccines and Diagnostics (Coordinating Unit)	0.00	0.00	620.32	620.32
e.	National Agricultural Science Fund (NASF) (5 projects)	218.40	21.43	-	239.83
f.	Niche Area of Excellence (NAE)-Clinical Nutrition and Gut Health	29.21	-	-	29.21
g.	National Innovations on Climate Resilient Agriculture (NICRA)	37.69	-	-	37.69
h.	Veterinary Type Culture Centre (VTCC) (2)	2.28	-	-	2.28
i.	Central for Agricultural Bioinformatics (CABin)	10.65	0.00	0.00	10.65
k.	Centre of Advance Faculty Training (CAFT) (Animal Nutrition Division)	11.86	-	-	11.86
l.	Centre of Advance Faculty Training (CAFT) (Physiology & Climatology Division)	9.92	-	-	9.92
m.	Emeritus Scientist Scheme (6 schemes)	35.78	-	-	35.78
n.	Krishi Vigyan Kendra (KVK)	67.00	-	-	67.00
o.	National Agriculture Innovation Fund, (NAIF) Project	5.64	-	-	5.64
p.	ZTMC Project, NAIF	1.36	-	-	1.36
q.	Enhancing Livelihood of Rural Women Through Livestock	20.85	-	-	20.85
r.	P.G. Education	465.28	0.00	14.99	480.27
s.	ASRB/NET Examination-2017-18	3.05	0.00	0.00	3.05
t.	NMSHE	0.00	7.53	0.00	7.53
u.	Experimental Learning – Germ Plasm Centre	2.88	0.00	0.00	2.88
v.	Library Strengthening	30.59	3.08	0.00	33.67
1.	ICAR, Fellowship	208.90	-	-	208.90
2.	National Talent Scholarship	-	-	-	-
3.	ICAR Summer School	3.00	-	-	3.00
4.	ICAR National Professor	32.02	-	-	32.02
5.	ICAR National Fellow	32.37	-	-	32.37

STATEMENT SHOWING THE TOTAL NUMBER OF EMPLOYEES AT IVRI AND ITS CAMPUSES/ STATION AND NUMBER OF S.C. AND S.T. CATEGORY EMPLOYEES (AS ON 31.03.2018)

Class of posts	No. of sanctioned posts	No. of employees in position	No. of Female employees	No. of S.C. category employees	No. of S.T. category employees	No. of O.B.C category employees	No. of PHs in position
Scientific							
Scientist	203	166	15	18	02	32	-
Sr. Scientist	61	46	0	03	-	08	-
Pr. Scientist	36	19	11	10	-	02	01
R.M.Ps	07	05	-	-	-	-	-
Total	307	236	26	31	02	42	01
Technical							
Category-I (T-1 & T-2)	337	158	08	23	08	12	04
Category-II (T-3 & T-4)	79	43	03	13	06	04	-
Category-II (T-5)	15	01	-	-	-	-	
Category-III (T-6 to T-9)	40	20	04	-	02	-	
Total	471	222	15	36	16	16	04
Administrative							
Jt Director (Adm.)	01	01	-	01	-	-	
Comptroller	01	01	-	-	-	-	
C.A.O.	01	01	-	-	-	-	
CF&AO	-	-	-	-	-	-	
SF&AO	01	01	-	-	-	-	
S.A.O.	02	02	-	-	-	1	
A.O.	02	02	1	-	-	-	
A.A.O.	29	23	03	03	02	-	-
F&AO	02	01	1	-	-	-	
AF&AO	03	03	-	01	-	-	
Dy. Director (OL)	01	01	01	-	-	-	
Asstt. Director (OL)	01	-	-	-	-	-	
Security Officer	02	01	-	-	-	-	
Private Secretary	11	10	01	-	-	01	
Assistant	140	102	09	21	01	10	06
UDC	54	48	10	10	-	04	03
LDC	39	15	02	04	-	05	-
P.A.	15	07	-	-	-	02	01
Steno Grade III	05	01	-	-	-	01	-
Jr. A/cs Officer	01	01	-	-	-	-	-
Asst. Manager (Canteen)	01	01	-	-	-	-	-
Cook	01	01	-	-	-	-	-
Total	313	223	28	40	03	24	10
Skilled Support Staff	1170 (includ-ing 4 canteen staff)	636	60	217	10	52	08

3.1
Development and Improvement of Vaccines

VACCINES AGAINST VIRAL DISEASES

Attenuation of FMDV strains/ serotypes to develop a stable and effective attenuated vaccine

Major objective of this project is to develop a live attenuated vaccine strain for FMDV which gives long duration of immunity. Twelve infective cDNA constructs were created by swapping (by inserting the codon de-optimised segments in to the Asia-1 infective cDNA construct) and confirmed by nucleotide sequencing. These constructs were used for virus rescue by transfecting the plasmids individually into T7 BSR cells and further passaged into LFBK cells. Replication of the virus was confirmed by amplification of negative strand PCR. Eight viruses rescued from the codon de-optimised constructs were passaged up to 20 passages and genetic stablility of the viruses in BHK21 cells was determined by sequencing of the de-optimised segment. Mice experiments to evaluate the pathogenicity of the viruses rescued from the codon de-optimized constructs are in progress.

Characterization of fidelity variants of foot-and-mouth disease virus isolated *in vitro* in the presence of nucleoside analogues

To isolate possible RdRp variants, foot-and-mouth disease virus (FMDV) was passaged under mutagen selection pressure. The deduced amino acid sequence of RdRp gene, 3D polymerase region from the passaged viruses in the presence of nucleoside analogue ribavirin showed two specific amino acid changes in RdRp gene of the passaged viruses from 10^{th} passage onwards. In another approach, using site directed mutagenesis and reverse genetics, mutations were introduced at specific residues of RdRp gene and mutated viruses were rescued. Mutation at G62S of RdRp gene resulted in lower fidelity of RNA dependent RNA polymerase while the hypervariable region of VP1 showed two amino acid changes in mutated virus and none in wild type virus.

Evaluation of selected FMD virus strains for their potential as vaccine

Through vaccine matching studies, DFMD, Mukteswar has identified FMDV serotype A IND 27/2011 as a potential alternative to serotype A IND 40/2000. To evaluate the virus strain for its suitability as vaccine, potency testing will be carried out. In preparation for potency testing, inactivated antigen has been prepared for vaccine blending and challenge virus is being prepared through cattle passage by intradermolingual inoculation.

Through reverse genetics approach, thermostable mutant of serotype O FMD virus IND R2/1975 was produced and characterized at laboratory level at DFMD, Mukteswar. The vaccine worth attributes and efficacy study was carried out in cattle at IVRI, Bengaluru campus.

Thermal inactivation kinetics at 45°C, 37°C and 26°C revealed that the thermostable virus also loses infectivity but the rate of reduction in log titres of virus was comparatively less than its parent virus. Though thermostable virus exhibited superior thermal inactivation kinetics with respect to virus titres on exposure to different temperatures, 146S content as estimated by CsCl density gradient method, did not show apparent superiority over parent virus when antigen mass of virus exposed to 37°C, with and without BEI were compared.

To assess the efficacy of the thermostable vaccine, a short term immunity study was conducted. In the animals vaccinated, higher neutralizing antibody titre was estimated on 28 days post vaccination serum samples with thermostable vaccine in comparison to parent type O vaccinated animals. On challenge with parent O virus, 5/6 animals were protected in thermostable vaccine group as against 6/6 in parent O vaccine group.

Construction and characterization of 3A truncated foot-and-mouth disease virus serotype Asia-1

The work was aimed at developing disabled virus which can multiply in helper cells and induce sterile immunity to vaccinated animals. FMDV 3A gene was cloned in pcDNA3.1 and characterised the 16 kDa protein by immunoblotting. FMDV Asia-1 63/72 cDNA was modified to produce viable virus and six FMDV 3A truncated cDNA clones were generated. Out of six clones, viable virus was rescued from two clones and characterized the mutant and parent viruses were characterized. The recovered virus from parental clone pAsia and pAsiaΔ95-104 showed comparable growth characters, plaque morphology and 100% virulence in suckling mice (P2). Mutant pAsiaΔ95-132 showed reduced virus quantity, about five fold less

than the parent virus, smaller plaques, and reduced virulence in suckling mice. Genetic stability of recovered mutant pAsiaΔ95-104 and pAsiaΔ95-132 was studied in BHK-21 cells by 15 serial passages (mp15) and in mice up to P2 passage and was found stable in nucleotide sequence analysis. Recovered mutant viruses in BHK-21, PK-15, Flp-In3A cells indicated that the deletion at positions 95-132 in 3A does not affect the replication efficiency and are tolerated by the virus without affecting its infectivity in cultured cell lines.

Evaluation of inactivated trivalent FMD vaccine using novel adjuvant in Indian cattle

Safety, immunogenicity and protective efficacy of the novel adjuvanted FMD vaccine was assessed in calves following 28 days post vaccination. Three new adjuvants viz ZAF-01, ZAF-02, ZAF-03, were blended with inactivated antigens to form three separate vaccine preparations. All the vaccines were sterility tested before the start of animal experiments. Sero-negative animals (n=36) were randomly divided into six groups using randomized design and immunized with the experimental vaccines along with a commercial vaccine, including one group as control (placebo). Potency studies in animals showed that all three novel adjuvanted vaccines (groups T03, T04 & T05) elicited high levels of neutralizing antibodies, CMI response as evidenced by interferon-gamma ELISPOT assay and complete protection upon challenge infection in comparison to commercial vaccine group (T02, single dose; T06, booster dose) or placebo treatment group (T01).

Protection levels in different treatment groups following monovalent virus challenge infection

Treatment	Animals/ Group	No. protected	Protection level %
T-01	6	0	0.00
T-02	6	4	66.67
T-03	6	6	100.00
T-04	6	6	100.00
T-05	6	6	100.00
T-06	6	6	100.00

Duration of immunity study was initiated to assess the longevity of serum neutralizing antibodies and protective immunity induced in animals following vaccination with single dose of vaccine in calves.

Development and characterisation of thermostable foot-and-mouth disease virus like capsid (VLP) as diagnostic antigen and vaccine candidate

Recombinant baculovirus carrying FMDV wild type or mutant capsid gene sequences was expressed in Tn5 insect cells and the expressed cell lysate was confirmed by sELISA and western blotting for serotype specificity and reaction with whole virus antibody. Thermostability study of stored lysate at different temperature of -20°C, 4°C, 24°C and 37°C showed that S93Y, S93F and F98Y mutants were stable till 75th day. Further analysis of S93Y, S93F and F98Y for degradation kinetics by storing the purified VLPs at 37°C showed F98Y is the most stable antigen of all the clones. The mutant F98Y which was observed to show better stability under all conditions, showed 4°C rise in thermal stability at pH 6.0 than at pH 7.0 and 5°C rise in comparison to pH 8.0 which is a deviation from whole virus particle. These findings are important in improving the stability of the vaccines in endemic countries which depend on the maintenance of the cold chain.

The mutant F98Yshowing better stability in all the analysis was further tested in LPBE. The specific antibody titres determined by LPBE were comparable to those obtained using cell culture antigen, supporting the idea that stable F98Y capsid antigen may be used as an alternate antigen in LPBE as it avoids handling infective cell culture virus.

Determination of 146S content in FMD oil adjuvanted vaccine by chemical extraction methods and Sandwich ELISA

Cell culture derived inactivated and concentrated FMDV antigens for serotype O, A and Asia-1 were prepared and 146S contents were determined before formulating FMD vaccine using oil as adjuvant. The standard vaccine was prepared, aliquoted and labelled for storage at 4°C before testing for the antigen extraction. In this project five different chemical methods viz., benzyl alcohol, chloroform, EBT buffer, sodium citrate buffer and isopropylmyristate methods for extraction of antigen from the vaccine were employed. The extracted amount of antigen was quantified, following CsCl ultracentrifugation method. Our results showed that benzyl alcohol extraction method resulted in 95.4%, 93%, 90% recovery for O, A, Asia-1, respectively, in monovalent and 95.5% recovery for O, A, Asia-1 in trivalent vaccines, demonstrating that benzyl alcohol is the better method for extraction of antigenic content from the oil emulsified vaccines compared to other methods. It was concluded that benzyl alcohol extraction method could be a suitable *in vitro* technique for extracting 146S content from oil adjuvanted FMD vaccines which might be applied as a potential quality control test for FMD vaccine after testing the stored vaccine samples at monthly or quarterly time interval and analysing the percent antigen recovery.

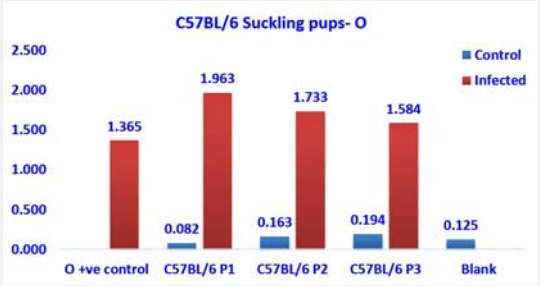
Development of HS-FMD combined oil adjuvanted vaccine (HS-FMD *Combi-Vac*)

A Combined HS-FMD vaccine, (HS-FMD *Combi-Vac)*, is being formulated for field use. The growth characteristics for *Pasteurella multocida* were verified and the isolate passaged in mice and rabbits. The inactivated *P. multocida* and FMDV antigens have been prepared. The *P. multocida* has been characterized for its size and stability. The stability of the *P. multocida* suspended in PBS was determined by Zeta potential. The safety test for *Combi-Vac* comprising inactivated *P. multocida* and FMDV antigen is in progress in mice model.

Evaluation of laboratory mice as alternate animal model for potency testing of FMD vaccine

Evaluation of FMD vaccine potency using laboratory mice/rat by challenge method requires virulent mice/rat adapted challenge virus. An attempt was made to adapt FMD virus serotype O initially in the suckling rat of Wistar strain and suckling mice of Swiss albino and C57BL/6 strains. Five consecutive passages of FMDV serotype O virus vaccine strain was made in Wistar rat pups of 3 day old by intra-muscular route. Similarly, three passages of FMDV serotype O virus vaccine strain was made in 4-6 day old Swiss albino and C7BL/6 mice.

Inoculation of FMDV serotype O virus in Wistar rat did not induce clinical signs or histo-pathological changes. However, the infection in Swiss albino and C57BL/6 suckling mice resulted in paresis of limb followed by death. The presence of virus in these mice tissue showed high degree of specific reactivity to FMDV serotype O. Heart from dead suckling mice showed mild degeneration in the muscle fibres with vacuoles and haemorrhages with



Sandwich ELISA reactivity of PBS suspension of musculo-skeletal tissue

RBCs upon histo-pathological examination. The mice adapted viruses were further used to infect adult mice (9-10 weeks of age) of Swiss albino and C57BL/6 strains. The adult mice did not develop clinical signs of disease. Hence, suckling mice adapted virus cannot be directly used as challenge virus in adult mice for FMD vaccine potency testing in these strains.

Vaccines against PPR and combination vaccines

Combination vaccines of Thermoadapted (Ta) PPR and goatpox/sheeppox vaccines were prepared and the quality control has been completed. Experimental evaluation in animals is in progress.

The complete genome of PPRV Sungri/96 (15948 bases) was amplified as four overlapping fragments which were spliced together by PCR. The success of the splicing has been confirmed by RE analysis. Ribozyme sequences were added on either end of the genome length cDNA and the entire fragment of 16,099 bp was placed under the control of P_{CMV} and $SV40_{PA}$ elements.

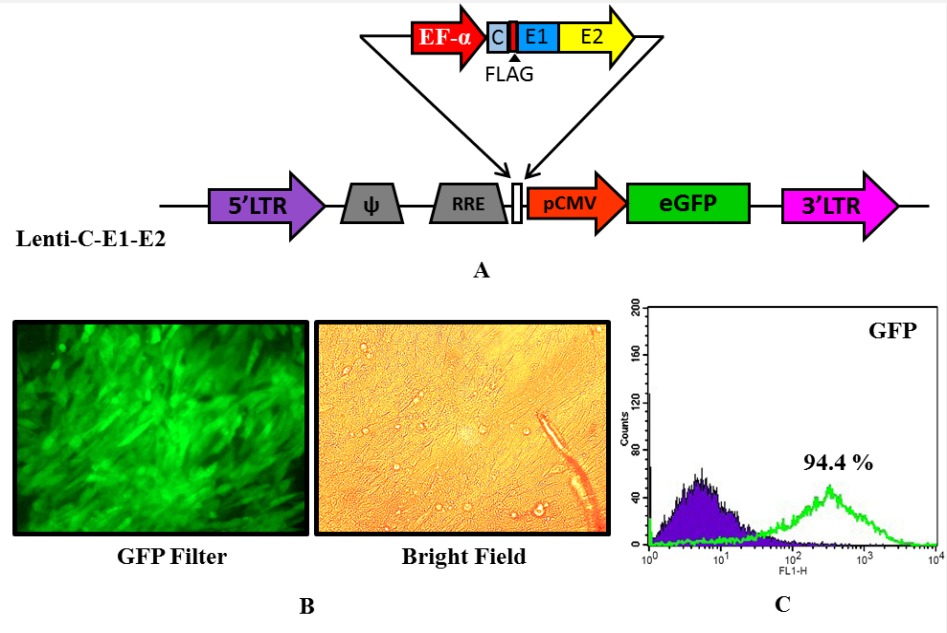
Development and evaluation of non-structural protein (NSP) defective mutants of PPRV

To develop NSP suppressed PPR viruses through reverse genetics, the full-length N, P and L genes of PPRV Izat/94 have been amplified by RT-PCR, cloned and sequence confirmed. Primers have been designed using the sequence information and the N, P and L genes have been placed individually under the control of P_{CMV} and $SV40_{PA}$ sequences. To verify the functionality of the constructs, eGFP marker gene was introduced downstream of the three genes in the expression cassettes and their functionality confirmed using fluorescence microscopy.

Development of DIVA-based classical swine fever virus vaccine candidate

To develop DIVA-based classical swine fever virus (CSFV) vaccine candidate, capable of differentiating infected from vaccinated animal (DIVA)-strategy, the structural genes of CSFV namely, capsid, E1 and E2 were expressed and self-assembled as virus-like particles (VLPs) in a mammalian cell line. The CSFV-VLPs, having structural proteins of CSFV without Erns protein, have potential to be used as DIVA-based CSFV vaccine candidate.

For production of CSFV-VLPs, a mammalian cell line (Vero) constitutively expressing structural proteins of CSFV (CSFV-C, E1 and E2) was generated using lentiviral-mediated delivery of CSFV-C-E1-E2 genes into the genome of Vero cells. The lentivius encoding CSFV-C-E1-E2 genes (Lenti-C-E1-E2) along with green fluorescent protein (GFP) gene (as reporter gene) was produced by co-transfection with lentiviral helper plasmids in HEK-293T cells used to transduce Vero cells. The Lenti-C-E1-E2-transduced Vero cells expressing GFP were sorted by FACS to a homogenous population and characterized for presence of CSFV transgene in the genome and RNA-transcripts in the Vero-C-E1-E2 cells using PCR and RT-PCR, respectively. The CSFV E1 and E2 proteins

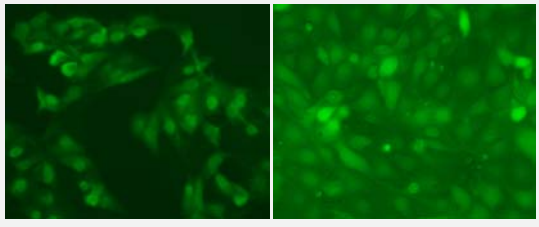


Vero cell line expressing CSFV-C, E1 and E2 proteins was produced by transduction with lentivirus (Lenti-C-E1-E2) encoding C, E1, E2 and eGFP (reporter) genes (A). The eGFP expressing cells were sorted using flow cytometer to a homogenous population and analysed using fluorescent microscopy (B) and flow cytometer (C). (Magnification 200 X)

expressed in cells were localized in the cytoplasm as confirmed by immunocytochemistry and flow cytometry. The self-assembled VLPs containing CSFV-C, E1 and E2 proteins were harvested in cell culture supernatant and purified using sucrose density gradient ultracentrifugation. The purified CSFV-VLPs were characterized by western blot analysis using anti-CSFV hyperimmune serum. The transmission electron microscopy (TEM) of purified VLPs revealed that the CSFV-C, E1 and E2 proteins self-assembled into VLPs and secreted in the cell culture supernatant.

Development of a classical swine fever marker vaccine through reverse genetics system

The research project is targeted to establish a reverse genetics system for development of marker vaccine candidate against classical swine fever disease of pig. Refinement on rescue plasmids was done to generate full length classical swine fever virus (CSFV) transcripts. However, stable CSFV rescued plasmid was unable to produce proliferative viral progeny in transfected PK15 cell line. To improve the stability of rescue construct in bacterial host, self-cleavable synthetic intron was incorporated near recombination hot-spot. Finally, proliferative virus was recovered through transfection of reconstructed rescue plasmids with intron and new set of ribozyme pCSFV with intron (15555 bp) and pCSFV–GFP with intron (16344 bp) (Fig. 2) in PK15 cell line. Rescued CSFV-GFP progenies were confirmed by expression of green fluorescence protein (GFP) in infected PK15 cell line while recovered progenies of native CSF virus were confirmed by immunofluorescence of infected PK15 cell using CSFV specific Anti-E^{ms} monoclonal antibody. Both native CSFV and CSFV-GFP were also characterized by viral specific RT-PCR amplification of 1080 bp from PK15 cell infected with recovered CSFV progeny followed by sequencing. The titer of rescued CSFV-GFP was $10^{5.64}$ FFU /ml (fluorescence-forming units) in PK15 cell line at 7th passage level.

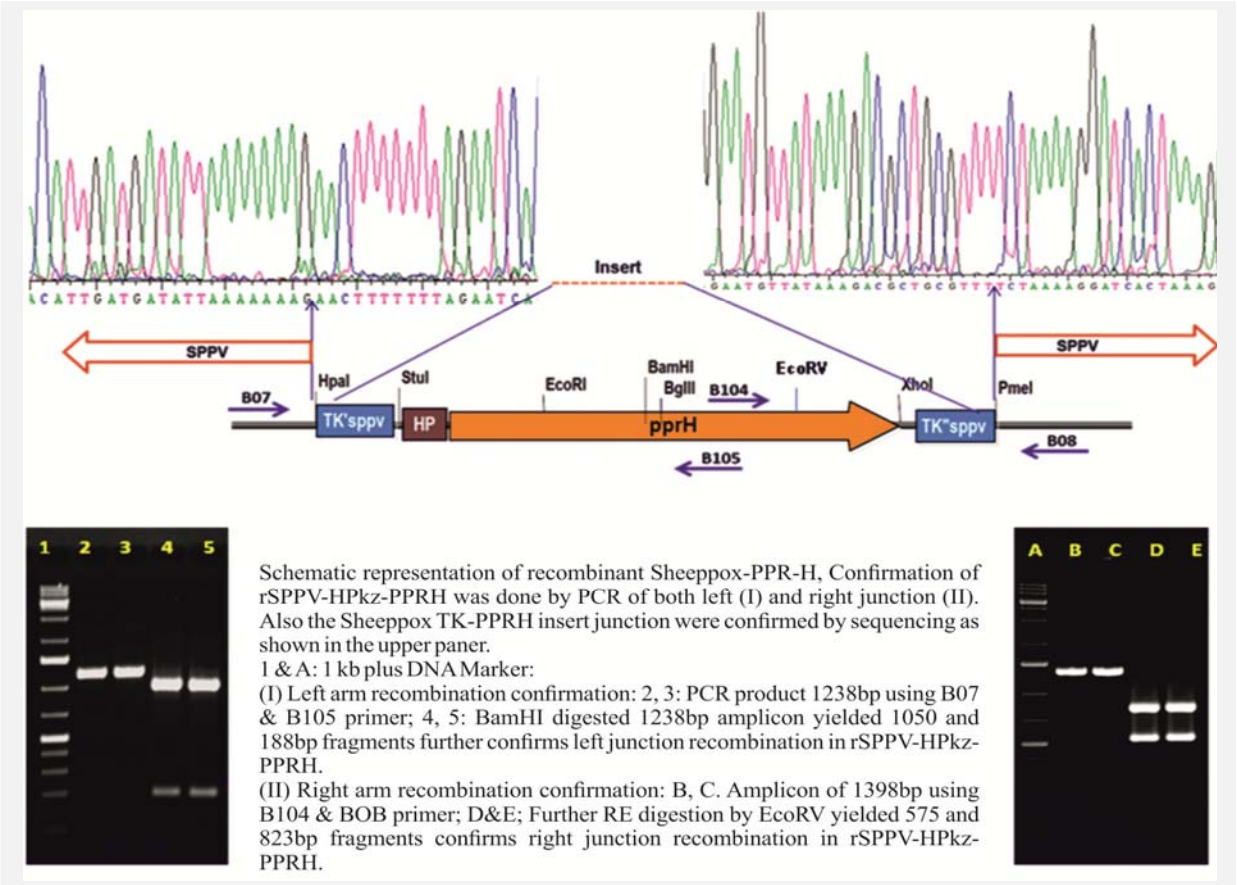


A B

A: PK15 cell line infected with rescued CSFV-GFP projeny (7th passage). Green fluorescence under UV light in PK15 cell confirms the presence of recombinant CSFV-GFP virus. B: FAT using Anti-E^{ms} FITC Mab in PK15 cell line infected with rescued CSFV progeny. Images taken with 20X lens.

Recombinant *Peste des Petits Ruminants* (PPR) vaccine using sheeppox vector

Eight transfer vector constructs were developed with four having synthetic pox virus promoter (Hp) and four having native sheeppox promoter (L4) with enhancer leader sequences and evaluated for development of recombinant sheeppox-PPRV through homologous recombination. An hour prior to transfection, Vero cells were infected with 0.1MOI of SPPV-Srinagar followed by transfection of cells with constructs as per manufacturer's protocol using Lipofectamin 3000 (Invitrogen). At



Schematic representation of recombinant Sheeppox-PPR-H, Confirmation of rSPPV-HPkz-PPRH was done by PCR of both left (I) and right junction (II). Also the Sheeppox TK-PPRH insert junction were confirmed by sequencing as shown in the upper paner.
1 & A: 1 kb plus DNA Marker:
(I) Left arm recombination confirmation: 2, 3: PCR product 1238bp using B07 & B105 primer; 4, 5: BamHI digested 1238bp amplicon yielded 1050 and 188bp fragments further confirms left junction recombination in rSPPV-HPkz-PPRH.
(II) Right arm recombination confirmation: B, C. Amplicon of 1398bp using B104 & BOB primer; D&E; Further RE digestion by EcoRV yielded 575 and 823bp fragments confirms right junction recombination in rSPPV-HPkz-PPRH.

48 to 72 hr post transfection, Vero cells transfected with plasmids having GFP (pTKsppv-Hpkz-pprH-GFP, pTKsppv-Hpkz-pprF-GFP and pTKsppv-L4kz-pprH-GFP, pTKsppv-L4kz-pprF-GFP) showed fluorescence under microscope. The recombination point in the TK gene of SPPV-Srinagar was confirmed by PCR and RE digestion. PPRV gene (Insert) specific and SPPV genome specific primers were designed and used to confirm recombination event resulting in double crossover. PCR confirmation of PPRV gene insert in the left junction of SPPV-Srinagar-TK was done with primers B07 (for) and B102 (rev) for pprF gene (1184 bp) and primers B07 (for) and B105 (rev) were used for recombinant sheeppox with pprH gene (1238 bp).

Similarly, the right end of the insert junction was confirmed by PCR using forward primer within the insert sequence and reverse primer taken from the SPPV-Srinagar TK with primer combinations B101(for) /B08(rev) for pprF gene (1221 bp) and B08(for)/B104(rev) for pprH gene (1398 bp). The PCR product of primers B07/B08 will yield either 648 bp product if there is no homologous recombination or the product size will be more than 648 bp i.e. as in the present case for pprF gene, PCR product was 2256 bp and 3039 bp with GFP while for pprH gene insert it was 2445 bp and 3228 bp with GFP, respectively. The left arm insertion was confirmed by PstI and BamHI RE digestion and the right junction was confirmed by EcoRV digestion in case of PPRV-F/H. The insertion point was confirmed by sequencing.

Subviral particle based infectious bursal disease vaccine

Subviral particle based infectious bursal disease vaccine (SVPs) is a recombinant vaccine intended for use against Infectious bursal disease (IBD) of poultry. The IBDV major capsid protein VP2 led to the formation of SVPs when expressed in *Saccharomyces cerevisiae*. The vaccine induces protective immunity in specific pathogen free (SPF) chicks against very virulent IBDV challenge. All the vaccinated SPF chicks showed no clinical signs indicating 100% protection even at the lowest dose of 50 µg at M/S Globion India, Pvt. Ltd., Hyderabad. SVPs based IBD vaccine proved to be effective at day old vaccination in the presence of maternally derived antibodies with a single dose of 300 µg of SVPs with adjuvant both at IVRI, Izatnagar and M/S Globion India, Pvt., Ltd., Hyderabad. The generated SVPs are also highly effective in stimulating antigen specific lymphocyte proliferative and cytotoxic T lymphocyte responses. The vaccine does not cause immunosuppression as has been demonstrated by an intact histological architecture of the bursa of Fabricius.

Development and evaluation of a genetically engineered vaccine against Newcastle disease and chicken infectious anaemia infection of chickens

To develop a bivalent vaccine against Newcastle disease and Chicken infectious anaemia of chickens, the virulence motif (RRQKRF) encoded in the fusion protein cleavage site (FPCS) of mesogenic NDV strain R2B was modified to a less virulence motif (GRQGRL) that are present in less pathogenic lentogenic strains. The modified NDV strain R2B can be used as a vaccine candidate for primary immunization in young chicks which are less than 6 weeks of age.

To achieve this, a portion of the fusion protein gene of the virus that encompasses the FPCS region was amplified with the objective to introduce nucleotides that code for less virulent amino acids by site directed mutagenesis using overlapping PCR. Briefly, three overlapping fragments of sizes 720 bp, 610 bp and 487 bp were amplified and ligated. The altered fragment size of 1817 bp was cloned into pCR 2.1 TOPO vector and confirmed by restriction digestion.

VACCINES AGAINST BACTERIAL DISEASES

Development of a genetically engineered live vaccine against brucellosis for animals

Brucella abortus Strain 19 was modified by deletion of perosamine synthetase gene and named as S19Δper strain. The modified S19 strain was highly attenuated eliciting strong immunological response. Vaccine trial in buffalo calves have been initiated to study safety, potency and DIVA status of newly developed S19Δper strain. Sensitivity to serum complement of buffaloes used for vaccine trial was carried out. S19Δper strain was more susceptible in comparison to S19 strain. Buffaloes were immunized with normal dose (4 X 10^{10}cfu/dose) and reduced dose (2 X 10^{9}cfu/dose) of S19Δper strain. Transient colonization of S19Δper strain was observed in spleen and different lymph nodes. It helped priming the animals for immunological response. Post vaccination animals were normal. Vaccinating strain was not detected in the secretion of nasal and lacrimal discharge, in urine and in vaginal swab. RBPT could differentiate day 30 post-immunization sera from S19Δper immunized buffaloes from Brucella positive animal sera and S19 vaccinated animal sera. Vaccine challenge study has been completed and results are being compiled.

Passive mouse immunization assay to assess protection conferred by brucella vaccine

To establish an indirect correlate of protection for Brucella vaccine, passive mouse immunization assay against direct challenge of virulent *B. abortus* 544 was evaluated. Three different groups of mice containing six in each group were immunized with undiluted neat serum (250 IU), diluted serum (25 IU) and PBS (as negative control), respectively, in a dose of 0.2 ml. All the mice were challenged 24 h post immunization, with virulent *B. abortus* 544 ($2x10^5$ c.f.u) in 0.1 ml dose. All the mice were sacrificed 7 days post challenge and spleen was collected aseptically. The findings indicated that mice immunized with cattle immune serum revealed a significant reduction in bacterial count in spleen in comparison to control as well as lower splenic weight index.

Mean splenic Brucella count at 7th Day Post Challenge in immunized mice

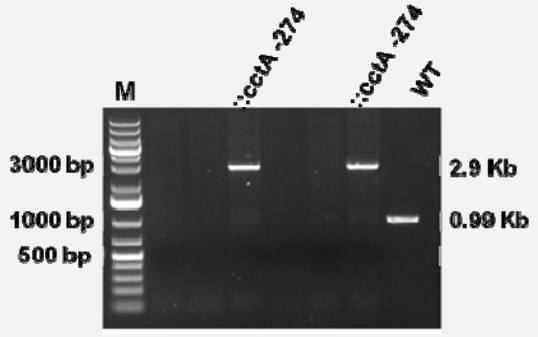
Groups	Log_{10} Brucella CFU (Mean±SD)	Log (X/LogX) (Y-value ±SD)	Log_{10} unit of protection
Neat serum*	2.29±0.92	1.99±0.67[a]	1.02
Diluted Serum#	2.45±1.00	2.13±0.80[a]	0.86
Control	3.31±0.33	2.79±0.31[b]	0.00

(*250 IU; #25 IU)

Inactivation of cctA gene of *Clostridium chauvoei*

To inactivate *cctA* gene of *Clostridium chauvoei,* several ClosTron (gene knock-out system) constructs targeting different regions of *cctA* gene were prepared. However, transfer of Clostron construct into *C. chauvoei* was not successful, possibly due to non-compatibility of Gram-positive replicon present in pMTL007C-E2 vector. However, pIM3 (repL) replicon could be successfully transferred into *C. chauvoei* by conjugation method. Therefore, the replicon present in pMTL007C-E2 vector construct was replaced with pIM3 (repL) replicon to generate pMTL007C-E6 vector construct.

pMTL007C-E6:Cch-*cctA*-274a construct was prepared and transferred to *C. chauvoei* by conjugation method. Even though the plasmid DNA could be efficiently transferred, inactivation of the



Screening for mutants using *cctA* gene-specific PCR

gene could not be achieved, possibly due to non-functionality of the pFdxpromoter. Hence, the pFdx promoter (from *C. sporogenes*) was replaced with native (*C. chauvoei*) promoter (cc-pFdx promoter) to generate pMTL010:Cch-*cctA*-274a construct, which was transferred into *C. chauvoei* cells by conjugation. This construct could efficiently inactivate the *cctA* gene of *C. chauvoei*, generating Cch-*cctA*274a:CT mutant and was further confirmed by PCR and haemolytic assay.

Manipulating anaerobic respiration to attenuate pathogenicity of *Salmonella* Typhimurium

Salmonella Typhimurium contributes to majority of non-typhoidal salmonellosis, a food-borne zoonotic disease occurring in a broad host range showing symptoms of gastrointestinal disorder. For colonization, organism senses a low oxygen pressure in the GI tract that activates two anaerobic sensors viz. Fumarate and Nitrate Reductase regulatory protein (FNR) and Aerobic respiratory control A protein and they are global regulators of virulence and anaerobic metabolism. Therefore, targeting these genes may compromise the colonizability of *Salmonella* and thus may reduce the pathogenicity of organism.

FNR gene was deleted from *Salmonella* Typhimurium by standard protocol. Wild and mutant organisms were grown anaerobically and there was sharp reduction in the growth of mutant organism. Proteins from wild and mutant organism were extracted and analysed by 1D and 2D-PAGE. It was found that many proteins are downregulated in mutant organism and surprisingly few are also upregulated.

Evaluation of novel adjuvants for HS Vaccine

Two proprietary novel adjuvant formulations were assessed using different doses of *Pasteurella multocida* antigen (2.5, 0.5 and 0.1 mg). Different groups of cattle were immunized with novel adjuvant formulations and the potency of the vaccine was studied by passive mouse protection test in Swiss albino mice using 28 day post immunized de-complemented cattle sera. All the mice in different groups except the control mice were passively protected upon challenge (and also excluding 0.1 mg group), whereas, the control healthy mice succumbed to virulent challenge. All the vaccine formulations were found efficacious and potent in PMPT test after passive transfer of 28 dpi respective cattle sera in the respective mice groups, followed by challenge with virulent bacteria. A difference of 7-8 log protection was observed between the control and vaccinated groups. Sero-conversion of immunized cattle monitored by IHA and indirect ELISA tests indicated that there was a graded immune response in all the immunized groups of cattle.

In vitro evaluation of saponins from North-western Himalayas as adjuvant in veterinary vaccine

The fruits of *Asparagus adscendens* Roxb., seed coat of *Sapindus mukorossi* Gaertn., leaves, flowers and stem of *Silene inflata* and leaves of *Chlorophytum* spp. were collected and processed for extraction of saponin-rich extracts. Saponin-rich extracts of *Sapindus mukorossi* were prepared for *in vitro* cytotoxicity studies for further evaluation as an adjuvant.

VACCINES AGAINST PARASITIC DISEASES

Irradiated trypanosoma vaccine

Three groups of adult Swiss albino mice (n=10 in each group) were immunized through intra-peritoneal route (i.p.) with 4×10^4 trypanosomes irradiated at 450, 480 & 500 Gy, respectively, on day 0 and boosted on day 15 and 30.

The predominant antibody response post-immunisation (PI) in the Gr I (450 Gy) and Gr II (480 Gy), was of IgG2a, where as in Gr III (500 Gy), it was of IgG2b type. Interferon gamma (IFN γ) response was predominant in PI, however, IL-10 response was dominated in post-challenge (PC) mice. In Gr II (480 Gy) and Gr III (500 Gy), IFN γ response was predominant PI, while predominant TNFα response was observed PC. The mice were challenged with a heterologous virulent *T. evansi* (buffalo isolate) ($n=1\times10^2$) on day 45 through sub-cutaneous (s.c.) route. The immunized mice failed to resist the heterologous challenge with *T. evansi* (buffalo isolate, $n=1\times10^2$).

Recombinant protein-based vaccine against coccidiosis

Cocktail formulations of different recombinant proteins of *Eimeria tenella viz.* rEtIMP+rEtSO7+ rEtProfilin (gp.I), rEtIMP+rEtSO7+rEtGam22 (gp.II) and rEtIMP+rEtMIC3-MAR1c+rEtProfilin (gp. III) were subcutaneously administered along with titermax gold adjuvant in 7 day old broiler chicks of different groups followed by a booster dose after 2 weeks. The protective efficacy of the cocktail immunizations was assessed against homologous challenge with 10^4 sporulated oocysts of *Eimeria tenella* on day 7 post-booster immunization. Results revealed that oocyst reduction was highest in rIMP+rSO7+rGAM22 (gp.II) immunized birds (80.21%) followed by rIMP+ rMIC3-MAR1c+rProfilin (gp. I) and lowest in rIMP+rSO7+r Profilin immunized birds (gp. III). The relative weight gain was also highest in the

chickens of gp. II (90.4%) followed by gp. I (90.1%) and gp. III (85.09%) in the immunized birds. The average caecal lesion scores also showed similar trends, with least lesion score in gp. II (1.67±0.21) indicating reduced parasite establishment and damage to ceacal mucosa. The anticoccidial index (ACI) of rEtIMP+rEtSO7+ rEtProfilin (gp.I), rEtIMP+rEtSO7+rEtGam22 (gp.II) and rEtIMP+rEtMIC3-MAR1c+rEtProfilin (gp. III) were 160.1, 168.7 and 143.4, respectively.

Recombinant protein-based anti-tick vaccine

Ferritin2 (FER2) and Tropomyosin (TPM) of *H. anatolicum* were selected as possible recombinant protein based vaccine candidates. On the basis of sequence analysis, the rHaFER2 and rHaTPM proteins were observed to be non-glycosylated and predicted to be phosphorylated. The Ramachandran plot statistics for rHaFER2 protein model showed 94.2 % residues in most favored regions and 5.2% residues in additional allowed regions. However, in rHaTPM, the model showed 100.0 % residues in most favored region. In rHaFER2 and rHaTPM, two and ten B- cell epitopes, respectively, were predicted.

The 649 bp and 901 bp fragments of the gene, HaFER2 and HaTPM, were cloned and expressed as ~35 kDa and ~51 kDa fusion proteins with 6x His tag, respectively. Western blot analysis showed specific and strong reaction with hyperimmune sera and with anti-His tag mAb, respectively. In a limited experimental immunization trial, a protection of 52% and 66% against larval and 51% and 64% against adult *H. anatolicum* infestations, respectively, was observed. Protection against *R. microplus* adult ticks fed on rHaFER2 and rHaTPM immunized cattle was 37% and 46%, respectively. Silencing these genes conferred reduction of 60-80% in attachment, 50-60% in engorgement and egg production.

3.2
Development and Improvement of Diagnostics

VIRAL DISEASES

Development and evaluation of MAb based ELISA systems for detection of antigen/ antibody of FMDV

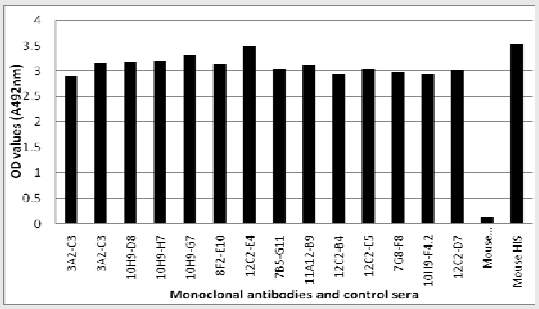
Hybridomas against FMDV serotype Asia 1

Purified preparation of 146S of FMDV Asia-1 was prepared and mice were immunized with inactivated virus antigen with 25 µg of viral antigen. Following two booster injections in mice, splenocytes were collected and fusion carried out to produce hybridomas. Hybridomas secreting antibodies that are reactive with viral antigen were screened by double antibody sandwich ELISA and indirect ELISA. Subcloning was carried out to obtain monoclonal antibodies that are highly specific to FMDV Asia-1 and reactive to 146S (whole virus particles). Three antibodies that are highly neutralizing to FMDV infectivity were obtained. Production of hybridomas to FMDV serotypes O (R2/75 strain) and A (Ind-40/00 strain) is under progress.

Hybridomas against FMDV non-structural protein (3AB) antigen

Recombinant 3AB antigen was produced using baculovirus system and antigen was purified for immunization of mice for production of hybridomas. Hyrbdiomas were produced by fusion of splenocyotes from immunized mice and myeloma cells (SP2/0). Hybridomas secreting antibodies against 3AB antigen were identified by ELISA.

Subcloning was performed to obtain monoclonal antibodies that were specifically reacting with the recombinant 3AB antigen. Reactivity of the protein

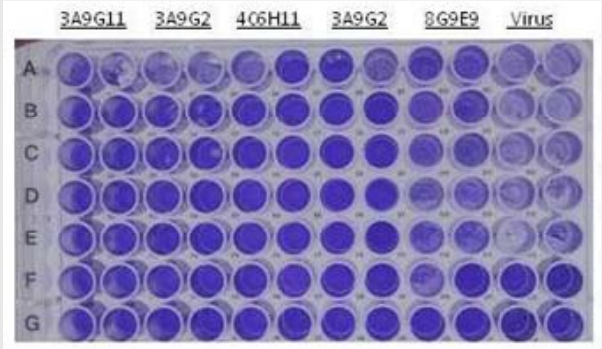


Reactivity of monoclonal antibodies and control sera from mouse with the recombinant 3AB antigen in the indirect ELISA

was also confirmed in western blot. Clone 10H9D8 and 12C2-E4 competed with polyclonal antibodies in the animal sera and showed potential application in developing blocking ELISA for detection of NSP antibodies in sera from multiple species of animals.

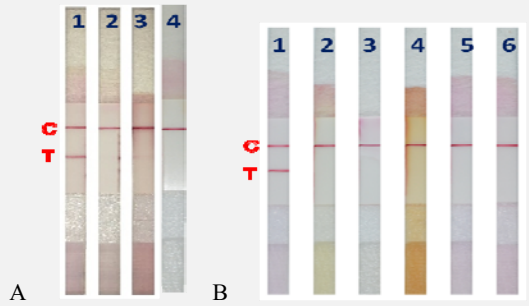
Lateral Flow Assay for diagnosis of *Peste des Petits Ruminants* (PPR)

The developed LFA/IFD for PPR diagnosis was tested for the specificity of the assay. Among morbillivirus group, Measles virus and Canine distemper virus ($10^{5.4}$ $TCID_{50}$/mL) did not cross react whereby only PPRV was detected by LFA/IFD. Similarly, Newcastle disease virus was also included because of its wider host range and did not cross react. The more common pathogens of sheep and goat namely *Mycoplasma mycoides*, *Pasteurella multocida*, Goatpox virus, Sheeppox virus and Bluetongue virus were tested and none of the organism showed any cross reaction and were clearly negative by LFA/IFD.



S.No.	Mab	NI
1	3A9-G11	3.5
2	3A9-G2	2.0
3	4C6-H11	4.5
4	8G9-E9	4.0
5	1G10-G4	0.0
6	Virus titre	6.8$TCID_{50}$

Mabs 3A9G11, 3A9G2, 4C6H11 and 8G9E9 showed high NI with the homologous virus FMDV Asia-1 in the cell culture plate stained with coumassie following Virus neutralization assay (A). Neutralizing antibody response is given on the right panel



A: Specificity of detection with closely related viruses, (1) PPRV (Sungri/96 Strain), (2) CDV (Ondersport Strain), (3) MV (Edmonstron Zagreb Strain), (4) NDV (Lasota Strain). **B:** Specificity of detection with other small ruminant pathogens, (1) PPRV (Sungri/96), (2) *Mycoplasma mycoides* subspecies Capri, (3) *Pasteurella multocida* (P52 B2), (4) Goatpox (Uttar Kashi)

Comparative efficacy of LFA/IFD with RT-PCR

Freshly collected samples, archived samples and samples received from other sources were tested with optimized LFA/IFD. The samples were also tested by RT-PCR assay for PPR virus detection using universally accepted Primers. The relative sensitivity and specificity of the LFA/IFD test was calculated in comparison to RT-PCR (reference test) and was found to be 85.29% and 90.58%, respectively, based on 153 samples tested. The kappa statistic revealed that there is a 'good' agreement between the two tests (κ= 0.761; SE=0.053).

Efficacy of IFD/LFA for PPR virus detection in comparison to RT-PCR

		RT-PCR		
		Positive	Negative	Total
IFD/ LFA	Positive	58	8	66
	Negative	10	77	87
	Total	68	85	153

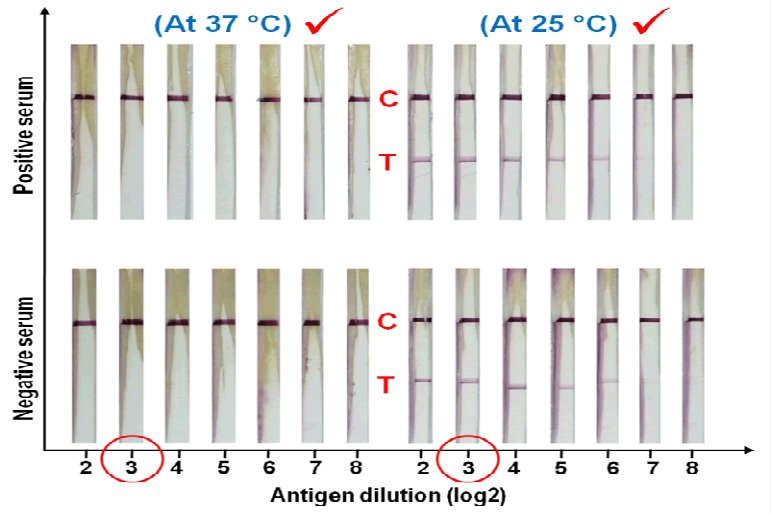
*Relative diagnostic sensitivity of IFD/LFA= 85.29%
*Relative diagnostic specificity of IFD/LFA= 90.58%

LFA/IFD for antibody detection

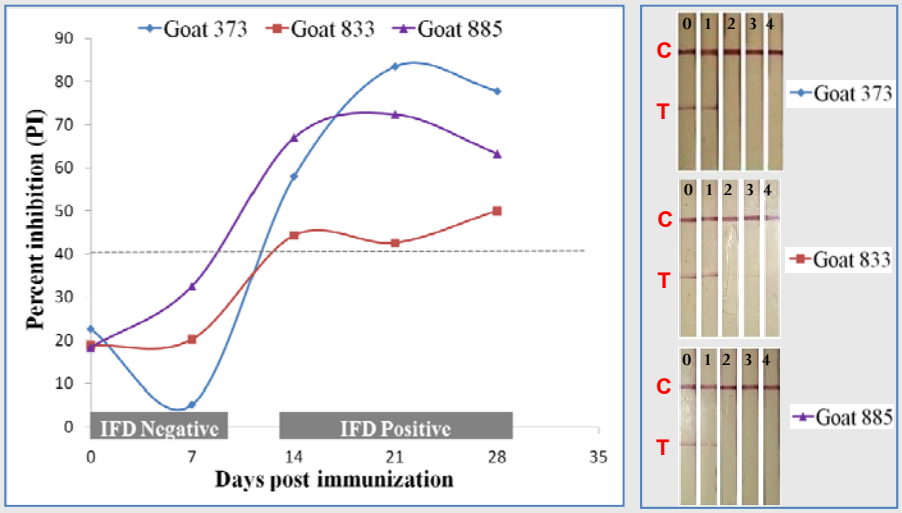
The same LFA/IFD strip designed for antigen detection was optimized for detection of PPRV antibody following the principle of blocking/competitive ELISA complying with combinatorial approach. In order to perform the test, the cell culture antigen was incubated with equal volume of serum for 45-60 min either at 37°C or room temperature (25°C) and subsequently tested by LFA/IFD within 5-10 min. Findings indicated that antibody detection by LFA/IFD is a fairly rapid test and can be done even under field conditions without any need for equipment.

The PPRV antibody detection by LFA/IFD revealed similar detection limit as that of competitive ELISA. The serum dilutions with percent inhibition values < 40% were clearly negative by LFA/IFD.

The LFA/IFD in blocking/competitive mode was able to detect specific antibodies to PPRV only but feline sera vaccinated against CDV with high anti-CDV antibody titre (VN titre >1:1024) had shown cross reactivity. This could be due to steric hindrance as observed for RPV antibodies where certain cross-reacting antibodies to adjacent/ overlapping epitope(s) hinder the binding of PPRV mAb '4B11' to its corresponding epitope as reported during development of 4B11 mAb based c-ELISA. A similar observation was also made using RPV antibody while developing competitive ELISA for antibodies to PPR virus. Based on screening of 71 serum samples by IFD/LFA in parallel with competitive ELISA, a relative diagnostic sensitivity and specificity of 92.3% and 100%, respectively was observed with 'very good' agreement (kappa=0.938) for antibody detection.



Optimization of standard dilution of inactivated antigen for Blocking/Competition



Antibody kinetics of immunized goats as tested by IFD/LFA test and compared with c-ELISA

This was supported by VNT data whereby all the samples (n=7) that had VNT titre >1:16 tested positive by LFA/IFD and samples (n=20) with VNT titre <1:8 tested negative. The ability of LFA/IFD to detect antibodies 2-4 weeks post-immunization in three goats just similar to competitive ELISA is yet another proof for LFA/IFD to serve as antibody detection test suitable for vaccine sero-montoring.

LFA/IFD as dry sample source for PPRV nucleic acid detection

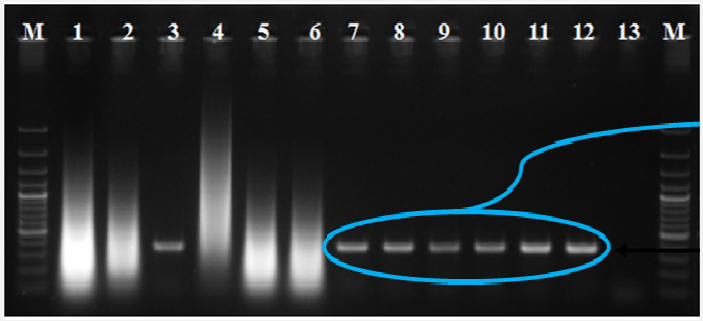
LFA device was also used as a dry source of sample for PPRV nucleic acid detection from tested strips. The device after testing could be stored up to 10 days at 37°C (tested so far). The nucleic acid was extracted from T-Line and RT-PCR was performed using universally accepted primers. During initial evaluation, nucleic acid extracted directly from clinical samples and also from tested LFA strips were subjected for RT-PCR and visualized upon agarose gel electrophoresis. As a whole, 149 samples were tested using LFA strip and by RT-PCR. The efficacy of RT-PCR from tested strips was found to be 81.53% diagnostic sensitivity and 89.28% diagnostic specificity based on 149 samples tested.

Antigen capture ELISA kit for PPRV

An improved sandwich ELISA kit (IVRI-M antigen capture ELISA kit) has been developed, validated, and the kit was released by Hon'ble Union Minister of Agriculture and Farmers Welfare, GOI on the occasion of the Annual conference of Vice Chancellors of Agricultural Universities and Directors of ICAR institutes at NASC Complex, New Delhi, on 8th March 2018.

Closed tube LAMP assay for rapid detection of goatpox and sheeppox viruses

Sheeppox and goatpox of small ruminants and lumpy skin disease of cattle are identified by molecular diagnostics namely PCR/real-time PCR and gene sequencing/analysis that are applicable only in highly equipped laboratories. In resource-limited laboratory settings, a novel nucleic acid amplification technique known as a LAMP with simple visual detection approach using indicator dye like hydroxyl naphthol blue will be very useful in the rapid diagnosis of capripox infections in sheep and goats. In this study, three LAMP assays targeting P32, DNA polymerase (DPO) and RNA polymerase (RPO) genes were optimized in closed tube format using HNB dye as a pre-addition mix to avoid carry-over contamination. They are found to



Agarose gel (1.5%) electrophoresis of RT-PCR amplified products for PPR positive samples from original clinical sample and their corresponding LFA/IFD strip

be rapid, specific and sensitive for CaPV DNA detection. However, on the comparison in terms of analytical sensitivity and specificity for detection of CaPV genomic DNA, RPO based LAMP assay in closed tube format was found to be highly sensitive, specific and affordable. The evaluation of the diagnostic efficacy of this closed tube LAMP assay is in progress.

Development of a competitive ELISA for detection of group-specific antibody to bluetongue virus in a species-independent manner

Recombinant VP7 antigen expressed in insect cells and chicken immunoglobulins (IgY) produced against the BTV core antigen was used for development of a competitive ELISA (IgY-cELISA). The ELISA was optimized to maximize the discrimination between positive and negative serum samples based on the PI values. The assay was found highly sensitive (dsn=97.7%) and specific (dsp=97.2%) for detection of antibodies against BTV in multiple susceptible species. The assay performance was evaluated and compared with commercial ELISA kit. Concordance between the commercial cELISA kit (VMRD, USA) and the in-house developed cELISA was evaluated from the test result of random serum samples (n=893) from sheep, goats and cattle. The overall concordance between commercial cELISA and IgY-cELISA was estimated to be 97.08% (867/893). Random field serum samples (n=1323) were screened by the newly developed cELISA for evaluation of the assay performance. Frequency distribution of the test samples showed the mean PI of 52.31% with a range from minus (-) 56.56% to plus (+) 98.8% in the IgY-cELISA.

Improved c-ELISA for PPRV antibody detection

For antibody detection, two forms of PPRV H protein, viz., full protein and ectodomain have been expressed in insect cells. The expression of both the forms has been confirmed by immuno-blot and their reactivity with the anti-H monoclonal antibody (MAb) has been tested by ELISA. It was found that only the full protein retained the reactivity with MAb and the ectodomain part could not react with the anti-H MAb.

Indirect IgM ELISA for sero-diagnosis of Japanese encephalitis (JE) in swine

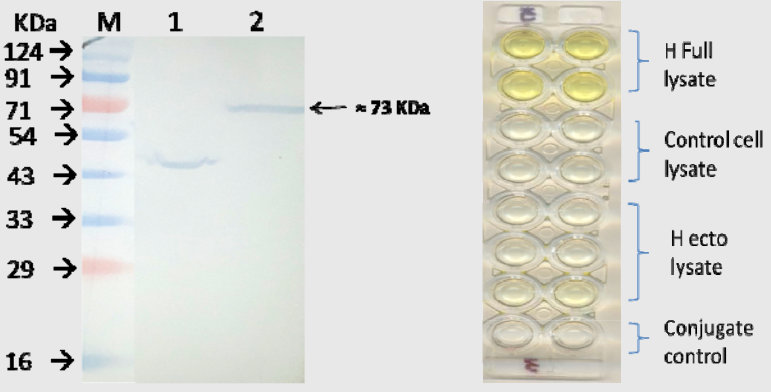
Indirect IgM ELISA was standardized to know the active infection of JE virus in swine. Relative diagnostic sensitivity and specificity in comparison with commercially available JE IgM ELISA kit for swine (Bluegene) was found to be 95.34% and 98.6%, respectively.

Indirect IgG ELISA for sero-diagnosis of Japanese encephalitis (JE) in equine

Indirect IgG ELISA was successfully standardized for sero-diagnosis of JE in equines.The diagnostic sensitivity of the developed in-house ELISA (79.66%) was found to be better than that of commercial ELISA kit (12.65%) and HI test (15.85%). Further efforts are being carried out to improve the diagnostic sensitivity of the in-house IgG ELISA.

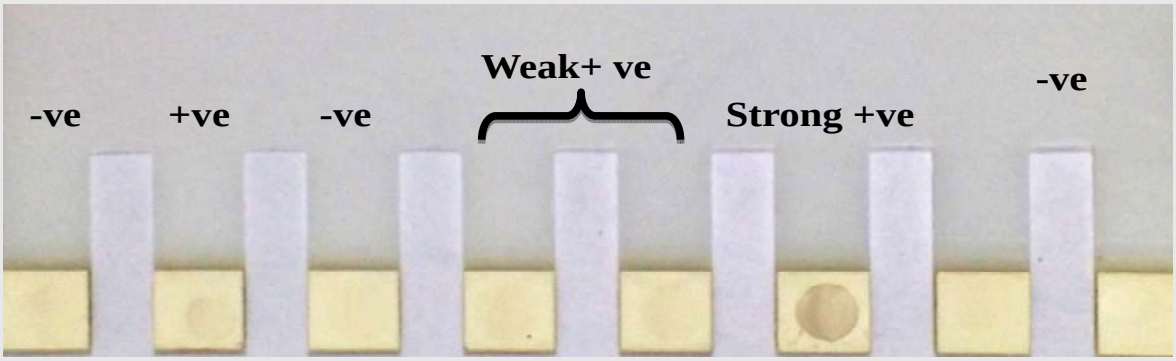
Dipstick IgG ELISA for sero-diagnosis of Japanese encephalitis (JE) in swine

Dipstick IgG ELISA was standardized as an on-site test for the detection of antibodies against JE virus in swine serum. Based on standardized conditions 255 swine serum samples were screened and sero-positivity was observed in 53.33% (136/255) samples. Relative sensitivity and specificity in comparison with in-house indirect ELISA was 100% and 92.9 %, respectively. Coated Dipstick combs were stable up to 7 months at 4°C.Validation done in 3 laboratories as per method described by OIE (2013).



Panel A **Panel B**

Panel A: Confirmation of protein expression with Anti-His Ab. Lane 1: H ectodomain; Lane 2: H full protein. **Panel B**: Reactivity of anti-H MAb in ELISA



Screening of field swine serum samples using dipstick IgG ELISA for JE

TaqMan real time RT-PCR for diagnosis of Japanese encephalitis

TaqMan real time RT-PCR was standardized targeting envelope gene of Japanese encephalitis virus. Envelope gene specific MGB TaqMan fluorescent probe along with the primers were designed. The amplification efficiency of assay was 98.67%. The analytical sensitivity was found to be 2.8 copies/reaction and it was found to be 4-log more sensitive than conventional RT-PCR. The applicability of the standardized TaqMan assay was evaluated by screening representative sets of 40 field swine blood samples and 947 mosquitoes for JEV. The viral load ranged between $3.32x10^{7}$-$4.2x10^{2}$ copies/ml of swine blood samples, and $5.7x10^{9}$-$1.3x10^{2}$ copies/pool of mosquitoes.

Recombinant protein based iELISA for detection of rotavirus D (RVD) infection

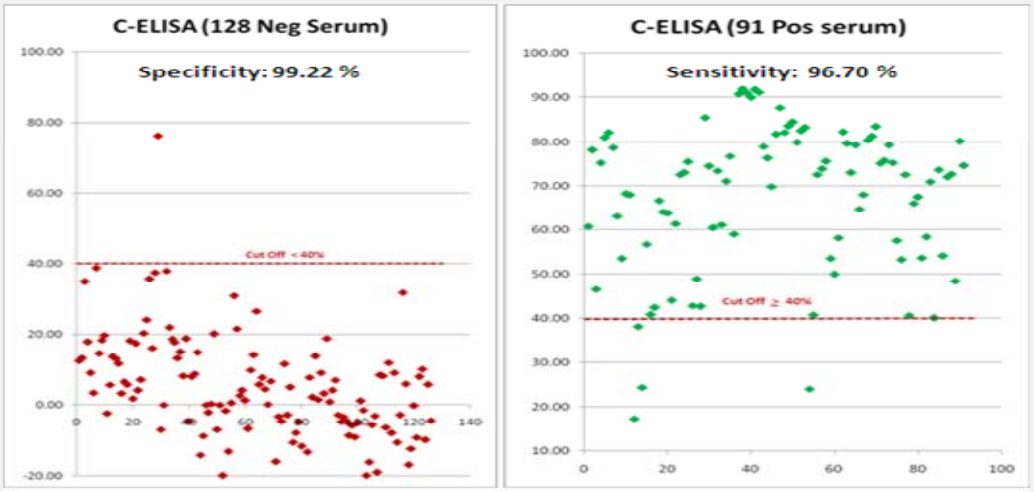
In continuation of the previous work, further improvement in the sensitivity of the detection and specificity of the assay was worked out. The amount of antigen for detection was reduced from 20 µg/ml to 0.5 µg/ml, making it 40 times more sensitive and reliable. The sensitivity and specificity was tested on 350 serum samples collected from different states for the last two years. The cutoff value was determined at 0.25 OD using the MedCalc statistical software. Software evaluated the iELISA as 98% sensitive and 99% specific.

c-ELISA for detection of CSF antibodies

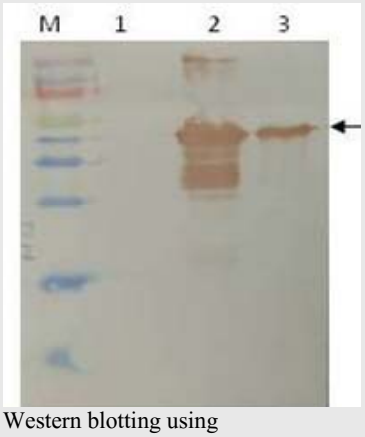
A competitive ELISA developed for detection of CSFV antibodies in pigs with purified antigen showed 99.22% specificity and 96.70% sensitivity compared to Idexx ELISA kit as tested on 219 known serum samples. Test has been validated at intra and inter-institutional laboratories. The test can be used by the manufacturers of CSF vaccines for QC tests of CSF vaccines and for sero monitoring in the control programme for CSF launched recently by Govt. of India. The use of the kit would be a cheap alternate to the commercial CSFV antibody kits.

Expression of truncated PCV2 capsid protein gene and evaluation of its diagnostic potential

The N- terminal truncated capsid protein gene (582 bp) of PCV-2 (tPCAP) was amplified and expressed. The 42 kDa recombinant capsid protein was confirmed by western blotting using monoclonal anti-histidine antibody and also by commercially available anti-PCV2 polyclonal serum.



Graphical representation of Specificity & Sensitivity of c-ELISA for detection of CSF antibodies



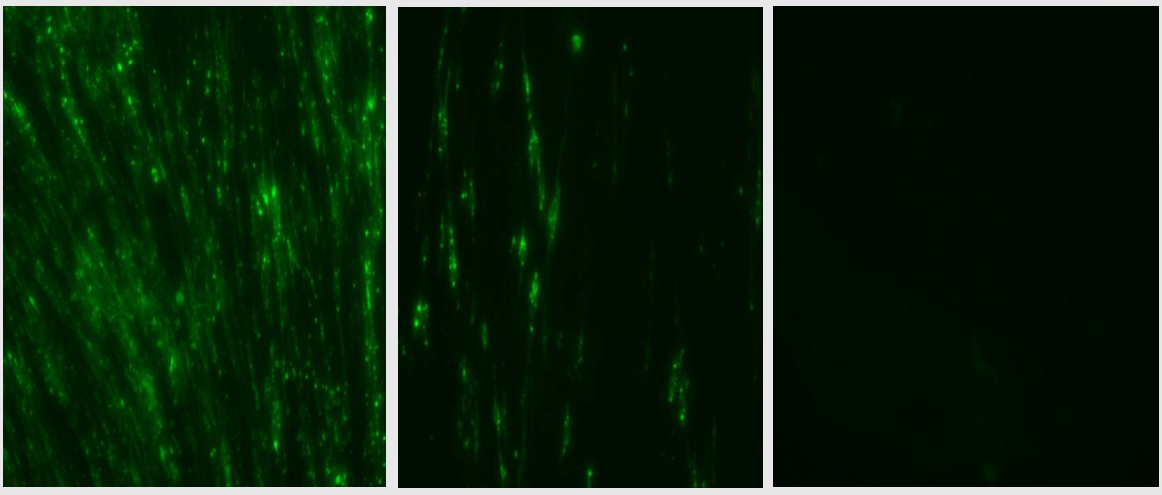
Western blotting using
anti-his Monoclonal antibody.
M: Prestain protein marker,
Lane 1: Uninduced culture lysate,
Lane 2: Induced culture lysate,
Lane 3: Purified protein.

Recombinant truncated protein was used as a coating antigen for detection of PCV-2 antibodies in pig serum samples. Based on the checker board titration, 300 ng of antigen /well and 1:50 dilution of test serum was determined. One hundred seven serum samples were screened using commercially available Greenspring® PCV2 antibody ELISA test kit and in-house standardized recombinant protein based ELISA. The absorbance values (OD_{450}) of all the test serum samples were recorded and their sample/positive ratio (S/P ratio) was calculated. The cut-off value (S/P ratio- 0.21) of the rCAP-ELISA was fixed as per OIE guidelines and based on ROC curve data. The performance of rCAP-ELISA in terms of relative sensitivity and specificity was compared with that of commercially available kit (GreenSpring® porcine circovirus (PCV2) ELISA Test kit). Out of the 9 positive sera samples, 1 sample was found to be negative by rCAP-ELISA, whereas out of the 98 negative sera samples, 9 samples were detected as positive. Relative specificity of the rCAP-ELISA was found to be 90.81% (89/98) and relative sensitivity was found to be 88.88% (8/9) based on the limited serum samples tested.

Repid Fluorescent Foci Inhibition Test (RFFIT) for detection of neutralising antibody titre against rabies virus

RFFIT, a gold standard test, can be used to check protection status of animals and high risk human population against rabies. The test was developed by Smith et al., in 1973. Since then many modifications of test have been described. We optimized direct format of test using 96-well microtitre plates. Test is based on ability of test serum to neutralise CVS-11 strain. BHK-21 cell adopted and characterized virus (BP Division, ICAR-IVRI) cultured in BHK-21 cells and titrated using FAT. The virus titre was found to be 10^5 FFD_{50}/ml.

All the parameters of the test were optimized. Both the test and WHO reference serum were diluted by 5-fold serial dilution (1:5 to 1: 15625) in EMEM medium. Each dilution of serum was added into 2 wells of 96-well micro titre plate. The titre of stock virus was adjusted to 100 FFD_{50}/ml. Period of virus neutralisation was kept for 1h Cell number added to the wells was fixed at the level of $5x10^5$ cell/ml and 100 µl cell suspension was added to each well. Plates were incubated for 24±2 h. After incubation, cells were fixed in 80% acetone for 20 min at -20°C. Anti-rabies FITC-conjugate dilution was optimized at 1:70 (in 1X PBS). Incubation with anti rabies FITC-conjugate was done for 45 min in humidified incubator at 37°C. All washes were done with 1X PBS and mounting with 50% glycerol. For recording results, 20 different microscopic fields per serum dilution were observed at 200X for presence of florescence and accordingly marked as positive or negative. A 50% end point inhibition titre was calculated by



100% microcopic fields positive | 60% microcopic fields positive | All microcopic fields negative

Spearmen and Karber method. Titre of test sera in IU was calculated by comparing with reference serum. The test performed well with aforementioned optimized conditions.

Development of a user friendly diagnostic for BHV-1 infection

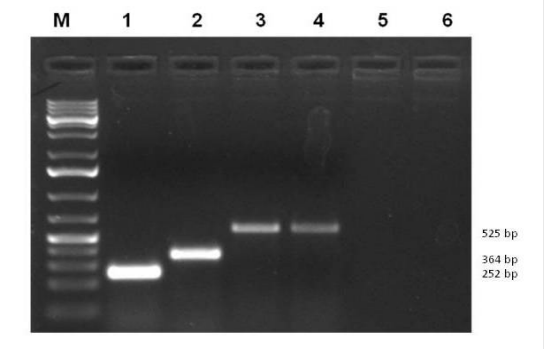
Bovine herpesvirus-1 (BoHV-1) causes infectious bovine rhinotrachietis and Pustular Vulvovaginitis in cattle. BoHV-1 causes significant reduction in milk yield leading to huge economic loss to dairy industry. Glycoproteins gB, gC and gD of BoHV-1 are highly immunogenic and induce protective immunity in cattle. One of the hallmarks of herpesviruses is its ability to become latent in the host and after reactivation from latency, animals shed virus through nasal secretions, tears and semen. The glycoprotein D (gD) a viral envelope protein, involved in virus penetration has been considered as a major target in vaccine development and can be exploited for serological diagnosis of BoHV-1. The gD gene was expressed in prokaryotic cell system to be used for diagnostic purpose. Viral genomic DNA was extracted from BoHV-1 infected MDBK cells and used as a template for PCR amplification of gD gene (1255 bp length). Gel purified gD gene was cloned into ptz57R/T T/A cloning vector and further subcloned into pET-32a, prokaryotic expression vector. Recombinant plasmids were screened and again transformed in BL21 strain of *E.coli* competent cells. Expression was induced using IPTG. Expression of recombinant gD protein was seen in SDS-PAGE at 4 h of induction and further confirmed with Ni-HRPO conjugate. The expressed gD protein can further be evaluated for the development of a field-based diagnostic tool for easy detection of BoHV-1 infection.

Polymerase Spiral Reaction (PSR) for detection of infectious pathogens

A novel isothermal nucleic acid amplification method named PSR has been developed and standardized for the detection of BHV-1 genomic DNA in the semen samples of bovines. The test has been found to be highly sensitive and specific and can detect both BHV-1.1 and BHV-1.2 subtypes. Further, this test has been found to be 100 times more sensitive than PCR and could detect 23 fg of DNA compared to 2.3 pg in PCR. The PSR for BHV-1 was also tested for specificity against *M. tuberculosis*, Brucella sp., BVDV and FMDV and found to be specific for BHV-1. PSR was developed and standardized for detection of *M. bovis* genomic DNA. The detection limit of PSR was found to be 1.71 fg and found to be 10 times more sensitive to PCR. The specificity was also checked using *M. avium* subsp. paratuberculosis, Brucella sp., BVDV and BHV-1 and found to be specific for *M. bovis*. PSR was also developed and standardized for detection of *M. avium* subsp. paratuberculosis genomic DNA. The detection limit of PSR was found to be 1.6 fg which is 10 times more sensitive to PCR. The specificity was also checked using, *M avium* subsp. paratuberculosis, Brucella sp., BVDV and BHV-1 and found to be specific for *M. avium* subsp. paratuberculosis. The PSR has been developed and standardized for detection of BVDV genomic nucleic acid. The detection limit of PSR was found to be 0.4 pg and found to be 10 times more sensitive to PCR. The specificity was also checked using *M. tuberculosis*, *M. avium* subsp. paratuberculosis, *Brucella* sp., and BHV-1 and found to be specific for BVDV genome only.

ARMS/Allele specific PCR for detection of BHV-1 infection

BHV-1 infection is manifested into two forms *viz.*, respiratory form and reproductive form and caused mainly by BHV-1.1 and BHV-1.2 subtypes, respectively. BHV-1.1 associated respiratory tract infections is known as Infectious bovine rhinotracheatis (IBR); while BHV-1.2 has been linked with vesicle and pustule formation in genital tract known as “infectious pustular vulvovaginitis” (IPV) in cows or balanopostitis (IPB) in bulls or other forms of reproductive anomalies and abortions. The differentiation of BHV-1.1 and BHV-1.2 is usually carried out by RE digestion of genomic DNA with some specific enzymes followed by agarose gel electrophoresis of the digested DNA. This method is laborious, time consuming and require highly sophisticated laboratory with costly equipments. Thus, a simplified rapid, single tube multiplex Amplification Refractory Mutation System-PCR (ARMS-PCR) strategy has been developed and standardized for differentiation of BHV-1 subtypes based on a single nucleotide change between the subtypes. The PCR was done with different set of



Agarose (1.5%) gel of ARMS-PCR showing the amplicons of 525 bp in case of BHV-1, 252 bp in BHV-1.1 and 364 bp in BHV-1.2

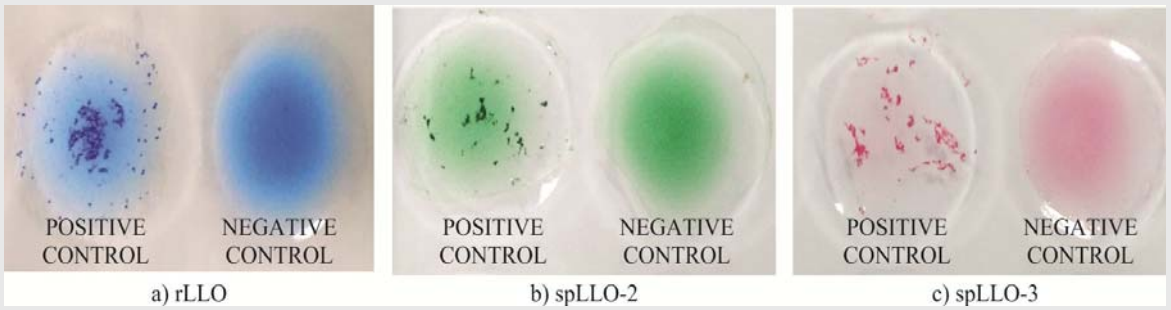
primers to differentiate BHV-1 subtypes. The one outer and one inner were used to differentiate BHV-1.1 and BHV-1.2 with amplicon size of 252 bp for BHV-1.1 and 364 for BHV-1.2. The two outer primers were used to show presence with one specific band of 575 bp separately.

BACTERIAL DISEASES

Latex Agglutination Test (LAT) and indirect ELISA employing synthetic peptides of LLO for serodiagnosis of listeriosis in caprine and bovine species

Globally efforts were undertaken to develop a serodiagnostic assay for listeriosis, wherein different antigens were tried. However, they cannot be relied upon because for their poor specificity and sensitivity. Besides, these assays fail to discriminate between pathogenic and non-pathogenic *Listeria* strains. Of all the virulent markers studied so far, Listeriolysin O (LLO), an extracellular 58 kDa haemolysin, is a major virulence factor of *L. monocytogenes* and is produced by all the pathogenic strains. Also antibodies to LLO (ALLO) were shown to be reliable indicators for serodiagnosis of listeric infections in humans and animals. However, the cross reactivity of antibodies of LLO (ALLO) with those produced against streptolysin O (SLO), a hemolysin produced by *Streptococcus* spp. remains a major limitation of this assay, which calls for adsorption of test sera with SLO prior to its testing by this assay, thereby increasing the test cost as well as time.

For sero-screening of listeriosis in bovine and caprine species, an i-ELISA and LAT employing synthetic peptides of LLO (LLO-2, LLO-3, LLO-4) was developed and evaluated with a total of 1096 serum samples collected from caprine (n=654) and bovines (n=442) having history of reproductive disorders and/or nervous disorders, including healthy animals. Overall, all the synthetic peptides of LLO were found highly specific and less cross-reactive for serodiagnosis of listeriosis in caprine and bovine species. Also the need of prior adsorption of test sera with SLO can be eliminated;



Latex Agglutination Test (LAT) using polyclonal IgY antibodies against recombinant LLO (a) and synthetic peptides of LLO (b&c) for direct detection of *L. monocytogenes* from enrichment broth

Evaluation of synthetic peptide(s)-based i-ELISA for serodiagnosis of capro-bovine species

Serum samples	LLO-2		LLO-3		LLO-4	
	SLO adsorption		SLO adsorption		SLO adsorption	
	Before	After	Before	After	Before	After
Caprines (n=654)	60 (9.17%)	46* (7.03%)	56 (8.56%)	44* (6.72%)	57 (8.71%)	45* (6.88%)
Bovines (n=442)	110 (24.88%)	101* (22.85%)	116 (26.24%)	104* (23.52%)	112 (25.33%)	99 * (22.39%)

*(p>0.05)

Evaluation of synthetic peptide(s)-based LAT for serodiagnosis of capro-bovine species

Serum samples	LLO-2		LLO-3		LLO-4	
	SLO adsorption		SLO adsorption		SLO adsorption	
	Before	After	Before	After	Before	After
Caprine (n=654)	56 (8.56%)	42* (6.42%)	51 (7.79%)	40* (6.11%)	51 (7.79%)	43* (6.58%)
Bovine (n=442)	95 (21.49%)	87* (19.68%)	98 (22.17%)	85* (19.23%)	94 (21.26%)	85* (19.23%)

*(p>0.05)

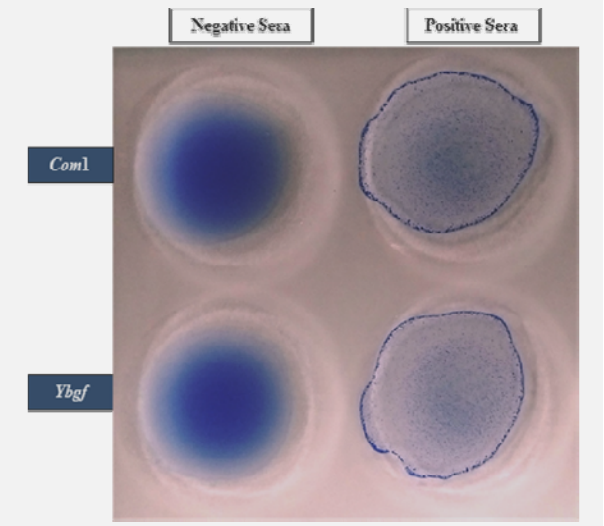
which in turn could decrease the cost and time of test analysis. Since the assay has employed synthetic form of antigen, such antigens are highly stable, easy-to-store even at room temperature, and also they can be synthesized in bulk. Thus, both the developed assays can be explored for screening of listeriosis cases in bovine and caprine population; in particular, i-ELISA can be used for mass screening of herd while LAT can be performed even under field conditions to identify the sero-reactors.

Latex Agglutination Test (LAT) for direct detection of *Listeria monocytogenes* in foods and clinical samples from enrichment broth

In India, till date only one commercial LAT kit is available to detect colonies of *Listeria* spp. grown on selective media plate. Thus, to provide the results, it takes almost more than 72 h. Moreover, it also fails to discriminate between pathogenic and non-pathogenic *Listeria* species. Our laboratory has developed a LAT (rLLO, spLLO-2, spLLO-3) for detection of *Listeria monocytogenes* directly from enrichment broth. The in house developed LAT assay provides the results within 24 h. In an artificially spiked study conducted in milk sample, the in-house developed LAT can detect upto 10 CFU of *L. monocytogenes*/ml of sample. On testing with 69 known cultures (53 positive and 16 negative cultures), the diagnostic sensitivity and specificity of rLLO based LAT was 100% and 78.95 %; whereas with spLLO-2 based and spLLO-3 based LAT revealed 100% diagnostic sensitivity and 84.21% diagnostic specificity each, respectively. On comparing commercial LAT test with the same test cultures, 88.68 % diagnostic sensitivity and 81.25% diagnostic specificity was observed. Further, on evaluation of 830 field bovine clinical samples, the developed in-house LAT assays; especially spLLO-2 and spLLO-3 based assays were found 100% specific and sensitive compared with isolation method. Thus, in the light of FSSAI guidelines for *L.monocytogenes* in food, we believe that the developed in-house LAT assays could serve as important screening tool for food industries which are involved in export and import of foods.

Latex Agglutination Test (LAT) employing synthetic peptides of *Com1* and *Ybgf* for serodiagnosis of Coxiellosis in bovines

Currently, for detection of *C. burnetii* both serological and molecular tools are in place. However, they are not cost effective and field oriented. In short, there is dearth of economical rapid point of care screening method. In this regard, a LAT employing synthetic peptides (*Com1* and *Ybgf*) was standardized for sero screening of coxiellosis in bovine.



Latex agglutination test employing synthetic peptides of *Com1* and *Ybgf* for serodiagnosis of coxiellosis in bovines

In brief, one synthetic peptide identified using bioinformatic tools for each *Com1* and *Ybgf* gene were outsourced for synthesis. The LAT test reagent was prepared using 1.25% of carboxy blue dyed latex beads (Polysciences, USA) and 100 µg of each individual peptide. The conjugation of latex beads and the antibody against each peptide was performed using covalent coupling method. Later, the test was optimized by using varying concentration of test reagent and known positive and known negative sera obtained from naturally infected cases of animals under study.

Polymerase Spiral Reaction (PSR) for rapid detection of *Brucella* spp

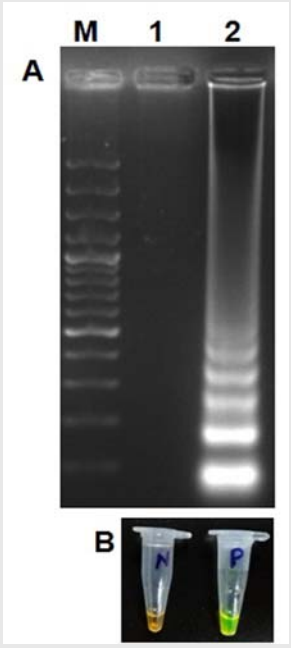
A rapid and sensitive isothermal amplification based molecular assay PSR for detection of *Brucella* organism was optimized. PSR, targeting genus specific *IS711* gene was used for detection of *Brucella* spp. PSR assay was visually detected with the aid of a fluorescent dye (SYBR Green).The detection limit of target DNA was approximately 11.8 fg/µl within 60 min at isothermal temperature (65°C).

In spiked milk sample it was able to detect up to $2.8x10^2$ C.F.U of *B. abortus* S99 organism. It was validated on limited number of clinical sample. After validation on various type of clinical sample, it can be used as an onsite detection of Brucella organism in different clinical specimen.

PARASITIC DISEASES

Canine ehrlichiosis

Out of 136 canine blood samples screened by microscopy and PCR, 65 were found positive for *Ehrlichia canis*. The p19 gene of *E. canis* has been



(A) Agarose gel (2.5%) electrophoresis of positive and negative control after PSR amplification. Lane M: 100 bp plus DNA ladder, Lane 1: Non-template control (NTC), Lane 2: Positive control (*B. abortus* S99) **(B)** Visual detection with SYBR Green-I showing green fluorescence in positive and orange colour or no fluorescence in negative after PSR amplification.

cloned, expressed and purified. On Western blot and, the recombinant P19 protein showed strong reactivity with hyperimmune sera as well as with convalescent sera from infected dogs. Indirect ELISA for detection of *E. canis* infection in dogs is being standardized.

Bovine toxoplasmosis

The diagnostically important SAG-1 and SAG-3 proteins of *Toxoplasma gondii* were expressed in *E. coli*. A diagnostic ELISA was standardized using the cocktail of recombinant SAG-1 and SAG-3 proteins. The sensitivity and specificity of the cocktail ELISA were 91.60% and 79.48%, respectively. Goat sera samples collected from various parts of Kumaon region and cattle sera samples received by CADRAD, IVRI were tested for *Toxoplasma* specific antibodies. Out of 420 goat and 100 cattle sera samples, 89 (21.19%) and 14 (14%), respectively, were found positive.

CANCER DIAGNOSIS

Differentially expressed (de) genes in canine mammary tumour and identification of relevant networks and pathways

For identification of differentially expressed genes (DEGs), microarray hybridization was performed in duplicates with total RNA isolated from malignant (n=6), benign (n=4) tumours of mammary gland and normal healthy mammary tissue (n=3). On analysis, 1700 and 1286 differentially expressed genes (DEGs) were identified in malignant (n=6) and benign (n=4) tumours of mammary gland, respectively. In malignant tumours, of the 1700 dysregulated genes, 765 were up-regulated and 935 were down-regulated. Likewise, among the total 1286 dysregulated genes in benign tumours, 744 were up-regulated and 542 genes were down-regulated. Only 384 genes were uniquely up-regulated to benign tumours and 251 genes were uniquely down-regulated. Among malignant tumours, maximum fold change was observed for *COL11A1* gene (Log_2 FC=4.8), while among benign tumours maximum fold change was observed with *MMP3* gene (Log_2 FC=6.6). Top five up-regulated genes in malignant tumours were *COL11A1*, *SFRP2*, *LCN2*, *COL2A1* and *H19*, while top up-regulated genes in benign tumours were *MMP3*, *MMP1*, *AREG*, *PTHLH* and *SFRP2*.

Venn diagram showing overlap of dysregulated genes among malignant and benign mammary CMT tissues

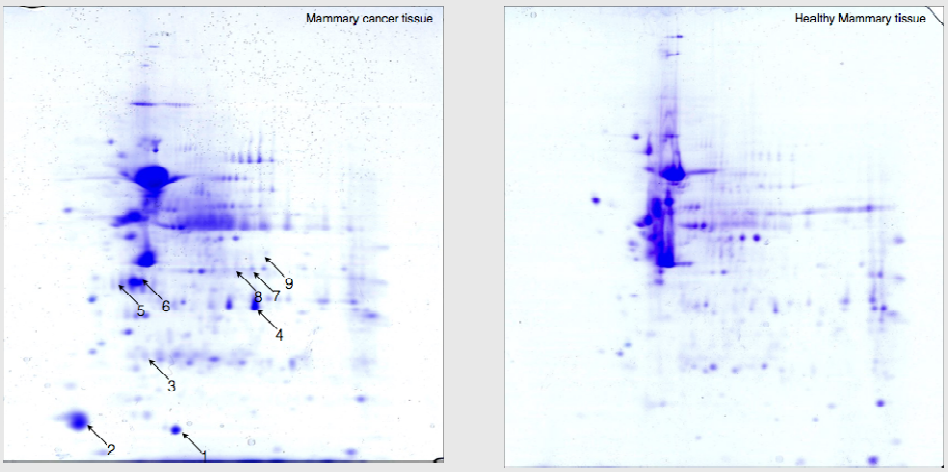
The microarray results were validated by qPCR for selected genes. To identify the gene functions and associated processes of dysregulated genes, they were assigned to IPA. Top canonical pathways activated in malignant tumours included TREM1 signalling, cyclins and cell cycle regulation, ILK signalling, etc. Top inhibited pathways included intrinsic prothrombin activation pathway and neuroprotective role of THOP1 in Alzheimer's disease. Top activated canonical pathways in benign tumours were TREM1 signalling, dendritic cell maturation, ILK signalling. Top inhibited pathways were related to cell cycle regulation and neuroprotective role of THOP1 in Alzheimer's disease.

Identification of differentially up-regulated proteins (protein biomarkers) in canine mammary tumour by 2D-gel electrophoresis (2D-GE) and MALDI-TOF PMF analysis

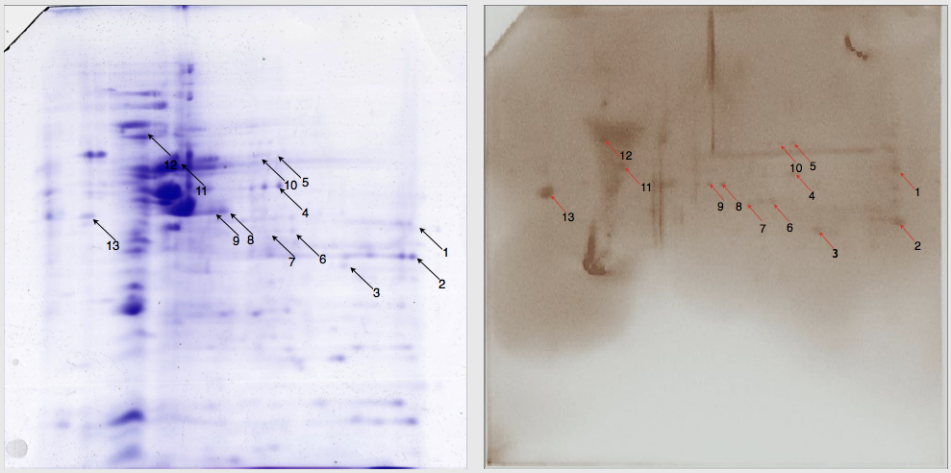
2D-GE was performed for mammary tumour tissue and normal healthy mammary tissue. Approximately 293 protein spots were identified on malignant tumours and 328 spots identified in case of healthy mammary tissue sample. A total of 178 protein spots matched in both malignant tumour and healthy mammary tissue. Based on staining intensity, peak height, area of a spot and saliency, a threshold of 3 was selected for saliency for selecting proteins that were up-regulated and a total of 9 protein spots were excised from gel and subjected to MALDI-PMF. These proteins were CDK6, GDI2, GATC, ANXA2, HORMAD1/CT46, MYH9, SOD1, APOC2, and GNAQ.

Identification of autoantibody biomarkers in canine mammary tumour (Cmt) sera by serological proteome analysis (SEPRA) technique

Autoantibody biomarkers associated with CMT were identified by serological proteome analysis technique (SERPA) using dog mammary cancer cell line REM134. Individual proteins from cancer cells were resolved by 2-DG electrophoresis (2DGE), and then transferred to PVDF membrane by semi-dry blotting and probed separately with pooled mammary cancer positive sera (n=10) and pooled healthy dog sera (n=8). Upon developing the membranes using ECL reagent, 13 differential spots were identified in mammary cancer as compared to healthy samples. MALDI-TOF PMF analysis was done to identify these proteins. The proteins identified were ALDOA, UCP1, ALB, SPCS2, CYTSA/SPECC1L, ANXA2, ANXA2, HPT, ACTB, CXCL10, PDIA3, PPARA, ZDHHC8.



2D-gel electrophoresis of malignant mammary cancer versus healthy mammary gland tissue. Upon analysis of 2D-gels of malignant versus healthy mammary tissue, 9 differentially overexpressed protein spots, (indicated by arrows 1-9) were identified in malignant tissue

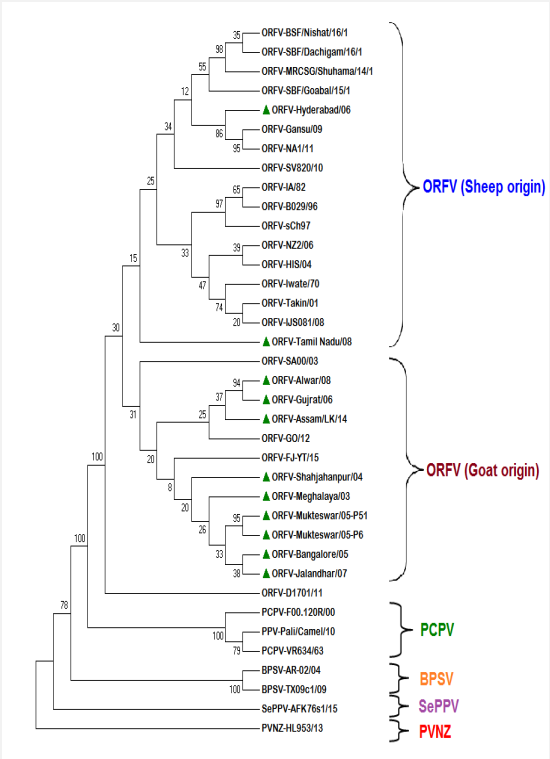


Serological profiling of mammary cancer sera and healthy dog sera was done by 2DE-WB. 13 protein spots reactive to mammary cancer sera samples were identified by MALDI-PMF

3.3 Molecular Characterization of Pathogens and Epidemiology

Genetic characterization of Orf virus

Genetic analysis of eleven Indian ORFV isolates of different geographical regions targeting viral interferon resistance (VIR) gene revealed that a high percentage of identity among themselves and other ORFV isolates at both nucleotides and amonoacids levels as compared to low identity among parapoxviruses (PPVs). Phylogenetic analysis showed species-specific clustering among PPVs along with sub-clusters based on host species of origin among ORFVs. Comparative sequence analysis of poxviral E3L orthologs showed genus-specific clustering along with conserved N-terminal DNA-binding domain and C-terminal double-stranded RNA binding domain. Several conserved amino acids were found in all parapoxviruses and other poxviruses corresponding to ORFV-E3L positions namely N37, Y41, P57, and W59 (necessary for Z-DNA binding) and E116, F127, F141, and K160 (necessary for dsRNA binding).

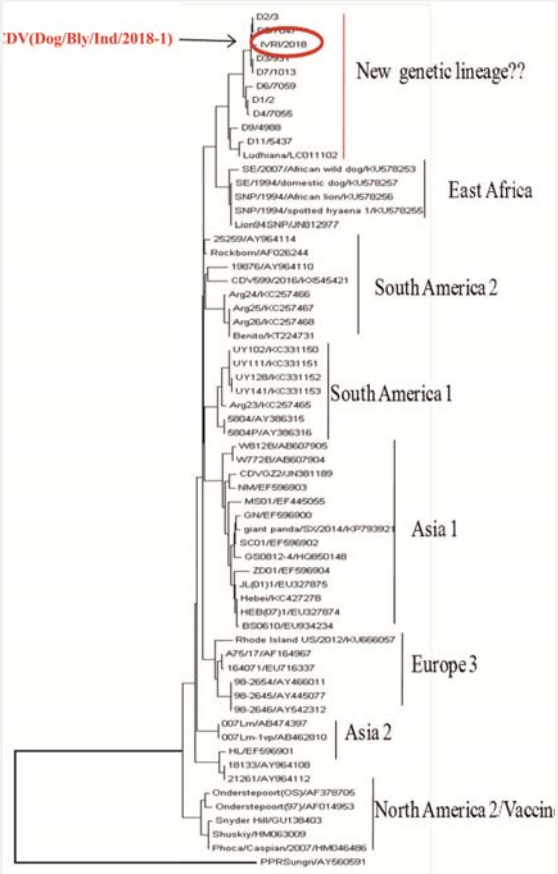


Phylogenetic reconstruction of different parapoxviruses targeting full-length VIR gene sequences using the neighbor-joining method with a bootstrap model using 1000 replicates of MEGA 7.0 software

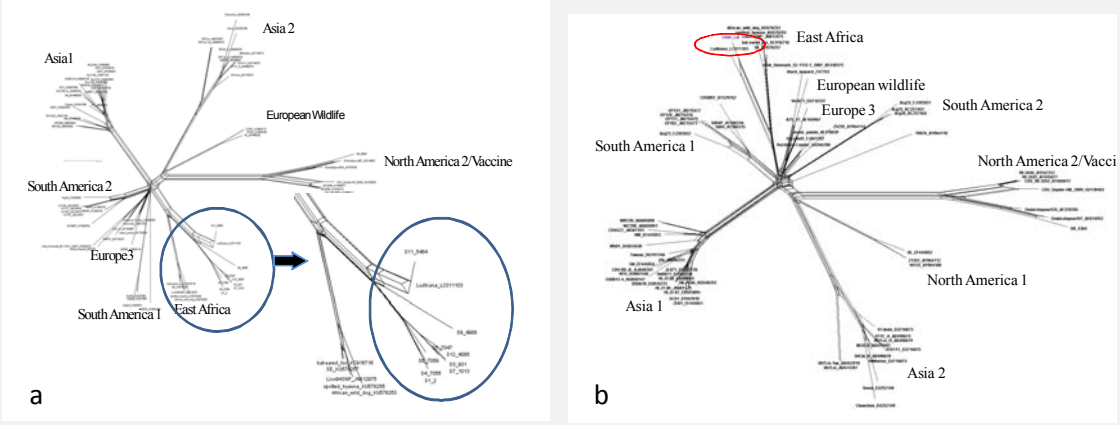
This study on E3L genetic analysis of Indian ORFV isolates may provide a better understanding of the molecular epidemiology of circulating strains. Also, E3L deleted or mutated ORFV may be as vaccine candidate and/or compounds blocking E3L may prove as an effective method for treating broad spectrum poxviral infections, suggesting a wider application in control of poxvirus infections.

Isolation, identification and characterization of canine distemper virus from domestic dog

The present study was undertaken to isolate and adapt CDV positive sample in suitable cell line towards attenuation of candidate virus and to identify key biologicals for different diagnostic techniques. Successful isolation could be made



Phylogenetic analysis of *CDV(Dog)/Bly/Ind/2018* (P4) targeting F-signal peptide (Fsp, 681 bp). Tree was constructed using MEGA7.0, maximum likelihood method model: Kimura-2 parameter with Gamma distribution



H-gene (1824bp, full length) based phylogeny of canine distemper virus from domestic dogs **(a)** and civet cat **(b)**: In both the cases, viruses grouped under new genetic lineages (encircled). Phylogenetic tree was constructed using Split tree analysis v.4 programme

from the blood sample in MDCK cell line. Later on, the MDCK passaged (P3) virus was successfully adapted to Vero cell line. The identity of isolated virus was checked by lateral flow assay (LFA) for CDV antigen and RT-PCR targeting nucleoprotein (N) gene**.** Further, the isolated virus was also confirmed by neutralization assay using CDV antiserum and nucleotide sequencing (N-gene and Fsp region). Nucleotide BLAST results of newly isolated virus showed high degree of similarity to the wild type CDV than vaccine strains. The isolated virus after confirmation by various tests/assays named as *CDV (Dog)/Bly/Ind/2018*.

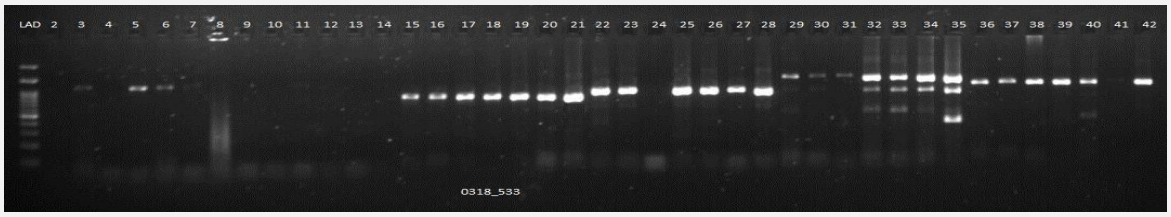
Hemagglutinin (H) gene based phylodynamic analysis of canine distemper virus

To assess the genetic lineages currently circulating in India, phylogenetic tree based on H gene (1824 bp, full length) was carried out for both dog and wildlife samples. RNA extraction and cDNA synthesis was done using commercially available kits. Preliminary confirmation of CDV infection was done by PCR using self-designed N-gene based primers. Subsequently, positive cDNAs were used for amplification of full length H gene using self-designed primers for phylodynamic analysis.

Genotypic diversity of human, bovine and porcine group A rotaviruses

A total of 696 fecal samples from children (158), piglets (261) and calves (277) were collected from coastal parts of Karnataka, Kerala, Goa and Maharashtra. About 132 human, 181 bovine and 118 porcine samples were collected from Maharashtra while 26, 32 and 30 samples for the respective species from Goa. In addition, 29 and 35 bovine fecal samples and 38 and 75 fecal samples were also collected from Karnataka and Kerala. Standardized Phenol:choloroform method was used for extraction of dsRNA of rotavirus from these fecal samples. All the extracted dsRNA was then subjected to RNA-PAGE followed by silver staining for detection of 11 stranded segments of rotavirus. Additionally, it was also subjected to standardized RT-PCR targeting VP6 gene for detection of group A rotaviruses. About 31, 12 and 9 samples from human, bovine and porcines found positive for rotavirus, respectively. The most prevalent genotypes found were G1P[8], G12P[11] in humans while G3P[11] & G6P[11] in bovine and G4P[6] in porcine from Maharashtra and Goa. The VP6, NSP3 and NSP4 genes of these rotaviruses were also characterized. Details of the genotypic diversity is presented as under.

Several attempts were made for isolation of rotavirus from fecal samples, where RNA-PAGE and RT-PCR positive samples (4 human & 4 bovine samples) were used for inoculums prepared by standard method. Initially Vero cells and PK15



Genotypic determination of group A rotaviruses
Lane 1: 100 bp DNA ladder; Lane 2, 4, 7, 8: negative samples (NSP2 gene); Lane 3, 5, 6: positive sample (NSP 2 gene); Lane 9-14: negative samples (NSP3 gene); Lane 15-21: positive samples (NSP4 gene); Lane 22-28: positive samples (VP4 gene); Lane 29-35: positive samples (VP6 gene) & Lane 36-42 except 41: positive samples (VP7 gene)

cells were inoculated with these viruses and observed up to 5-7 passages. Cells were failed to show characteristic CPE, however, suspected flask were tested by RT-PCR for confirmation where none of the flask found to be positive. Therefore, MDBK cell line was used for isolation of rotavirus from above samples. Passages are in progress. Simultaneously, LLC-MK2 cell line was procured from NCCS, Pune and was propagated. Inoculation studies will be continued.

Characterization of porcine rotavirus A (RV-A)

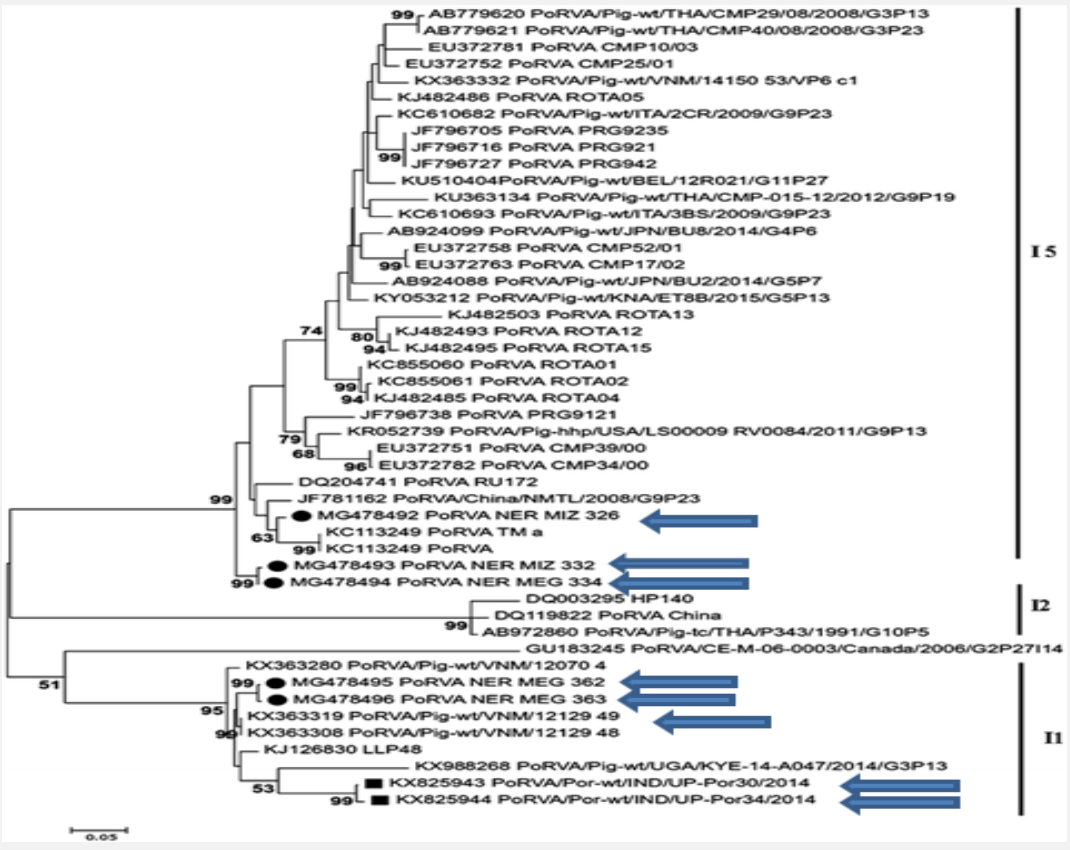
Although, there are few reports available on detection of porcine RV-A based on VP6 gene from India, no lineage/genotype based characterization is available for the target gene. Full length cds of VP6 gene was amplified & sequenced. Percentage identity calculation at nucleotide level of the VP6 gene sequences from different porcine RV-A revealed 77.1–97.3% identity within the Indian porcine RV-A strains. Phylodendrogram and percent identity based analysis of the amplified and sequenced full length VP6 gene confirmed the presence of I1 and I5 VP6 genotypes.Till date, only a single VP6 type (I2) has been confirmed from pig population of India. The findings confirmed the circulation of diverse RV-A strains in porcine population in India.

Antigenic characterization of Bluetonguevirus (BTV) isolates

Indian BTV-16 isolates (N=5) recovered from different parts of the country were studied by *ex vivo* neutralization study with isolate-specific hyperimmune serum (HIS). Viruses were produced in bulk and purified through density gradient ultracentrifugation. HIS against the virus isolates were produced against a purified viral antigen in guinea pigs. Neutralization behavior of the BTV-16 isolates was studied by beta neutralization method in BHK-21 cells. Observations show there is minor or no divergence in the phenotypic antigenic relationship as predicted from the *ex vivo* neutralization behavior.

Characterization of poultry rotavirus-D (RV-D) based on VP7 gene

An avian RV-D isolate (UKD48 strain) from northern India was targeted for amplification of its VP7 gene complete coding sequences of 996 bp. Upon sequence analysis, it was found to be closely related to a South Korean strain, and the nucleotide percent identity varied from 80.4–84.2% with other globally available strains. Aligned amino acid sequences of the VP7 gene affirmed for a conserved glycosylation site (N–I–T) for protein folding; a N-terminal signal peptide ("ITG") for endoplasmic reticulum retention; and two

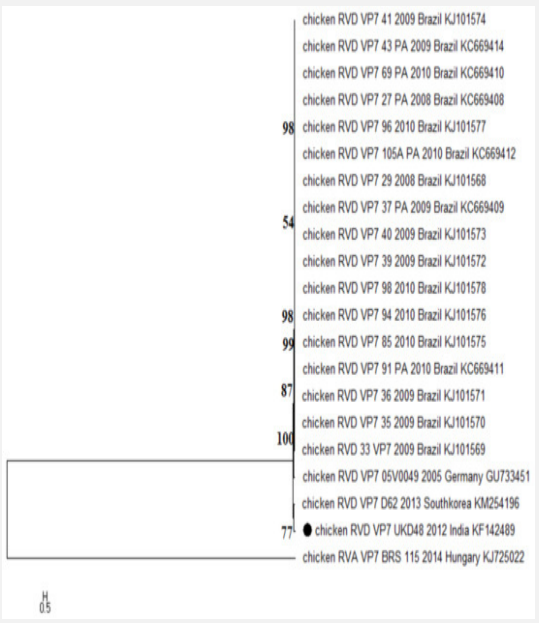


Phylogenetic analysis of partial VP6 gene of RVA confirmed the presence of VP6 genotypes (I1 and I5)

hydrophobic sites for elucidating transmembrane portions, antigenic structures, suggesting for genetically distinct Indian RVD strain.

Genetic analysis of RV-D VP6 and NSP4 genes

Genetic and phylogenetic analysis of VP6 and NSP4 genes was done to identify evolutionary relationships of RV-D isolates and global RV-D strains. *In silico* sequence analysis revealed three N-glycosylation sites (N11, N20 and N118) in VP6 gene sequences. Two putative open reading frames (ORFs) in NSP4 gene were also discovered which is in contrast to a single ORF seen in rotaviruses of other species/types for the same gene. Both the genes were analyzed based on phylogeny with other reported strains of different studies. Genetic variability of VP6 and NSP4 genes was suggestive of their independent evolution. Sequence comparison of rotavirus species-specific protein, VP6, of an earlier isolate and new isolate of RV-D, suggests slower evolution of Indian RV-D isolates than Brazilian RV-D strains. Identification of an additional ORF (ORF2) encoding a hypothetical protein, partially overlapping to NSP4 encoding ORF, is a notable finding of this study.



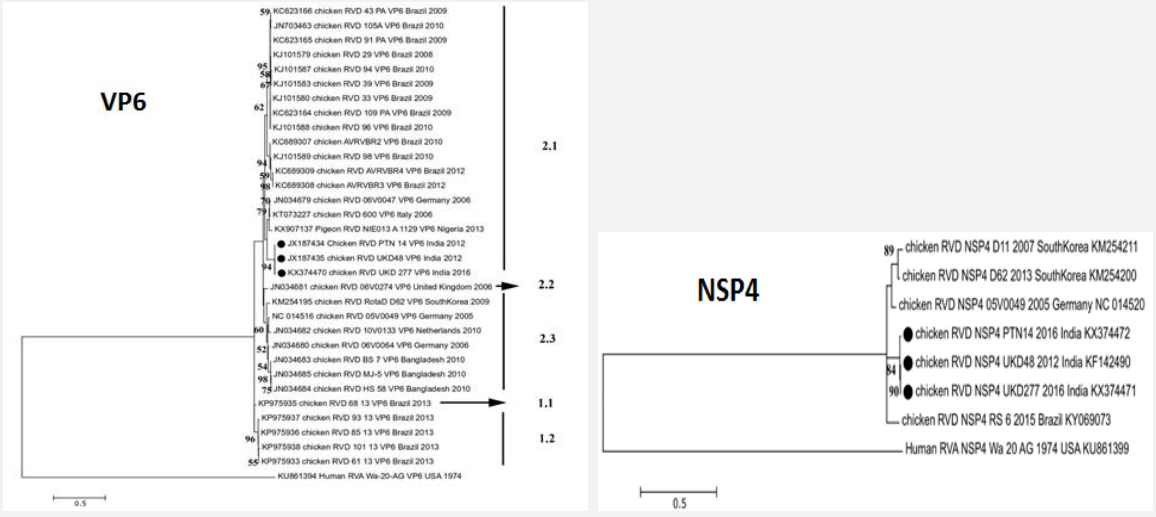
Maximum likelihood phylogenetic analysis of rotavirus D (UKD48 strain), based on 996 bp complete coding sequence of the VP7 gene

Whole genome sequencing of *P. multocida* isolates

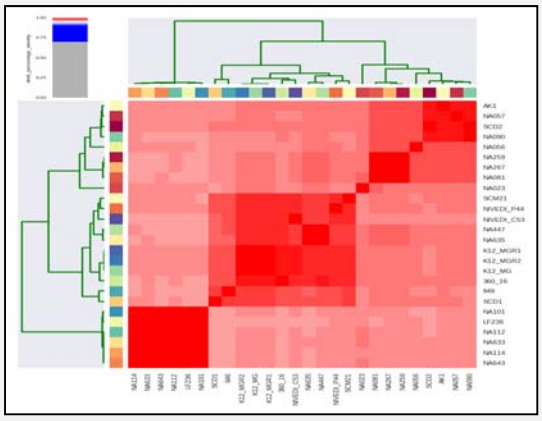
Pasteurella multocida strain 375-A/15, isolated from a cattle calf died with lesions of fibrinous pleuritis and pneumonia, and strain DP1, a very virulent strain isolated from ducks from Kerala, were subjected to whole genome sequence analysis. The genome of strain 375-A/15 consisted of 1,372 coding sequences, 2 ncRNAs, and 21 tRNAs with two CRISPR arrays and the genome of strain DP1 consisted of 1,175 coding sequences, 1 ncRNAs, 24 tRNAs with single CRISPR array. The genome sequences of *P. multocida* strain 375-A/15 and strain DP1 have been deposited in the GenBank database under accession numbers CP023305 and CP023304, respectively.

Whole genome sequencing of *E. coli* isolates

Whole genome sequencing of two *E. coli* strains, designated 360/16 and 646, isolated from fecal samples of neonatal calves was carried out. The genome of *E. coli* strain 360/16 consisted of 4,649 coding sequences, 7 ncRNAs, and 61 tRNAs with two CRISPR arrays and the genome of *E. coli* strain 646 consisted of 4,901 coding sequences, 10 ncRNAs, and 58 tRNAs with two CRISPR arrays. The genome sequences of *E. coli* strains 360/16 and 646 have been deposited in the GenBank database under accession numbers CP023201 and CP023200, respectively.



Phylogenetic inference of rotavirus-D based on nucleotide sequence of VP6 and NSP4 gene



Average nucleotide identity (ANI) based heat map of *E. coli* strains

Comparative genomics of *E. coli* isolates (646 and 360/16) were performed with other Indian *E. coli* genomes (n = 26) available in NCBI genome database. Average nucleotide identity (ANI) analysis revealed that strain 646 and strain 360/16 were part of a loose group consisting of 11 other *E. coli* genomes, though there were differences in nucleotide content among these two strains. It also revealed three large groups among all *E. coli* genomes evident in the heat map. Using a combination of existing available databases and custom database created for AMR genes from NCBI, the genomes of two *E. coli* strains (646 and 360/16) contained 50 and 47 AMR genes (non-duplicate), respectively.

Mosquito vectors of Flavivirus screened for viral species by NGS

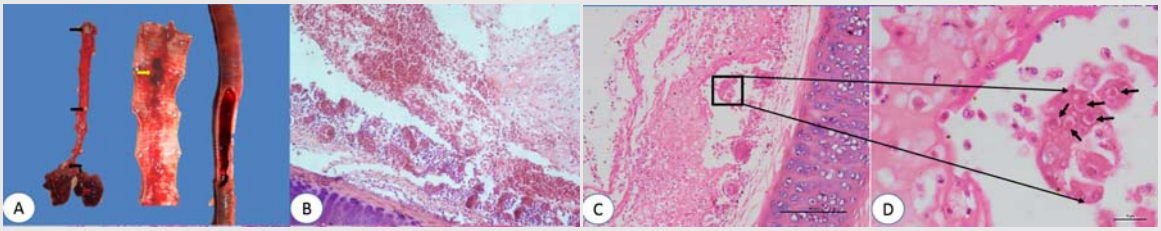
Out of 20 mosquitoes pools tested by real time RT –PCR, 6 were found positive for JEV. The NGS data analysis of mosquitoes samples collected from swine farm and other livestock farms of IVRI, revealed presence of Nege virus, Biggie virus, Dianke virus, Merida virus, Shuange Chryso like virus, Culex rhabdo virus, *Wuchereria bancrofti* and Malaria parasite etc.

Campylobacter in poultry meat and their genotypic characterization

The current study revealed a cultural isolation of 51 (11.64%) *Campylobacter* isolates from a total of 438 samples from different sources and *C. coli* was the predominant species isolated (31/51). A total of 111 *Campylobacter* isolates from different sources were evaluated for their biofilm forming ability using microtiter plate assay. All the isolates were genotyped by *fla*A typing and ERIC-PCR. The ERIC-PCR assay generated a total of 10 genotypes and showed a good discriminatory power (D value) of a 0.88-0.90. *Fla*A typing generated 6 genotypes with a D value of 0.76-0.79. Dendrogram analysis showed that human isolates were clustered with animal origin isolates (chicken, quail and poultry skin) irrespective of origin of the isolates (Bareilly and Pantnagar) showing a genetic similarity between them. The activity of disinfectants at various time intervals (1/2/5 min) had no significant difference on weak/moderate biofilm formers. The time interval of activity was statistically significant with respect to strong biofilm formers, with best activity observed at 5 min. Phenol, sodium hypochlorite and benzalkonium chloride showed a similar activity with best action on biofilm. However, potassium permanganate, ethanol, propanol, iodine and hydrogen peroxide showed poor action on biofilms. The best lytic activity on biofilms was showed by phenol at 10% concentration and 5 min contact time.

Viral respiratory diseases of poultry

A total of 600 respiratory tract tissues with gross pathological lesions were screened for NDV, LP-AIV, ILT, IBV, FAdV and Fowlpox virus. Eighty four samples were positive for NDV, 23 for IBV, 6 for AIV-A, 8 for FAV and 12 for ILTV genome. Histopathological lesions in respiratory tract caused by NDV, IBV, ILT and AIV were analyzed and interpreted. Multiplex PCR to screen these viral pathogens was standardized, and is being routinely used. Viral antigens in tissue sections were demonstrated for NDV, IBV and FAdV by IHC. Three isolates of NDV, 4 isolates of IBV and 3 isolates of ILTV from tissues were isolated. Phylogenetic analysis of NDV isolates revealed involvement of 3 different genotypes (VI,VII,XIII). For IB isolates the phylogenetic analysis revealed involvement of Mass strain and nephropathogenic strain. For ILTV, it was observed that its sequence was closely related to CH04 isolate of Switzerland and AIV closely related to H9N2.



A) Caseous plug in larynx and trachea (black arrows); hemorrhagic exudate in trachea; B) Severe hemorrhagic exudate in the tracheal lumen; C) Presence of heterophils, syncytia formation (arrow) in the tracheal lumen; D) Syncytia formation with intranuclear eosinophilic inclusion bodies (arrows)

Epidemio-surveillance of piglet diarrhea in organized farms

Data collected through questionnaire survey was used to identify risk factors, in which weaning status, season, altitude, ventilation in the shed, use of heater/cooler for temperature control in the sheds, feed type, water source, use of disinfectant, altitude of the farm location were the potential risk factors. The logistic regression prediction model revealed weaning and source of water among the significant risk factors. The piglet diarrhoea prevalence was almost similar across the regions.

Antimicrobial drug resistance in bacteria of veterinary clinical importance

Carvacrol resistant and Cinnamaldehyde resistant *Pseudomonas aeruginosa* was analyzed using Transposon mutagenesis followed by whole genome sequencing (WGS) to identify the putative genes responsible for two herbal antimicrobials. Two genes in *P. aeruginosa, mex*A (encoding a multi drug efflux fusion protein, which is part of MexAB-OprM operon in *P. aeruginosa*) gene in one carvacrol sensitive mutant, while, *oxy*R (stress induced protein) and *rec*G (DNA helicase) genes in another carvacrol sensitive mutant were identified as inactivated through transposon mutagenesis. The study concluded that the genetic mechanism of carvacrol resistance is mediated by *mex*A gene, which is possibly regulated by *rec*G in *P. aeruginosa*. The mutant strains which turned carvacrol sensitive also lost their resistance to cinnamaldehyde, indicating generalized nature of the herbal resistance system in *P. aeruginosa*, common for efflux mediated drug resistanc.

Transposon mutagenesis on an *E. coli* strain showing synergy between antibiotics and cinnamaledhyde followed by WGS led to identification of a gene, which has not yet been assigned any role in *E. coli*.

Molecular epidemiological studies, complementation studies and targeted cloning and expression of the identified genes can be next step to confirm these genes in herbal drug resistance and herbal and conventional antimicrobial drug resistance.

Out of 824 bacteria isolated from clinical samples, 145 (17.6%) were resistant to one or more carbapenem drugs. Out of 145, only 19 (13.1%) produced metallo-β-lactamases indicating that resistance to carbapenem drugs due to non-metallo-β-lactamase pathway(s) is more common in bacteria than metallo-β-lactamase pathways. In the study on 19 phenotypically metallo-β-lactamase (MBL) positive bacteria (one isolate each of *Acinetobacter lwoffii, Aeromonas salmonicida, Alcaligenes denitrificans, Serratia plymuthica, Pseudomonas aeruginosa, Budvicia aquatic, Staph. epidermidis* and *Staph. xylosus*, two isolates each of *E. fergusonii* and *K. pneumoniae* and 7 of *E. coli*), only five (~26%) strains (3 *E. coli* and one each of *Staph. xylosus* and *Budvicia aquatica*) were found positive for New Delhi metallo-β-lactamase(NDM) with PCR indicating either presence of other MBL genes or variation in NDM genes at the primer site.

Meta-analysis on *Peste des Petits Ruminants* in small ruminants in India

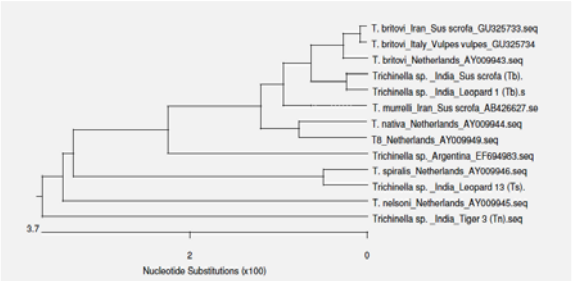
Consortium for e-Resources in Agriculture, India, Google Scholar, PubMed, annual reports of PD-ADMAS/NIVEDI, All India Animal Disease database of NIVEDI (NADRES), IVRI, DADF were used for searching and retrieval of PPR prevalence data (seroprevalence, virus antigen, and virus nucleic acid detection), mortality in India using a search strategy combining keywords and related database-specific subject terms from January, 1997 to December, 2017 in english. From more than 50 research papers/articles information like authors, study year, animal affected/test positive, test used, animal died etc. were retrieved and compiled in excel sheet for further processing.

Geospatial and meta-analysis on bluetongue in small ruminants

Systematic research was performed on the literature about bluetongue in India. The retrieval dates were limited to the period from 2000 to August 2017 and the retrieval language was limited to English. The databases included were PubMed, Springer, Elsevier, indianjournals.com, Consortium of e-Resources in Agriculture (CeRA) under Indian Council of Agricultural Research, conference, seminar and symposium abstracts, etc. More than 75 articles were searched and classified according to prevalence study, diagnosis etc. Three reviewers independently extracted the characteristics of each included study onto Excel forms. These included publication year, authors, study participant eligibility criteria, study period, numbers of animals positive, the total number of animals tested and the test used etc.

Molecular characterization of *Trichinella* sp. circulating in India

In order to characterize the different isolates of *Trichinella* sp. circulating in Indian wild animals (wild boar, leopard and tiger), 5S ribosomal DNA intergenic spacer region (5SISR) of 4 different isolates (wild boar 1, leopard 1 &13, tiger 3) were PCR amplified and sequenced. Sequences of two isolates (wild boar 1 & leopard 1) showed more than 98% sequence homology with published sequences of *T. britovi* (Acc. No. GU325733-Iran,



Phylogenetic analysis of *Trichinella* sp. isolates circulating in India

AY009943-Netherlands) and one isolate (Leopard 13) showed 98% homology with *T. spiralis* (Acc. No. AY009946). However, one isolate (Tiger 3) showed more than 94% homology with *T. nelsoni* published sequence (Acc. No. AY009945). In phylogenetic analysis, all the four isolates clustered with these 3 respective species. This is the first molecular evidence on circulation of *T. britovi*, *T. spiralis* and *T. nelsoni* or *T. nelsoni* like genotype in India.

Characterization of acaricide resistant ticks

Ivermectin resistance in field tick isolates was studied. The country specific discriminating concentration (DC) of Ivermectin was determined (DC = 2 x LC_{95}) as 93.54 ppm. The DC was validated in 07 tick isolates of *R. microplus* collected from Ludhiana, Lucknow, Kanpur, Amroha, Saharsa, Fatehgarh Sahib and Mathura districts. On the basis of RR_{50} values, level I resistance was detected in 6 isolates (Lucknow, Kanpur, Amroha, Saharsa, Mathura) showing RR_{50} of 1.56 – 4.69 whereas level II was detected in Fatehgarh isolate (RR_{50} 8.25).

Field isolates collected from Lucknow, Kanpur, Moradabad, Amroha of Uttar Pradesh and Rewa, Udyanagar, Mhow, Dewas of Madhya Pradesh were characterized using laboratory standardized assay. The isolates collected from Uttar Pradesh were resistant to deltamethrin, cypermethrin and diazinon with Resistance Factor (RF) of 4.48-18.05, 2.9-15.9 and 3.5-15.07, respectively, while they were susceptible to coumaphos and fipronil. Elevated β-esterase enzyme activity in terms of ratio of 6.181, 7.317, and 7.791 ($p < 0.05$) was observed in Kanpur, Lucknow, and Muradabad isolates. Similarly, GST activity from 1.811 – 4.920 folds higher in comparison to susceptible line was observed in the SP-resistant isolates. In case of isolates collected MP, a level II resistance (RF = 7.04 to 24.02) to synthetic pyrethroids, level II resistance to one of organophosphate compounds, coumaphos (RF= 8.52-13.2), low level of resistance to ivermectin (RF = 1.53 to 3.02) and no resistance to fipronil was recorded.

Assess the resistant status in ticks of NEH region, isolates of *Rhipicephalus microplus* were collected from Barpeta, Kamrup Metropolitan, Morigaon, Sonitpur and Nagaon districts of Assam state. The resistance to OP and SP compounds was assessed. It was observed that the cattle ticks are mostly susceptible to level I resistant to both SP and OP compounds except the isolates collected from Morigaon and Barpeta districts where resistance to deltamethrin has reached to level II to III.

A reference multi-acaricide resistant tick strain was characterized and established. Lethal Concentration (LC) 50 values for deltamethrin, cypermethrin, fenvalerate and diazinon against the laboratory selected resistant tick (LSRT) strain were determined as 306.7 ppm, 2776.9 ppm, 30262.1 ppm and 9458.7 ppm, respectively. Relative to the susceptible IVRI-I tick strain, the LSRT strain showed 4.78- and 5.84-fold increases in activity of esterases, a 6-fold increase for monooxygenases and a 2.24 fold increase for glutathione S-transferase. In the acetylcholinesterase 2 gene, 22 single nucleotide polymorphisms (SNPs) were identified in the LSRT strain. Four of these SNPs lead to amino acid substitutions and were consistently found in resistant field populations in India. A C190A mutation in the domain II S4-5 linker region of sodium channel gene resulting in a L64I amino acid substitution was recorded in the LSRT strain. Monitorable indicators for the maintenance of the strain, designated as the reference IVRI-V tick strain and representing the first established multi-acaricide resistant tick strain in India, were identified.

Analysis of nucleotide substitution in AChE2 gene

Sl. No.	SNP	Amino acid position	Line-I	LSRT
1.	T35C	12	V (val)	A (ala)
2	T107C	36	V (val)	A (ala)
3	C238A	80	Q (gln)	K (lys)
4	G783T	261	K (lys)	N (asn)
5	G889A	297	V (val)	I (ile)
6	A896C	299	D (asp)	A (ala)
7	G908C	303	R (arg)	T (thr)
8	T1090A	364	S (ser)	T (thr)
9	T1224G	408	D (asp)	E (glu)
10	C1234T	412	H (his)	Y (tyr)
11	G1403A	468	R (arg)	K (lys)

Synonymous SNPs: C30G, G138A, G240A, A252G, G255A, T264C, T714C, A831G, T1014C, T1173C, T1245C.

3.4
Host-Pathogen Interaction and Immunobiology

Comparative analysis of host responses to foot and mouth disease virus infection in indigenous and crossbred cattle

Comparative transcriptome analysis of Malnad Gidda, Hallikar cattle breeds and HF crossbred cattle following FMDV infection was conducted. Male calves of the three breeds, aged 6-9 months, weighing approximately 150 kg were screened by VNT and NSP ELISA. They were confirmed to have virus neutralization titre of ≤ 8, and negative for non-structural protein antibodies. The animals were infected with 10^4 BID_{50} FMDV serotype O/IND/R2/75 by sub-epidermo-lingual injection, in a BSL-3 animal facility. Clinical signs and rectal temperatures were recorded over 7 days period. Serum samples from the infected animals were aseptically collected at regular time intervals to assess virus load. There was no significant difference in the disease progression and appearance of clinical signs among the cattle breeds studied.

Further, using cell culture infection, it was demonstrated that endoplasmic stress induced autophagy plays an important role during the replication of FMDV. It was also shown that inhibition of autophagy restricts FMDV replication in the cell culture.

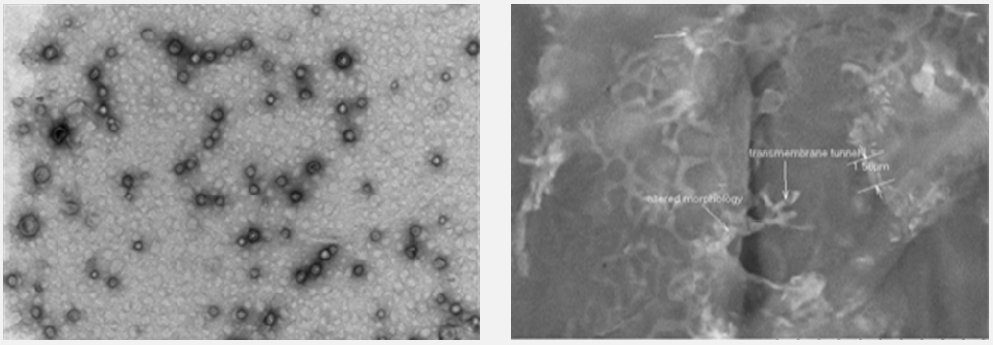
In vitro dendritic cell responses to inactivated FMD virus antigen co-stimulated with *P. multocida* outer membrane vesicles (OMV)

Outer membrane vesicles (OMV) are the vesicles released into the medium from the outer membrane of Gram-negative organisms as they grow. Immunogenic potential of OMV has effectively been studied and they are being researched upon to be developed as efficient vaccine candidates for same organism or adjuvants for inactivated antigens. OMV's of *Pasteurella multocida* were prepared and characterized. OMVs were isolated from the culture media using ultracentrifugation and characterized by TEM, SDS-PAGE and dynamic light scattering (DLS). The purified OMVs have an average diameter of 100 nm. The stability of the preparation was also characterized by DLS and found to have a zeta potential of -11 mV and on SDS-PAGE, they showed a band of 27 kDa. OMV's will be utilized as potent immune-enhancing agents.

Bacterial ghosts (BG) are empty cell envelopes derived from Gram-negative bacteria. They contain many innate immunostimulatory agonists, and are potent activators of a broad range cell types involved in innate and adaptive immunity. BGs were prepared chemically by NaOH method to study the effect of *P. multocida* ghosts on the immunogenicity of inactivated FMDV antigen in an *in vitro* bovine dendritic (DC) cell cultures model.

Immunomodulatory effect of nano-emulsion incorporated with inactivated FMDV on bovine dendritic cells

For generation of immune response to FMD, it is important that antigen interacts with antigen presenting cells. So, different stimulating agent (LPS, Nanoemulsion, FMD virus) were used to study different surface markers expressed on dendritic cells (DCs) to investigate the effect of



A B

Transmission electron micrograph of negatively stained outer membrane vesicles (OMVs) of Pm magnified (x20000) having less than 200 nm size (A); Transmission electron micrograph showing morphological changes and transmembrane tunnels of negatively stained *Pasteurella multocida* bacterial ghosts, size 1.5 µm. x9000 (B)

various activation signals on ability of DC to express maturation co-stimulatory molecules CD80, CD86, CD40, to produce immunomodulatory effect on bovine MoDCs. This study was a target to generate dendritic cells from monocytes, and compare surface marker expression between immature and mature DCs. The result showed that generating monocyte-derived dendritic cells required 5-6 days to complete differentiation of monocyte with a typical DC morphological character. Monocytes were characterized by higher expression of CD14 molecules. Stimulation of immature MoDCs with LPS increases expression of cell surface markers, including, CD40, CD86 and CD80, whereas expression of CD14 molecule was downregulated. FMDV antigen along with nanoemulsion stimulated MoDCs showed up-regulation of CD80 and CD86 molecules as compared to FMDV antigen alone stimulated cells.

Dysregulated miRNAome and proteome of PPRV infected PBMCs revealed a coordinated immune response

In this study, the miRNAome and proteome of virulent *Peste des Petits Ruminants* virus (PPRV) infected goat peripheral blood mononuclear cells (PBMCs) were analyzed. The identified differentially expressed miRNAs (DEmiRNAs) were found to govern genes that modulate immune response based on the proteome data. Top ten significantly enriched immune response processes were found to be governed by 98 genes. Top ten DEmiRNAs governing these 98 genes were identified based on number of genes governed by them. Out of these 10 DEmiRs, 7 were upregulated and 3 were downregulated. These include mir-664, mir-2311, mir-2897, mir-484, mir-2440, mir-3533, mir-574, mir-210, mir-21-5p and mir-30. miR-664 and miR-484 with proviral and antiviral activities, respectively, were upregulated in PPRV infected PBMCs. miR-210 that inhibits apoptosis was downregulated. miR-21-5p that decreases sensitivity of cells to the antiviral activity of IFNs, and miR-30b that inhibits antigen processing and presentation by primary macrophages, were downregulated, indicative of a strong host response to PPRV infection. miR-21-5p was found to be inhibited on IPA upstream regulatory analysis of RNA-Sequencing data. This miR was down regulated and found to govern 16 immune response genes in the proteome data was selected for functional validation *vis-a-vis* TGFBR2 (TGF-beta receptor type-2). TGFBR2, that regulates cell differentiation and involved in several immune response pathways, was found to be governed by most of the identified immune modulating DEmiRNAs. The decreased luciferase activity indicated specific binding of miR-21-5p to its target, thus establishing specific binding of the miRNAs to their targets. This is the first report on miRNAome and proteome of virulent PPRV infected goat PBMCs.

Understanding the pathogenetic mechanism of *Peste des Petits Ruminants* virus

One tissue sample from Patna was confirmed for PPRV and whole genome of the outbreak strain was sequenced. The phylogenetic analysis revealed that this strain belongs to lineage IV and is closely related to other strains reported from India.

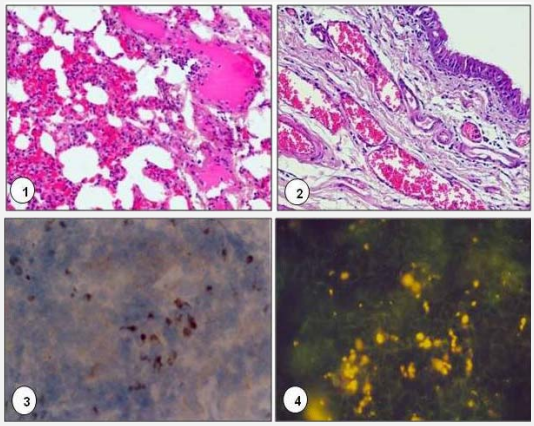
In order to decipher the role of individual viral proteins in attenuation/virulence of PPR vaccine and challenge viruses, the genes encoding PPRV N, P, C & V proteins of vaccine and challenge viruses were amplified and expression cassettes harboring individual genes were constructed and verified for their functionality.

Elucidation of interaction between non-structural proteins of bluetongue virus with mammalian host and vector cells

A study was undertaken with the objective to study protein-protein interactions between NS3 and NS4 proteins of bluetongue virus (BTV) with vertebrate and invertebrate host proteins. BHK-21 and KC cell lines were revived and maintained for isolation of highly integrated RNAs to construct Yeast two hybrid (Y2H) compatible cDNA libraries to serve as the prey for mating and interaction analysis. The integrity of the extracted RNAs was assessed by agarose gel electrophoresis. BTV-10 and BTV-1 serotypes were freshened in both BHK-21 and KC cells. NS3 and NS4 region of BTV were successfully amplified to generate bait constructs.

Pathological studies on bluetongue in sheep infected with BTV serotype 2

Pathogenesis of bluetongue virus serotype 2 was studied in sheep using intradermal route. Moderate buccal lesions, conjunctival congestion, facial edema, swelling of nasal lips giving monkey face appearance and nasal discharge were detected on 4^{th} day onwards of infection. The pathological lesions were more prominent during 7^{th}-14^{th} DPI. Lungs were often swollen with emphysematous changes and were congested. Lungs showed thickening of interalveolar septa, presence of serosanguineous fluid in alveolar lumen, congestion and haemorrhages with focal infiltration of MNCs. Tracheal mucosa was found congested whereas sub-mucosa showed focal haemorrhages and MNCs infiltration. Tongue dermis and musculature showed infiltration of MNCs. Besides hyalinization in musculature, multiple areas of haemorrhages and congestion were also revealed in tongue musculature. Spleen tissues section showed



(1) Hemorrhages, thickening of inter-alveolar septa, infiltration of MNCs and accumulation of sero-sanguineous fluid in alveoli. H&E X 200. (2) Congestion and infiltration of MNCs in tracheal sub mucosa. H&E X 200. (3) Immunohistochemical demonstration of BTV antigen in lymph node sections. IHCx200. (4) Immunofluorescence demonstration of BTV antigen in lymph node sections. IHCx200

congestion of red pulp and depletion of lymphoid cells. In lymph nodes, dendritic cell hyperactivity in medullary sinuses was observed. Blood samples showed lower TLC, PCV, Hb and TPC values. Serum samples showed increased ALT, AST, AP and CK values from 3 to 21 DPI. Kinetic study of CD4+ and CD8+ subsets of lymphocyte revealed that the percentage of CD4 cells was found to be static up to 3 DPI in animals of GrID and then was decreased from 7 to 21 DPI. CD8 count was on increasing trend from 1 DPI (10.97%) to 3 DPI (12.51%). On 7 DPI (6.55%) values were significantly decreased. The values were significantly high again at day 11 (13.62%) and day 14 (13.83%). At 21 DPI, the values regained the normal level (10.43%).

Pathological studies on bluetongue in sheep infected with BTV serotypes 10 and 24

Twenty adult sheep of either sex, aged between 2-3 years, tested negative for BTV antibodies, were used to study the pathogenesis of BTV-10 and BTV-24. Animals were inoculated intradermally with either both serotypes separately or together (co-infection) along with suitable control. The clinical course of disease was mild and of short duration in BTV-10 infected animals. The severity of clinical signs was more in BTV-24 infected and co-infected groups. Serous to purulent nasal discharge was observed with conjunctivitis and cyanosis of tongue. BTV-24 alone and BTV-10 co infected animals showed significant increase in temperature at 2 and 7 DPI.

BTV infected animals showed enlarged and oedematous lymph nodes, along with hydropericardium and pulmonary hemorrhage on 11 and 16 DPI. Pinpoint hemorrhages over the thymus were the consistent lesions. In BTV-10+BTV-24 infected animals, pulmonary hemorrhage was observed along with pleural and pericardial effusion. Lungs showed presence of serosanguineous fluid in alveolar spaces, thickening of interalveolar septa, congestion and haemorrhages with focal infiltration of MNCs. Congestion, haemorrhages with focal infiltration of mononuclear cells in dermis and hyalinization in musculature observed in tongue. Spleen tissues section showed congestion of red pulp and depletion of lymphoid cells. Lymph nodes showed depletion of lymphoid cell at initial period and dendritic cell hyperactivity at later stages. The pathological lesions were more prominent during 7th to 14th DPI. The blood count values (Hb, PCV, RBC and WBC) were low in BTV-24 infected and co infected groups at 3 to 7 DPI. However, AST, ALT and ALP showed high values in co infected group at 3 to 7 DPI.

Highest viral load was observed in the thymus of BTV-10 infected sheep sacrificed at 16 DPI (Cq-30.11), followed by prescapular lymph node (Cq-30.99). At 4 DPI, skin (Cq-31.04), trapezius muscle (Cq-31.79) and lungs (Cq-32.96) showed maximum viral load. At 7 DPI, lungs (Cq-31.94), skin (Cq-32.29) and tongue (Cq-32.37) showed maximum viral RNA. At 11 DPI, heart (Cq-31.54), thymus (Cq-32.35) and pulmonary artery (Cq-32.69) showed maximum viral load. At 16 DPI, maximum viral RNA was observed in tonsils (Cq-30.11), PSLN (Cq-30.99) and heart (Cq-32.23). BTV-24 infected animals showed highest viral load in the bone marrow at 7 DPI, followed by tongue at 11 DPI. At 4 DPI, skin, trapezius muscle and tongue recorded maximum viral RNA, Cq of 32.42, 32.6 and 32.64 respectively. At 7 DPI, bone marrow showed maximum viral load with Cq of 26.39 followed by skin and heart (33.19 and 34.03, respectively). At 11 DPI, tongue (Cq-30), heart (Cq-31.82) and skin (Cq-33.2) recorded maximum viral load. Viral load at 16 DPI in BTV-24 infected sheep showed same trend as BTV-10 with highest viral load in tonsil (Cq-31.86), followed by prescapular lymph node (Cq-32.24) and pulmonary artery (Cq-32.72). Maximum viral load in coinfected group was observed at 7 DPI followed by 11 DPI. At 7 DPI, pulmonary artery recorded a Cq of 27.11 followed by prescapular lymph nodes (Cq- 29.6) and trapezius muscle (Cq-29.64). At 11 DPI, heart showed maximum Cq of 29.17 followed by trapezius muscle (Cq-29.65) and tongue (Cq-30.09).

The cytokine study showed high expression of IL2 and IFN G in BTV-24 infected and BTV-10 co-infected group at 1dpi whereas TNFα expression was high in these groups at 7 DPI and IFN a at 4 DPI.

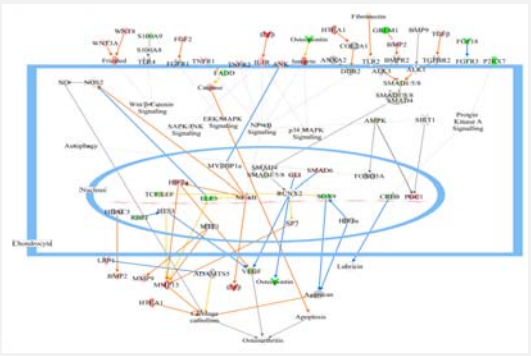
Pathogenesis of Japanese encephalitis in mouse model

Pathogenesis of swine origin JEV was studied in mouse model by intraocular route. In this study, two weeks old 10 mice were inoculated with 5 µl of Vero cell cultured swine origin JEV having titer of 10^7 TCID50/ml by conjuctival route. The typical clinical signs were observed at 4 dpi and all mice died on 5-6 dpi. Histopathologically, meningitis, neuronal necrosis, gliosis, hemorrhage, perivascular mononuclear cell infiltration were observed in the cerebrum, hippocampus and brainstem areas, and in retina haemorrhage was observed. Immunohistochemically, JEV antigen was demonstrated in the cytoplasm of bipolar and ganglion cells of eye and neurons of brain. The expression profile of cytokines (TNF-α, MCP-1, INF-γ, IL-10) of mice inoculated with JEV by intra peritoneal route was studied by Real time RT-PCR. These cytokines in spleen were found to be increased from 1st to 3rd DPI, peaked on 5th day, and then started decreasing after 7th day onwards. The expression of IL-10 was found to be more significantly increased as compared to other cytokines in the spleen.

LD50 was determined for the swine origin JEV by inoculating 10 fold dilution to 26 two-weeks -old Swiss albino mice (4 in each six groups and 2 in control group) intra peritoneally and observed for 14 days. All mice in neat, 10^{-1} and 10^{-2} showed clinical signs and died by 6th dpi. LD50 was calculated to be $10^{2.5}$ /0.1ml. To know the sterility of inactivated JEV and inactivated JEV with seppic montanide 50V 2, it was inoculated to Soyabean Casein Digest agar and no growth was observed.

In vitro study on role of σB protein in avian reovirus pathogenesis

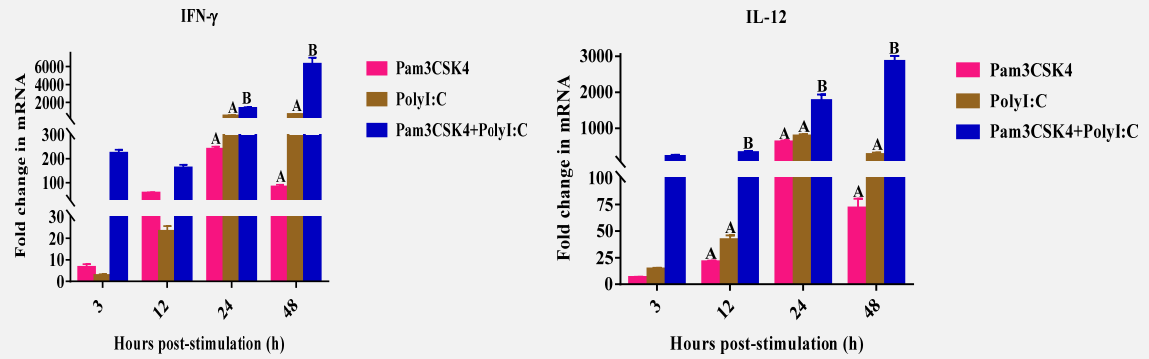
Avian Reoviruses, members of *Orthoreovirus* genus are known to cause diseases like tenosynovitis, runting-stunting syndrome in chickens. To establish the role of σB protein in osteoarthritis, an *in vitro* microarray study was conducted consisting four groups *viz.,* virus infected and control; pDs-Red-σB and empty pDs-Red transfected, CEF cells. With cut-off value as FC>2, p value <0.05, 6709 and 4026 numbers of DEGs in virus and σB, respectively were identified. The Ingenuity Pathway Analysis gave an idea about the involvement of σB protein in "osteoarthritis pathway", which was activated with z-score with 3.151. The pathway "Role of IL-17A in arthritis pathway" was also enriched with –log (p-value) 1.64. Among total 122 genes involved in osteoarthritis pathway, 28 up regulated and 11 down regulated DEGs were common to both virus and σB treated cells. Moreover, 14 up regulated and 7 down regulated were unique in σB transfected cells. Using qRT-PCR for IL-1B, BMP2, SMAD1 and SPP1 genes, the microarray data was validated. It was concluded that during ARV infection, σB protein partially leads to molecular alteration of various genes of host orchestrating the different molecular pattern in joint of host leading to tenosynovitis syndrome.



Pathway containing the differentially expressed genes related to ARV infected cells showing their relation and role in osteoarthritis activation

Exploration of Toll-like receptor agonist(s) as adjuvant and prophylactic agents in chicken

The interaction of TLR2 and TLR3 was studied using their cognate ligands Pam3CSK4 and poly I:C, respectively in the chicken peripheral blood mononuclear cells (PBMCs). The combination of Pam3CSK4 and poly I:C synergistically up-regulated the expression of IFN-β, IFN-γ, IL-12, IL-4 and IL-13 transcripts and cross-inhibited IL-1β, IL-10 and iNOS transcripts as well as NO production. Further, the immunomodulatory effect of Pam3CSK4 and/or poly I:C on live intermediate plus infectious bursal disease virus (IBDV) vaccine induced immunosuppression was evaluated in chickens. Four weeks old SPF White Leghorn chickens (n = 60) were randomly divided into six groups; immunized with live intermediate plus IBDV vaccine with or without Pam3CSK4 and/or poly I:C along with an unvaccinated control group. The IBDV vaccine induced deleterious effects were assessed by various parameters. The results indicated that poly I:C and its combination with Pam3CSK4 alleviated the vaccine induced immunosuppression as evidenced by higher weight gain, increase in overall antibody responses against both sheep erythrocytes and live infectious bronchitis virus (IBV) vaccine, up-regulation of IFN-γ transcripts and NO production by the PBMCs ($P<0.05$) and an apparently normal bursal morphology with lower bursal lesion score in the experimental birds. In conclusion, poly I:C *per se* and its combination with Pam3CSK4 restored the function of B cells, T cells and macrophages and reduced the bursal damage when used with live intermediate plus IBDV vaccine.



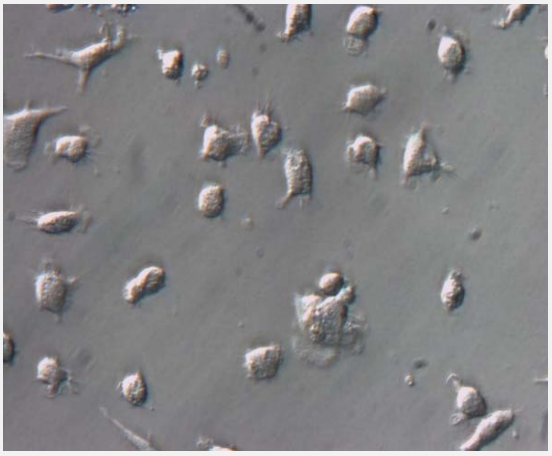
Relative expression of immune response gene transcripts in chicken peripheral blood mononuclear cells (PBMCs) stimulated with Pam3CSK4 (10 µg/mL) and/or poly I:C (50 µg/mL) over a period of 48 h. Two-way Anova was done to find the effect of treatment and time (n = 6/treatment). Tukey served as *post-hoc* test. Multiplicity adjusted P value was calculated to minimize the alpha error ($P < 0.05$). Bars with different superscript indicate significant effect of TLR agonist(s) at a time point.

Modulation of *Staphylococcus aureus* infection by vitronectin

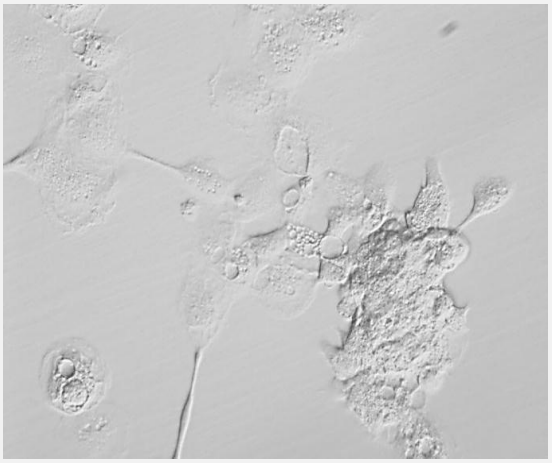
Vitronectin (Vn), a blood and extracellular matrix protein, is a regulator of membrane attack complex (MAC) formed by the association of complement proteins. MAC causes cytolysis including those of pathogens. C9, a component of MAC, interacts with Vn, but the details of this interaction are limited. Using goat homologous system, we have reported that the second RGD motif of Vn was involved in C9 binding. This interaction may hamper complement activity leading to bacterial growth. In order to understand why the first RGD did not interact with the C9, smaller recombinant fragments of Vn having RGD1 or RGD2 were generated and their binding to C9 was tested. None of these fragments reacted with C9 complement suggesting involvement of Vn sequences other than the RGD motifs. The RGD motif appears to have surface deposition as the fragments supported attachment of epithelial cells; the cell binding to these fragments was inhibited by the RGD peptide. Attempts are being made to generate Vn proteins having additional attachment of sequences to these fragments to map the precise C9 binding site.

Relevance of macrophage polarization towards M1 & M2 during pathogen interaction

Monocyte population is dynamic during infection and tissue remodeling situation. In the present study, the objective was to explore the role of M1 and M2 macrophage for intracellular pathogen removal or survival. The blood monocyte derived macrophage under the influence of recombinant GMCSF and rIFNγ has led to macrophage phenotype, whereas in presence of rIL-4, it appeared to be of dendritic morphology. Nonspecific esterase staining of these phenotypes has confirmed its macrophage lineage. The relative concentration of ornithine decarboxylase enzyme is of higher value in M1 phase is supportive finding for M1 phenotype. Subsequently, the pathogen killing ability towards mutant *Salmonella* has revealed M1 being superior to destroy the invaded pathogen than M2 evidenced due to low CFU released from invaded M1 macrophage. The role of anti-salmonella antibody for pathogen removal has



Blood monocytes differentiating into macrophage like cells under the influence of rec-GMCSF and rIFNγ.



Blood monocytes differentiating into cells with dendritic appearance under the influence of rIL-4.

found to be of limited role. Sub agglutinating concentration of *Salmonella* specific antibody in complement free situation has favoured bacterial invasion through Fc receptor in comparison to antibody deprived situation. *In vivo* experiment is under trial, which may justify above finding. However, *in vivo* experiment encompasses several aspects of host immune system for pathogen removal than the single window exit unlike *in vitro* trial.

Identification of antibody binding site and the complement C3 binding region in *Haemonchus contortus* Glyceraldehyde-3-phosphate dehydrogenase

Glyceraldehyde-3-phosphate dehydrogenase (GAPDH) of *H. contortus* appears to be a promising target for developing new therapeutic as the parasite has developed resistance to many common anthelmintics. *H. contortus*-infected animals have antibody against the enzyme and therefore GAPDH appears as a natural immunogen. However, the enzyme degrades on storage even in the frozen state. It is, therefore, possible that a smaller fragment, with the antibody binding site (antigenic domain) may remain stable for a longer period of time.

The C3 binding site and the antigenic region of the enzyme were identified by generating short recombinant fragments and deleting a defined region of the enzyme. Using these proteins in ligand overlay and plate binding assays, C3 binding region of GAPDH was localized within the 38 residues represented by 77 to 114 amino acids, whereas the antigenic epitope was identified in between 77 to 171 amino acids. Fragment D comprising 95 residues (77 to 171), had both the above attributes and like the parent enzyme, it stimulated host peripheral blood mononuclear cells *in vitro.* This truncated GAPDH moiety was stable at refrigerated temperature for at least 12 weeks and appears as a promising new therapeutic tool considering its longer shelf life as compared to parent protein.

Innate immune response to *Eimeria tenella* infection

The role of some innate immune response components in primary and secondary infections with *Eimeria tenella* in broiler chicken was assessed. Birds were infected at 3 weeks of age with 10,000 sporulated *E. tenella* oocysts and re-infected 14 days later for secondary infection. The caecal tissues were collected at 0, 2, 6, 12, 24, 48, 72 and 96 hours post- primary and secondary infections for measuring mRNA expression of TLR's (TLR 1, 3, 5 and 15), pro-inflammatory cytokines (IL-1β, IL-6 and IL-17), antimicrobial peptide (LEAP2) and antioxidant status (SOD, CAT, MDA). Results revealed that all the TLRs were significantly upregulated in the early (12 hpi) and later (96 hpi) stages of primary *E. tenella* infection corresponding to sporozoite penetration and second generation merozoite release, respectively. In secondary *E. tenella* infection, only TLR3 was upregulated in both initial and later stages. In secondary infection, maximum upregulation of the proinflammatory cytokines was observed at 48 hpi, which is the time period when first generation shizonts appear. The antimicrobial peptide, LEAP2 was observed to have an increased expression in the later stage of secondary infection. SOD and CAT were increased in initial stage of primary and secondary infection as a response to contain the radical damage caused by sporozoite penetration. However, in later stage of primary infection, SOD was increased and CAT activity reduced, and vice versa in secondary infection. MDA level corresponded to the degree of tissue damage, with less increase in concentration in secondary infection as compared to primary infection.

3.5
Wildlife Healthcare and Management

Assessing the safety of non-steroidal anti-inflammatory drugs in vultures (*Gyps* spp.) for veterinary use in India

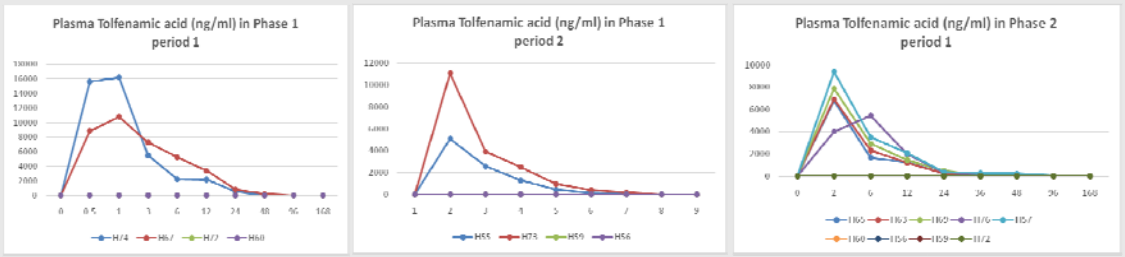
India hosts large population of raptors. Since 1990, 97% of the population of two species (*Gyps indicus* and *Gyps tenuirostris*) and 99.9% of another species (*Gyps bengalensis*) of South Asia's vultures have been lost to the toxic effect of NSAIDs, particularly the diclofenac leading to ban on veterinary use of diclofenac in India (2006). Since then population decline was checked to some extent. The NSAID safety studies on vultures carried out at Vulture Conservation and Breeding Centre (VCBC), Pinjore by ICAR-IVRI and BNHS in collaboration found that meloxicam was safe to vultures. Similar toxicity studies of ketoprofen on African white backed vulture also proved to be toxic to the vultures.

There are many other NSAIDs being used in veterinary practice have not been tested for their safety to vultures. With this context, in the present study toxicity of Paracetamol, Analgin, Nimesulide, Ibuprofen and tolfenamic acid towards vultures will be tested under the project funded by MoEF&CC. All the drugs will be tested *in vivo* on *Gyps himalayensis* and *Gyps bengalensis* in collaboration with BNHS at VCBC, Pinjore. The drugs which are safe will be recommended for veterinary use.

Safety testing of tolfenamic acid on Himalayan griffons (*Gyps himalayensis*)

The present study on safety testing of tolfenamic acid towards Himalayan Griffons is being conducted in three phases, where in phase 1 and 2 will be on Himalayan griffon and phase 3 on *Gyps bengalensis*. Until now, study was conducted on 17 birds which included nine birds treated with the drug and eight birds with sham control. The birds were captured by standard method and maintained in aviaries at VCBC, Pinjore.

Maximum level of exposure (MLE) was calculated based on the residue concentration in cattle liver tissue (1.4 mg/kg) for tolfenamic acid and ranged between 0.21-0.25 mg/kg body weight for Himalayan griffon. With the calculated MLE, nine birds were fed with tolfenamic acid orally by gavage at maximum MLE of 19.5 mg/kg and eight birds kept as sham control (benzyl alcohol). Blood samples were collected from all the birds at intervals (0, 2, 6, 12, 24, 36, 48, 96, 168 h) and sera/plasma samples were separated. Tolfenamic acid concentration was analyzed in plasma samples. Serum samples were used for analyzing biochemical parameters.



Plasma tolfenamic acid levels in Himalayan Griffons

During this preliminary study, the serum uric acid was marginally elevated between 2-6 h intervals and later returned to normal level. Similarly, other serum biochemical parameters like creatinine, AST, ALT, total protein, albumin, electrolytes remained normal during the entire period of study. The findings were also supported by the kinetics of the tolfenamic acid where in maximum metabolite concentration was found at 2 h interval with almost undetectable at 96 h.

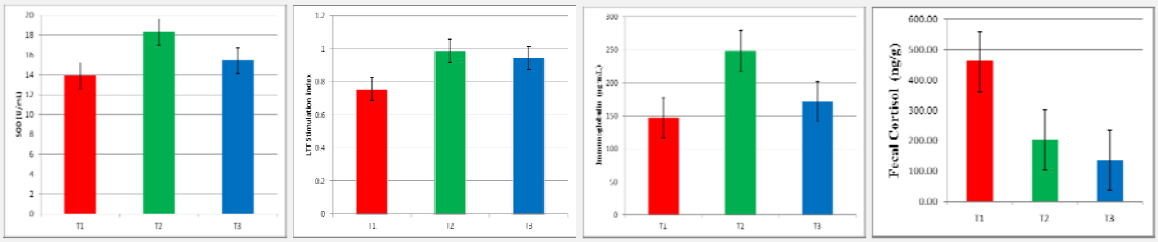
Effect of lutein supplementation on nutrient utilization and antioxidant status in captive Indian leopards (*Panthera purdus fusca*)

Experiment was conducted on nine leopards (6 Male and 3 Female, 3-10 years age, 40-55 kg body weight) which were randomly distributed in 3 groups of 3 each in Latin square design (3 treatments X 3 periods and 3 animals X 3 sequences). All the animals were fed fresh buffalo meat on bone @ 2.0-2.5 kg/d/animal for six days a week. While animals in group I were given no supplement. Diets of animals in groups II and III were supplemented 20 and 40 ppm lutein on DM basis. Meat consumption was similar among the groups. Intake of total carotenoids increased with increased level of lutein in the diet. Serum concentrations of SOD increased ($P<0.001$) with increased level of lutein in the diet. Serum concentration of Immunoglobulins and lymphocyte stimulus index was higher and fecal concentration of cortisol was lower ($P<0.01$) in leopards fed supplemental lutein. However, the response of supplementary lutein was quadratic and there may not be any benefits of supplementation of lutein at a rate higher than 20 mg/kg DM basis. Thus, it is evident that supplementation of lutein at 20 mg/kg DM improved immune status, antioxidant level and the ability of captive Indian leopards to combat stress.

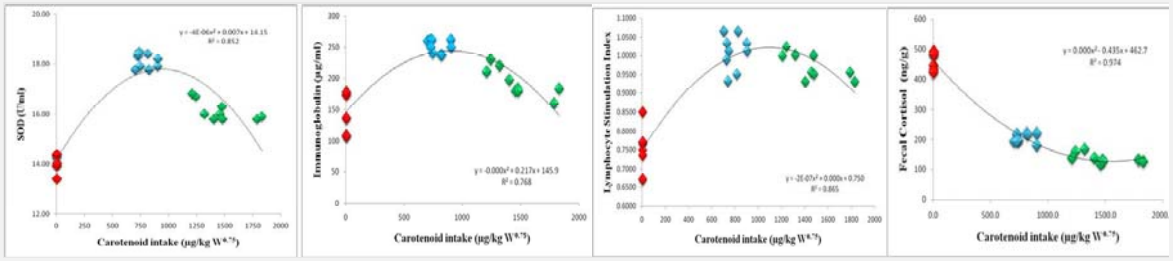
Effect of graded levels of supplementation of lutein on feed consumption and diet digestibility in captive Indian leopards

Parameter	Dietary treatments			P-value
	T_1	T_2	T_3	
Meat consumption (on DM); g/d	643±33.4	670±32.0	626±37.1	0.667
Meat consumption (on DM); g/kg $BW^{0.75}$	37.4±1.16	39.0±1.26	36.5±1.80	0.451
Carotenoids intake; mg/day	0.12^{a}±0.063	13.53^{b}±1.20	25.17^{c}±1.80	0.001
Carotenoids intake; µg/kg $BW^{0.75}$	7.11^{a}±0.22	789^{b}±25.53	1467^{c}±72.5	0.002
DM Digestibility (%)	92.0±0.25	93.3±0.30	92.9±0.51	0.069

^{a,b,c} values bearing different superscript differ significantly ($P<0.005$)



Stimulus index (Lymphocyte transformation test), serum concentration of immunoglobulin and activity of SOD in leopards



Regression of stimulus index (Lymphocyte transformation test), serum concentration of immunoglobulins and activity of SOD in leopards

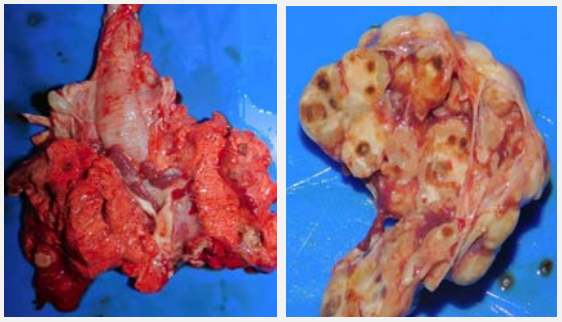
National Referral Centre on Wildlife: Healthcare and consultancy services

At the National Referral Centre on Wildlife Healthcare, consultancy services were provided to the following Zoos, National parks and other agencies:

1. MCZP, Chhatbir, Punjab for general health checkup of wild animals
2. Lion Safari, Etawah for providing treatment of lions and sloth bears
3. NZP, New Delhi for treatment of lions and tigers
4. Lucknow Zoo for health evaluation of animals
5. Bear Rescue Centre, Keetham, Agra for health examination of sloth bears
6. GB Pant High Altitude Zoo, Nainital for health evaluation of animals
7. Elephant care and conservation centre, Wildlife SOS, Mathura for treatment of elephant
8. Health evaluation of spotted deers at IFFCO, Aonla
9. Mortality among musk deers, Makhroori, Bageswar, Ministry of Ayush
10. Pelican mortality at Kokkare Belluru Bird Sanctuary, Mysuru
11. Treatment of tiger at Pilibhit Tiger Reserve, UP
12. DFO, Bareilly, Pilibhit and Baduan for treatment of wild animals

Post mortem examination of wild animals

A total of 67 carcasses were necropsied which included 36 wild ruminants (spotted and hog deer, black buck, nilgai), 9 Carnivores (tiger, leopard, and black bear), 11 Reptiles (turtles and crocodile), 9 Wild birds (vulture, peacock, saras crane and owl), 2 Primates (monkey).



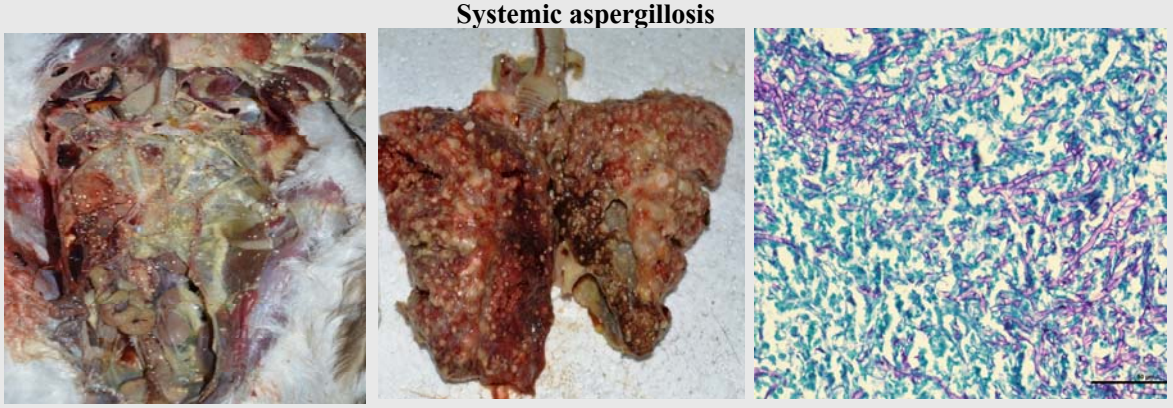
Generalized tuberculosis in Himalayan Griffon: (a) Lungs showg nodular tubercles; (b) Multiple tuberculous nodules almost replacing the spleen parenchyma

The important conditions diagnosed were systemic aspergillosis and tuberculosis in Himalayan Griffons, suppurative pneumonia in hog deer, heavy metal toxicity in monkey and crocodile, phosphine gas toxicity in monkeys and trichinella infestation in tiger and leopard.

ICAR-IVRI Scientists interacting with officers of MoEF & CC

Treatment of an elephant at Wildlife SOS, Mathura

Systemic aspergillosis



Numerous variable sized mycotic nodules (*Aspergillus fumigatus*) on the visceral organs and air sacs. Branching fungal hypae in the mycotic granuloma in Himalayan Griffon. PAS x 400.

Histopathological examinations

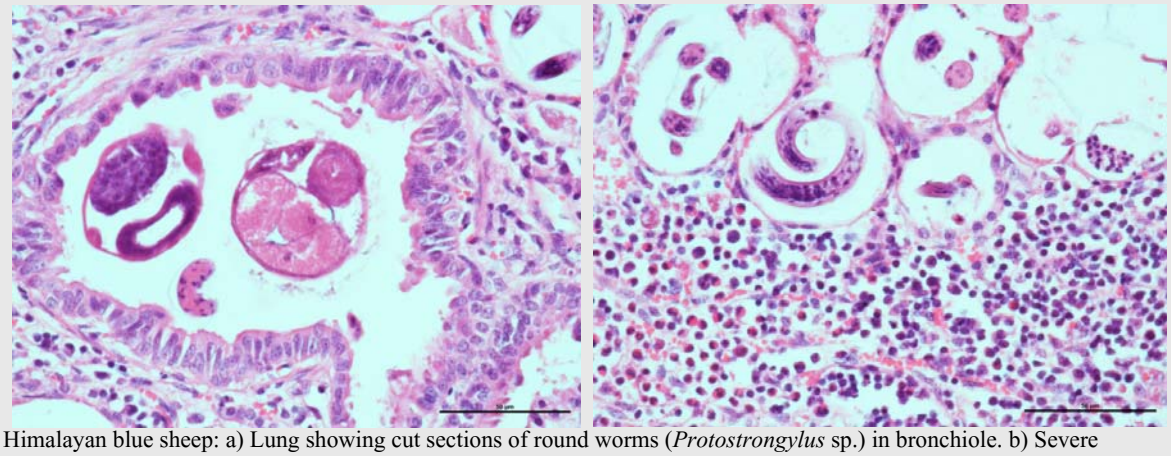
Morbid specimens from 160 cases (869 tissues) of different wild animal species received for histopathological examination included 24 wild ruminants (spotted deer -1, black buck-6, hog deer-1, nilgai-1, barking deer-2, sambar-4, thamin deer-1, musk deer-7, Himalayan blue sheep 1); 89 wild carnivores (leopard-36, tiger-20, lion-8, sloth bear-16, leopard cat-4, biturong-1, wild cat-1, wolf-1, caracal-1, civet cat-); 07 reptiles (soft shelled turtle-1, Monitor lizard-3, sand boa-2 and python-1); 27 elephants and one honey badger. Important conditions diagnosed were canine distemper in leopard, tuberculosis in sloth bear and nilgai, spotted deer and himalayan griffon; verminous pneumonia due to *Protostrongylus* sp in Himalayan blue sheep; Trichinella sp infestation in tiger and leopard; suppurative bronchopneumonia in wolf, black buck and hog deer; pyelonephritis in caracal; chronic interstitial nephritis in tiger, wild boar and black buck; mucinous cholangiocellular carcinoma in sloth bear; necrotic proventriculitis in emu; squamous cell carcinoma in biturong and biliary cystadenoma in leopard.

Bacteriological examinations

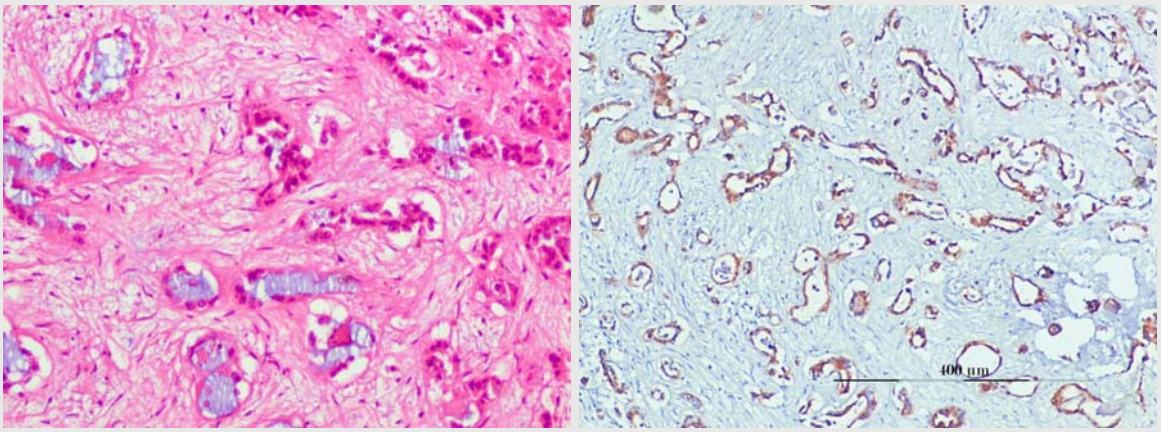
A total of 71 samples from wildlife were subjected to various bacteriological examinations. Samples from 16 animals (15 sloth bears and 1 black buck) were found positive for TB by PCR and LFA. *Mycobacterium tuberculosis* from six sloth bears and *M. avium* from one Himalayan griffon were isolated. In total, 12 samples were found positive for *Streptococcus* sp*, E. coli, Citrobacter* sp which were isolated and subjected to ABST. Suitable antibiotics were suggested for the treatment of lioness and black buck. *Aspergillus fumigatus* and *Aspergillus flavus* were isolated from Himalayan griffons with lesions of aspergillosis.

Virological investigations

A total of 273 samples (Blood, serum, nasal/ocular swabs, tissues and feces) were tested for canine distemper virus, rabies virus, rotavirus, CAV-1, FPV, BTV and PPRV. Out of 190 samples tested for CDV, only 4 samples were found positive by RT-PCR. The 27 samples tested for rabies by FAT; 29 samples for CAV-1 and FPV by PCR; and 30 samples for BTV and PPRV by RT-PCR were found negative. Out of 28 fecal samples, 7 fecal samples of sloth bears tested for rotavirus and



Himalayan blue sheep: a) Lung showing cut sections of round worms (*Protostrongylus* sp.) in bronchiole. b) Severe cellular reaction including large number of eosinophils around the parasitic larvae. HE x400



Mucinous cholangiocellular carcinoma in sloth bear: a) Liver parenchyma showing mucin containing dilated cholangioles within fibrous tissue stroma, HE, x400. b) Infiltrating neoplastic cholangioles showing positivity for cytokeratin, x200

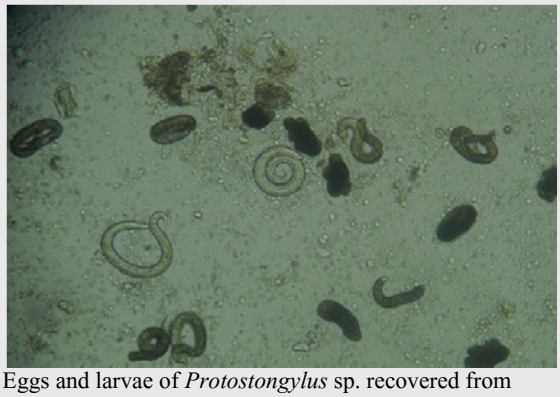
one each from sloth bear and monkey for Picobirnavirus were found positive by RT-PCR.

Serodiagnosis

Out of 92 serum samples from various wild animals subjected to MAT, 3 were found positive for leptospira antibodies. The MAT titre varied from 1: 100 to 1:400. CDV antibody titre monitored post vaccination in 66 serum samples from different zoos/safari parks. Further, six sera samples tested for brucella antibodies were found negative.

Parasitological examinations

Out of 134 samples (blood, feces, GIT contents and muscles), 45 were found positive for parasitic infection. The important parasites identified



Eggs and larvae of *Protostongylus* sp. recovered from lung of Himalayan blue sheep

included *Trichinella* sp. in 05 leopards and 05 tigers; *Trichuris* sp., *Toxocara cati*, Physolaptera sp. and *Spirometra* sp. in tiger and leopard; *Anclyostoma* sp. and *Toxocara* sp. in lion; Hydatid cyst, Murshidia sp, *Bathmostomum sangeri*, Strongyle and Amphistomes in elephants; *Taenia* sp. in sloth bear; Lung worm (*Mullerius* sp.) in musk deer and *Protostrongylus* sp. in Himalayan blue sheep.

Occurrence of *Trichinella* sp. infection in Indian wild animals

Occurrence of *Trichinella* sp. in its sylvatic cycle was studied. A total of 27 skeletal muscle samples

Nurse cell of *Trichinella* sp. in the muscle

from wild animal species (leopard-10, tiger-09, wild boar-02, bear-01, jackal-01, wolf-01, crocodile-01, porcupine-01 and monkey-01) were screened for *Trichinella* sp. infection during the year. In muscle press as well as in acid-pepsin digest, a total of 10 muscle samples (5 each of leopard and tiger) were found positive for *Trichinella* spp.

Toxicological investigations

Out of 51 samples tested for toxicological examination, five were found positive for various toxicants. Important toxicants identified included HCN in stomach content of elephant, heavy metal in liver of crocodiles and turtles, phosphine gas in stomach contents of monkeys. Additionally the testing of the green fodder being taken by wild herbivores at Safari Park, Etawah showed high content of HCN and nitrate/nitrite.

Investigation of mortality among musk deer at Bageshwar, Uttarakhand

Musk deer (*Moschus leucogaster*), an endangered species is maintained at the Musk Deer Research Centre under Ministry of Ayush. Spate mortality was reported through a short span of time during September to October, 2017. An investigation was carried out to ascertain the cause of ill health and mortality in musk deer. This farm is located at the height of 7320 feet above the sea level and animals are maintained in individual pens with provision of *ad lib* feed and water. Morbid samples of one case and fecal samples of clinical cases revealed heavy infestation of *Muellerius* sp. The investigation ruled out other diseases like TB, HS, trypanosomosis, PPR and blue tongue. On spot collection and examination of fecal samples also revealed mild infection of *Muellerius capillaris* in 9 animals and moderate infection in 2 animals. Based on results, all animals were treated with ivermectin injection @ 0.2 mg/kg body weight, subcutaneously. Subsequent fecal examination of animals on day 10 post treatment revealed persistence of *M. capillaris* infection in 7 animals with mild infection in 5 animals and moderate infection in 2 animals. In order to terminate the persistent lung worm infection from infected animals, retreatment of all animals was done with fenbendazole @ 5 mg/kg body weight (orally) for 15 days. Fecal examination carried out on day 10 post last dosing of fenbendazole treatment, indicated clearance of lung worm infection from all the animals. The animals regained their health status following the fenbendazole treatment.

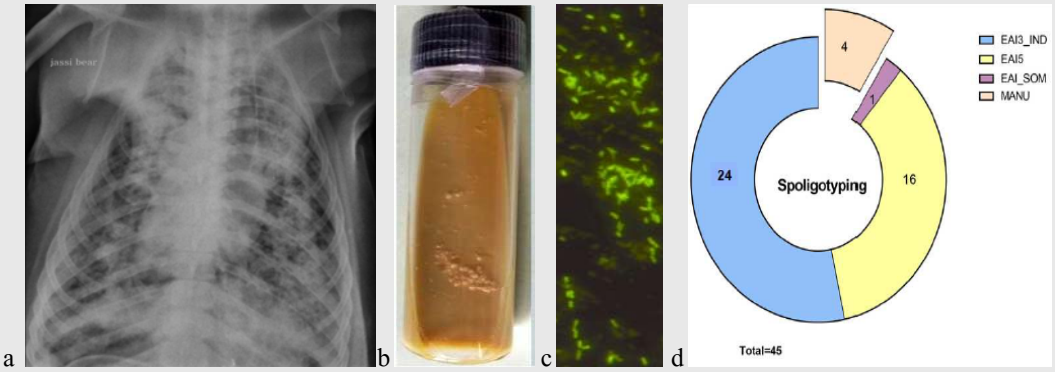
Disease investigation at musk deer farm, Bageshwar, Uttarakhand

Tuberculosis among sloth bear at a Bear Rescue Centre

The Wildlife SOS informed that some of their rescued bears showing progressive weakness, debility with rough hair coat and requested the Centre for Wildlife to investigate the problem. The morbid samples of few sloth bears received revealed lesions of pulmonary tuberculosis. Keeping in view the detailed investigation was carried out. A total of 123 adult sloth bears of either sex were clinically examined. The blood, serum, nasal and fecal swabs were analysed using LFA (Wild TB Alert Kit™), X-ray, ZN staining and PCR. In addition, a total of 124 dead morbid samples of sloth bears were also analysed for tuberculosis. Out of 123 cases 43.90% showed seropositivity for tuberculosis by lateral flow assay, 32.52% lung lesions by X-ray, 15.45% by nasal and 12.20% by fecal swabs showing positivity for acid fast bacilli. Among the 123 clinical samples, 8.87% blood, (20.32% nasal swabs and 18.70% fecal swabs were found positive for *M. tuberculosis* by multiplex-PCR.

Sloth bear suffering from tuberculosis with emaciated body condition

The LFA was found to be 80 % sensitive for clinical diagnosis of TB. Out of 124 morbid cases, 60 were of tuberculosis (38 pulmonary tuberculosis and 22 generalized tuberculosis). Of these positive samples, 15 isolates of *M. tuberculosis* were obtained at Eastern Regional Station, ICAR-IVRI, Kolkata. Spoligotyping of 45 TB positive DNA samples were carried out at Jalma Institue of Leprosy and Other Mycobacterial Diseases, ICMR, Agra, which revealed two lineages of *M. tuberculosis* EAI 41 in (91%) and ancestral MANU in 4 (9%). EAI sub lineages observed were EAI3_IND in 24 (53%), EAI5 in 16 (36%) and EAI_SOM in 1 (2%). From the present study, it was concluded that the tuberculosis among rescued



Laboratory investigations of sloth bear suspected for tubeculosis: a)Radiograph of a TB affected sloth bear showing dense opaque patches. (b) Rough and granular growth of *Mycobacterium tuberculosis* from sloth bears on L-J media slants. (c)Fluorescent acid fast staining of culture isolate showing apple green bacilli. x1000. (d) Analysis of spoligotyping data.

ICAR-IVRI Scientists treating a sick lion at National Zoological Park, New Delhi

sloth bears at ABRC was due to human strain of *M. tuberculosis.* Biosafety measures such as isolation of infected animals, separate provision for food and drinking water, periodical health check up and prophylactic measures of the in contact persons/attendants; and antituberculosis treatment for the infected animals were advised.

Diagnosis and management of canine distemper at National Zoological Park, New Delhi

National Zoological Park inhabits various wild animals including big cats like lion, tiger and leopard. A lion named 'Rohan' had sudden onset of paralysis. Clinical samples like blood, ocular, nasal, fecal swabs and serum samples analysed at ICAR-IVRI were found positive for canine distemper virus by RT-PCR. The IVRI team visited and suggested for vaccination against CDV in remaining lions and tigers with Recombinant canary pox vectored CDV vaccine along with other corrective measures. The disease was successfully controlled from spreading to other animals.

Wildlife species identification using molecular methods

Genomic DNA samples (155) of different wild life species have been collected and stored in our institute wild life repository. The isolated genomic DNA was used for species level identification. During the year, known samples from 21 species have been characterized for species identification based on mitochondrial cyt b and 12S rRNA genes. Cyt b and 12s rRNA genes of 440 bp and 470 bp, respectively were amplified with universal primers and cloned. The recombinant clones were sequenced. All the sequences from known species were >99% similar to the sequences of the same species available at NCBI database.

Non-invasive pregnancy diagnosis

Pregnancy diagnosis at 45 days post-mating through fecal hormone profile was successful in 14 animals (lionesses and tigresses). This service was provided to Lion Safari (Etawah), Sajjangargh Biological Park (Udaipur) and Nahargargh Biological Park (Jaipur).

Jessica of Lion Safari, Etawah: Diagnosed positive for pregnancy, subsequently gave birth to cubs, Symbha and Sultan.

3.6 Therapeutics

Assessment of *in vivo* antiviral activity of ribavirin on FMDV A replication in C57BL/6 mice

The *in vivo* antiviral efficacy of ribavirin has been evaluated against FMDV A (A/IND/40/2000) using both suckling and adult C57BL/6 mouse models. The virus was successfully adapted to replicate both in suckling and adult mice. The suckling mice adapted FMDV A was titrated in suckling mice, adult mice, LFBK and BHK21 cell systems; and the titers were, $10^{7.67}$SMLD_{50}/ml, $10^{4.40}$MID_{50}/ml, $10^{7.30}$ TCID_{50}/ml and $10^{6.70}$ TCID_{50}/ml, respectively. The antiviral efficacy of ribavirin at 50 mg/kg was tested both in suckling and adult mice which was found to prevent the clinical disease. The drug reduced the virus load drastically in all of the organs tested in treated groups compared to the infected control group. The ribavirin at 50 mg/kg body weight did not induce any toxicity in adult mice as measured by loss of body weight and total RBC counts. Therefore, C57BL/6 mice can be used as a model for FMDV A/IND/40/2000 infection and is an useful tool for assessing the antiviral efficacy of chemical compounds/biomolecules. Further, the study indicated that the ribavirin is a promising antiviral agent and can be used against FMD as a curative and/or prophylactic agent. However, its efficacy needs to be assessed in a natural host of FMDV.

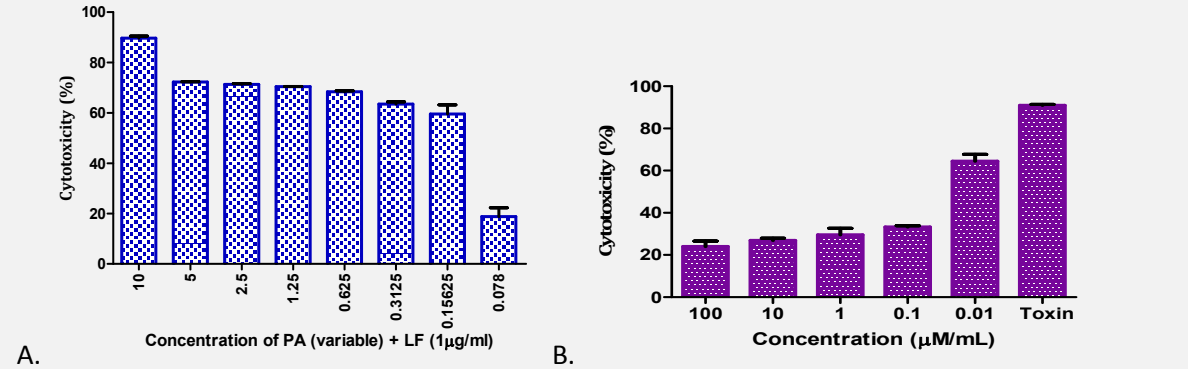
The *in vitro* efficacy of inhibitor molecules against Lethal Toxin (LT) of *Bacillus anthracis*

The main virulence factor of *Bacillus anthracis* is its tripartite toxin complex formed by lethal factor (LF), a zinc metalloprotease that causes cell death, edema factor (EF), a calmodulin dependent adenylyl cyclase that impairs host defense and protective antigen (PA), which is required for the entry of both LF and EF into cells. In this study, these regions were exploited to identify inhibitor molecules using computational high throughput screening method which could simultaneously block formation of LT and ET toxin. The identified inhibitor molecules (n=3) were initially evaluated in an *in vitro* system (RAW murine macrophage cell line) to evaluate their efficacy.

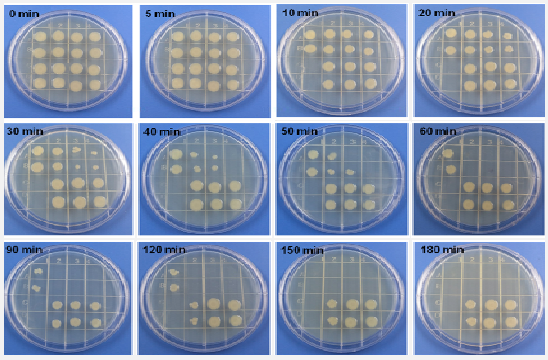
Initially *in vitro* cytotoxicity dose of LT was determined using RAW murine macrophage cell line in MTT assay. Based on the result obtained, a standardized dose (10 µg/ml of PA + 1 µg/ml LF) of LT which revealed ~90% cell cytotoxicity; was further used to study the efficacy of catechin, silymarin, taxifolin against LT. A dose dependent decrease in cell cytotoxicity against LT was observed with all the three inhibitor molecules. However, silymarin and catechin at concentration of 10 µM were found more effective than taxifolin.

The *in vitro* antimicrobial susceptibility of antimicrobial peptides (AMPs) against multidrug resistant Enteroaggregative *E. coli* (MDR-EAEC)

Three antimicrobial peptides (AMPs) having different mechanisms of action *viz*., AMP-1, AMP-2 and AMP-3 were identified from BaAMP database and were outsourced for their synthesis. To evaluate the efficacy of these AMPs, 3 EAEC strains resistant towards three or more class of antibiotics, termed as multidrug drug resistance

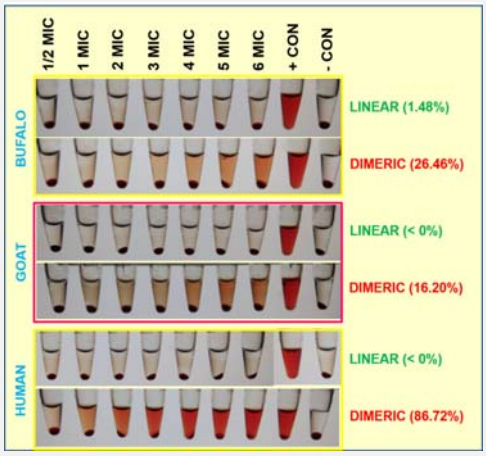


A: Dose dependent cytotoxicity of LT (PA variable and LF constant) in RAW264.7 cells; **B:** Dose dependent decrease in LT cytotoxicity (%) treated with catechinin RAW264.7 cells



Antibacterial activity of AMP determined by complete elimination of *E. coli*: The concentration of AMP at spots at A1, B1 (1MIC); A2, B2 (2MIC); A3, B3 (3MIC) and A4, B4 (4MIC). At the spots C1& D1 antibiotic kananmycin and at spots C2 and D2 antibiotic ampicillin were mixed with bacteria. At the spots C3, D3 and C4, D4 only bacteria were spotted

(MDR) strains, were used. The Minimum Inhibitory Concentrations (MICs) and Minimum Bactericidal Concentration (MBCs) of the



Comparison of hemolytic activity of linear and dimeric AMP on buffalo, goat and human RBCs

individual AMPs against three MDR-EAEC strains were determined according to the CLSI (2018) guidelines. The MIC values (µM) of AMP-1, AMP-2 and AMP-3 against MDR-EAEC strains were found to be 32.0, 4.0 and 32.0, respectively; whereas, the MBC values (µM) were 64.0, 4.0 and 32.0, respectively. All the three AMPs were found stable when subjected to varying temperatures (70°C and 90°C), enzymes (trypsin and proteinase-K) and physiological concentration of salts.

Development of synthetic antimicrobial peptides (AMPs) and evaluation of their activity in standard and clinical bacterial isolates

A new antimicrobial peptide molecule was identified from the secretions of hornet. The TFA extraction fraction showing antibacterial activity was pooled and subjected to peptide sequencing by HPLC-MS. After identifying the amino acid sequence, the synthetic peptide was synthesized by solid phase peptide synthesis methodology using Fmoc chemistry (CS-336X). The mass of the purified peptide was confirmed by ESI-MS. The synthetic peptide was prepared as linear and dimeric molecule on a lysine core and was tested for various activities. The MIC of linear and dimeric synthetic AMP was determined on standard strains of *E. coli* (ATCC 25922) and *Staphylococcus aureus* (ATCC 29213) following CLSI guidelines (2016). The MIC on linear AMP on *E. coli* was 10 µM, whereas for dimeric AMP molecule it was 20 µM. Similarly, for *S. aureus*, the MIC was 50 µM for linear molecule and 100 µM for dimeric molecule. The AMP could completely inhibit the growth of *E. coli* at 1 MIC concentration in 150 min, at 2 MIC in 60 min and at 4 MIC in 40 min.

Determination of minimum bactericidal concentration (MBC) of linear AMP

The growth of *E. coli* was completely inhibited and no colonies were visible at a concentration of 2 MIC. Therefore, the MBC of linear AMP on *E. coli* was 20 µM. To determine the hemolytic acitivity of linear and dimeric AMP, fresh erythrocytes from different species (cattle, buffalo, goat, dog, rabbit, rat and human) were collected in Alsever's solution. It was observed that the linear AMP identified in this study is minimally haemolytic on different species of RBCs even at a concentration up to 60 µM. However, the dimeric AMP with same amino acid sequence was highly hemolytic although it had very good antibacterial activity.

Testing antibacterial activity of linear AMP on different clinical isolates of bacteria

Sl. No	MDR Bacterial Isolates	Number of isolates	MIC of AMP (Insect origin)
[A]	*E coli* isolates	45	10 µM
		56	20 µM
		3	30 µM
		1	Not Inhibited up to 40 µM
[B]	*Staph aureus* isolates	4	100 µM
		2	Not Inhibited up to 250 µM
[C]	*Klebsiella pneumoniae* isolates	4	50 µM
		1	150 µM
	TOTAL	116	

In order to study the stability of linear AMP molecule, the activity was tested at different storage temperatures and in the presence of different salts like ammonium chloride, sodium chloride, calcium chloride, ferric chloride and potassium chloride.

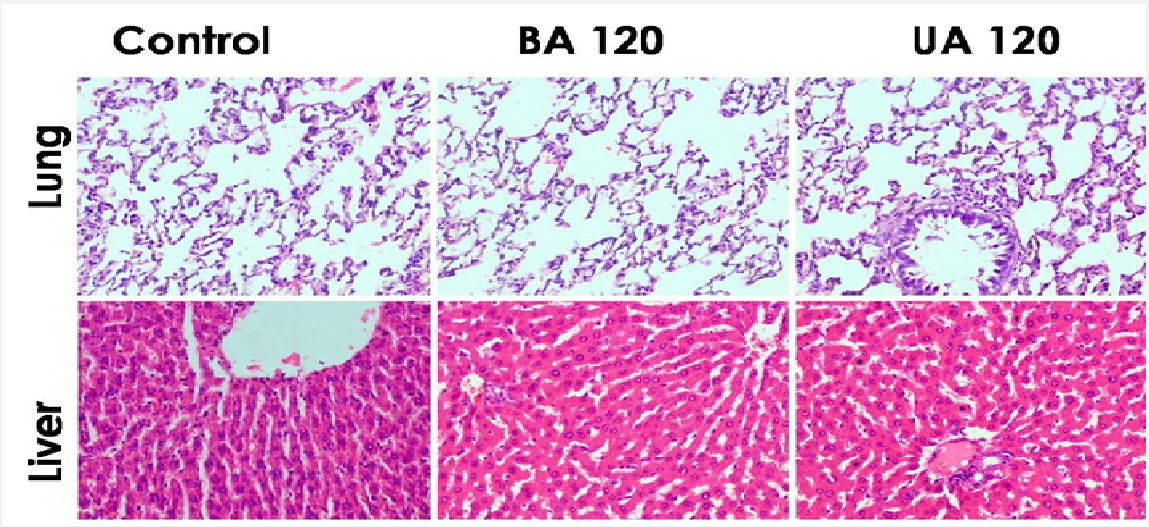
The anti-bacterial activity was determined for each of the parameters. It was observed that the linear AMP retained the potent antibacterial activity at all temperatures tested and in presence of physiological amounts of different salts.

Evaluation of cardioprotective potential of isoflavonoids biochanin A and kaempferol in cardiomyopathy

To evaluate the vaso-relaxant potential of kaempferol and biochanin A, to explore their signaling mechanisms in the rat isolated pulmonary artery, tension experiments were conducted on left and right branches of the main pulmonary artery from male Wistar rats. Kaempferol and biochanin A produced relaxation in endothelium-independent manner in this vasculature. There was no inhibition of kaempferol and biochanin A-induced relaxation either in the presence of NOS inhibitor L-NAME or COX inhibitor indomethacin. Kaempferol and biochanin A-induced relaxation was not mediated through nitric oxide (NO) and cyclooxygenase (COX) pathways. Potassium channel blocker TEA had significant decrease in kaempferol-induced relaxation. K_{ATP} channel blocker glibenclamide, and K_{IR} channel blocker $BaCl_2$ had no significant effect on kaempferol and biochanin A-induced relaxation. Voltage activated K^+ channel blocker 4-aminopyridine showed a significant decrease in the relaxation in both the compounds. However, BK_{Ca} channel blocker iberiotoxin significantly decreased the relaxing effect of kaempferol but did not influence the biochanin A-induced relaxation. SK_{Ca} channel blocker apamin and IK_{Ca} channel blocker TRAM-34 did not show any effect on kaempferol-induced relaxation. Further, it was confirmed that there was no involvement of SK_{Ca} and IK_{Ca} channel mediated endothelium-dependent hyperpolarizing factor in kaempferol-induced relaxation. The estrogen receptor antagonist, ICI182780 did not show any effect in kaempferol and biochanin A-induced relaxation. TRPV4 channel blocker HC047067 had no significant effect on relaxing effect of kaempferol. A marked difference was observed in $CaCl_2$-induced contraction between control and in the presence of kaempferol. Soluble guanylyl cyclase inhibitor ODQ showed significant reduction in the relaxation response of kaempferol as well as biochanin A. Protein kinase A inhibitor H89 showed significant effect on kaempferol-induced relaxation. Kaempferol and biochanin A-induced relaxation was reduced in 60 mM KCl pre-contracted rat pulmonary arterial rings. The present study demonstrates that kaempferol-induced relaxation is mediated in endothelium-independent manner through BKCa, KV, L-type Ca^{++} channels, cGMP and PKA signaling pathways. However, biochanin A-induced relaxation was mediated through cGMP and K_V channels in this vasculature. Further, safety assessment of kaempferol and biochanin A was also observed in 28 days toxicity study. Mice were orally administered different doses of kaempferol (3, 10 and 30 mg/kg) and biochanin A (3, 10 and 30 mg/kg) in mice for 28 days. There was no difference in blood parameters in control and other groups treated with kaempferol and biochanin A in mice.

Therapeutic potential of triterpenoids and isoflavones in chronic renal failure

Investigation of the safety of betulinic acid (BA) and ursolic acid (UA) in the rat model at 30, 60 and 120 mg/kg doses was done. Both BA and UA when treated for 28 days at different dose levels did not significantly affect the body weight gain and different organ weight, including organ function,



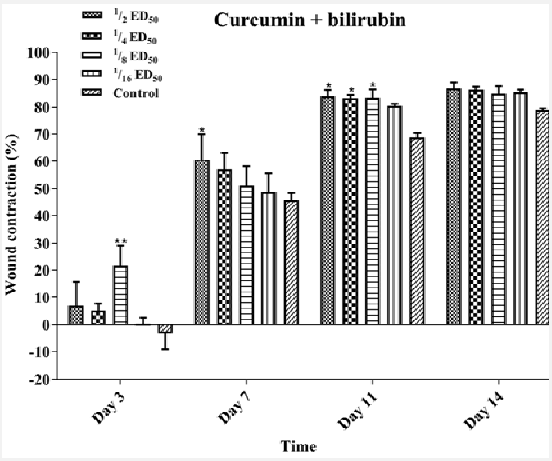
Effect of BA and UA at 120 mg/kg dose for 28 days on histomorphology of lung and liver. Histomorphology of the tissues were normal as revealed by normal alveolar tissue of lung, well arranged hepatic cords and sinusoids in liver. Further there is no evidence of any pathological alterations in both the tissues.

biochemical indices as compared to control rats, which were further reflected in histological analysis revealing the non-toxic effects of BA and UA.

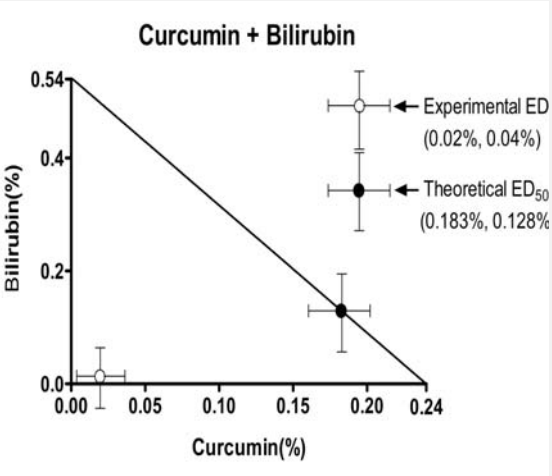
Evaluation of synergistic efficacy of curcumin with hemin, bilirubin and deferoxamine in cutaneous wound healing by isobolographic studies in rats

Based on earlier results, it is contemplated that a combination of curcumin with hemin, bilirubin and deferoxamine might synergize their effects on cutaneous wound healing in rats. Presently, ED_{50s} of individual agents namely, hemin, bilirubin and deferoxamine were calculated and synergizing effect of combination of curcumin plus bilirubin was also evaluated. Approximately, 2 x 2 cm^2 cutaneous skin deep wounds (thoracic region) were created in adult rats under pentobarbitone anesthesia. Four log doses of hemin (0.02, 0.1, 0.5 and 2.5%), bilirubin (0.02, 0.1, 0.5 and 2.5%) and deferoxamine (0.01, 0.05, 0.25 and 1.25%) ointments were applied b.i.d. topically on cutaneous wounds for 14 days.

A



B

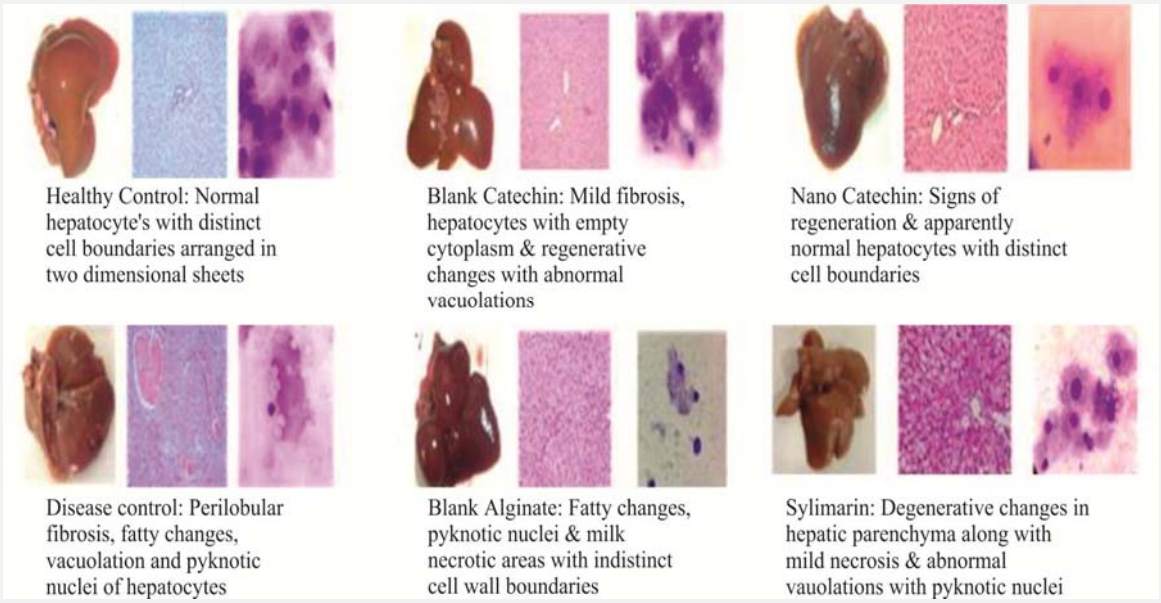


A: Graphical presentation showing dose- and time-dependent effect of curcumin plus bilirubin combination on cutaneous wound contraction/healing in adult rats. **B:** Isobolographic presentation showing the synergistic effect of curcumin plus bilirubin combinations on the 7th day on cutaneous wound contraction/healing in adult rats

Wound area was photographed and planimetrically measured on days 3, 7, 11 and 14 post-wounding. In treated animals, in comparison to untreated wounds the ED_{50s} of hemin, bilirubin and deferoxamine based on planimetrically measured wound contraction/healed area were 0.28, 0.53 and 0.0546%, respectively, on the 7th day. Further, four combinations of ED_{50s} of curcumin and bilirubin (1/2, 1/4, 1/8 and 1/16th) were applied b.i.d. topically on cutaneous wounds for 14 days. Wound area was photographed and planimetrically measured on days 3, 7, 11 and 14 post-wounding. Contraction/healed area data on 7th day was fitted to generate isobolograph which shows synergistic effect of curcumin and bilirubin, as the experimental ED_{50} [0.02% (B) + 0.04% (C)] was markedly below the theoretical ED_{50} [0.12% (B) + 0.26% (C)].

Characterization and evaluation of antioxidant property of catechin loaded polymeric nanoparticles to ameliorate hepatopathies

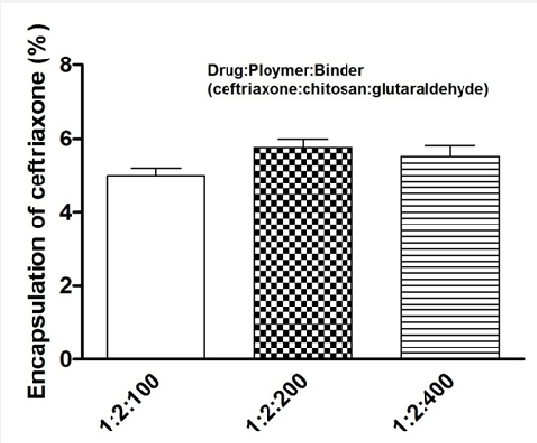
Catechin is a primary polyphenolic compound available naturally with multiple health-promoting properties including excellent antioxidant activity. However, its application is limited due to low bioavailability in the body system which could be enhanced by adopting bio-polymeric nano-delivery system to enable sustained drug release. Hybrid nanopolymer of Catechin-Na Alginate-$CaCO_3$ was prepared and found to be of 50.7 x 49.1 nm size as measured by Microtrac Zeta analyzer and reconfirmed by transmission electron microscopy. In the prepared nano polymer, 32.7% of catechin was found to be loaded equivalent to 61.1% encapsulation efficacy. Catechin remains protected in simulated gastric fluid with minimum (10%) release accompanying an enhanced (85%) release in simulated intestinal fluid even up to 96 h. After characterization and evaluation of antioxidant property of prepared catechin-Na-alginate hybrid, the nanopolymer was subjected to *in vivo* rat model study, which revealed significant improvement in hemato-biochemical, oxidative stress markers and in healing pattern of gross liver tissues along with regenerative changes. Results of gross pathology and histopathology were further re-confirmed by May-Grunwald Giemsa staining, which recorded prominent regenerative changes in liver cells. Modified scoring pattern also re-ascertained regenerative changes in the liver tissue. It is concluded that structured catechin hydrate nanoparticles using Na-alginate polymer may be useful to alleviate compromised liver condition.



Gross pathology, histopathology and May-Grunwald Giemsa staining of rat liver tissue after therapy

Evaluation of ceftriaxone loaded polymeric nanoparticles for the enhanced antimicrobial activity in experimental sepsis

Preparation of PLGA-ceftriaxone nanoparticle using sonication and solvent evaporation method was done. Zetasizer dynamic light scattering analysis was done for particle size and polydisperity index. However, the particle size was larger, ranging from 800-1200 nm. Ceftriaxone (100 mg) and Chitosan (100-1000 mg) were mixed at different ratio from 1:1 to 1:10. Binder glutaraldehyde or tripolyphosphate (TPP) was added at 2% and 1 mg, respectively. It was found that 1:1 to 1:2 ratios are suitable proportion for clear solution whereas a 1:10 was very viscous. Yield with glutaraldehyde at 2% was good, however, encapsulation efficiency was low. Yield with 1 mg TPP was very low.



Encapsulation efficiency of ceftriaxone when mixed with polymer and binder at different ratios

Ameliorative potential of a microsphere encapsulated recombinant Staphylococcal Enterotoxin-C (SEC) in mice mastitis model

Recombinant SEC protein was isolated from *E. coli* and encapsulated in poly lactide co glycolide (PLGA) microparticles. Adult Swiss albino female mice were immunized with PLGA-rSEC and other comparatives via subcutaneous route in a prime-boost regimen. The IgG titers of mice immunized with rSEC vaccine were higher than those in the bacterin group. The immunized lactating mice were challenged for induction of mastitis with 10^7 CFU of β-hemolytic coagulase positive *S. aureus* into the mammary ducts of R-4 and L-4 inguinal mammary glands. Compared to bacterin, PLGA-rSEC engender significant level of protection by 99.93% reduction of bacterial CFU in mammary glands10 days post challenge. Histopathological examination of mammary gland showed greater integrity and a milder inflammatory response upon challenge afforded by immunization with PLGA-rSEC microparticles. C-reactive protein, clinical scores, tissue demonstration of bacteria were also performed with significant difference in PLGA-rSEC group. In conclusion, the rSEC encapsulated in PLGA provided strong immune protection against *S. aureus* mastitis in mice, and could therefore be a promising vaccine candidate against bovine mastitis induced by *S. aureus.*

Diagnostic and therapeutic interventions on gastritis and peptic ulcer disease (GPUD) in canines

Around 20.13% dogs of different breeds, sex and age groups were observed to have one or the other signs related to gastrointestinal tract disorder. Out

of these, 43.07% were under one year of age. Breed wise, non-descript breeds were found to have the highest occurrence (26.60%) followed by Labrador retriever (24.26%). On the basis of history, clinical signs and symptoms, laboratory findings, response to treatment, 35.43 % dogs were tentatively diagnosed of having only gastritis as the main problem and the rest were having gastritis as an additional or secondary problem. Dogs (50.72%) with signs and symptoms of gastritis were screened for secondary gastritis, due to hepatitis, renal affection, haemoprotozoa, GI parasitism.

Improvement of therapeutic response against canine parvovirus infection using immunoglobulins and antioxidants

Hospital-based occurrence of canine parvovirus was found to be 63% of canine gastrointestinal cases with maximum occurrence in Labrador breed at the age group of 0-3 months. Inclusion of antioxidant (N-acetyle cystein) in standard supportive treatment significantly improved the therapeutic response as compared to supportive treatment alone. Further, IgY extraction from egg yolk by different methods were standardized and chloroform-PEG method was found to be more suitable.

Hydro-ethanol extract of ORP-EVM 18 possess anti-urolithiatic activity

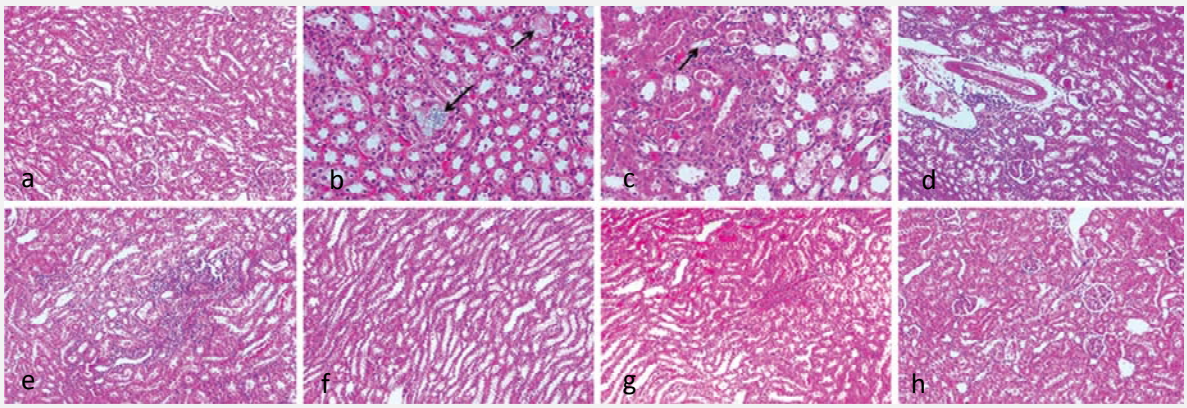
A study was undertaken to evaluate antiurolithiatic effect ORP-EVM 18 to rationalize its medicinal use. Urolithiasis was induced in hyperoxaluric rat model by giving 0.75% ethylene glycol (EG) for 28 days along with 1% ammonium chloride (AC) for the first 14 days. The antiurolithiatic effect of aqueous and ethanol (hydro-ethanol) extract of ORP-EVM 18 was evaluated based on urine and serum biochemistry, microscopy of urine, kidney calcium content, and histopathology. Administration of EG and AC resulted in increased crystalluria and oxaluria, hypercalciuria, polyuria, crystal deposition in urine, raised serum urea, and creatinine. In lithiatic group, however, ORP-EVM 18 treatment (EC_{50} 200 mg/kg body weight orally) significantly restored the above impairments in kidney function test. The present findings demonstrate the efficacy of ORP-EVM 18 in EG induced urolithiasis, and its potential to inhibit biochemical markers of renal impairment.

Herbal antimicrobials to counter drug resistance in bacteria of veterinary clinical importance

A study on 824 bacterial strains revealed that *kalonji* essential oil, carvacrol and cinnamaldehyde had synergistic antibacterial activity with colistin, tetracycline and nitrofurantoin. The most effective herbal antimicrobials included carvacrol (98.2%), ajowan oil (95.6%), thyme oil (94.1%) and cinnamaldehyde (93.2%) while the least effective were agarwood oil (16.7%), guggul oil (18.8%), patchouli oil (20.6%), and sandalwood oil (25.2%). However, it varied with source of bacterial isolation. The results obtained can be exploited for development of herbal antimicrobials or herbal and conventional antimicrobial combinations.

In vitro trypanocidal potential of norclomipramine and imipramine HCl

Norclomipramine and imipramine hydrochloride cause damage to the DNA by trapping the topoI-DNA complex. The *in silico* docking of the molecules on the TetopoI model displayed their high affinity binding near the metal binding site of the enzyme and were, therefore, selected for exploring their trypanocidal potential *in vitro* on culture grown *T. evansi*. Norclomipramine-HCl was added to the axenic culture of *T. evansi* ($n=4\times10^4$/ml) in duplicate wells at the final concentration of 0.195 to 100 µM and incubated at 37°C in 5% CO_2 atmosphere. The trypanolysis was checked with an inverted microscope at 400x magnification. The minimum inhibitory



Histology of representative kidney section stained with H and E stain (×100). (a) Untreated healthy control, (b) lithiatic control, (c) rat treated with ORP-EVM 18 at 100 mg/kg, (d) rat treated with ORP-EVM 18 at 150 mg/kg, (e) rat treated with ORP-EVM 18 at 200 mg/kg, (f) rat treated with ORP-EVM 18 at 250 mg/kg, (g) rat treated with ORP-EVM 18 at 300 mg/kg, (h) cystone at 100 mg/kg body weight.

concentration (MIC) for norclomipramine was determined as 3.125 µM at 24 h post-treatment. Similarly, trypanosome growth was totally inhibited at a concentration of 1.56 µM of imipramine-HCl. The IC_{50} value was determined as 0.195 µM by counting the cell number from the treated wells and comparing them to their untreated counterparts 48 h post-incubation. Imipramine and norclomipramine-HCl showed a promising trypanolytic effect *in vitro.*

In vitro assessment of plant extracts as trypanocides

Methanolic extracts of two plants were evaluated for trypanolytic potential. The recovery percentages of the extracts were 2.0% and 2.33%, respectively. The trypanolysis was determined by serial dilutions of the extracts up to 12 h. Both the plant extracts caused trypanolysis while incubating at a concentration of 3 mg/ml with 5×10^4 parasites per ml within 3 h at 37°C in 5% CO_2. The MIC value for both the extract was recorded as 1.5 mg/ml.

Ethnoveterinary study, phytochemical analysis and evaluation of medicinal plants commonly used as herbal remedies for cold stress by local tribes of Pithoragarh (Uttarakhand)

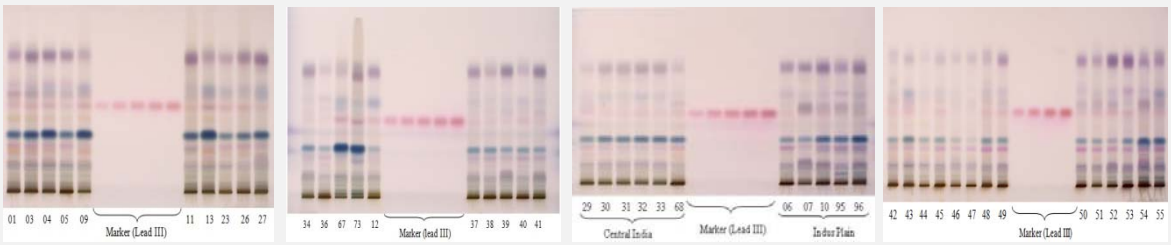
Aqueous and ethanolic extracts of *Xantholxylum armatum* (fruit and fruit kernel) and *Pleurospermum angelicoides* (root) were prepared by the Soxhlet extraction method at 41°C. Percent yield of aqueous and ethanolic extracts of *Xantholxylum armatum* (fruit kernel) and *Pleurospermum angelicoides* (root) were 22.30% and 30.0%; 21.42% and 28.30%, respectively, whereas aqueous and ethanolic extracts *of Xantholxylum armatum* (fruit) showed 10.71% and 17.85% yield, respectively. Qualitative phytochemical analysis revealed the presence of flavanoids, saponins and phytosterols in aqueous extract of the fruit kernel of *Xanthoxylum armatum* with the strong positive reaction. Alkaloids showed strong positive reaction in aqueous extract of *Pleurospermum angelicoides*. Aldehyde was strongly detected in the ethanolic extract of *Xanthoxylum armatum* (fruit). Ethanolic extract of the fruit kernel of *Xanthoxylum armatum* showed strong positive reaction for the presence of phytosterols. Total phenol and flavanoid content of the aqueous extract of fruits of *Xanthoxylum armatum* were 33.24±1.98 TPC (mg GAE/g extract) and 5.43±0.46 TFC (mg CE/g extract), respectively. The total phenol content of aqueous extract of *Pleupermum angelicoides* was evidenced as 14.70±0.36 TPC (mg GAE/g extract). The percent inhibition activity of AICPP was 66.97±5.76% in aqueous extract of the fruit kernel of *Xanthoxylum armatum,* whereas it was 67.35±4.47% in the ethanolic extract of *Pleupermum angelicoides.* The highest FRAP activity of 0.362±0.01 mmol Fe^{2+}/gm extract was found in aqueous extract of *Xanthoxylum armatum* fruits. The TD_{50} concentration of aqueous and ethanolic extracts of *Xantholxylum armatum* (fruit) and *Pleurospermum angelicoides* (root) in MDBK cell line was evaluated as per OECD guidelines. TD_{50} concentration for aqueous and ethanolic extracts of *Xantholxylum armatum* fruit and aqueous extract of *Pleurospermum angelicoides* root was 33 µg/ml, while *Pleurospermum angelicoides* (ethanolic) extract showed >1000 µg/ml TD_{50} concentration.

Herbal acaricides

The lead plant materials were collected from different states and were profiled in collaboration with partner institute, CSIR-NBRI. The profiling was done using lead III as a marker compound for generation of data on availability of raw materials in the country. Although variable, but the accessions collected from different phyto-geographical zones possessed good concentration of the marker compound.

The work on the toxicokinetic/pharmacokinetic and safety analysis of lead/combination following OECD guidelines was initiated in collaboration with the partner institute at Pookode, Kerala. Both *in silico* and *in vivo* experiments were conducted. *In silico* study using GUSAR, and the compounds were observed non-toxic at 2000 mg/kg by IP, oral and SC route of administration. The oral absorption and blood brain barrier (BBB) permeation study revealed or the oral absorption is high for compounds VP3 and VP1 while for VP5 and Lead III oral absorption is very poor. The VP1 and VP5 can penetrate BBB to some extent while Lead III and VP3 do not penetrate BBB. The VP1, VP3 and VP5 are neither substrate for p-glycoprotein, nor an inhibitor. They do not inhibit p-glycoprotein or renal organic cation transporter. The mutagenic and carcinogenic properties of the lead compounds were assessed and it was observed that VP1 is non-AMES test positive (non-mutagenic) and non-carcinogenic; VP5 is non-AMES test positive (non-mutagenic) but carcinogenic. The Lead III is non-AMES test positive (non-mutagenic) and non-carcinogenic and VP3 is non-AMES test positive (non-mutagenic) but carcinogenic.

No mortality and clinical morbidity in any of the animals treated with VP1, VP5 and lead III compounds were observed. No remarkable adverse effect on the body weight of VP1, VP5 and lead III treated animals was observed in comparison to control group. Gross examination of the visceral organs was apparently normal in all the treated animals.



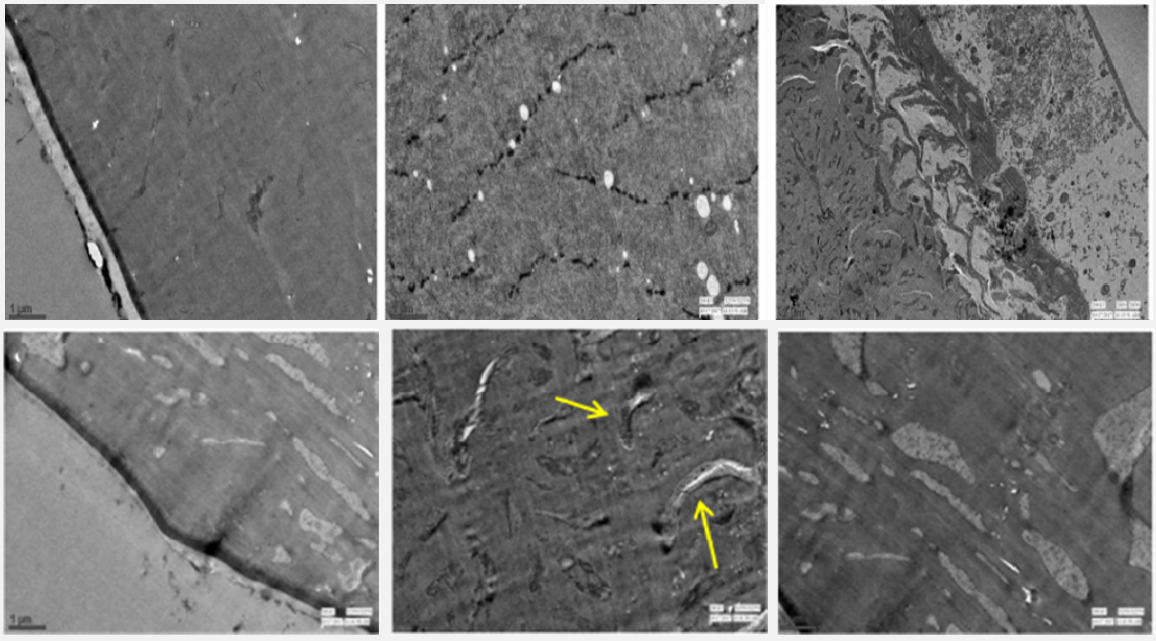
HPTLC chromatogram of NAC-01 germplasms from a, Gangetic plain NAC-01, 03 to 05, 09, 11, 13, 23, 26, 27; Central India b, 34, 36, 67, 73, 12, 37, 38, 39, 40, 41; Central India c, 29 to 33, 68, Indus plain 06, 07, 10, 95, 96 and d, Eastern Himalaya NAC-42 to 55.

Pharmacokinetics: The response linearity, limit of detection, limit of quantification, of the molecules lead III, VP5 and VP1 were analysed by GC-MS. The retention times were 14.84, 7.76 and 18.475 min, respectively. All the coefficients of correlation were higher than 0.993. The results indicated a good linearity within the described ranges for each analyte. The recovery of the analytes ranged from 75-95%.

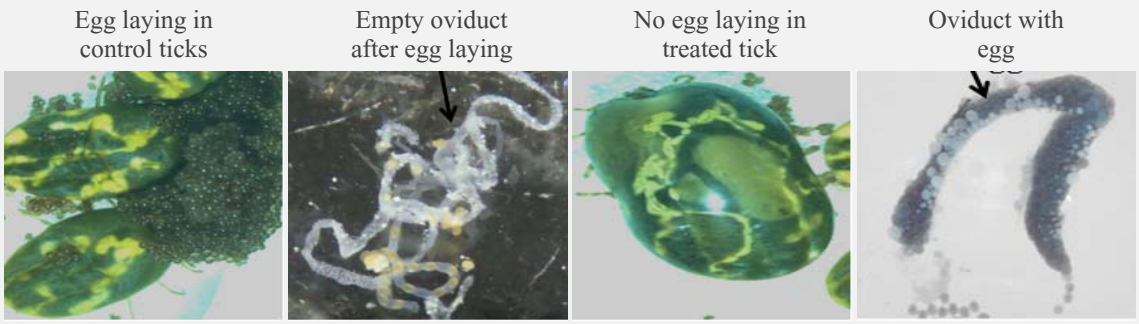
The effect of lead compounds on gut, ovary and cuticle: Treatment of ticks with Lead III compound induced a highly fragile gut with leakage of ingested host blood after 4 h of treatment and after 24 h complete disorganization with loss of cellular identity.

Remarkable changes in the cuticle of treated ticks were observed in scanning electron microscopy study, which indicates damaged areas, undistinguished sub-divisions of the cuticle, disorganization and disappearance of some regions of the cuticle and vacuolation.

Lead IV compound showed inhibition in egg laying capacity in treated ticks. These ticks were unable to expel eggs which might be due to the effect on muscle contraction & relaxation.



Effect of lead III on cuticle of treated and untreated ticks. A: Control; B: Treated



Effect of lead IV compound on ovary of treated and untreated ticks

Development of phyto-formulation using adjuvant and carriers: The work was initiated with active involvement of the Directorate of Medicinal and Aromatic Plant Research, Anand. Initially, 41 samples having different carriers and solvents were prepared and tested without any efficacy. Another seven formulations (F1 to F10) were prepared and tested *in vitro* in which four (F1, 5, 9, 10) were found effective showing 75-90% mortality in treated ticks. In a pilot *in vivo* experimentation, F5 and F10 were found effective in killing feeding ticks on the body of animals. Further, *in vivo* experiments are going on.

To work out the possible relationship between the endophyte population of plants and soil with variation in acaricidal compounds in potential plants, whole germplasms and rhizospheric soil samples of the two identified acaricidal plants (NEA= NBA22/F1) and (NED = NBA/18/D1) from six agro-climatic zones of Assam were collected. A significant variation from 20 to 80% of anti-tick activity was noticed in extracts prepared from both the plants. The physical, chemical and microbial properties of collected soil studied and both bacterial and fungal isolates were recovered. Similarly, the fungal and bacterial endophytes were isolated from whole plants and are under characterization. Altogether 16 bacterial and 07 fungal isolates were identified till date in the collected plant materials.

Development of nano-formulation having high anti-tick activity

The baseline information of various synergists of multifunctional oxidase and, esterase enzymes was used in various combinations with lead compounds. In collaboration with the ICAR-IARI, the protocol for nano-sizing of identified lead compounds was standardized. A number of formulations comprising of lead phyto-compounds, synergists and different formulations were developed and tested against tick infestations. Nano formulations of lead compounds resulted in better anti-tick activity than parent extracts, but significantly higher efficacy at low and very low doses is yet to be achieved. The process of developing more combinations and best combination for delivery of the compounds is underway.

Assessment of anti-proliferative effect of selected herbal extracts in animal cancer cell lines and their effect against Bovine papillomavirus induced tumors in experimental model

To study the occurrence of bovine papillomatosis in cattle population in and around Mukteswar (Uttarakhand), totally 21 wart samples were collected and preserved. Further, all the wart samples were subjected for molecular detection and histopathological study. The PCR protocol using different sets of primers was optimized for detection from clinical cases. All the positive amplicons were cloned in pGEMT easy TA cloning vector and the recombinant clones were sent for sequencing. For anti-proliferative effect of herbal extracts, leaves of bicchu (*Urtica dioica*) were collected and phytochemical analysis of the herb is in progress.

Phytocompounds as inhibitors of matrix metalloproteases and therapeutic agent for cancer

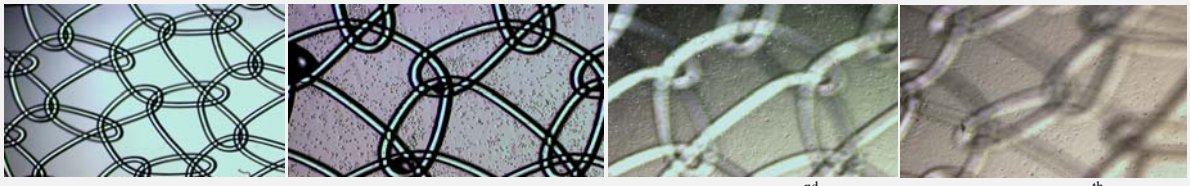
Antimetastatic effect of bacosine (*Bacopa monnieri*) and alizarin (*Rubia tinctorium*) as inhibitors of MMP were studied on mouse breast cancer cell line (4T1). The IC_{50} on the basis of cytotoxicity of 4T1 cell line was 21 µM and 495 µM, respectively. However, the IC_{50} was found to be above 1 mM concentration for MDCK cell line for both the phytocompounds indicating that bacosine and alizarin were non-toxic to normal cell line. The 5% hemolysis was observed at 200 µM concentrations of alizarin and 320 µM of bacosine indicating no toxic effect on red blood cells. The expression study of MMP-9 and MMP-11 by qPCR revealed the downstream expression of both the genes in 4T1 cells treated with alizarin and bacosine. The enzyme activity of MMP-11 and MMP-9 was inhibited in bacosine and alizarin treated 4T1 cells studied using gelatin zymography. Transwell chamber invasion assay showed slight inhibition of invasion at 50 µM bacosine and 600 µM alizarin. Flow cytometric analysis showed apoptotic and necrotic changes in 4T1 cells treated with bacosine and alizarin, respectively.

3.7
Stem Cell Research for Clinical Applications

Bioactive meshes: An innovative stem cell delivery system for therapeutic application

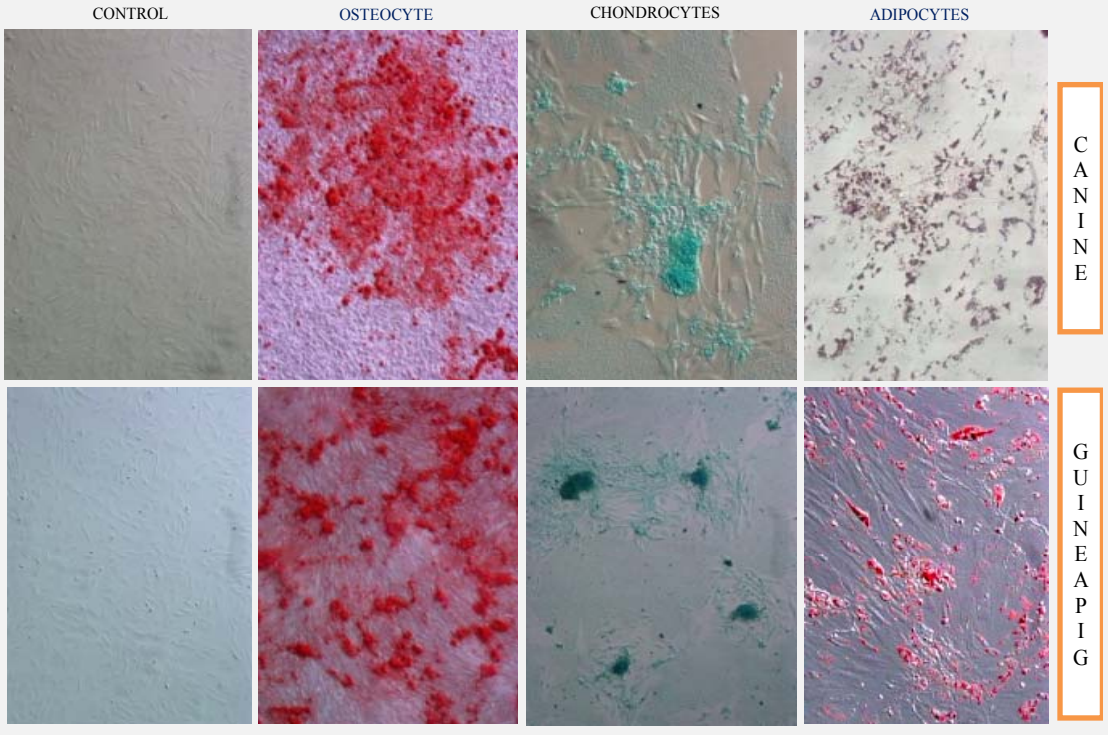
Isolation, proliferation, molecular characterization and *in vitro* differentiation of canine and guinea pig bone marrow mesenchymal stem cells (MSCs) were done. Conditioned media (CM) of both the cell types were collected and lyophilized. For augmentation of mesh material with MSCs and its conditioned media, the surgical mesh was treated with either of the two compounds, viz. gelatin from porcine @ 0.1% in sterile distilled water and/or Poly-L-Lysine @ 0.1% in sterile distilled water to promote cell adhesion to the inert support before incubation with MSCs. MSCs and CM adherent mesh were prepared and the cells were cultured over the coated mesh. Detachment of cells from mesh scaffold was done for counting of MSCs onto the mesh. A cryopreservation protocol for MSC augmented mesh scaffold was also standardized.

The canine and guinea pig MSCs were repeatedly passaged and the same were submitted to the Institute VTCC (IVRI-IZ/2017/C/183 and 184). These MSCs depicted typical fibroblast-like growth with plastic adherence, positive for CD73, CD90 and CD105 and negative for CD34 and CD45 as confirmed by reverse transcription-polymerase



Control mesh in media without cells | Day of seeding MSCs on mesh | Attachment on the 2nd day of seeding | Attachment on the 4th day of seeding

A



B

(A) Impregnation of MSCs to make bioactive mesh; (B) Trilineage differentiation of canine and G. pig MSCs

Generation of stable transfected MSCs

chain reaction (RT-PCR) analysis, immunocytochemistry (ICC) and fluorescence-activated cell sorting (FACS) assay and depicted the tri-lineage pattern after the post thaw from mesh material. To demonstrate the homing property, the pGL4.51 vector that contained a luciferase reporter gene was used to transfect MSCs. Successfully transfected cells were injected around the skin wound in guinea pigs and *in vivo* imaging was done at different time intervals. It was revealed that transfected MSCs migrated and concentrated predominantly towards the center of the wound. The application of biological mesh as MSCs delivery agent was tested in guinea pig model along with MSC-conditioned media (CM) group and it was found that CM performed equally well. This outcome confirms that MSCs reach to the site of injury by its homing mechanism and can be used as a potent therapeutic candidate as cell based therapies.

Nanomaterial-based propagation and differentiation of animal stem cells for therapeutic applications

A 3D composite scaffold made up of natural polymers (beads) was analyzed for porosity, hydrophilicity, and *in vitro* biodegradability to check the suitability for propagating animal stem cells. A high porosity of beads is critical to facilitate cell seeding and diffusion throughout the complete structure of each cell and nutrients. The porosity of the beads prepared in the laboratory was assessed utilizing the liquid displacement technique and was found to be 86.73%. The hydrophilicity of the scaffold serves as one of the vital aspects in the evaluation of biomaterials for tissue engineering as it is crucial for the absorption of body fluid and for transfer of cell nutrients and metabolites. The swelling ratio of beads was found to be above 600% after immersion in PBS for 10 min and increased with time, which reflects the excellent hydrophilicity of the scaffold. After 60 min, no further swelling of beads (negligible swelling effects) was observed, which indicated the equilibrium point of swelling. The composite scaffold showed good biodegradability when kept in PBS solution as indicated by weight loss at various time points. The degradation comes out to be nearly 35% on day 5. It is observed that the degradation rate proceeds to 63% and 70% approximately, on day 7 and 21, respectively.

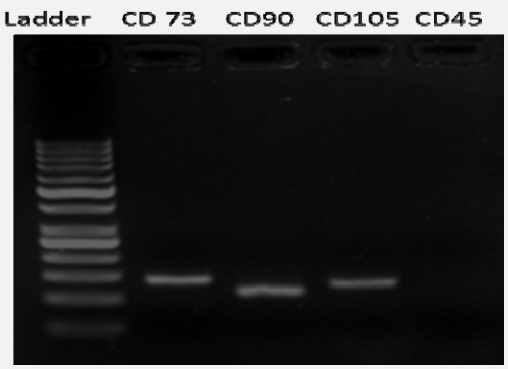
The MSCs cultured in beads were positive for specific markers (CD73, CD90, CD105), indicating the suitability of the scaffold for culturing MSCs.

Generation and characterization of canine iPSC from adipose tissue derived mesenchymal stem cells

Induced pluripotent stem cells (iPSC), generated by reprogramming adipose tissue derived mesenchymal stem cells were transfected with mouse specific pluripotent genes. Following transduction, many putative iPSC colonies appeared. These colonies were further propagated and characterized. The colonies displayed

A

(A) Canine iPSC grown on COOH-functionalized carbon nanotube.



B

(B) Expression of MSC specific markers when cultured in 3D scaffold

embryonic stem cells (ESCs) like morphology, viz. positive for alkaline phosphatase staining, and immune-positive for ESC specific markers Oct4, Nanog, SSEA1, TRA-1-60 and TRA-1-81. The colonies were propagated for more than 60 passages. This is the first report at national level for generation of canine iPSC using adipose tissue derived mesenchymal stem cells.

Canine iPSC (ciPSC) were propagated by mechanical dissociation on gamma irradiated MEF Feeder layer (control) as well as on both COOH-Small Walled Carbon Nano Tube (T1) and Multi Walled Carbon Nano Tube (T2) scaffolds under standard culture conditions. Cell morphology was observed at day 1, 2 and 3 of culture. It was observed that the colonies grew faster on CNT scaffold and the size (spreading) was quite larger than colonies grown on MEF feeder. To localize the iPSC markers (Oct4, SSEA, Nanog, TRA-1-60, TRA-1-81) in ciPSC-as grown on MEF Feeder layer (control) as well as on both COOH-SWCNT (T1) and MWCNT (T2) scaffolds under standard culture conditions immunocytochemistry was done. The ciPSC grown on feeder, T1 and T2 scaffolds expressed all the pluripotency markers tested. The ciPSC could be propagated for more than 20 passages maintaining colony morphology on CNT scaffold.

Evaluation of mesenchymal stem cells with or without growth factors (EGF and HGF) for liver regeneration in rat model

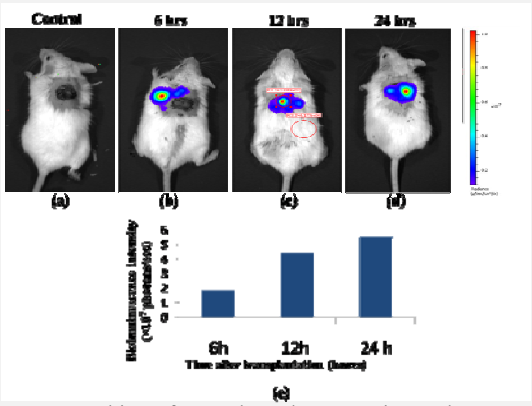
The present study was conducted in 96 Wistar rats divided into eight equal groups to evaluate the potential of rat bone marrow derived stem cells, conditioned media, epidermal growth factor individually and in combination to promote regeneration of liver after partial hepatectomy. Isolation, expansion and characterization of rat bone marrow derived mesenchymal stem cells (rBMSC) were standardized. For preparation of animal models of partial hepatectomy, the animals were anesthetized with xylazine and ketamine combination. A mid-line incision was made through the umbilicus up to the sternum and the left lateral and median lobes (68-70% of liver) were resected and abdomen wall was sutured. Partial hepatectomy wound was treated with only PBS as control; allogenic rBMSC; conditioned media; murine epidermal growth factor (m-EGF); rBMSC with EGF; rBMSC plus conditioned media; m-EGF with conditioned media; rBMSC plus m-EGF plus conditioned media. The liver wound healing was evaluated based on clinical, biochemical, hematological, histopathological, gross observations and immunohistochemistry. Three animals of each group were sacrificed on day10, 20, 30 and 40 of post-surgery. The individual body and liver weight was measured before and after sacrificing each animal. The animals were administered 5-Brdu 2 h prior to sacrifice for collection of samples for immunohistochemistry.

Grossly, liver regeneration in partial hepatectomised animal was found more in stem cell alone and in combination groups compared to other groups. There was an increase in liver weight in the groups treated with mesenchymal stem cells. Epidermal growth factor alone did not induce any significant changes in liver regeneration; however, it was better than the control group. At this point, it seems that stem cells have some positive role in liver regeneration. Results of biochemical, hematological, histopathological, and immunohistochemistry are under process.

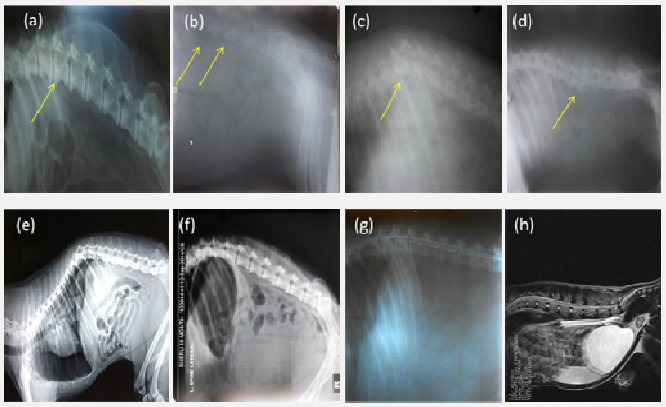
Allogenic canine mesenchymal stem cells can serve as a potent therapeutic candidate for spinal cord injury

This study was conducted to characterize canine bone marrow derived mesenchymal stem cells (BMSCs); *in vivo* tracking in mice, and therapeutic evaluation in canine clinical paraplegia cases. Canine BMSCs were isolated, cultured, characterized *in vitro* as per ISCT criteria and successfully differentiated to chondrogenic, osteogenic and adipogenic lineages. To demonstrate the homing property, BMSCs were transfected with pGL4.51 vector containing luciferase reporter gene. A 2x2 cm^2 excision wound was created aseptically on the dorsum of mice and successfully transfected cells were injected around the skin wound in mice and *in vivo* imaging was done at 6, 12 and 24 h post BMSCs delivery. *In vivo* imaging revealed that transfected BMSCs migrated and concentrated predominantly towards the centre of the wound.

The allogenic therapeutic potential of BMSCs was evaluated in canine clinical cases at IVRI polyclinic with written consent of the owners. A total of 44 clinical cases of spinal cord injuries (SCI) which were confirmed by clinical symptoms aided with radiographs, myelographs and MRI were divided in two groups (22 animals in each group). One group was treated with allogenic BMSCs (treatment) and the other group was treated with conventional therapy (control). Therapeutic potential as evaluated by different body reflexes and recovery score depicted significantly better results in stem cell treated group as compared to control group. In conclusion, it can be stated that MSCs possess homing property and can serve as a potent therapeutic candidate in cell based therapies even in allogenic mode, especially for diseases like SCI,



In vivo tracking of transplanted BMSCs in rats by bioluminescent imaging (BLI)

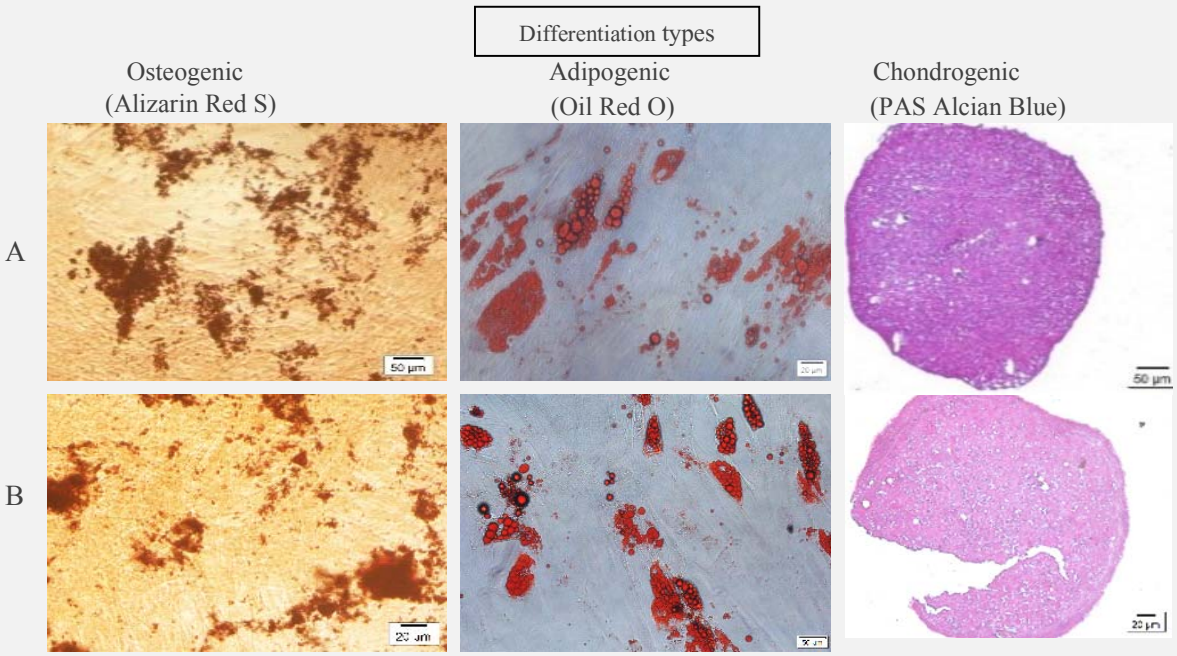


Diagnosis of spinal defects by different imaging devices in dogs: Radiographic (a-f), Myelographic (g) and MRI (h) appearance in selected cases of spinal cord injury

where the conventional medication is not so promising.

Additional step for selective lysis of erythrocytes may not be required for derivation of mesenchymal stem cells from porcine bone marrow

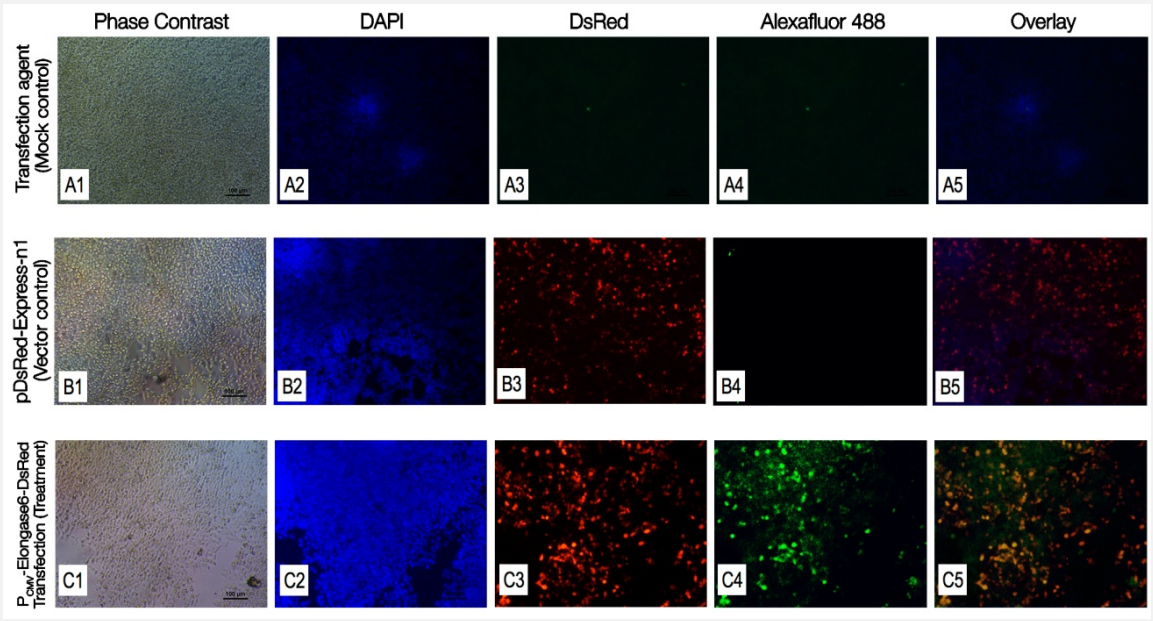
Porcine mesenchymal stem cells (MSCs) are plastic adherent cells, popularly isolated from bone marrow. To isolate MSCs, bone marrow cells are plated either directly or indirectly after enrichment by differential density centrifugation and lysis of erythrocytes. However, the relative advantage of direct plating *vs.* plating after erythrocytes lysis is not known. As a proof-of-concept, pig bone marrow cells were processed for derivation by direct plating and after erythrocyte lysis in uniform culture condition and media formulations. The time taken for confluence in the first passage, cell morphology, presence of pMSC marker genes and the lineage specific differentiation potential at passage 5 were tested in both the groups. The results indicated that the cells adhered similarly in both the methods, reached 80% confluence in about 10 days, appeared with similar morphology, with no difference in quality and expression of pMSC markers and maintained similar differentiation potential to lineage specific osteogenic, adipogenic and chondrogenic cells. Therefore, it is recommended to seed the bone marrow cells directly for MSC derivation in pig, and this method is easy to follow and less inexpensive.



Multilineage differentiation of passage 5 porcine MSC derived by direct plating (A) and after erythrocyte lysis (B) treatment: Calcium deposits in cells were confirmed by Alizarin Red S, lipid droplets of adipocytes by Oil Red O and glycosaminoglycans of chondrocytes by Periodic Acid Schiff's (PAS)-Alcian blue staining of sectioned aggregated differentiated cells. Cells were differentiated uniformly for 21 days for all the cell lineage types. Scale bars (µm) are shown in the respective image

Porcine ELOVL6 can be expressed in heterologous human cell line

Among various therapeutic targets, microsomal enzyme Elongase6 (ELOVL6) is considered to be one of the promising candidates in metabolic diseases such as obesity, diabetes and insulin resistance. Inhibition of ELOVL6 protects the obese mice against diet-induced insulin resistance. The same gene is expressed in MSCs. It was hypothesized that expression of porcine ELOVL6 could be supported by human cells. Accordingly, an expression cassette with porcine ELOVL6 gene in-frame with a red fluorescent protein (DsRed) as a reporter gene was constructed and its expression was assessed by detection of immunofluorescence in transfected heterologous host system (HEK293T cells). The co-expression of green- and red-fluorescence, corresponding to ELOVL6-DsRed fusion protein, confirmed that the construct is functional constitutively and hence is suitable for further over-expression study.



Transient expression of recombinant porcine Elongase6 in HEK293T cells 48h post-transfection. HEK293T cells were grown and transfected with pDsRed-Express-N1 (empty vector), PCMV-Elongase6-DsRed (transgene expression vector) or sole polyethylenimine reagent (no plasmid, mock control). At 48 h post-transfection, cells were fixed, immunostained to detect expression of Elongase6 protein (green) (for detail procedure, see text). Under a fluorescence microscope, cells expressing DsRed protein fluoresced red and nuclei stained with DAPI fluoresced blue. Photomicrograph of mock transfected HEK293T cells under bright field (A1), DAPI (blue) (A2), red channel (A3), green channel (A4), and overlay (A5) showed no fluorescence. For empty vector group, cells fluoresced blue (B2) and red (B3), not green (B4). (B1) The bright field image and overlay was shown in B5. However, in transgene expression vector group, cells exhibited blue (C2), red (C3) and green (C4) fluorescence. Phase contrast (C1) image and overlay of all different fluorescent channels (C5) are also shown. Scale bar=100 µm.

3.8
Clinical Research and Services

Composite scaffolds for bone and tendon repair using tissue engineering techniques

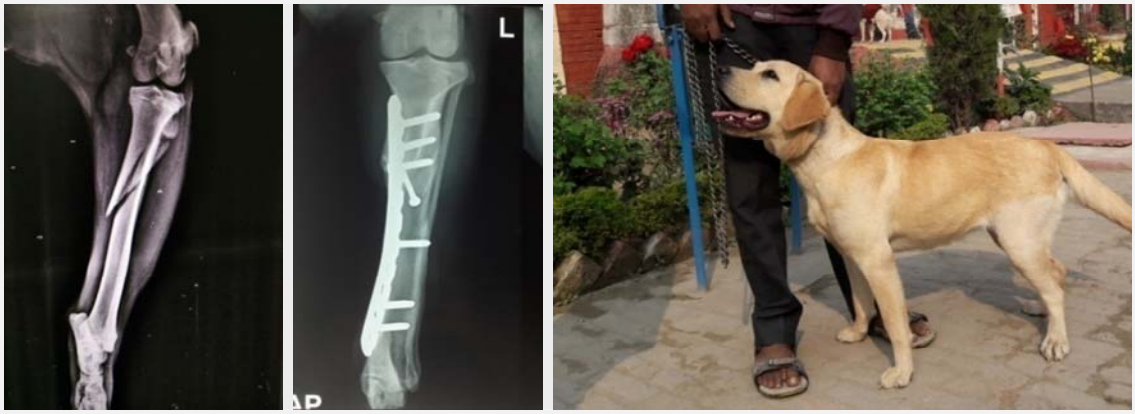
Bone and tendon biomaterials were prepared for the healing of the lost bone and tendon tissues by using tissue engineering techniques. These scaffolds were successfully found to be integrating well with the host tissue without any exudation, inflammation and necrosis which reflects a good potential and promising use of these biomaterials in the tissue losses. The composite scaffolds of bone and tendon were then prepared by seeding the fetal cells (isolated and characterized) of the experimental animals on the acellular xenogenic (bubaline derived) bone and tendon tissues. These composites were then evaluated for the healing of the bone and tendon critical gap defects. These grafts were found to be superior over the acellular grafts. However, both were found to be useful for tissue gap defects of tendon and bones. These composite grafts were then cryopreserved at -80°C in the growth medium containing 10% glycerol for a period of six months. The grafts were then evaluated for healing of the tissue gap defect healing. The experiment was designed by using a standard protocol. They were compared with their respective groups of freshly seeded composite grafts and autograft which is a gold standard. The healing was evaluated using the scores of pain, exudation, inflammation, weight bearing, serial photography of the wound, radiography, ultrasonographic examination (in case of tendon tissue) and histopathology etc. It was found that the freshly seeded composites of bone and tendon as well as the seeded cryopreserved grafts of both tendon and bone were accepted well as appreciated by the scores of the above parameters. However, the seeded grafts of bone and tendon both showed better and significantly early healing than the acellular grafts. The cells also have contributed to lower score of pain, inflammation, exudation and early remodeling of the tissues. In both the tissues, there is healing by substitution of the host tissue and degradation and resorption of the grafts. So the composite bone and tendon grafts can be cryopreserved at -80°C for six months period for future use. These acellular grafts are being applied in clinical cases of bone and tendon gap defects.

Diagnostic imaging and management of surgical conditions in animals

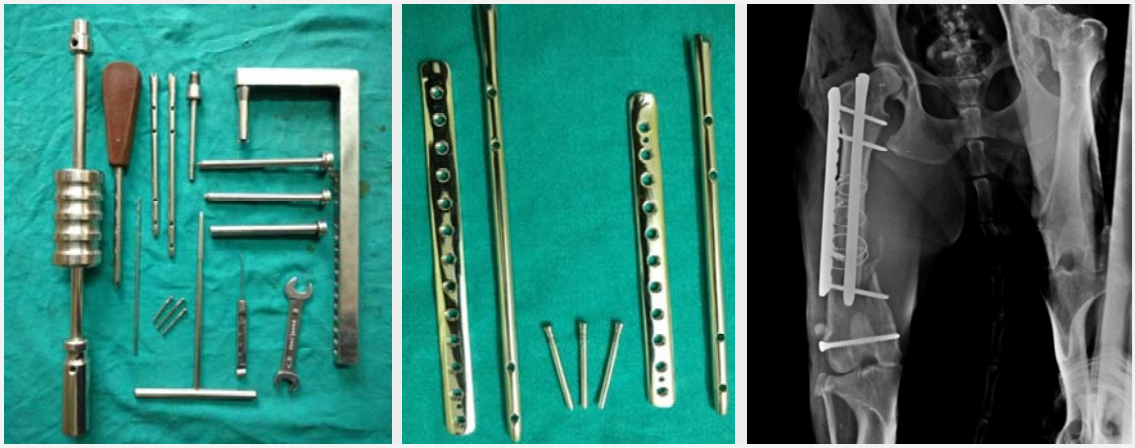
Metallic CESF, M-seal circular ESF, Stack intramedullary pinning and Acrylic cast were found suitable for fracture fixation in ruminants. Full and half ring fixator designs have been prepared and fabricated locally and are ready for the biomechanical study.

Hybrid locking plating technique produced excellent bone healing in dogs. A plate-interlocking nail construct for the repair of diaphyseal femur fractures in dogs was designed and evaluated in clinical cases.

Repair of congenital bilateral contracted carpal flexors using tissue engineered scaffolds



Hybrid locking plate fixation in dog



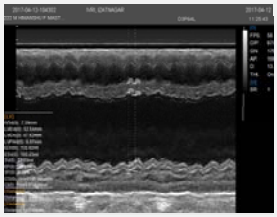
Designing and application of plate interlocking nail construct in dogs

Radiographic and ultrasonographic imaging for the diagnosis of cardiorenal syndrome in dogs

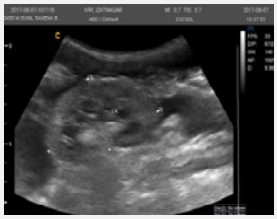
Conventional and Doppler echocardiographic evaluation was carried out in 102 cases suspected of cardiac abnormalities out of which 35 were found to have confirmed primary cardiac abnormalities. Doppler evaluation of renal hemodynamic parameters was also done for these dogs. Analysis of data revealed a strong correlation of renal resistive index with systolic function parameter (ejection fraction) and diastolic function parameter (isovolumic relaxation time and its ratio with peak Mitral E velocity). Biomarker studies are underway. During the year, 52 dogs were referred to the ultrasonography unit with suspected renal abnormalities out of which 73% cases were found to have confirmed renal changes on ultrasonographic examination but no changes in cardiac systolic and diastolic function were observed. Biomarker studies are underway.

Reconstruction of full thickness skin wounds in rats using bioengineered caprine forestomach matrix fabricated with cell adhesion molecules

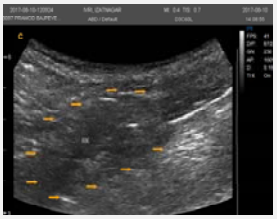
The goat forestomach matrix was decellularized using sodium dodecyl sulfate. Status of decellularization was assessed on the basis of histopathology, protein estimation, DNA quantification and SDS-PAGE analysis. The processed ECM at 48 h was found to be suitable without compromising biological activity and mechanical integrity. Mesenchymal stem cells from rat bone marrow were separated for *in vitro* and *in vivo* application. Cell adhesion molecules corresponding to fibronectin, vitronectin and laminin proteins were synthesized and used to



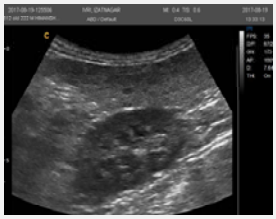
Normal kidney in a dog



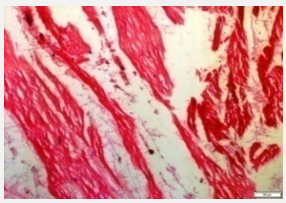
Loss of corticomedullary differentiation

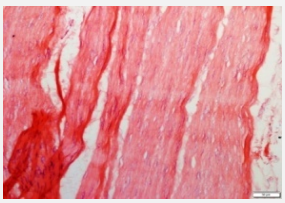


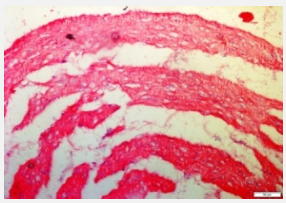
Increased renal contical thickness

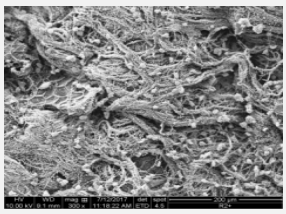


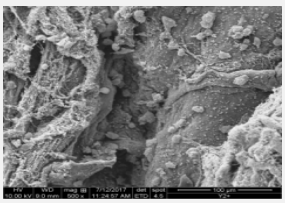
Severe congestive heart failure in dog

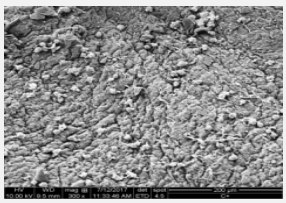

Decellularized caprine rumen

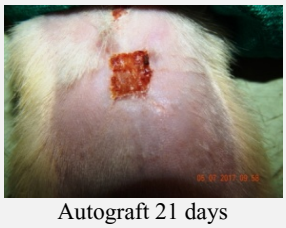

Decellularized caprine reticulum

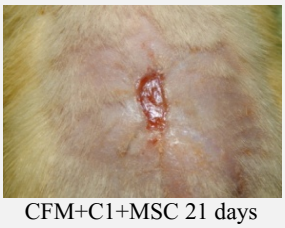

Decellularized caprine omasum

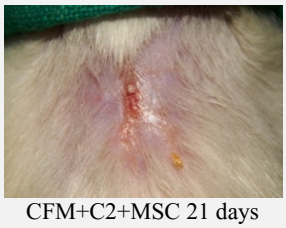

CFM+C1+MSC

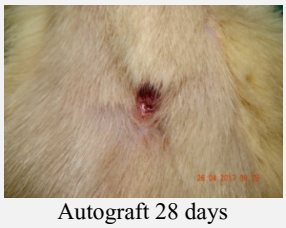

CFM+C2+MSC

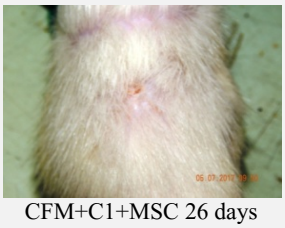

CFM +MSC

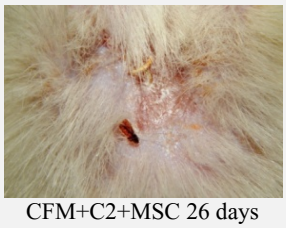

Autograft 21 days


CFM+C1+MSC 21 days


CFM+C2+MSC 21 days


Autograft 28 days


CFM+C1+MSC 26 days


CFM+C2+MSC 26 days

fabricate the CFM to improve adhesion of stem cells over the processed biomaterials. The bioengineered CFM were characterized for their structure using light as well as electron microscopy. The cell adhesion molecule fabricated CFMs were tested for their wound healing properties in a full thickness skin wound in rat model. Further, the bioengineered CFMs were able to reduce the healing time by 25-30% as compared to autograft. Further, the post-surgical assessment of different behavioral, clinical, histological and immunological parameters also reflected suitability of xenogeneic bioengineered CFMs for tissue regeneration.

Clinical management of Keratoconjunctivitis Sicca (KCS) in dogs

Out of 119 ophthalmic cases evaluated, nearly 11% animals had early and 6.7% had late KCS. Animals having ulcers (13.44%) were treated with graft and in others tarsoraphy was done. The rest of the ophthalmic cases were treated medically which included conditions like ulcer other than KCS (13), conjunctivitis (13), corneal opacity (11), cataract (10), sudden vision loss (7), ocular injury (7), lens luxation (4), cherry eye (4), glaucoma (2), pigmentary keratopathy (2), nasal fold trichiasis (1), uveodermatological syndrome (1), granulomatous growth (1), stye (1), tarsal gland swelling (1), microphthalmia (1), congenital anomaly (1), papilloma (1), dermoid cyst (1) were also treated. Both Tacrolimus 0.1% ointment and CsA 0.05% eye drops improved tear production in KCS affected dogs. Topical Tacrolimus 0.1% ointment effectively arrested the progression of pigmentation compared to CsA 0.05% eye drops in KCS affected dogs. Early and late stages of KCS were having a significantly higher expression for caspase 3 (89.33%) and INF γ (85.04%) but late KCS group had lesser expression of caspase 3 (25.56%) when compared to normal animals.

Characterization of membrane transporters of urate secretion in avian renal tubular epithelium for their role in drug induced nephrotoxicity

The attempts to characterize the basolateral transporter SLC22A8/OAT3 cDNA in the domestic chicken (*Gallus domesticus*) and vulture (*Gyps himalayensis*) yielded a 5'-truncated cDNA sequence. To ascertain whether the partial sequence obtained is OAT1 (SLC22A6) or OAT3 (SLC22A8), and also to obtain complete coding region further characterization using RNAseq approach is being attempted. Further, when the effect of diclofenac on OAT mRNA expression in chicken proximal renal tubular epithelial cells (cPTCs) was analysed in real time PCR, normalized

expression in drug treated cPTCs was found lowered as compared to untreated control cells.

ABCC4/MRP4, the renal luminal transporter plays a pivotal role in urate excretion in birds. Attempts are being made to gain molecular insight into urate transport in Gyps vulture through MRP4-expressing cells. Two transcript variants of MRP4 had been detected in domestic chicken (*Gallus domesticus*) as well as vulture (*Gyps himalayensis*). For their functional characterization, MDCK cell lines stably transfected with respective transcript variant were developed. For the purpose, constructs encoding all transcript variants in pCDNA^{TM}V5His backbone were prepared by site directed mutagenesis and fully characterized by sequencing. The stably transfected MDCK cells were characterized at the genomic DNA level and at the cDNA level. Expression of fusion protein with V5 epitope at the C-terminal end was confirmed by IFAT in the cell lines. Further, vulture MRP4 specific MAP peptide with four arms, each consisting 13mer N-terminal amino acid stretch was synthesised. Also partial recombinant MRP4 was expressed, purified and characterized using MALDI-TOF. These two antigens were employed to raise MRP4 specific hyperimmune sera for characterization of protein expression in cMRP4 and vMRP4 expressing MDCK cells.

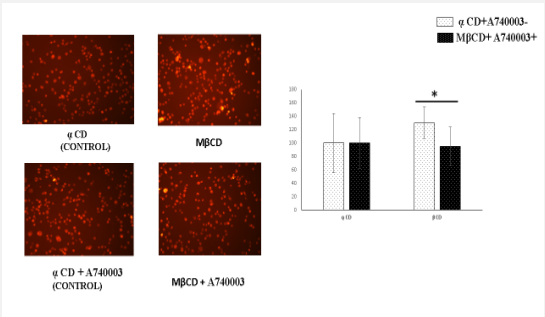
These MRP4 expressing cell lines when cultured in the presence of 50 to1600 µM concentration of diclofenac for 72 h, the cell viability was found reduced. MRP4 appears to be functional as diclofenac efflux transporter in both chicken and vulture (full MRP4 being more functional than 19 amino acid deleted one) as IC_{50} of diclofenac in MRP4 expressing cells was higher than that of mock transfected cells. Significantly higher IC_{50} of diclofenac in cMRP4 cell line ($p<0.05$) indicated higher efflux of diclofenac suggesting faster elimination of the drug (Reported half-life of diclofenac in chicken 2 h as compared to 16 h in Gyps vulture). Further, increase in MRP4-mediated urate efflux compared to mock transfected controls, though statistically non-significant, was observed in the presence of 200 µM diclofenac. It appears that in the presence of diclofenac, urate transport inhibition either due to decreased MRP4 transcripts or drug interaction with basolateral transporter OAT1/OAT3 is contributing to hyperurecemia and higher sensitivity of vultures as compared to chicken.

Role of lipid raft and P_2RX_7axis in mitochondrial side of autophagy

Activation of non-selective cationic channel P_2RX_7 receptor closely associated with disruption of lipid raft, play a crucial role in chronic inflammation and progression of cancer cells. Targeting these associations can be the better target for the therapeutic and preventive intervention. In this project, the role of P_2RX_7 and mitochondrial association in the induction of autophagy in membrane cholesterol depleted cancer was explored. Through agonist and antagonist approach, we have confirmed that P_2RX_7 mediated membrane pore formation is intriguingly associated with the membrane cholesterol depletion and having a profound impact of programmed cell death. Inhibition of P_2RX_7 abrogates the cell death induced by membrane cholesterol depletion in MDA-MB 231 cancer cells. Further, it was confirmed that P_2RX_7 regulates the mitochondrial depolarization which probably induces autophagy (or mitophagy) in membrane cholesterol depleted cancer cells. Further studies are continuing to understand mitochondrial depolarization regulating the onset of autophagy in cancer cells.

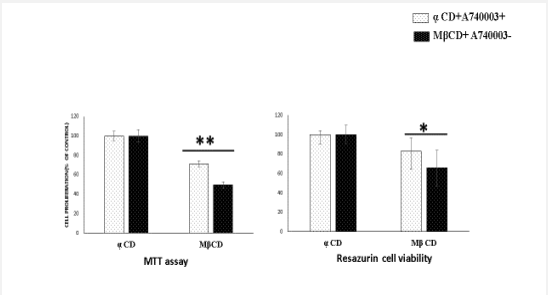
Drug resistance in bacteria of veterinary clinical importance

A total of 302 samples of clinical origin and associated environment, were analyzed for bacterial etiology. The study indicated that β-lactamase inhibitors may induce transient resistance in bacteria, sensitive to β-lactam antibiotics. Since last three years, the extended spectrum β-lactamase (ESBL) production and carbapenemase activity detected commonly among bacteria appears to be at



a

(a) Inhibition of P_2RX_7 by A-740003 reduces EtBr uptake in membrane cholesterol depleted MDA-MB231 cancer cells



b

b) Inhibition of P_2RX_7 by A-740003 reduces cell death in membrane cholesterol depleted MDA-MB231 cancer cells

a stable point. However, colistin, tetracycline and cotrimoxazole resistance is on a rising trend. *Gallibacterium antis* bv haemolytica was detected as cause of two outbreaks in birds. The isolates were sensitive to most of the commonly used antibiotics. *Pseudomonads* were the commonest producers of ESBL (75%) followed by *Salmonella* (71.4%), *Staphylococcus* (65.4%) and *E. coli* (63%). However, none of the eight *Brucella* isolates were ESBL or carbapenemase positive. New Delhi metallo-β-lactamase genes were detected by PCR in *Salmonella enterica* isolated from birds; *E. coli* isolates from pigs and poultry birds. Chloramphenicol and tigecycline were the most effective antibiotics killing 90.1% and 95.2% bacteria isolated from animal or their environment. Drug resistance patterns and trends for last 8 years has been evaluated.

Diagnostic and clinical services at Referral Veterinary Polyclinic- Teaching Veterinary Clinical Complex (RVP-TVCC)

A total of 16738 cases consisting of nearly 67% cases of Medicine, 29% cases of Surgery and 3.7% cases of Gynecology were attended and effective treatments were provided.

Total number of fresh clinical cases presented to OPD (Medicine) of RVP-TVCC, IVRI was around 8034 and further 3821 follow up cases were also treated effectively. The clinical health services were provided to the cattle (292), buffalo (630), horse (84), sheep & goat (1039), dog (5589), cat (168), and poultry and other species (232) for various diseases like bloat, ruminal impaction, acidosis, helminthiosis, theileriosis, anaplasmosis, ketosis, indigestion, gastroenteritis, babesiosis, trypanosomiasis, traumatic reticuloperitonitis, mastitis, colic, tetanus, PPR, mycoplasmosis, dermatitis, canine distemper, parvoviral infection, leptospirosis, babesiosis, hepatozoonosis, ehrlichiosis, pyoderma, congestive heart failure, liver failure, renal failure. Routine vaccination, deworming and other prophylactic measures were also provided to pet and ruminants.

A total number of new cases and follow-up cases were 7742, out of which 5022 new surgical cases were referred by field veterinarian and different sheds of divisions of this institute which were successfully treated. The maximum number of cases were of urolithiasis/urinary obstruction (769), followed by lameness (744), fractures (420), different types of wounds (389), ocular affections (284), otitis (161), posterior paresis (156), different types of tumours (139), multiple trauma (125), caesarean sections (81), aural haematoma (75), ovariohysterectomy (56), castration (47), udder/teat affections (44), foreign body obstruction (30), docking/amputation of tail (24) rickets/NBD (21), rectal / vaginal prolapsed (20), congenital conditions (14), hernias (10), followed by miscellaneous surgical conditions (412) which were treated successfully. 2125 radiographs were taken for diagnosis in clinical cases and for the evaluation of research results in experimental animals. Contrast radiography was also performed for diagnosis. Radiographs were also taken for wildlife cases. 1069 total ultrasonographic scanning were performed, out of which 56 in experimental and 1013 in clinical cases in different species of animals were done for evaluation/diagnosis of cardiac, reproductive tract disorders of ovaries and uterus, GIT and urinary tract disorders and for pregnancy diagnosis. In the OPD of Gynaecology and obstetrics, 984 cases were treated effectively. Out of those clinical cases, 212, 245 and 195 cases were of dystocia/induced calving, pregnancy diagnosis and uterine infection.

A total of 1297 samples from bovine, caprine, equine, canine, feline, avian and other species were analyzed in Clinical Diagnosis Laboratory. A total of 1205 blood samples were subjected to haematological tests such as, estimation of haemoglobin, total erythrocyte count, total leukocyte count, differential leukocyte count and packed cell volume. The peripheral blood smears (1070) were examined for presence of haemoprotozoan parasites. Fecal examination was conducted in 40 cases for the presence of eggs/larvae of various parasites. The skin scrapings were examined for the presence of mites in 27 animals. Routine urine examination of 25 animals was done.

Among the haemoprotozoan parasites, *Babesia* sp., *Theileria annulata*, *Erhlichia canis*, and *Hepatozoon* sp. were recorded in different animal species. In dogs, *Babesia gibsoni, Babesia canis/Babesia vogeli, Erhlichia canis* and *Hepatozoon canis* were recorded in 19, 13, 36 and 16 samples, respectively. In bovine, 13, 5 and 12 samples were found to be infected with *Theleria annulata, Babesia* sp. and *Anaplasma marginale* infection, respectively.

Healthcare management at institute farms

Cattle and Buffalo Farm: A total number of 1126 cases were treated for various ailments. A total of 3508 animals were vaccinated for FMD, HS and brucellosis. Deworming (2689 animals), anti coccidial therapy (741 calves), application of ectoparasiticide (4040) were also accomplished. Supplementation of multivitamins was given to 1419 animals. A total 208 cows were provided dry cow therapy.

Swine Production Farm: A total 1041 cases were treated for various ailments and 323 animals were vaccinated against FMD and 150 animals were vaccinated against classical swine fever. Deworming (216 animals) and ectoparasite spraying (150 animals) was also done.
Sheep and Goat Farm: Vaccination was carried out in 1308 animals against FMD, PPR, ET, HS, and Sheep pox. Deworming in 334 animals against gastro-intestinal parasites and spray/dipping of 146 animals with acaricidal solution was done.

Animal health services at IVRI, Mukteswar

Total of 810, 53 and 11 fecal samples of goats, cattle, langur, respectively were screened for the endoparasitic prevalence by conventional and molecular methods. The prevalence rates of gastrointestinal parasites were 89.12%, 56% and 6% in goats, cattle and langur, respectively. The representative positive samples of goats were subjected to larval culture and further identification by morphological and PCR-RFLP. Fecal culture analysis and PCR-RFLP revealed that *Haemonchus contortus* and *Teladorsagia circumcincta* were predominant parasites. Other notable strongyle infections were *Oesophagostomum* sp., *Bunostomum trigonocephalum* and *Trichostrongylus* sp. In general, mild coccidian infection was present throughout the year and intensity was more during winter months in goats and calves. All the farm animals were dewormed / deticking accordingly. For deworming, fenbendazole/albendazole, closantel and ivermectin were used sequentially. Animals were treated rotationally with Cypermethrin, Deltamethrin and Ivermectin for tick control at Experimental Cattle Herd (ECH).

Necropsy examinations of different livestock and experimental animals were conducted during the period (cattle - 21, goats - 44, sheep – 10, rabbit - 16 and guinea pig - 8). Among cattle, sheep, goat and laboratory animals, the major cause of death was pneumonia. Of these, 66% cattle were younger than 6 months of age. Similarly, in goats and sheep, majority of the necropsied animals were below 6 months of age. Additionally, 2 Sambar deer were also necropsied and the major findings included impaction of rumen with polythene bags. In Experimental goat farm (EGF), screening of goat serum (n=55) for brucellosis was performed using RBPT and STAT test and all the samples were found negative. Cattle (n=54) from ECH were screened for brucellosis and found negative. Eighty cattle at ECH, 34 goats at EGF, 15 laboratory animals at Laboratory animal production section and 93 animals of Virology Division were treated for specific ailments. Feed supplement was given to 35 cattle and 135 goats. Parasitic control measures were under taken for 1766 animals. For prevention of FMD in livestock, all animals of ECH, EGF, Surmane were vaccinated. In the institute veterinary dispensary unit, 347 animals of farmers were treated.

Diagnostic Clinical Microbiology

Enteric pathogens in neonates

Analysis of 102 fecal samples for *E. coli* and *C. perfringens* revealed all to be positive for *E. coli* and 21 for *C. perfringens*. Screening of *E. coli* to characterize pathotypes resulted in the identification of 40 EPEC and 16 VTEC pathotypes.

Detection of enteric pathogens by antigen based indirect – ELISA was done. A total of 110 fecal samples from diarrheic neonatal calves collected from various places of northern India were screened by multiplex ELISA kit (Bio-X Diagnostics, Belgium) for antigenic diagnosis of rotavirus, coronavirus, *E. coli* F5 attachment factor and *Cryptosporidium*. Study revealed the antigenic diagnosis of rotavirus in 10 samples (9%), coronavirus in 5 samples (4.5%), *E. coli* K5 in 2 samples (1.8%) and *Cryptosporidium* in 15 samples (13%).
Salmonella: A total of 96 cultures received from different institutions during the year were subjected to standard method of serotyping (Kauffman-White scheme). Of these, 90 isolates were found to be positive for Salmonella belonging to 3 different serotypes/serogroups. Serotypes identified were *S.* Kentucky (56.66%), *S.* Virchow (25.55%) and *S.* Typhimurium (17.78%).
Clostridium spp.: A total of 32 samples suspected for clostridial infections from cattle, buffalo, sheep and pigs were received. Out of these, 2 samples were positive for *Clostridium perfringens* and remaining samples were negative for *Clostridium* sp.
Pasturella multocida: A total of 45 isolates suspected *for P. multocida* were screened by cultural and molecular methods. Three isolates were confirmed positive for *P. multocida* belonging to capsular type A and B.
Leptospirosis: A total of 79 sera samples of different animal species (goat-15, sheep-1, lion-14, sloth bear–3, cattle-34, leopard-2 and tiger-6) were screened by microscopic agglutination test. Out of these, 5 sera samples (2 goats, 2 lion, 1 sloth bear and 1 cattle) tested were positive for agglutinins against leptospira. Pomona was the predominant serovar among the tested samples.
Mycoplasma: In total, 201 clinical samples of nasal swab, lung, milk, uterine fluid, serum and cell line were collected/ procured from different animal species *viz*., cattle, buffalo, goat, sheep, poultry, pig, horse, tiger, vulture, dear and cell lines. Of these samples, 8% samples were found positive for

Mycoplasma spp. by PCR and 21% were found positive for *Mycoplasma* sp. antibody.

Mycotic infections: Testing of 123 samples for fungal agents revealed 42.27% positivity. Out of 82 dog samples, 31.70% were found positive for fungal agents. Important fungal agents identified were *Alternaria* sp, *Malassezia* sp, and *Aspergillus niger*, *A. flavus*. Ten of 17 samples of goat were positive for *Candida* sp./*Alternaria* sp.. Two samples of vulture were positive for *A. flavus* and *A. fumigatus.* In addition, *Aspergillus flavus* and *Rhizopus* sp. was detected from feed samples, whereas milk sample was found positive only for Candida spp.

***Parasitic infestations*:** During the period 2017-2018, parasite material/samples collected from domestic/pet/wild animals/human were received from various places as mentioned below for identification/diagnosis. The results of diagnosis are tabulated below:

Diagnosis of parasitic diseases in biological samples

S.No.	Animal species	Sample type	Agency	Reported parasites
1.	Dog	Blood-353	Govt. agencies (Police, Military, RPF, SSB, CISF etc.) / Vets/ owners	Blood: *Babesia gibsoni* (07), *B. canis vogeli* (14), *Ehrlichia canis* (52), *Hepatozoon canis* (13), Mixed infection (01: *A. phagocytophilum* + *H. canis*)
2.	Large ruminants (cattle/buffalo)	Blood-64, Fecal-30	Vets./ Clinicians/ Owners/Health camps	Blood: *Theileria annulata* (06), *Babesia bigemina* (05), *B. bovis* (01), *Anaplasma marginale* (07), Mixed infection: *T. annulata*+*B. bigemina* (03) Fecal: All negative
3.	Small ruminants (sheep/goat)	Fecal-25, GI Content-01	LPM Division/ Pathology Div.	Fecal: *Stronyloides* (03), Coccidia (08) GI Content: *Haemonchus contortus* (01), *Oesophagostomum columbianum* (01)
4.	Equine	Blood-06, Faeces-01, St. content-01	Clinicians/ Owners	Blood: All negative Fecal: Negative Stomach content: *Gasterophilus* sp.
5.	Sloth Bear	Blood-01, Faeces-05, Muscles-01	WLC, IVRI	Blood: Negative Fecal: *Taenia* sp. (02) Muscles: Negative for nematode larvae
6.	Elephant	Liver tissue with cyst-01, Gross Parasite-03	WLC, IVRI	Cyst: Hydatid (01) Gross Parasite: *Murshidia* sp. (01), *Bathmostomum* sp. (01), *Cobboldia elephantis* (larvae) (01)
7.	Himalayan Vulture	Blood-02, Fecal-12, GI Content-01	WLC, IVRI	Blood: *Haemoproteus* Fecal: All negative GI content: Negative
8.	Nilgai	GI Content-01	WLC, IVRI	Parasite in GI cont.: *Mecistocirus digitatus*
9.	Deer (Musk deer, Black buck, spotted deer etc.)	Blood-22, Fecal-78, GI Content-03, Muscle-01	WLC, IVRI	Blood: Negative Fecal: *Mullerius* (26), Strongyles (01) Parasite in GI cont.: *Mullerius* (02), *Fischoederius* sp. (01), Muscle: Negative
10.	Big cats (Lion/ Tiger/Leopard)	Blood-30, Fecal-12, Muscle-18, Int. content-08, Gross Parasite-06	WLC, IVRI	Blood: *Hepatozoon felis* (01) Fecal: Negative Muscle: *Trichinella* larvae (08) Int. cont.: *Toxocara cati* (02), *Physeloptera* sp. (02), *Spirometra* sp. (02), *Trichuris* sp. (01) Parasite: *Toxocara cati* (02)
11.	Wild boar, Wolf, Jackal, Crocodile & Porcupine	Muscles-05 (one of each species)	WLC, IVRI	Muscle: All negative for nematode larvae
12.	Other zoo/ wild animals etc.	Fecal:02, Gross Parasites:01	WLC, IVRI	Fecal: All negative Parasites: Ticks (in Caracal)
13.	Humans	Gross Parasite:01	NCDC, New Delhi	Parasites: *Dirofilaria* sp. Parasite: *Trypanosoma brucei rhodesiense*

Int.cont.-Intestinal content

3.9 Disease Monitoring and Surveillance

Enteric viruses in cattle, buffalo and small ruminants

During the period, 300 diarrhoeic and non-diarrhoeic faecal samples from cattle (n=212), buffalo (n=24) and caprine (n=64) were screened for Astrovirus (AstV) and Coronavirus (CoV) infection. The presence of AstV and CoV was affirmed by RT-PCR method targeting the polymerase gene (ORF1b) for AstV and Nucleocapsid gene (N) segment for CoV, respectively. Astrovirus infection was seen in 22.17% (47/212) of cattle calves, whereas in samples from buffalo calves 4.17% (01/24) were found positive. In small ruminants, 28.13% (18/64) of caprine samples were found positive for AstV. Overall, percent positivity for the AstV infection was 22% (66/300). Similarly, in the diagnosis of CoV infection, 16.92% (11/65) of cattle calves were found positive whereas 22.73% (05/22) of buffalo calves and 9.38% (06/64) of goat samples were found positive. Overall, percent positivity for the CoV infection was 14.56% (22/151).

Enteric viruses in porcine and poultry

In the routine diagnosis of enteric viruses in porcine and poultry species, 33.76% (26/77) of porcine samples were found positive for RV-A infection, whereas 23.21% (13/56) of poultry samples were found positive for RV-D infection. For picobirnavirus (PBV) diagnosis, 40 porcine samples were screened out of which 32 (80%) were found positive, and all were GG-I type, whereas 13 samples tested positive of GG-II type. Porcine samples were also tested for Kobuvirus (KobV) where 45% (18/40) of samples were found positive.

Epidemiology of rotavirus A (RV-A) in pigs

The VP6 gene based RT-PCR based screening of the samples for RV-A identified 42.4% (321/757) positivity. Highest prevalence was seen in Uttar Pradesh (119, 37.07%), followed by Assam (74, 23.05%), Nagaland (34, 10.6%), Meghalaya (31, 9.65%), Tripura (21, 6.54%), Kerala (15, 4.67%), Manipur (11, 3.43%), Mizoram (8, 2.49%), AP (3, 0.93%), Karnataka (3, 0.93%) and Tamil Nadu (2, 0.62%).

Diagnosis of enteric viruses in wildlife samples

In the routine detection of enteric viruses, 15 wild mammals and 14 wild bird species were screened for different enteric viruses. In RV-A diagnosis, 14 wild mammal samples from sambar deer were found positive followed by 07 sloth beer, 02 each from bear and leopards and 01 each from goral, blue sheep, red panda, japmon, wolf, leopard cat, tiger and deer. For PBV, 08 sambar deer samples were found positive followed by 03 goral and 04 deer samples. In coronavirus diagnosis, 04 deer samples, 02 sambar deer samples and 01 sample each from bear, red panda, leopard cat and leopard were diagnosed positive.

Molecular screening of wild mammals for enteric viruses

S. No.	Species	Total Samples	RVA	PBV	CoV	AstV
1.	Blue golden macaque	01	00	00	00	00
2.	Goral	08	01	03	00	00
3.	Bark Deer	05	00	00	00	00
4.	Blue Sheep	02	01	00	00	00
5.	Bear	02	02	00	01	00
6.	Red panda	02	01	00	01	00
7.	Japmon	03	01	00	00	00
8.	Wolf	01	01	00	00	00
9.	Leopard Cat	01	01	00	01	00
10.	Palm Civet	01	00	00	00	00
11.	Leopard	03	02	00	01	00
12.	Tiger	02	01	00	00	00
13.	Sambhar deer	22	14	08	02	00
14.	Sloth bear	24	07	00	00	00
15.	Deer	09	01	04	04	01

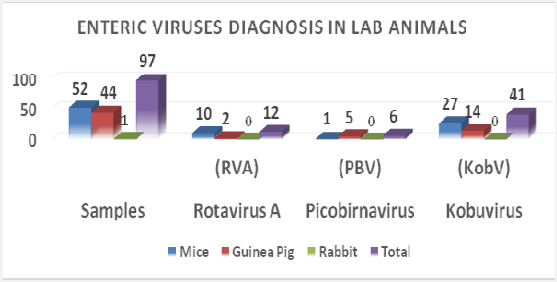
In the enteric virus diagnosis of wild birds, 18 peacock samples screened from Tamil Nadu were found positive for RV-D infection, whereas 02 and 01 sample from large hawk cuckoo and Kalij pheasant were also found positive for RV-D, respectively. All the wild bird samples were found negative for RV-A infection.

Molecular screening of wild birds for enteric viruses

S. No.	Species	Total Samples	RVD
1	Golden Pheasant	04	00
2	Kalij Pheasant	05	01
3	Large Hawk Cuckoo	04	02
4	Cheer Pheasant	02	00
5	Parakeet	02	00
6	Cocktail	02	00
7	Sunconure	02	00
8	White Pheasant	01	00
9	Hill Patridge	01	00
10	Jungle Fowl	01	00
11	Silver Pheasant	01	00
12	Edward Pheasant	01	00
13	Vulture	01	00
14	Peacock	23	18

Enteric viruses in laboratory samples

Faecal samples (n=97) from laboratory mice (n=52), Guinea pig (n=44) and rabbit (n=01) received from Lab Animal Facility of Central Research Institute at Kasauli (H.P) were screened for enteric virus infections. In mice, RV-A infection was found in 19.23% (10/52), PBV infection in 1.93% (1/52) and Kobuvirus infection in 51.93% (27/52). In guinea pig samples, RV-A infection was found in 4.54% (2/44), PBV infection in 11.37% (5/44) and Kobuvirus in 31.82% (14/44) of the samples. The single rabbit sample received was diagnosed negative for all enteric viruses.

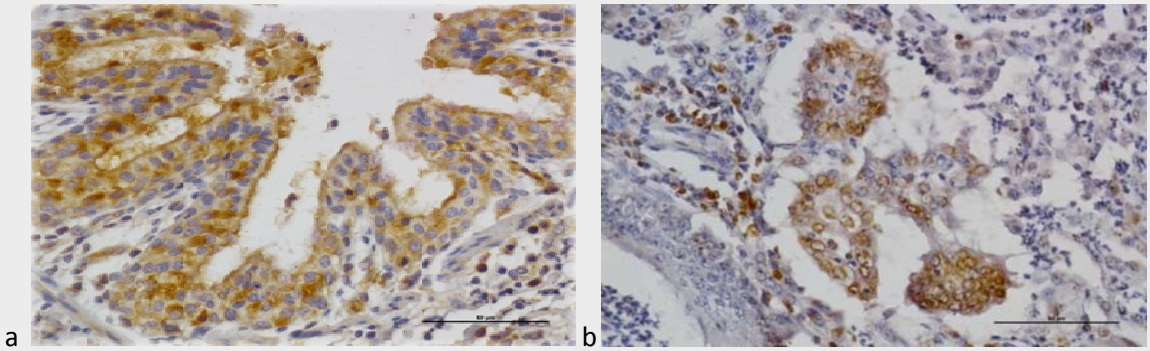


Prevalence of enteric viruses in different lab animal samples from CRI, Kasauli, Himachal Pradesh

Prevalence and pathobiology of retroviral diseases in sheep and goats

Biological samples from sheep and goats (serum 459, blood 325, tissues 185) were collected from Uttarakhand, Himachal Pradesh, Jammu and Kashmir, and Delhi. Seropositivity detected by cELISA in UK, HP, J&K and Delhi serum samples were 17.98% (41/228), 2.7% (3/111), 14.89% (7/47) and 6.85% (5/73), respectively. DNA extracted from the lung tissues (185) was subjected for PCR detection of JSRV by using primers from gag gene and U3 region of JSRV genome which showed 45 samples were positive by gag gene primer (enJSRV) and 4 samples by U3 region (exJSRV). Partial sequence (2650 bp) of one sample positive with U3 region primer showed that it was more closer to USA and European isolates. DNA extracted from blood (325) and tissues (185) was subjected for nested PCR to detect the MVV genome. DNA of 29 blood samples (UK 25, Delhi 4) were found positive for MVV.

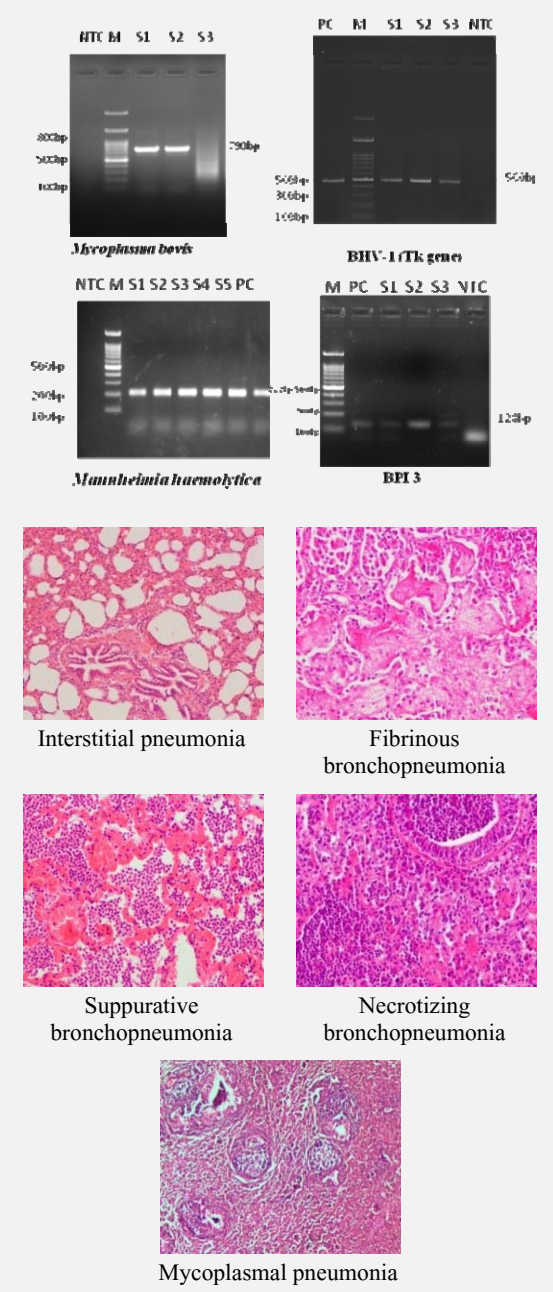
Microscopic examination of the lungs revealed bronchopneumonia (97), interstitial pneumonia (14), ovine pulmonary adenocarcinoma (OPA; 4) and maedi-like lesions (7). IHC staining in OPA affected lungs (18) showed presence of JSRV proteins in both the epithelial cell lining of the bronchioles and the proliferated pneumocytes of the alveoli. IHC was also performed on OPA lung tissues which revealed that PCNA immunostaining was present in the nucleus of both proliferated pneumocytes and the infiltrating MNCs. FOXO3a immunostaining was detected in 8/18 OPA cases, which showed low inflammatory reaction, while MMP2 immunostainng was detected in 12/18 cases and most of them had high degree of inflammatory reaction. MHC2 immunostaining was found in 6/18 cases, while MYC immunostaining was present in only one case only.



(a) Ovine pulmonary adenocarcinoma: JSRV CA immunostaining in bronchial epithelial cells of OPA affected lung
(b) Ovine pulmonary adenocarcinoma: PCNA immunostaining in the pneumocytes and MNCs of OPA affected lung

Respiratory disease complex in ruminants

A total of 751 tissue samples were collected from small and large ruminants of the IVRI post-mortem facility and slaughterhouses of Moradabad, Delhi, Maharashtra, Madhya Pradesh, Karnataka, Himachal Pradesh, Punjab, Andhra Pradesh and Jammu and Kashmir. Besides, 50 nasal swabs from different sheep and goat farms of Uttarakhand, 254 archived tissue samples were also included in the study. Single or multiple pathogens were detected by PCR using genome specific primers in 79/450 samples, which included 28 cases of *P. multocida*, 17 cases of BHV-1, 11 cases of *M.hemolytica*, 7 cases of each BPI3 and BVDV, 5 cases of BCV and one case of BRSV. Single pathogen infection was detected in 53% (37/79) cases, while mixed infection was detected in 47% (37/79) cases.



Sero- surveillance of Japanese encephalitis (JE) in swine and equine species

A total of 707 swine serum samples were screened for JE during the year using in-house IgG ELISA. Out of these samples, 200 were found positive for JE IgG with a total sero-positivity of 28.29 per cent. The highest sero-positivity was observed in samples of Madhya Pradesh (63.01%) followed by Punjab (58.62%), Bihar (35.13%), Uttar Pradesh (28.71%) and Goa (5.09%).

A total of 339 field equine serum samples were screened by standardized rNS1 protein based indirect IgG ELISA. The overall sero-positivity was found to be 24.78 per cent. The sero-positivity was found to be 25.46 percent and 23.58 percent in equine population of Gujarat and Uttar Pradesh, respectively.

Surveillance of Coxiellosis

A total of 566 cattle from three different states were screened for coxiellosis by PCR and commercial ELISA. Of the cattle (n=224) screened from the organized dairy farm of Bareilly (UP), 75 were found positive by either one the two tests employed. Similarly, out of the stray and abandoned cattle (n=208) screened from the unorganized farm of Jhunjhunu (Rajasthan) and cattle (n=134) screened from the households of Malappuram (Kerala), 36 and 6 cattle were found positive for coxiellosis, respectively.

Further, commercial ELISA kits were used to explore seropositivity against coxiellosis among cattle having a history of reproductive disorders (n=252) and their human contacts (n=34) from Bareilly and Jhunjhunu. Sero-positivity of 35.55% (32/90) and 16.67% (27/162) was observed among the animals, whereas their human contacts revealed seropositivity of 89.47% (17/19) and 40.0% (06/15) from Uttar Pradesh and Rajasthan, respectively. Overall a higher seropositivity against coxiellosis was observed in human contacts.

Antimicrobial profiling of *Pasteurella multocida*

Antimicrobial profiling of 430 Indian isolates of *P. multocida* revealed the highest resistance for tetracycline (36.74%), followed by sulfatrimethaxazole (24.65%), pefloxacin (23.95%), ciprofloxacin (22.79%), spectinomycin (20%), chloramphenicol (18.6%), cefepime (17.67%), streptomycin (15.58%), kanamycin (14.41%), ampicillin (12.55%), ceftriaxone (8.37%), amoxycillin (3.25%), erythromycin (2.79%), enrofloxacin (1.62%), cefoperazone (1.16%) and gentamicin (0.69%). The isolates were found to be intermediately sensitive to erythromycin (50%),

enrofloxacin (28.83%), kanamycin (25.81%) and ciprofloxacin (21.39%). The antibiotics gentamicin, amoxycillin/clavulanic acid and cefoperazone were found to be highly effective against the isolates tested in the study. Also, 33.3% of the isolates were found to be multidrug resistant (MDR). The prevalence of *tet*B, *sul*2, *str*A and *dfr*A genes were found to be 41.9, 44.05, 38.4 and 9.1%, respectively, among the MDR isolates. Multiplex PCR for the detection of *tet*B, *sul*2 and *str*A was optimized and found to be promising for rapid screening of these antimicrobial resistance genes in isolates.

Disease outbreak investigations

Various referred disease outbreaks and cases of toxicosis were investigated by the team of experts from IVRI as described below. The etiology of the diseases and mortality were determined after laboratory examination and post-mortem examination and suitable measures to be adopted, were communicated.

S No	District and State	Animal spp	Etiology
1.	Kamdhenu dairy Pathra (Aonla), Bareilly UP	Cattle & Buffalo Bulls	Theileriosis and Anaplasmosis
2.	Patna, Bihar	Cattle	Theileriosis
3.	Devipura Guashala, Pilbhit, Uttrakhand	Cattle and buffalo Bulls	Theileriosis
4.	Patna, Bihar	Goats	PPR
5.	Patna, Bihar	Cattle	Thieleriosis
6.	Kamdhenu Dairy, Saijna, Pilibhit, UP	Cattle	Anorexia
7.	Siddharth Nagar, U.P.	Cattle	Lantana toxicity
8.	Malkangiri, Odisha	Pigs	PRRSV
9.	Sahabad, Rampur, U.P.	Cattle	Hemorrhagic Septicemia
10.	Police Training Academy, Sitapur.	Horse	Routine checkup
11.	Amroha, U.P.	Cattle and buffalo	Reproductive problems
12.	Raj Bhavan Gaushala, Lucknow, UP	Cattle	Theileriosis
13.	Amroha, U.P.	Monkeys	Phosphine poisoning

Pathomorphological diagnosis

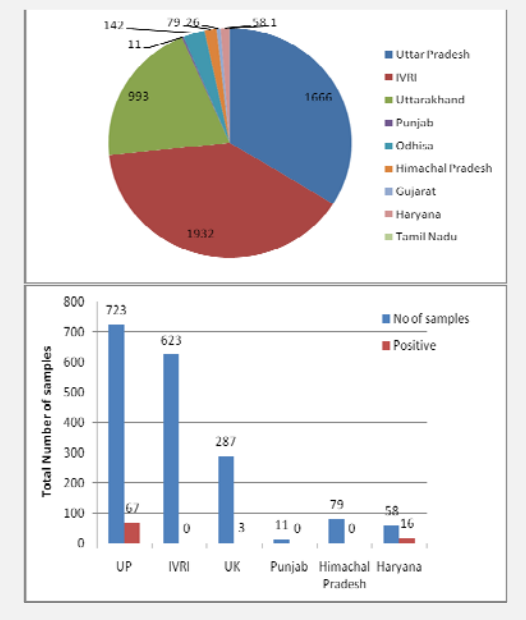
Total 681 biological specimens, including 247 morbid tissues, abortions (35) and 434 clinical samples of different species including wildlife were received and processed for pathomorphological and hematobiochemical diagnosis of diseases. The samples were obtained from U.P. (303), UA (341), Rajasthan (02), New Delhi (01), Madhya Pradesh (04), Odisha (05) and Bihar (25). Different disease conditions like FMD, rabies, tuberculosis, theileria, anaplasma, babesiosis, pasteurellosis, septicaemia, toxicity, hematuria, hepatitis and abortions (infectious / non-infectious) in cattle & buffalo; interstitial pneumonia, pneumonia, PPR and anaemia in sheep & goat; shock and anaemia in horse, pneumonia and epicarditis in pig; rabies, ehrilichiosis, anaemia, chronic nephritis and urinary tract infection in dog and verminous pneumonia, hepatorenal syndrome, toxicity in wildlife.

FMD in cattle at Ghaziabad, pasteurellosis in buffalo at Rampur, PPR in goats at Patna, Phosphine posioning in monkeys at Amroha (UP) were investigated.

Bacterial diseases

During the period under report, a total of 4908 (Serum – 1941, Clinical – 2841, Morbid 126) were analyzed for the diseases suspected of bacteriological origin.

These 4908 samples of different species *viz*. cattle, buffalo, goat, dogs, sheep, pigs *etc* were obtained from U.P. (1666), UK (993), Punjab (11), Odisha (142), Haryana (58), Himachal Pradesh (79), Gujarat (26), and Tamil Nadu (1). In addition, samples from animals at IVRI farm (1932) were also screened for bacteriological diseases. After bacteriological processing of morbid samples different bacterial spp. were isolated and were characterized by colony characteristics, morphology, biochemical reactions and sugar fermentation tests. Among the isolates, one *Pasturella multocida* type –B was isolated from lung tissue.



A total of 1781 serum samples of cattle and buffalo were screened for presence of antibodies against Brucella and 86 samples were found positive by using RBPT, STAT.

A total of 1191 animals from organized healthy farm located in Uttar Pradesh (910) and Uttarakhand (281) were screened for TB and JD. Testing for tuberculosis (TB) and Johne's Disease (JD) was conducted in animals using Tuberculin and Johnin PPD antigens in a single intradermal test. No positive reaction was observed in any of the animals tested.

Serum samples were anlaysed for antibodies against mycoplasma. Out of 194 serum samples tested for mycoplasma, 78 (Odisha 46, Gujarat 26, Himachal Pradesh 19) were found positive. Four morbid samples (lung) were anlaysed for presence of genome of mycoplasma and one sample was found positive by PCR. Breeding bulls at organized farms were screened for presence of *Campylobacter* sp. as per the standard procedure in the preputial wash. No bull was found positive in 438 screened bulls.

Viral diseases

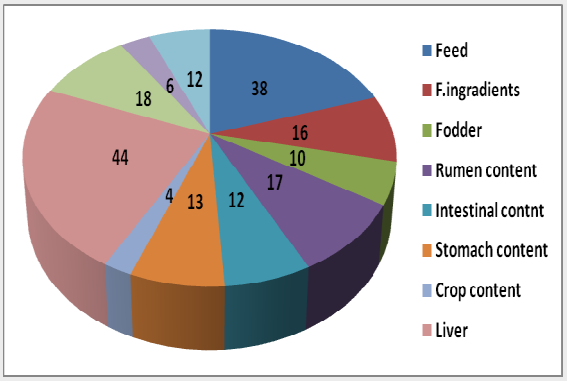
Samples of different species suspected for various viral diseases were investigated by laboratory examination. Samples were obtained and collected from various parts of the country like U.P., H.P., Punjab, MP, Rajasthan, Sikkim, Bihar, Haryana, Karnataka and Uttarakhand. Various viral diseases such as IBR, Classical Swine Fever, BVDV, BHV-4, Feline panleukopenia virus, Schmallenberg virus, canine parvovirus, canine adenovirus-1 and canine adenovirus -2, PPRV, JE virus, bluetongue virus, sheeppox, goatpox, cowpox, buffalopox, swinepox, FMD and avian influenza were examined in the obtained samples. Samples were screened by Ag, Ab ELISAs, PCR, and virus isolation methods. A total of 21630 clinical and morbid samples including 8825 serum samples, 107 semen samples, 12698 tissue samples/blood samples/swabs were analyzed. The detailed results of the samples analysed during this period is presented here.

Disease	Antibody testing		Antigen/ genome testing	
	Total	Positive	Total	Positive
BHV-1	671	296	107	0
BVDV	-	-	22	9
BHV-4	-	-	22	4
Schmallenberg	167	105	-	-
CSF	10	0	-	-
Feline Panleukopenia	-	-	46	0
Infectious canine hepatitis	10	0	77	1
CPV	10	0	27	2
CAV-1	-	-	2	0
Japanese encephalitis	764	125	284	50
PPR	139	92	35	17
FMD	39	0	-	-
Swinepox	-	-	2	2
Cowpox	-	-	2	0
Buffalopox	-	-	3	0

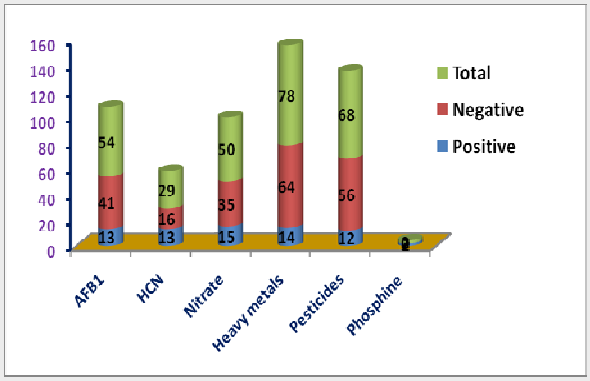
In addition, pre-outbreak screening for avian influenza in the healthy flock were also performed where 7008 serum and 12141 swab samples were tested as per the guidelines of DADF, GoI. All the samples were found negative for highly pathogenic avian influenza virus.

Toxicoses

Toxicological analysis of 188 samples including feeds, fodder and biological materials was carried out. The samples received in the laboratory were analysed for the presence of various toxicological agents. Out of 54 samples of compounded livestock feed (C & B-21, poultry-17 and feed ingredients-16) analyzed for Aflatoxin-B1, a major feed contaminant, 13 feed samples were found positive. The concentration of AFB1 ranged from 0.5 to 3.78 ppm which is quite higher than the permissible levels in cattle/ poultry feed. These samples were also analyzed for another mycotoxins i.e. Ochratoxin-A, T-2 toxin however found negative. A total of 10 fodder samples, suspected for cause of



Toxicological analyses



Toxin-wise samples analysed

mortality in animals, were analyzed for the presence of various toxicants and found to contain Hydrocyanic acid (5/10) and nitrate (5/10) and were associated with mortality in cattle and buffalo. Toxicological analysis of various morbid samples i.e., liver (44), kidney (18) rumen contents (17), intestinal content (12), stomach content (13) and crop content (04) from various species was carried out for toxicants like alkaloids, heavy metals, nitrate/nitrite, pesticides etc. HCN was detected in five and nitrate/ nitrite in 10 GI content samples, respectively. One sample of rumen content was found to contain Lantana triterpenoids. Organochlorine group of insecticides were detected in 5 samples of liver and 2 kidney samples. Presence of heavy metals/ Arsenic was detected in 16 samples including GI contents (03), liver/kidney tissues (07) and hair (06) samples. Cypermethrin/ Pyrethroid insecticide was detected in stomach content (02) of monkeys and gizzard (02) of peacocks. Presence of phosphine was detected in four samples of stomach content and liver of monkeys.

Parasitic diseases

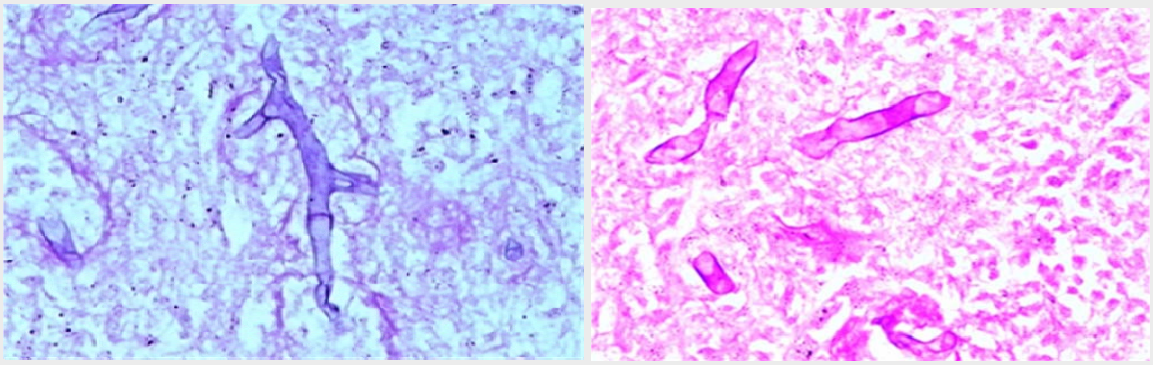
During the period, 1092 samples of faeces, blood, blood smear, preputial washing and skin scrapping were received and examined and results were communicated along with advices for control. 315 blood smears/blood samples of different animals were examined and 59 were found positive for blood protozoan infection. In cattle, theileriosis caused by *Theileria annulata*, and anaplasmosis caused by *Anaplasma marginale* were recorded. Out of 349 faecal samples from different animals, 60 were positive for different gastro-intestinal parasitic infection. 427 preputial washings from cattle and buffalo bulls received were cultured and examined and were found negative for *Trichomonas foetus* infection. Modified Diamond medium was prepared and about 450 tubes of prepared medium were supplied to different semen collection centres (DFS Chakgajaria, Lucknow; ULDB Lucknow, Meerut, DFS Majhara, Babugarh, Muzaffarnagar) for collection of preputial washings.

Epidemiological studies and clinical profiling of theileriosis in relation to various risk factors in cattle

During the year, 342 blood samples were analyzed and out of these 79 samples were found positive for Theileria infection. Among these 79 positive animals, 19 animals were showing the clinical symptoms. Hyalomma ticks were recorded in the month of May to August, and in January and February. Most cases of theileriosis were recorded in May, 2017. Samples were collected/received from eight districts of Uttar Pradesh. Clinical history showed that transportation stress was the major reason for flaring up of theileriosis in organized dairies as most of the animals were purchased from Haryana and Punjab.

Species wise samples examined

Species	Sample type	Total	Numbers positive	Positive for
Cattle (UP)	Blood	194	57	*Theileria*-56, *Anaplasma*-1
	Faecal	208	39	Strongyle-20, Amphistome-9 Coccodia-8 , *Moneizia*-5, *Fasciola*-1
	Preputial washing	364	Negative	-
Dog (UP)	Blood	30	2	*Babesia canis*-2
	Faecal	15	Negative	-
Buffalo (UP)	Blood	8	Negative	-
	Faecal	20	5	Strongyle-1, Amphistome-2, *Fasciola*-2
	Preputial washing	63	Negative	-
Horse (UP)	Blood	81	Negative	-
	Faecal	56	1	Strongyle-1
Sheep (Uttrakhand)	Faecal	50	15	Strongyle-14, *Moneizia*-2, *Trichuris*-3
Pig (UP)	Blood	1	Negative	-
Goat (UP)	Abomasal Fluid	1	1	*Haemonchus contortus*, Bladder worm of *Cysticercus tenuicollis*, *Taenia hydatigena*
Deer (Uttarakhand)	Blood	1	Negative	-
Total		1092	120	



Mycotic rumenitis and reticulitis in sheep

Studies on mortality pattern and causes of mortality among livestock, poultry and wild animals

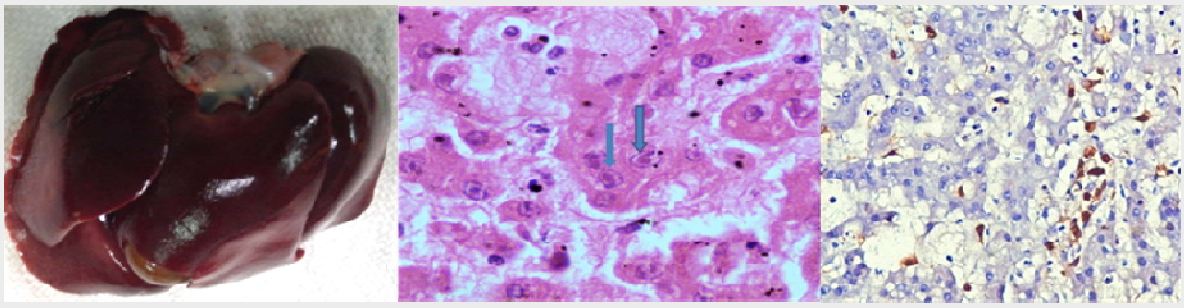
Cattle: 96 bovine carcasses (male 60; female 36) of varying age groups viz. <6 months (48), 6-12 months (25) and >1 year (20) were necropsied. Important conditions diagnosed included: pneumonia (20), pneumoenteritis (22), enteritis (10), joint ill (3), septicaemia (14), and jaundice (1). Important pathogen detected includes BHV-1, BCoV, BRSV, Bovine Rotavirus, BPI3, *P. multocida*, *Manheimia haemolytica*, *E. coli,* Salmonella, etc.

Buffalo: 14 carcasses of buffaloes (male 5; female 9) showed lesions of pneumoenteritis (3), pneumonia (2), septicaemia (1), rabies (1), splenic rupture (1), ruminal impaction (1), toxemia (1) and fetal monster (1). Important pathogens detected were *P. multocida*, *E. coli* and rabies virus.

Sheep: 25 carcasses of sheep (male 9, female 16) of varying age groups viz. ≤ 6 months (2) and 6-12 months (23) were necropsied and diagnosed as cases of enteritis (3), pneumonia (3), septicemia (3), pneumoenteritis (2), pimply gut (3), haemonchosis (2), debility (2) and fungal abomasitis and ruminitis (1). Important pathogens detected were *Clostridium perfringens*, streptococcus, mycoplasma, *E. coli* etc.

Goat: 46 goat carcasses (male 15; female 31) of different age groups viz. ≤ 6 months (9), 6 -12 months (3) and above 1 year (34) were necropsied and diagnosed as cases of pneumonia (17.39%), enteritis (17.39%), pneumo-enteritis (17.39%), haemonchosis (13.04%), septicaemia (8.69%) and hepatitis (2.17%). Important pathogens detected were *P. multocida*, *E. coli,* Salmonella, *Proteus* spp., and Mycoplasma.

Pig: 136 pigs were necropsied, out of which, 132 belonged to SPF of the institute. Breed-wise break up of mortality indicated that maximum mortality was in crossbred pig (127) followed by Landrace (8) and Desi (1). Age-wise breakup of the mortality indicated that maximum losses (38.24%) were among 0 day age group due to late term abortion (n=23; 16.91%) belonging to four dams; mummification (n=19; 13.97%) and stillbirth (n=10; 7.35%) belonging to eight dams. Among 1 to 7 days age group, mortality was 33 (24.26%) with cases of catarrhal enteritis (21 cases), pulmonary oedema (3 cases), septicaemia (2 cases) and hepatitis (2 cases), etc. In unweaned piglets aged 1 week to 1 month, the proportional mortality rate (PMR) was 20.59% (28) and the important causes of mortality were catarrhal enteritis (7), pneumoenteritis (4), trauma (3), and pulmonary oedema (3), etc. In the weaner piglets (aged 1-3 months), the PMR was 11.03% (15). Most important cause of mortality was enteritis, pneumonia, and pulmonary oedema, etc. In the growers (aged 3-9 months), the PMR was 3.65% (5) and causes of death were septicaemia and haemorrhagic enteritis. The PMR in adult was 2.21% (3), out of which 2 were completely autolysed and one was septicaemic. Different pathogens like PCV2, PPV, CSF, Sapelo and Tescho viruses and bacteria like *Klebsiella* sp.,



Infectious canine hepatitis in dog

Pasteurella multocida, E. coli, Proteus sp. were identified in different cases.

Canine: Out of the 27 dog carcasses examined important diseases/conditions diagnosed were infectious canine hepatitis and parvoviral enteritis mixed infection (9), rabies (3), chronic interstitial nephritis (3), gastroenteritis (3), pneumonia (3), hepatonephropathy (2), and encephalomalacia (1), etc.

Laboratory animals: 3 rabbit carcasses were necropsied and diagnosed as enteritis (2) and pregnancy toxemia (1).

Poultry and captive birds: A total of 43 disease investigations were carried out in poultry carcasses brought by farmers of Uttar Pradesh, Haryana, Uttarakand, Chattisgarh and Himachal Pradesh. Important conditions diagnosed were aflatoxicosis (2), bacterial pneumonia and tracheitis (3), bacterial septicemia (2), coccidiosis (1), colibacillosis (9), colibacillosis and mycoplasmosis (9), debility (3), duck plague (1), enteritis (1), hepatosis, nephrosis, toxemia (1), IB (1), IBH (1), mycoplasmosis (3), ND (2), necrotic enteritis (1), pneumoenteritis and bacterial septicemia (1), toxicity (1), traumatic injury (1) and visceral gout (1). A total of 8598 poultry carcasses from ICAR-CARI comprising of 2120 layers, 2576 broilers, 3546 desifowls, 228 turkeys and 128 guinea fowls were necropsied. Gross, microscopical, serological examination and molecular techniques revealed ND, MD, LL, bacterial hepatitis, enteritis, bacterial septicemia, aflatoxicosis, spontaneous tumor condition, fatty liver, liver rupture, nutritional roup, rickets, egg bound, egg peritonitis, oophoritis, salphingitis, omphalitis, ascites, nephritis, airsacculitis, coccidiosis, ascaridiasis and capillariasis. Fatty liver, hepatiis and enteritis were the major conditions.

Investigation on diseases, seroprevalence and animal husbandry practices in NWHR

Investigations were conducted on various materials received at ICAR-IVRI Regional Station, Palampur, from livestock owners and government institutions. The carcasses (41) received for post mortem examination included goats (04), leopards (02) and poultry (35). The important observations at necropsy were multi-organ failure in goats, traumatic injuries in leopards, and vitamin B deficiency and haemorrhagic enteritis in poultry birds. Faecal examination was done for 132 samples collected from cows, buffalo, sheep and goats. The major parasitic eggs observed included, *Paramphistomum* sp., Fasciola hepatica, *Trichstrongylus* sp., *Trichuris* sp. and *Eimeria* sp. oocyst. In disease surveillance studies, a total of 79 serum samples were collected from cattle, sheep and goats for screening against common pathogens.

Linkages were established with Deputy Directors, Animal Husbandry (AH) of five districts *viz*., Kangra, Kullu, Chamba, Mandi and Bilaspur. A total of 69 uterine discharges including 25 samples from Kangra, 16 samples from Kullu, 13 samples from Chamba, 11 from Mandi, and 4 samples from Bilaspur. The samples were from cattle (66) and buffaloes (3), all confirmed as repeat breeders. The cultures were detected as indole negative, methyl red positive, VogesProskauer's negative, citrate (Simmons) negative, acetate positive, urea negative, malonate negative. Serotyping performed in Central Research Institute, Kasauli on 7 *E. coli* isolates depicted prevalence of 6 serogroups, namely, O7(1), O8(1), O11(1), O22(1), O88(2) and O118(1). *In vitro* antibiotic sensitivity tests of whole cultures revealed highest sensitivity to tetracycline (30 µg) in the samples from Kangra (66.6%), Mandi (66.6%) and Kullu (57.1%). Highest sensitivity (70%) of furazolidone (100 µg) was found in samples originating from Chamba. *In-vitro* antibiotic sensitivity test reports of 55 samples were provided to concerned beneficiaries. Thirty-one (62%) animals treated for reproductive infections delivered healthy calves. Therefore, tetracycline (30 µg) and furazolidone (100 µg) may be one of the therapeutic choices in repeat breeder dairy cows.

Monitoring of drug residues and environmental pollutants

A highly sensitive HPLC method was standardized for simultaneous determination of metronidazole and oxytetracycline residues in buffalo meat below MRLs. A total of 242 buffalo meat samples were collected from 10 different districts of Uttar Pradesh namely Agra, Firozabad, Aligarh, Hathras, Mathura, Kanpur, Lucknow, Farukhabad, Barabanki and Hardoi. These samples were analyzed for the presence of residues of the benzimidazole group (albendazole and fenbendazole) using the highly sensitive HPLC method. Out of 242 samples analyzed, 3 samples were found to contain albendazole residues, but below MRL (100 µg/kg) and no sample was found to contain fenbendazole residues.

3.10
Production and Standardization of Biological Products

Standardization and quality control of veterinary immunodiagnostic antigens and antisera

Details of testing immunodiagnostics produced at Biological Products Division

Sl. No.	Name	No. of Batches
1.	*B. abortus* RBPT Antigen	11
2.	*B. abortus* Plain Antigen	3
3.	*B. abortus* ABR (MRT) Antigen	3
4.	*S.* Pullorum Plain Antigen	1
5.	*S.* Abortus equi H Antigen	1
6.	*S.* Pullorum Col. Antigen	3
8.	Johnin PPD	1
9.	Mallein PPD	1
	Total	24

Standardization and quality control of immunodiagnostic antigens and antisera were done as detailed below. A total of 24 batches of diagnostics received from Biological Products Division of the institute were tested and found satisfactory in quality and passed as per the provisions in IP-2014.

Standardization and quality control of veterinary vaccines

As a part of quality assurance programme, standardization and quality control of 41 batches of veterinary vaccines were carried out. These included 9 bacterial vaccines, 31 viral vaccines, and one combined vaccine from different production units as detailed in table.

Bacterial and Viral vaccines tested during 2017-18

Sl. No.	Name of Vaccine	Bacterial / Viral	Production Unit	No of batches
1.	Haemorrhagic Septicaemia Vaccine IP (Vet)	Bacterial	Drugs Inspector, Odisha	2
2.	Raksha ET+TT vaccine	Bacterial	IIL, Hyderabad	3
3.	Black Quarter (Bivalent) Vaccine	Bacterial	Drugs Inspector, Odisha	1
4.	*Brucella abortus* Vaccine Live IP (S19 strain)	Bacterial	Hester Bioscience, Ahmedabad	3
5.	Swine fever vaccine- Live	Viral	IIL, Hyderabad	3
6.	Avian Infectious Bronchitis Vaccine Inactivated IP	Viral	Hester Bioscience, Ahmedabad	3
7.	Newcastle Disease Vaccine Live IP (LaSota)	Viral	Hester Bioscience, Ahmedabad	1
8.	Avian Infectious Bronchitis Vaccine Inactivated	Viral	Venkateshwara Hatcheries (P) Ltd. Pune	3
9.	Avian Infectious Bronchitis Vaccine Live IP (H120)	Viral	Hester Bioscience, Ahmedabad	3
10.	Rabies Veterinary Vaccine (Rabivac Vet)	Viral	Brilliant Biopharma (P) Ltd, Hyderabad	1
11.	Infectious Bursal Disease Vaccine, Live (Intermediate Invasive Strain)	Viral	Drug Inspector, CDSCO, Ahmedabad	1
12.	Newcastle Disease Vaccine Live IP (LaSota)	Viral	Drugs Inspector, CDSCO, Ahmedabad	1
13.	SVAC-Las	Viral	Drugs Inspector, CDSCO, New Delhi	2
14.	SVAC-Chick-ND	Viral	Drugs Inspector, CDSCO, New Delhi	1
15.	SVAC-INA-IBD ND	Viral	Drugs Inspector, CDSCO, New Delhi	1
16.	SVAC-L-Las-Mas	Viral	Drugs Inspector, CDSCO, New Delhi	2
17.	SVAC-Livacox 5Q	Viral	Drugs Inspector, CDSCO, New Delhi	1
18.	SVAC-INA-REO	Viral	Drugs Inspector, CDSCO, New Delhi	1
19.	Vectormune HVT NDV &SB-1 Vaccine	Viral	Ceva Polichem Pvt. Ltd, Pune	3
20.	Newcastle Disease Vaccine, Live Master Clone	Viral	Ventri Biologicals Pvt. Ltd., Pune	3
21.	Rabies Vet. Vaccine, Inactivated Cell Culture IP	Viral	Drugs Inspector, Ranchi	1
22.	GIGAVAX Vaccine	Combined	IIL, Hyderabad	1
			Total	41

Sterility of 144 batches of FMD vaccines was also done.

Veterinary Type Culture

A total of 288 cultures including 209 bacterial, 43 viral, 15 mycotic and 11 r-clone/ phages/ cell line - were maintained in the repository. During 2017-18, 80 cultures (out of 262) including 64 bacterial, 8 viral and 8 MSC cell lines were collected, and 72 cultures were submitted to NCVTCC, Hisar. A total of 60 cultures (53 bacterial and 6 viral) and one anti-*Brucella abortus* serum were supplied on demand to various stakeholders.

Cultures supplied during 2017-18

S. No.	Supplied to	Culture/ Virus	No of ampoules/ vials/slant supplied
1.	Joint Director, Institute of A.H & B.P, Zakura, J&K	*Pasteurella multocida* (P52) *Clostridium septicum* *Clostridium chauvoei* Fowl Cholera	02 02 02 02
2.	Director K.V.A.F.S.U. Inst. of A.H. & Vet. Biologicals, Bengaluru	*Mycoplasma arginini* *Mycoplasma agalactie* *Brucella abortus* Strain 19 *Brucella melitensis* Rev-1 *Brucella abortus* Strain 544	01 01 01 01 01
3.	Dr R.C. Ghosh, College of Vet. Science & A.H., Anjora, Durg	*Pasteurella multocida* P52	01
4.	Prof. Altaf Ahmad, Department of Botany, Aligarh Muslim University, Aligarh	*Campylobacter jejuni*	01
5.	Joint Commissioner, Inst. of Vet. B.P. Aundh, Pune	*Clostridium perfringens* Type-D	02
6.	Dr Naveen K Navani, Associate Professor, Department of Biotechnology, IIT. Roorkee	*Salmonella enteritidis* *Campylobacter jejuni*	01 01
7.	Director, Haryana Veterinary Vaccine Institute, Hisar	Enterotoxaemia Vaccine strain	01
8.	Joint Director, C.C.S. National Institute of A.H., Baghpat	*Pasteurella multocida* P52 *Clostridium chauvei* 49 *Clostridium perfringens* Type-D	01 01 01
9.	Director, Institute of Veterinary Preventive Medicine, Ranipet	Anti *Brucella abortus* serum	01
10.	Deputy Director, A.H, I/c PVVI, Ludhiana	*Clostridium chauvoei* 49 *Clostridium perfringens* Type-D Fowlpox *Brucella abortus* Strain 19	03 02 01 01
11.	Additional Director, Institute of Vet. Biologicals, Lucknow	Swine Fever Challenge Virus	01
12.	Chief, Central Biological Production Laboratory	*Clostridium chauvoei* 49 *Pasteurella multocida* P-52	01 01
13.	Joint Director, Institute of Veterinary Biologicals, Khanapara, Guwahati	*Pasteurella multocida* P-52 *Clostridium chauvoei* 49	01 01
14.	Joint Director, VBRI, Shantinagar, Hyderabad	*Clostridium chauvoei* 49	01
15.	Additional Director, Regional Veterinary Biological Unit, Jamdoli, Jaipur	*Clostridium perfringens* Type-D *Clostridium chauvoei* 49	01 01
16.	Assistant Professor, Department of Zoology, CCS Univ. Meerut	NDV R2B strain	01
17.	Joint Director, M.S. Antirabies Vaccine Lab R.S.Pura (J&K)	*Pasteurella multocida* P-52 *Cl. chauvoei* 49	08 04
18.	Dr. Vineeta Mittal, RMLIMS, Lucknow	*Leptospira interrogans*	01
19.	Joint Director, Odisha Biological Products Institute, Bhubaneswar	*Pasteurella multocida* P-52 *Clostridium chauvoei* 49 *Bacillus anthracis* Spore *Cl. perfringens* Type D RDV-F1 strain R2B strain FPV	01 01 01 01 01 01 01
Total			60

Analysis of manufacturing, testing protocols and summary report

During 2017-18, certificate of analysis and manufacturing dossiers of 243 batches of vaccines and diagnostics, submitted by various importers *viz*; M/s Zoetis India Ltd, Mumbai; Intervet India Pvt Ltd, Pune; Stallen South Asia Pvt. Ltd; Boehringer Ingelhiem; and Panab Biotech etc. were received. All the documents were examined and found to be in order as per the Drugs & Cosmetics Act 1940.

Revival, bulk production and supply of poultry viral vaccines

Various poultry vaccine strains *viz.*, ND-F, ND-Komorov, ND-R2B, ND-Lasota, fowlpox, turkeypox, pigeonpox, and HVT were propagated and supplied to Biological Standardization and National Centre for Veterinary Type Cultures, Hisar. A total of 150 ampoules of ND strains, 100 ampoules of fowlpox, and 80 ampoules of turkeypox, pigeonpox and HVT strains were freeze dried and stored. The vaccine strains were confirmed by various tests including spot hemagglutination, hemagglutination, hemagglutination inhibition, PCR, nucleotide sequencing and BLASTn analysis. The freeze dried ampoules were checked for cross contamination using PCR for various viral agents like LPAI, MDV, FADV, NDV, HVT, ILTV, IBV, CAV and IBD.

Production of veterinary biologicals at Mukteswar

A total of 31 kits of PPR c-ELISA and 14 kits of s-ELISA were produced and supplied to various disease surveillance units in the country.

Bluetongue iELISA and sELISA kit reagents for testing of serum (n=600) and blood samples (n=400), respectively, were produced and supplied to the collaborative centres of DBT-NER twining program on bluetongue. Kit reagents for bluetongue iELISA were also produced for in-house testing of 800 samples.

FMD vaccine quality testing at Bengaluru

A total of 233 batches of commercial FMD vaccines referred by DAHD&F were received and three randomly selected batches were tested for quality in terms of sterility and safety and potency in cattle. In addition, a total of 137 batches of commercial FMD vaccine batches were tested for their sterility.

Revenue generated

A revenue of Rs. 13,52,338/- was generated by the sale of biologicals during the current financial year. Product wise quantity produced and supplied are as mentioned under:

Diagnostic antigens produced and supplied

S. No	Product	Production (Quantity)	Supplied (Quantity)	Dept. supply
		In Doses		
1.	Tuberculin PPD	70000	70360	1000
2.	Mallein PPD	3170	4750	-
3.	Johnin PPD	61000	60360	1320
		In ml		
4.	Br.Ab.Plain (SAT) antigen	30750	22750	1250
5.	Br.Ab.Bang Ring antigen	5710	7520	60
6.	Rose Bengal Plate Test antigen	12485	9820	280
7.	Sal. Pull. Plain antigen	2075	1250	-
8.	Sal. Pull. Coloured antigen	1935	3000	20
9.	Sal. Ab. Equi 'H' antigen	3550	2500	-

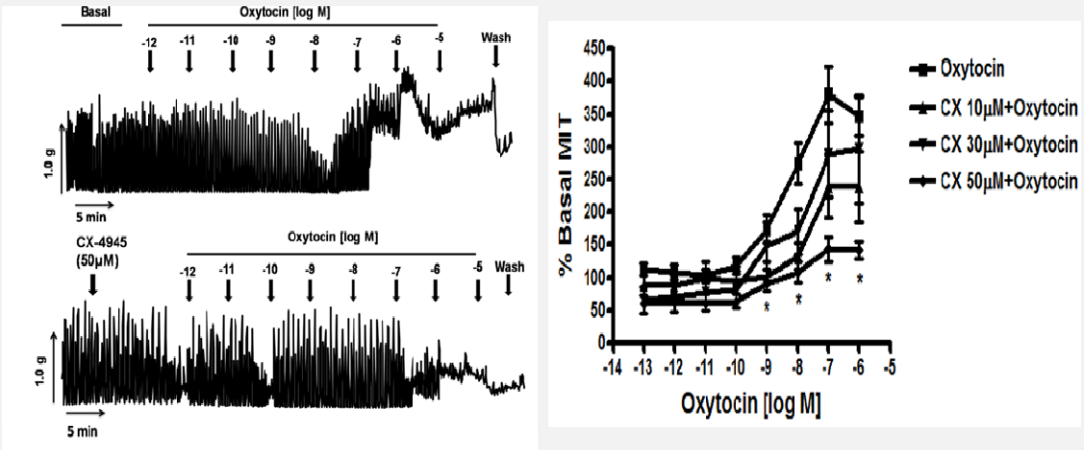
3.11
Reproductive Health Management and Augmentation

Understanding the regulation of oxytocin signaling in obesity-induced dysfunctional labor

The effect of casein kinase 2 inhibitors (CK2 inhibitor) on spontaneous and oxytocin-induced response in late pregnant mouse uterus was assessed. CK2 inhibitor, CX-4945 elicited a concentration-dependent relaxation in late pregnant mouse uterus. A significantly different ($p<0.001$) response was obtained at 10^{-4} M concentration of CX-4945 compared to that of the vehicle control, DMSO, added in equal volumes (72.23±15.05%, n=6 vs DMSO, 29.84±4.08% of basal MIT, n=5). There was a significant decrease in the oxytocin-induced response at 50 µM ($p<0.001$) concentration of CX-4945 (E_{max} and –log EC_{50} of 143.4±32.44% and 8.27±1.04, n=14 in comparison with control, E_{max} and –log EC_{50} of 364.5±83.76% and 8.38±0.87, n=21). However, CX-4945 did not affect ($p=0.49$) the contractile response to $PGF_{2\alpha}$ at any of the concentrations (10^{-5}M, 154.3±41.49%, n=6 vs control, 176.9±67.3%, n=7). Apigenin (50 µM) also produced a significant decrease ($p<0.05$) in the oxytocin response at 10^{-7} M and 10^{-5} M concentrations (E_{max} and -log EC50 194.4±25.46% and 8.56±0.58, n=5 vs control, 353.5±70.4% and 8.41±0.89, n=22). It also blunted the $PGF_{2\alpha}$ response (10^{-5} M, 96.16±48.47%, n=5 vs control, 176.9±62.31%, n=6). The CK2 was located in the lipid raft fractions of the cell membrane and disruption of lipid rafts by methyl-β-cyclodextrin was found to reverse its effect (E_{max} and –logEC50 with CX-4945, 142.8±29.18%, 8.37±1.15, n=14 vs, MCD+CX-4945, 323.8±65.64%, 9.55±1.08, n=7). The current study suggests that casein kinase 2 located in lipid rafts of the cell membrane, is an active regulator of spontaneous as well as an oxytocin response in late pregnant mouse uterine tissue.

Lysophosphatidic acid (LPA) signaling in early pregnant buffalo uterus: Possible role in endometrial receptivity and embryo implantation

The purpose of the study was to characterize LPA signaling in non-pregnant buffalo uterus and to assess its role in early pregnancy. The non-pregnant and early pregnant buffalo uterine tissues (<42 days) were collected from the local slaughterhouse. LPAR3 receptor was the highest expressed receptor as compared to LPAR1 and LPAR6 in non-pregnant uterine tissues after 6 h incubation in Dulbecco's Modified Eagle Medium (DMEM). A 50 µM LPA increased the mRNA expressions of COX-2 and iNOS enzymes, which were attenuated by the treatment of LPAR1/3 antagonist Ki16425. The PPARγ antagonist GW9662 prevented the LPA-induced increase in iNOS mRNA expression but did not alter the COX-2 expression. LPA also enhanced PGE_2 to $PGF_{2\alpha}$ ratio in uterine tissue homogenates which was inhibited by all the receptor antagonists as well as by the inhibitors of COX-2 and iNOS. LPA also increased total nitrite level in tissue homogenates in LPAR1/3- and iNOS-dependent manner. Additionally, PPARγ

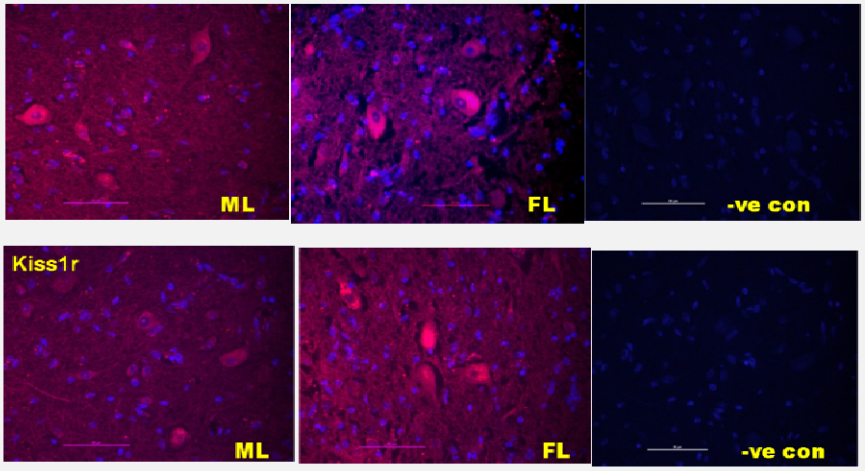


Representative raw tracings (left panel and line diagram (right) demonstrating the concentration-dependant effect of CX-4945 on oxytocin-induced uterine contractions at term. Data are presented as mean±standard error of mean. * indicates $p<0.05$ as compared to control response

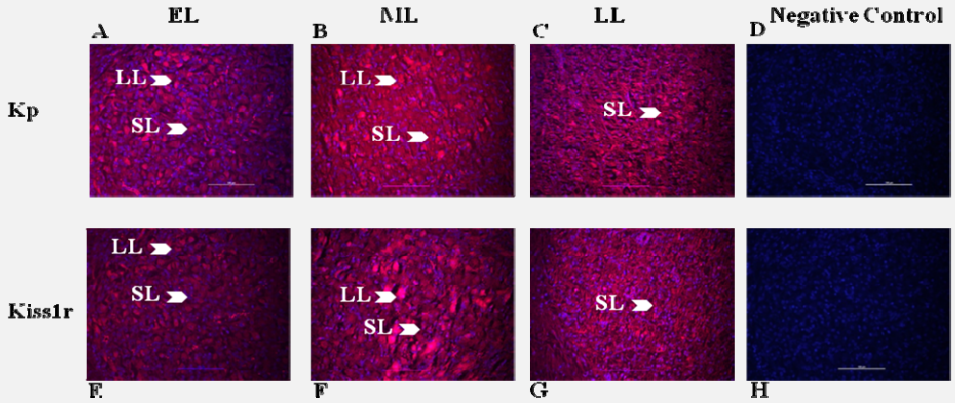
mRNA and protein expressions in the nonpregnant buffalo endometrium were demonstrated. Lysophosphatidic acid (50 µM) also stimulated mRNA expressions of galectin-1 and solute carrier 5 genes and down regulated mRNA expression of mucin-1 gene. In conclusion, the present study suggests that LPA acts as a luteotropic factor during the estrus cycle in non-pregnant buffalo uterus by enhancing PGE2 to PGF2α ratio and NO level through multiple receptors. In early pregnancy, it modulates mRNA expression of genes that facilitate the establishment and maintenance of pregnancy in buffalo uterus.

Buffalo kisspeptin: Differential expression in hypothalamo-gonadal tissues and application in resumption of cyclicity during anestrus

The objective was to study the differential expression of kisspeptin in the hypothalamus and ovarian tissue of buffalo at different stages of cyclic and acyclic condition. Blood, brain and genitalia were collected from each of 32 slaughtered buffaloes, which were retrospectively categorized into early luteal (EL), mid luteal (ML), follicular (FL) and acyclic (n=8/group). Tissue samples were collected from anterior hypothalamus (preoptic nuclei, POA), and medio-basal hypothalamus (arcuate nucleus, ARC) for differential expression of Kiss1, Kiss1r, GnRH regulators - neurokinin B (NKB) and dynorphin (Dyn); estrogen receptor (ER α) and progesterone receptor (PR) in the hypothalamic tissue. Similarly, Kiss1, Kiss1r, LHR and enzymes in progesterone synthesis (StAR, CYP11A1 and HSD3B) were analyzed in the luteal tissue at different stages of corpus luteum (CL) using real time PCR. The acyclic group served as calibrator and GAPDH and β-actin were used as reference gene for data normalization of hypothalamic and luteal samples, respectively. Immunolocalization of Kp and Kiss1r was carried out in the hypothalamus and CL of the respective stages using polyclonal primary antibody and alexa fluor tagged secondary antibody. The differential expression of GnRH regulator genes in the hypothalamus revealed a significant upregulation of Kiss1-Kiss1r, NKB with a concomitant down regulation of Dyn in the POA, whereas in the ARC there was significant up-regulation of Dyn along with Kiss1 and Kiss1r and down-regulation of NKB, suggesting KNDy mediated episodic release



Abundant expression of Kp and Kiss1r observed in the neuronal soma at mid luteal (ML) and follicular (FL) stage



Immunolocalization of Kp-Kiss in the buffalo CL at early, mid and late luteal stage

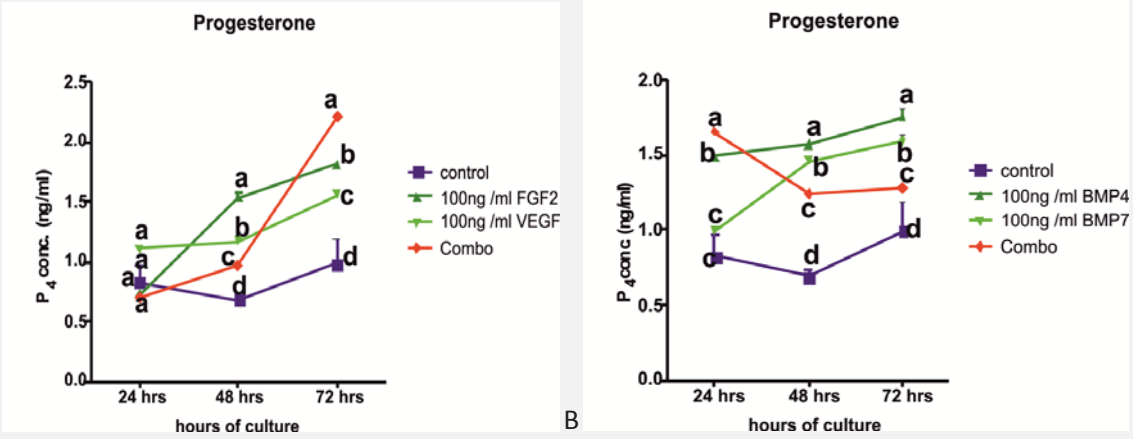
of GnRH at ML stage. A strong positive correlation of Kiss1r with GnRH pulse accelerators (ERα, NKB) and brake (Dyn) supports the episodic release pattern of GnRH over the surge release at ML in the POA. On the other hand, at ARC there was a positive correlation of Kiss1 with NKB, and Kiss1r with ERα at ML suggesting estrogen mediated regulation of GnRH release. Further, IHC localization of Kp and Kiss1r revealed a strong antigenic reaction in the EL followed by ML, similar to the transcripts profile observed at respective stages. Additionally, a significant strong positive correlation of Kiss1 and Kiss1r with LHR, StAR, leptin receptor (LEP-R), and ghrelin receptor (GHSR) at EL stage and Kiss1 with Kiss1r, LHR, StAR, CYP11A1 and HSD3B at ML supports the extra-hypothalamic role of kisspeptin in the steroidogenesis and luteal differentiation.

Regulation of placental function by locally produced angiogenic growth factors in water buffaloes (*Bubalus bubalis*)

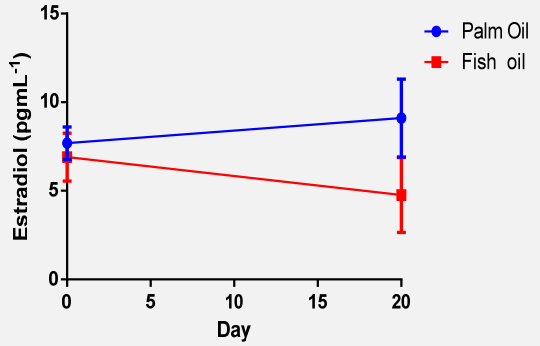
The role of growth factors in the modulation of placental function is an important area of research in reproductive biology. The study was designed to investigate the combined effect of fibroblast growth factor 2 (FGF2) and vascular endothelial growth factor A (VEGF-A) and also BMP4 and BMP7 on progesterone (P4) secretion and relative mRNA abundance of steroidogenic enzyme viz. StAR, cytochrome P450 (CYP11A1), 3-betahydroxysteroid dehydrogenase (3βHSD), proliferating cell nuclear antigen (PCNA) and BCL-2 associated X protein (BAX) were demonstrated in cultured trophoblast cells (TCC) obtained during early pregnancy by qPCR. The studies on TCC showed a time and concentration dependent effect of FGF2 and VEGF ($P<0.05$). At 100 ng /ml, the FGF2/VEGF or combinations maximally stimulated the transcript of vWF ($P<0.05$). Further, FGF2 as well as VEGF upregulated transcripts of PCNA and downregulated BAX in TCC at the same concentration ($P<0.05$).
In addition, FGF2/VEGF and BMPs promoted mRNA expression of genes coding for steroidogenic enzymes viz. STAR, CYP11A1and 3βHSD and thereby stimulated P4 secretion. BMP4 and BMP7 stimulated PCNA expression and downregulated BAX expression in cultured Trophoblast cells. The present findings indicated that FGF2 and VEGF-A function in a synergistic manner to promote steroidogenesis and survival of cultured buffalo TCs. In addition, it has also demonstrated that BMP plays significant role in modulating placental function by promoting angiogenesis, cell survivability and steroidogenesis in cultured trophoblast cells.

Effects of ω-3 Polyunsaturated Fatty Acid (PUFA) on ovarian and uterine functions in goat

A study was undertaken to investigate the effect of dietary ω-3 PUFA supplementation on ovarian function and hormonal profile in goat during the non-breeding season. Apparently normal and clinically healthy, non-pregnant goats aged between 2-3 years within 1-2 parity, with sonologically normal ovaries and uterus were selected. Goats in the treatment group (n=12) were fed concentrate feed supplemented with ω-3 PUFA rich, refined fish oil (FO) containing 16.35% eicosapentaenoic acid (EPA) and 10.23% docosohexaenoic acid (DHA) (Total 26.58% ω-3 PUFA) on a body weight basis. A dose of FO 156 mg/kg was chosen based on earlier studies. Palm oil (PO) was supplemented to the goats of control group (n=12) according to the body weight to make the diet isocaloric. Supplementation of FO or PO in the feed was < 5% (w/w) of total dry matter (DM) to avoid any adverse effect on palatability and digestibility.



Time and concentration dependent effects of growth factors combination on progesterone secretion in bubaline trophoblast cell culture (TCC) *in vitro*. (A) Effects of combination of (FGF2 and VEGF) on progesterone secretion. (B) Effects of combination of (BMP4 and BMP7) on progesterone secretion Each point in the line chart indicates mean±SEM



Concentration of serum E_2 (pg/ml) in the experimental does during the non-breeding season. Each point in the line chart indicates LSM±SE. Repeat Measure Anova revealed group effect (P<0.05). Decreasing trend of E_2 in the FO is in agreement with our published observations. Red and blue lines indicate fish oil and palm oil group, respectively.

Feeding trial was carried out in a non-breeding season of India for goat after an acclimatization period of seven days, during which increasing amount of FO or PO was supplemented to the respective groups to make the animal adjusted to new diet. Experimental goats received the respective diets for 10 weeks.

Based on the ovarian scanning for first 21 days, the data revealed that does were an ovular/acyclic during winter (non–breeding) period with maximum size of 8.0 mm follicle. No significant effect of FO feeding on the mean number of surface follicles and diameter of the largest follicle. This is supported by non-significant variation in the serum P_4 concentration during the corresponding time period. However, there was a significant decrease in the E_2 in FO group on day 20. The effect of fish oil feeding on estrus induction rate and pregnancy was not significant (P>0.05).

This is supported by the comparable concentration of P_4 on day 8 post-estrus. An estrus induction rate of 42-67% during the non-breeding season in the experimental does indicated that inducing an ovulatory LH surge through P_4 blocking was partly successful. A significant decrease in serum PGFM during the 16^{th} -18^{th} day post-estrus in FO group (P<0.05) was similar to our previous results in doe during breeding season. The results suggest that the supplementation of ω PUFA rich FO for 10 weeks could inhibit endometrial $PGF_{2\alpha}$ production during the luteolytic/maternal recognition window following estrus induction; however, it did not improve the ovarian function and fertility during the non-breeding season in the goats of Rohilkhand region which might be due imputed to the effects of seasonality *per se*.

Effect of FO or PO supplementation on the reproductive parameters during the induced estrus in the goats (n=12) of Rohilkhand region during the non-breeding season

Parameter (%)	Palm oil (Control)	Fish oil (Treat-ment)	Yate's corrected χ^2 value	P-value
EIR	41.66	66.66	0.67	0.41
Mating	33.33	33.33	0.19	0.67
Conception rate (35^{th} day)	33.33	16.66	0.22	0.47

Effect of n-3 Polyunsaturated Fatty Acid (PUFA) supplementation on pregnancy rate in repeat breeding cattle

The Repeat Breeding (RB) cattle (n=24) were selected on the basis of history, absence of subclinical endometritis by endometrial cytology and ruling out ovaro-bursal adhesion, ovarian cysts and other gross pathologies by ultrasonography. They were divided into two equal groups. In Gr. I, the diet was supplemented with n-3 PUFA rich fish oil for 4 weeks (two weeks before expected date of breeding and two weeks post-AI); the dose and schedule of feeding was calculated on the basis of previous results in the doe. In Gr. II, animals (positive control) were supplemented with Palm oil (deprived of n-3 PUFA) to maintain an isocaloric diet. All the animals were bred by AI and subsequently diagnosed for pregnancy at 45-50 days post AI. The results revealed that 75 % cows became pregnant in Gr. I and 70 % in Gr. II. The concentration of plasma P_4 on day 11 post-AI did not differ significantly between the groups.

Studies on partial deoxygenation of extender on bovine semen freezability

A study was initiated to develop a suitable method/tool for partial deoxygenation of extenders and to study the effect of partial deoxygenation on freezability of semen. In this, the membrane integrity with respect to semen quality at different levels of dissolved O_2, cryo-capacitation status & sperm Cholesterol (C) Phospholipid (P) ratio after partial deoxygenation of extender and *in vitro* & *in vivo* fertility test of best responded group after partial deoxygenation were studied. The results revealed that sperm membrane integrity is better maintained in both 4 & 8 ppm group. Dissolved oxygen (DO) at 4 ppm showed significant improvement in mitochondrial membrane potential, DNA integrity and C:P ratio of spermatozoa in frozen-thawed semen. Both 4 & 8 ppm of DO level maintained significantly higher non-capacitated sperm at post-thaw level. Significantly higher *in vitro* fertilizing capacity of post-thaw spermatozoa was obtained at 4 ppm level. *In vivo* fertility trial indicated that conception rate was 45% (n=100) under field condition and 53.33% (n=30, LPM

farm, IVRI) under farm condition for the best respondent group (4 ppm).

Study of oxidatively damaged proteins and the measures to reduce the protein damage due to cryopreservation in buffalo semen

Protocols with most refined freezing conditions and diluents modifications do not achieve more than 50% motility after freeze-thawing of semen partially due to the sub-lethal damage to the biomolecules. Proteins are among major targets of oxidative damage in any cells. So protein repair enzymes, especially those involved in repair of oxidatively damaged proteins in the male reproductive tract and semen were studied. Reproductive tract of male buffalo were collected from the local slaughterhouse. Samples for protein isolation, RNA isolation, and immunofluorescence assays were processed. Amplification of MsrA, cloning and sequencing of gene was done. The sequence is available in the NCBI GenBank Accession number MG386455.1. The amplified gene was sub-cloned into a expression vector. The bulk expression and purification of 33 kDa recombinant protein using Immobilized Metal Affinity Chromatography was carried out successfully. The hyper-immune serum had been raised in chicken against the recombinant MsrA protein.

Epitope specific antibody based assay for early pregnancy diagnosis in bovine

Sixteen Multiple Antigenic Peptides (MAPs) related to conception, implantation and pregnancy establishment and maintenance were synthesized using solid phase peptide synthesis (SPPS) employing Fmoc chemistry. All MAPs were subjected for antibody production followed by purification of IgY and the MAPs found immunogenic upon testing with indirect-ELISA. Initial tests in sandwich ELISA platform indicated that eight out of sixteen IgY against specific MAPs have shown immune-reactivity with pregnant sera and can detect antigen from 2-3 months onward.

Assessment of factors responsible for low success rate of artificial insemination (AI) in bovine under field condition

A study was carried out to identify the prevailing factors contributing low success rate of artificial insemination (AI) in cattle and buffaloes under field condition so that strategies for mitigation of identified problems could be ascertained. Under the investigation, information was to be collected from 60 livestock owners and 6 inseminators from 6 villages of 3 blocks in each district of 9 Agro-climatic zones of Uttar Pradesh. Accordingly, a suitable proforma was prepared to elicit information and was pretested. A total of 433 livestock owners and 58 inseminators were interviewed in 7 districts of 7 Agro-climatic zone. The data revealed that 77% livestock owner reported to follow natural breeding in buffaloes compared to 88% farmers by artificial insemination in cows. Farmers in some places informed that the conception rate due to AI was poor in buffaloes thus they are not adopting AI. In almost all the villages, AI was done by paravets (80%). The paravets are not paying much attention because they are neither under the control of veterinarians nor they are getting any remuneration from Govt. the department. Frozen semen, LN_2 and AI guns were mostly supplied by the private agencies to the inseminators and they are not aware about the semen quality. At most places farmers are not able to purchase the mineral mixture due to poverty and demanded for subsidy from the Government. They also expressed inability to keep high milk yielding cows due lack of proper distribution chain that inturn resulting in very less price for milk. Paravets desired refresher training to update their knowledge about recent advances and also incentive from the Government.

Role of sire and male progeny based on exogenous and endogenous behavior in relation to fertility and growth as a prediction model for selection of *Vrindavani* males

Five *Vrindavani* bulls used for semen collection were tracked for pedigree records up to third generation to assess production, levels of exotic and indigenous blood. Also, 200 *Vrindavani* females mated were evaluated with respect to blood level, production and reproductive health for selection of 15-20 dams to select 7-8 male progenies on the basis of effective progeny differences. The blood plasma testosterone of three bulls in semen collection was 8.26, 8.47 and 0.422 ng/ml with a reaction time of 3.54±0.86, 0.44±0.16 and 2.46±0.42 minutes, respectively. The semen plasma testosterone level of respective bulls was 2.06±0.60 (0.27-2.86 ng/ml), 0.32±0.2 (0.001-0.89 ng/ml) and 1.18±0.35 (0.28-1.92 ng/ml). Furthermore, the mean volume, gross motility and sperm concentration of the three bulls were 3.93±1.79, 3.63±0.63 and 2.88±0.66 ml; 3.25±0.75, 1.25±0.48 and 2.75±0.48; and 0.96±0.43, 0.66±0.29 and 1.11±0.49 billion/ml, respectively. Interestingly, gross motility showed significant positive correlation with reaction time ($r=0.565$, $P<0.05$) and seminal testosterone ($r=0.677$, $P<0.01$) indicating the role of circulating and plasma testosterone level in behavior and semen quality. Thus, estimation of testosterone concentration along with other parameters could be useful in selection of outstanding breeding bulls.

Development of a portable thawing kit for frogen semen straws

Low conception rate in bovines following artificial insemination under field condition is attributed to several factors. Inadequate facility for thawing of frozen semen straws is one of the important limiting factors. A prototype of the portable device with features like digital temperature control for frozen semen straw thawing at 37°C for 30 seconds, cut-off at 37.5°C and restart at 35°C, digital timer with beep after 30 seconds, indicator for cell charging, and water holder (50 ml, 14 cm height) for straw thawing and with scale resistance properties was developed. The prototype has provision for rechargeable (DC power output) coupled with solar charging, is lightweight, durable, and has provision for keeping accessories like scissor, tong and tissue paper. The affordable devise has cell power to last for 15-20 cycles for 2-3 days, and a marking platform with divisions for frozen semen straw identification. Field validation of this device is under process.

Pathological and immunological response in bovine abortions

A total 33 aborted fetuses of cattle (31) and buffalo (2) at different stage of gestation were investigated, post-mortem was carried out and gross lesions were recorded. Twelve cases of stillbirth, 3 cases of dystocia in cattle, 01 premature birth in cattle, 10 abortions occurred between 3-6 month of gestation and 7 abortions occurred at 7– 9 month gestation were recorded. The stomach contents were reddish brown in color in few cases while gruel like in others. In some cases, fetal carcasses revealed vascular congestion in lungs, liver, kidneys and brain. Histopathologically, degenerative, necrotic and vascular changes observed in liver, spleen and kidneys. Lungs showed changes like interstitial pneumonia along with congestion and haemorrhages. Brucella (11) and non-specific microbes (*E. coli, E. Fergusonii, Streptococcus pyogens, Streptococcus pneumonia, Streptococcus haemolyticus, Micrococcus* sp., *Pseudomonas aeroginosa, Klebsiella* sp, *Enterobacter agglomerans, Moraxella, Staphylococcus, Citrobacter* sp.) were isolated from 18 cases. All 33 cases found negative for *Listeria, Coxiella* spp. and BHV-1.

Production and supply of frozen semen of cattle and buffalo bulls from Germplasm Centre

In total, 28,226 frozen semen straws from *Vrindavani* (14,192), Tharparkar (1625), Sahiwal (3573) and buffalo (8836) bulls were produced. A total of 2785 frozen semen straws from *Vrindavani* (2305), Sahiwal (150) and buffalo (330) were supplied to the A.I. unit of Cattle & Buffalo farm (*Vrindavani*- 1925), Key Village unit of Animal Reproduction division (*Vrindavani*- 230, Sahiwal-150 and buffalo-230 semen straws) and other divisions (*Vrindavani*- 150 and buffalo-100 semen straws) through indent.

A total sum of Rs**.** 2,62,525/- was generated in lieu of 14,465 frozen semen straws (1,420 *Vrindavani,* 200 Tharparkar, 5155 Sahiwal and 7,690 straws of buffalo semen) sold to outside agencies. A total of 44,342 frozen semen straws {19,685 straws of *Vrindavani* (n=7), 4540 straws of Tharparkar (n=2), 8,508 straws of Sahiwal (n=3), and 11,609 straws of buffalo (n=7) semen} were stored at Germplasm Centre.

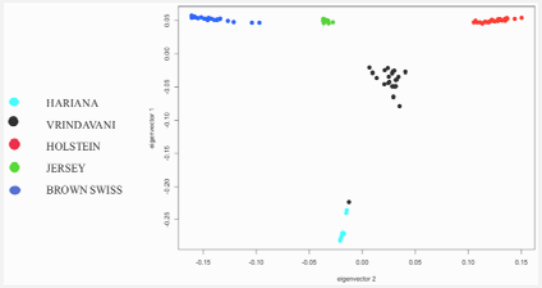
3.12
Genetic Improvement of Livestock

Prediction of breed composition and genetic diversity in crossbred cattle

A study was undertaken with the objective to assess genetic diversity and admixture levels in *Vrindavani* and Frieswal crossbred cattle populations with the help of Bovine 50K SNP BeadChip. SNP data for *Vrindavani* (n=24) and Frieswal (n = 14) crossbred populations were generated through genotyping while the data for the constituent breeds of these crossbred populations were retrieved from public repository. After applying all the quality control criteria and inclusion thresholds, genetic diversity parameters in terms of homozygosity, heterozygosity and genomic inbreeding coefficients (F_{HOM}) were calculated. The merged datasets of Frieswal (n=54) and *Vrindavani* (n=109) were analyzed for population stratification through the model based approach in STRUCTURE v2.3.4 and Principal Component Analysis (PCA) in the R-programming environment. The average MAF over all the autosomes of *Vrindavani* and its constituent breeds was found to be 0.280±0.05. The average heterozygosity values were estimated to be 0.310±0.033, 0.324±0.013 and 0.174±0.03 for *Vrindavani*, Frieswal and Sahiwal populations, respectively. The Frieswal population showed an average ancestry level of 62.35% from Holstein Friesian and 37.65% from Sahiwal breeds.

Similarly, *Vrindavani* population was found to possess an average ancestry of 42.60%, 27.01%, 19.75% and 10.6% inheritance levels from Holstein Friesian, Hariana, Jersey and Brown Swiss breeds, respectively

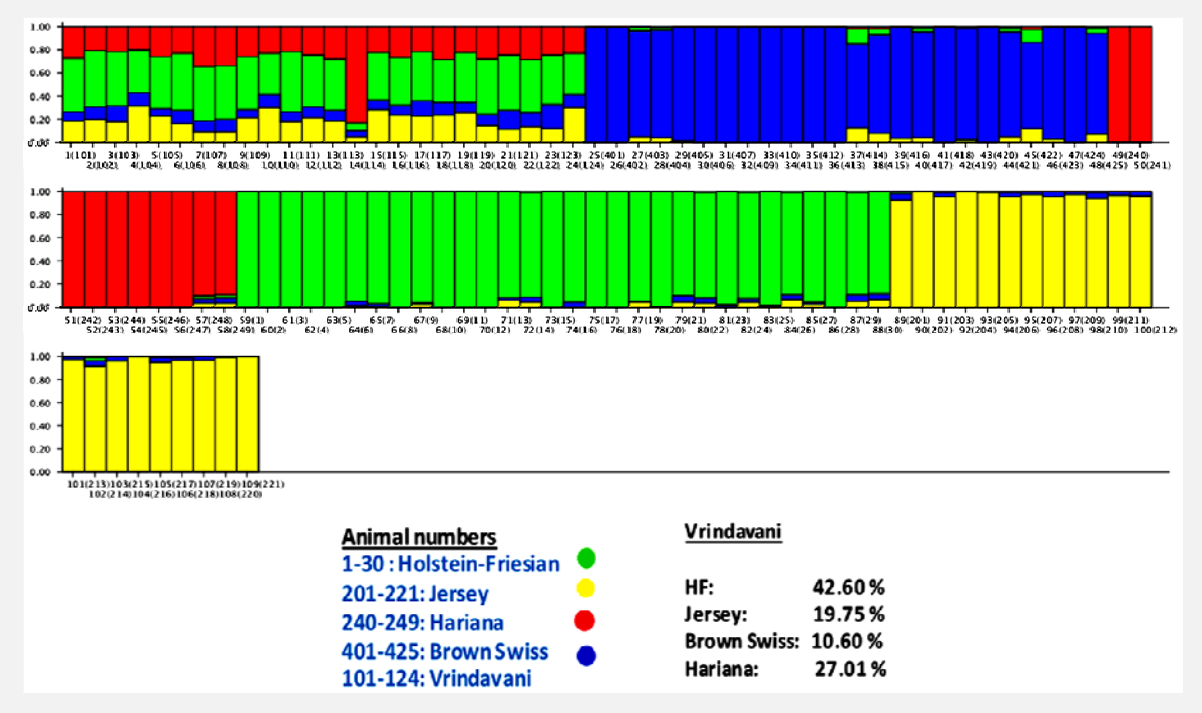
PCA-based clustering approach by employing eigenvector decomposition and multidimensional scaling (MDS) approach were also successful in stratifying different breeds showing different levels of within-population diversity under study.



Clustering of individuals from *Vrindavani* and its ancestral population using principal component analysis (PCA)

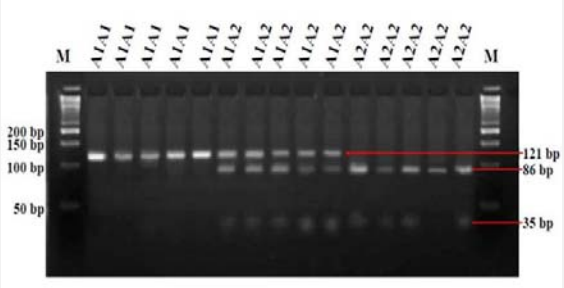
Association between A1/A2 variants of β-casein gene and economic traits in cattle

Association between A1/A2 variants of β-casein gene and economic traits in Frieswal, *Vrindavani*



and Tharparkar cattle was ascertained. Genotyping of cattle for A1/A2 variants of β-casein gene was carried out in 714 animals from different breeds. This comprised 189 Frieswal from Military Farm, Bareilly, 240 Frieswal from Military Farm, Lucknow and 235 *Vrindavani* and 50 Tharparkar animals from Cattle and Buffalo Farm, IVRI, Izatnagar. In case of the Frieswal crossbred cattle population, all 3 types of genotypes i.e., A1A1, A1A2 and A2A2 were observed with maximum genotypic frequency of A1A2 (0.515) followed by A2A2 (0.31) and A1A1 (0.175). In case of the *Vrindavani* crossbred cattle population, all 3 types of genotypes were observed with maximum genotypic frequency for A1A2 (0.481) followed by A2A2 (0.396) and A1A1 (0.123). In case of Tharparkar population, only two type of genotypes viz., A1A2 and A2A2 were observed with maximum genotypic frequency of A2A2 (0.90) followed by A1A2 (0.10).

Further, association between A1/A2 variants of β-casein gene and economic traits in Frieswal, *Vrindavani* and Tharparkar cattle was found out. β-Casein A1/A2 genotype, in Frieswal cattle, had significant effect on several production traits. Results revealed that genotype had significant effect (P≤0.05) on Total milk yield in kg (TMY), Milk yield at 300 days in kg (MY300), Lactation length in days (LL) and Peak Yield (PY). Statistical analysis revealed that A1A1 genotype had significantly lower milk yield as compared to A1A2 and A2A2 genotypes. While A1A2 genotype had highest milk yield, A2A2 and A1A2 genotypes however were not significantly different from each other. In *Vrindavani* cattle, β–Casein A1/A2 genotype had significant effect on Milk yield per day of lactation length in kg MY/LL (P≤0.05), LL (P≤0.05) and Fat% (P≤0.05). A2A2 & A1A2 had significantly higher lactation length (P≤0.05) and Fat% (P≤0.05) than A1A1 while A1A2 and A2A2 genotypes were not significantly different from each other for these traits. However, A1A1 had significantly higher milk yield per day of lactation length (P≤0.05) than A2A2 & A1A2 while A1A2 and A2A2 genotypes were not significantly different from each other. In Tharparkar cattle, genotype had no significant effect on any production and reproduction trait under investigation. The investigation addresses to an extent the importance of inclusion of A1/A2 genotype in selection criteria along with several economic traits.



PCR-RFLP profile of Beta-casein gene by DdeI in 3% agarose gel; Lane M: 100 bp ladder

Mining of milk phenomics in cattle and buffaloes

An investigation was conducted to compare milk minerals and constituents in different bovine species and breeds. The genetic and non-genetic factors affecting milk fat, protein and milk mineral composition in crossbred cattle were investigated. The effect of breeds was found to be highly significant (p≤0.01) on Copper (Cu), Zinc (Zn), Manganese, (Mn), Sodium (Na), Potassium (K), fat and protein, significant (p≤0.05) on Calcium (Ca) and non-significant on Phosphorus (P) and Iron (Fe) content. The Ca, Cu, fat and protein were found significantly higher in Murrah buffalo followed by Tharparkar cattle and crossbred cattle. However, Mn and Zn were higher in Tharparkar cattle followed by Murrah buffalo and crossbred cattle. Tharparkar milk was also rich in Na and K followed by crossbred cattle and Murrah buffalo. The effect of parity was highly significant (p≤0.01) only on Mn, whereas, effect of lactation stage (LS) was significant (p≤0.05) on Fe and Cu in milk of crossbred cattle. The effect of Test Day Milk Yield (TDMY) was significant (p≤0.05) on Fe and Cu. The product moment correlation was highest (0.414) between Zn and Fe and lowest (-0.347) between Cu and Zn. Among milk minerals, the estimates of heritability for Fe, Ca and Mn were moderate, whereas it was low for other minerals in crossbred cattle.

Further, association of milk mineral (P, Ca, Cu, Zn, Mn, Fe, Na and K) contents and milk constituents (fat and protein percentage) with five single nucleotide polymorphism (SNPs) *viz*., rs109421300, rs43691049, rs109727821, rs109047657 and rs135678421 in crossbred was investigated. The non-genetic factors, which were found to be significant, were adjusted using their least squares constants. It was revealed that the AA genotypes of rs109421300 locus pertaining to DGAT gene had significantly (p≤0.0001) lower (2.96±0.17%) fat percentage than AG (4.64±0.22 %), GG (4.62±0.27%) genotypes but simultaneously cows with AA genotypes had significantly (p≤0.05) highest (11.59±0.51 kg) test day milk yield than other two genotypes. At locus rs109727821, the manganese concentration was found to be significantly (p≤0.0001) highest (1.64±0.16 mg/L) for AG followed by AA (0.98±0.15 mg/L) and GG (0.77±0.24 mg/L) genotypes.

Performance evaluation and prediction of first lactation milk yield in *Vrindavani* cattle

An investigation was carried out using first lactation milk records of 1084 *Vrindavani* cows spread over a period of 17 years (2000-2017). The overall performance, effect of non-genetic factors on the first lactation test day (TD) milk yields, monthly milk yields (MY1 to MY10), age at first calving (AFC), first lactation length (FLL), first lactation peak yield (FLPY), first lactation average daily yield (FLADY), first lactation 305 days milk yield (FL305MY) and first lactation total milk yield (FLTMY) were investigated. The FL305MY and FLTMY were predicted on the basis of the test day milk yields as well as the monthly milk yields. The effect of season was highly significant (P≤0.01) on AFC, FLADY, FLPY, FLTMY and all the test day milk yields except TD6 and TD186, whereas, significant (P≤0.05) effect on FLL, TD6 and TD186. A highly significant (P≤0.01) effect of season was also observed on all the monthly milk yields except MY6 on which there was non-significant effect of season. The influence of period was highly significant (P≤0.01) on AFC, FL305DMY, FLTMY, FLL, FLPY, FLADY, all the test day milk yields, all the monthly milk yields and was significant (P≤0.05) for MY7. The effect of age at first calving (AFC) was highly significant (P≤0.01) on FL305MY, MY5 to MY9 and TD186 to TD246; significant (P≤0.05) on FLADY, FLTMY, MY4 and TD126 and non-significant on FLL, FLPY, MY1, MY2, MY3, MY10, TD6, TD36, TD66, TD96, TD156 and TD276.The heritability estimates of FL305DMY, FLTMY, monthly milk yields and test day milk yields were low to moderate. While predicting FL305MY, the highest coefficient of determination (R2) was obtained for TD96 and MY9. However, while predicting FLTMY, the highest R2 values were obtained for TD246 and MY9. Further estimated breeding values of *Vrindavani* sire were estimated using BLUP, animal model of REML and test day random regression model (TD-RRM).

Screening of FecB mutation and its association with litter size in Kendrapada sheep

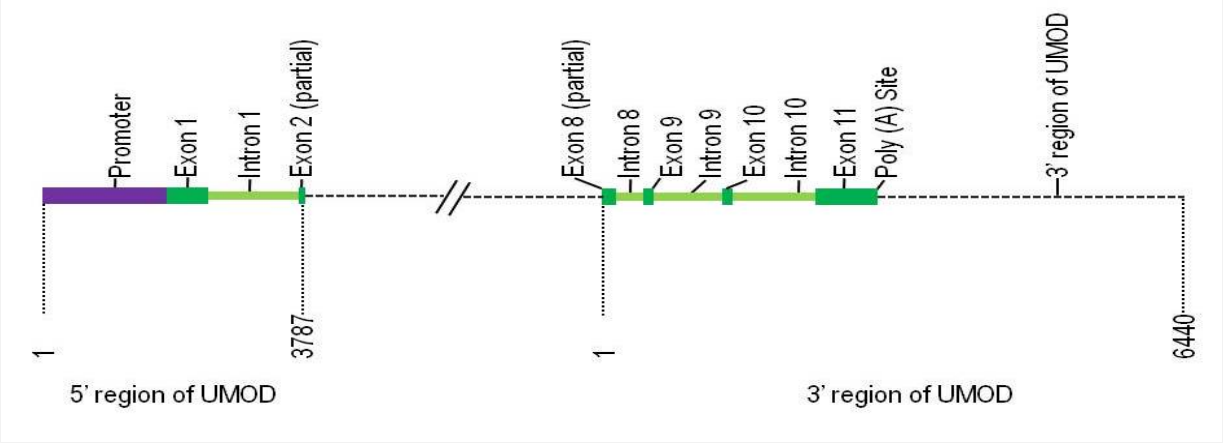
A study was undertaken to screen FecB mutation and its association with litter size in Kendrapada sheep in their native breeding tract. A total of 432 animals were selected from the natural breeding tract following stratified random sampling scheme. The data on litter size, parity, adult body weight (kg) and the managemental practices were collected by direct observations and information from sheep owners. This study was also carried out to identify the breedable animals of Kendrapada sheep for future introgression programme in non-prolific sheep breeds. Forced PCR-RFLP technique was carried out to find FecB allelic variants in Kendrapada sheep. Out of 432 Kendrapada sheep, 173 (40%) were homozygous carriers (FecBBB), 156 (36%) were heterozygous carriers (FecBB+) and 103 (24%) were homozygous non carriers (FecB++). The heterozygosity of the population was 0.351 which indicates that FecB gene is not fixed in native breeding tract. The least square mean on litter size was 1.82±0.03. The least square analysis of variance indicated that the effect of genotype on litter size was highly significant and one copy of the FecB allele increased the litter size from 1.0 to 2.0.The effect of genotype on body weight was not statistically significant. The phenotypic correlation between litter size and FecB genotypes was 0.7327±0.0001 which revealed that litter size and genotype were highly correlated. However, the correlation between parity and litter size was 0.1729±0.0006, the correlation between parity and FecB genotype was 0.007±0.89 and it has revealed that litter size was having very least correlation with parity. Further, 173 breedable animals with FecBBB genotype were also identified through this study.

Characterization of 5’ and 3’ regulatory regions of uromodulin gene in Black Bengal goat

A study was undertaken to characterize 5’ and 3’-regulatory regions from uromodulin (UMOD) gene in Black Bengal goat. For this, these regions from Black Bengal goat were PCR amplified using a proof-reading DNA polymerase to ensure error-free amplification. Characterization of amplified fragments was carried out using their complete sequencing using NGS wherein sequences were assembled on the basis of goat genome assembly available in the public databases. Through this, 3787 bp 5’ region and 6440 bp 3’ region of goat UMOD gene from Black Bengal breed was completely sequenced. The sequenced regions were annotated subsequently for the different features and sequences with proper annotation were submitted to the NCBI GenBank (GenBank accession number MH425385 for 5' region of UMOD and GenBank accession number MH425386 for 3' region of UMOD).

Annotation of the sequences

Sr. No.	Feature	3787 bp UMOD 5' region
1.	Promoter	1-2162
2.	Transcription start site (TSS)	2163
3.	Exon 1	2163-2305
4.	Intron 1	2306-3745
5.	Partial exon 2	3746-3787
6.	5’ UTR	2163-2305; 3746-3787



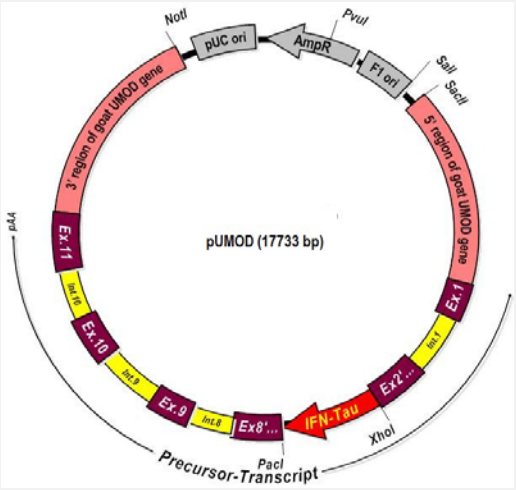
Characterization of 5' and 3' regulatory regions of uromodulin (UMOD) gene in Black Bengal goat

Annotation of the sequences

Sr. No.	Feature	6440 bp UMOD 3' region
1.	Partial exon 8	1-116
2.	Intron 8	117-718
3.	Exon 9	719-800
4.	Intron 9	801-1961
5.	Exon 10	1962-2003
6.	Intron 10	2004-3005
7.	Exon 11	3006-3534
8.	Poly (A) signal sequence	3506-3511
9.	Poly (A) site	3534
10.	Stop Codon	3065-3067
11.	3' UTR	3068-3534
12.	3' region of UMOD	3535-6440

Construction of urine-targeting transgene expression vector based on goat uromodulin gene

Construction of urine-targeting transgene expression vector was carried out which is based on regulatory regions from kidney-specific uromodulin gene from goat. The vector codes for goat interferon tau (IFNT) transgene. pBlueScript II SK (+) plasmid vector was used as backbone for construction of the vector. The vector is named as pUMOD. Transgene expression cassette of pUMOD comprises of 5' region of goat UMOD gene, goat IFNT ORF and 3' region of goat UMOD gene. In this, the 5' region of UMOD gene comprises of 5' region of the gene including its promoter, transcription start site, untranslated exon 1, intron 1 and untranslated partial exon 2; goat IFNT ORF and 3' region of UMOD gene comprises of untranslated partial exon 8, intron 8, untranslated exon 9, intron 9, untranslated exon 10, intron 10, untranslated exon 11, poly (A) signal sequence, poly (A) site and further 3' region of the goat UMOD gene. The vector was constructed using NEBuilder HiFi DNA Assembly method by PCR amplifying all the different DNA fragement as overlapping fragments and their subsequent ordered joining. Constructed vector was characterized using RE digestion using a panel of restriction enzymes. This confirmed successful construction of urine-targeting transgene expression vector based on goat uromodulin gene.

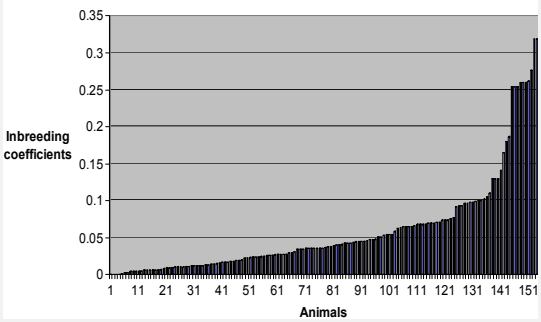


Map of pUMOD (urine-targeting transgene expression vector based on goat uromodulin gene)

Estimation of inbreeding coefficient in *Vrindavani* cattle by pedigree method

A study was carried out to estimate inbreeding coefficient in *Vrindavani* cattle by pedigree method. Pedigree data of 154 *Vrindavani* cattle, pertaining to 6 generations spread over 47 years (1970-2017) was collected, tabulated and digitized and inbreeding coefficient was calculated using Path Analysis Method. The inbreeding coefficients ranged from 0 to 32% in the population under study. These were categorized in acceptable (<5 %), moderate (5-10 %) and high (>10%) inbreeding groups. The mean inbreeding coefficients of acceptable, moderate and high inbreeding groups were 0.0216^{a}±0.0014 (96), 0.0729^{b}±0.0025 (38)

and 0.2043^{c}±0.0165 (20). Thus 62, 25 and 13 % *Vrindavani* animals belonged to acceptable, moderate and high inbreeding groups. All the means were significantly different from each other ($p<0.01$). The overall mean of inbreeding coefficients was 0.0580±0.0054 (154).



Distribution of inbreeding coefficient in *Vrindavani* cattle

Determination of primary sex ratio in crossbred boar semen

A total of 30 cyto-screened Landlly crossbred pigs from Swine Production Farm were used in the study. Genomic DNA was extracted and a set of 15 pairs of primers from different autosomes and sex chromosomes were screened for PCR amplification. Out of these, a pair of sex chromosome (X and Y) specific primers from each sex along with an autosomal primer was selected on the basis of specific amplification and quantification results. RT-qPCR was performed to study the copy number change of PHOX (X specific) using EIF1AY (Y specific) gene as control and BRMS1L (autosoml gene) as reference gene. The relative copy number of PHOX (X specific) gene in females was 1.866 times higher as compared to EIF1AY (Y specific) gene in males. The results indicated that RT-qPCR based copy number analysis of studied primers can be used for detection of primary sex ratio in boar semen.

Development of inbred strain of Swiss Albino mice

An activity towards development of inbred Swiss Albino strain of mice has been carried out. The data on fitness/economic traits viz. birth weight (BW), weaning weight (WW), adult body weight (ABW), litter size at birth (LSB), litter size at weaning (LSW), generation interval etc. was recorded in apparently 55 healthy pairs (55 males and 55 females) of Swiss Albino out bred strain of mice which were selected as base foundation parental stock (P generation) and were put for breeding in separate cages, pair wise. The average birth weight of total 918 mice pups of F0 generation was 1.68±0.01g and their mean litter size at birth was 9.46±0.08. The effect of litter size (litter size grouping was done as 1-5, 6-9 and 10 and above) at birth on birth weight was found to be significant ($P \leq 0.01$). The average weaning weight of mice of F0 generation was found to be 13.39±0.15 g. The effect of litter size at birth on weaning weight was found to be significant ($P \leq 0.01$). The mean of adult body weight of mice of F0 generation was found to be 33.39±0.31g. The effect of litter size at on adult body weight was also found to be significant ($P \leq 0.01$). The effect of litter size at weaning on weaning weight and adult body weight on mice of F0 generation was also analyzed and was found to be significant ($P \leq 0.01$). The overall (male + female) weaning weight of mice of F0 generation was found to be 13.39±0.15 g. The mean weaning weight of male (13.76±0.21g) was significantly ($P \leq 0.01$) different from the female (12.96±0.20 g). Similarly, the overall (Male + female) adult body weight (ABW) of mice of F0 generation was found to be 33.39±0.31 g. The mean adult body weight of male (35.26±0.41g) was significantly ($P \leq 0.01$) different from the female (31.19±0.39 g).

3.13
Sustainable Livestock Production through Nutritional Interventions

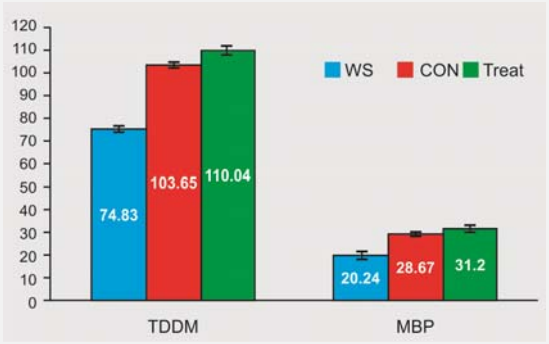
Nutri-physiological interventions for enhancing reproduction of dairy animals

Immunomodulatory effects of curcumin: *In vitro* studies were carried out to ascertain immuno-modulatory effects of curcumin on TLR4 agonist induced PGE_2 in endometrial cells. The results indicated a potent inhibitory effect on lipopolysaccharide (LPS) induced PGE_2 production from the primary endometrial stromal cells of the buffalo with curcumin effectively inhibiting the up-regulation of gene coding the cytokines IL-1β, IL-6, IL-8 and TNF-α. In addition, curcumin down regulated the basal expression of IL-1β and TNF-α transcript. However, flagellin either alone or in combination with LPS did not modulate the expression of the genes studied except for IL-8.

Double synch protocol for improving conception: The ovulation synchronization study was carried out with 50 non-pregnant animals (40 cattle and 10 buffalo) using double synch protocol revealed that all animals came to heat. Timed artificial insemination (TAI) performed after 16 h and 24 h of the second GnRH injection indicated achievement of a conception rate of 82% and 70%, respectively, in cattle and buffaloes, when pregnancy diagnosis was done following 60 days post TAI.

Evaluation of a mineral supplement: An on-farm trial carried out to assess the efficacy of the farming system based mineral supplement (FSMS) developed earlier indicated 65.8% of the problematic cows/heifers given FSMS came into heat within 61.4±6.1 days of feeding. Of the inseminated animals, 15.8% cows returned to heat and became pregnant upon successive two to three cycles. The serum levels of Ca, P, Zn, Cu and Mn were improved with FSMS supplementation accompanying a 13.4% increase in daily milk yield.

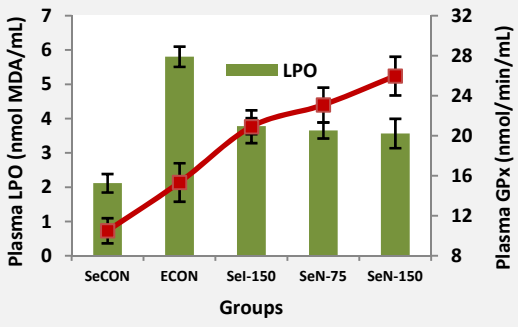
Strategic supplementation of concentrate mixture: A concentrate mixture specially formulated to be used as a strategic supplementation was evaluated through an on-farm trial. With the feeding of the supplement (1 kg/day in addition to existing farmers' practices) the problematic buffaloes came into heat after 35.5±5.3 days. Continuation of the feeding following insemination resulted in 71.4% of the buffaloes becoming pregnant upon successive cycles. Besides, it also improved milk yield by 11% during the 60 days of study. The *in vitro* evaluation of the supplement was shown to improve substrate degradation efficiency of microbial biomass production.



Effect of AICRP supplement on TDOM and MBP production (mg/200 mg) in buffaloes

Ameliorative role of nano-selenium in experimental endotoxaemia

In order to ascertain the effects of nano-selenium on clinico-nutritional performance of rats with experimental endotoxaemia, the diet of the rats was supplemented with either nano-selenium (75 and 150 ppb) or inorganic selenium (150 ppb) along with normal- and endotoxaemia-controls. The results indicated similar intake of nutrients and growth performance of the rats under different groups. However, the serum levels of various

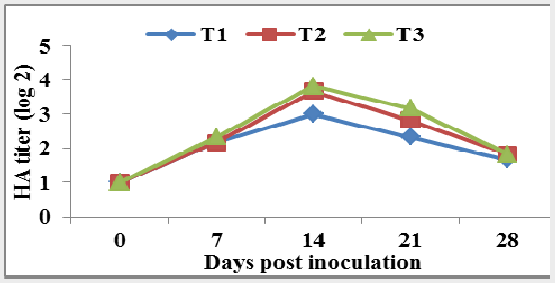


Effect of inorganic and nano-selenium on plasma lipid peroxidation and glutathione peroxidase activity of rats exposed to endotoxin

minerals showed variations among the groups. Supplementation of selenium attenuated the effects of endotoxaemia in terms of altered serum enzymes and lipid peroxidation. Plasma glutathione peroxidase (GPx) activity was improved in all the supplemented groups, irrespective of form and dose of selenium, as was the antibody titre against chicken egg white lysozyme. The cell-mediated immune response assessed at the end of the experiment remained similar among all the groups. It is concluded that selenium supplementation in nano- (75 ppb) or inorganic-form (150 ppb) exerted beneficial effects on select blood parameters, hepatic enzyme activity and antioxidant indices countering adverse effects of endotoxin. Moreover, nano-selenium supplementation was apparently superior than inorganic selenium in exerting the observed beneficial effects in rats exposed to endotoxaemia.

Nano-zinc for improved performance of goats

The effectiveness of dietary nano-zinc supplementation (at 20 and 40 ppm levels) versus zinc sulfate was tested in growing kids during a 165 days study. The results indicated that use of nano-zinc in the diet of kids improved their average daily gain without influencing the feed conversion. The balances of Ca, P and Zn were significantly higher with nano-zinc with no apparent influence on the nutrient digestibility. The supplementation also improved the activity of SOD and the zinc content in vital organs. Although, the carcass characteristics were comparable among the dietary groups, nano-zinc improved the keeping quality of meat as indicated by lower TBARS and higher DPPH levels. Semen quality parameters also responded positively to nano-zinc use in the diet of male goats in addition to their increased scrotal circumferences. It is deduced that supplementation of nano-zinc at the level of 20 ppm and 40 ppm exhibited beneficial effects on immune response, hormonal profile, antioxidant status, reproductive traits accompanying.



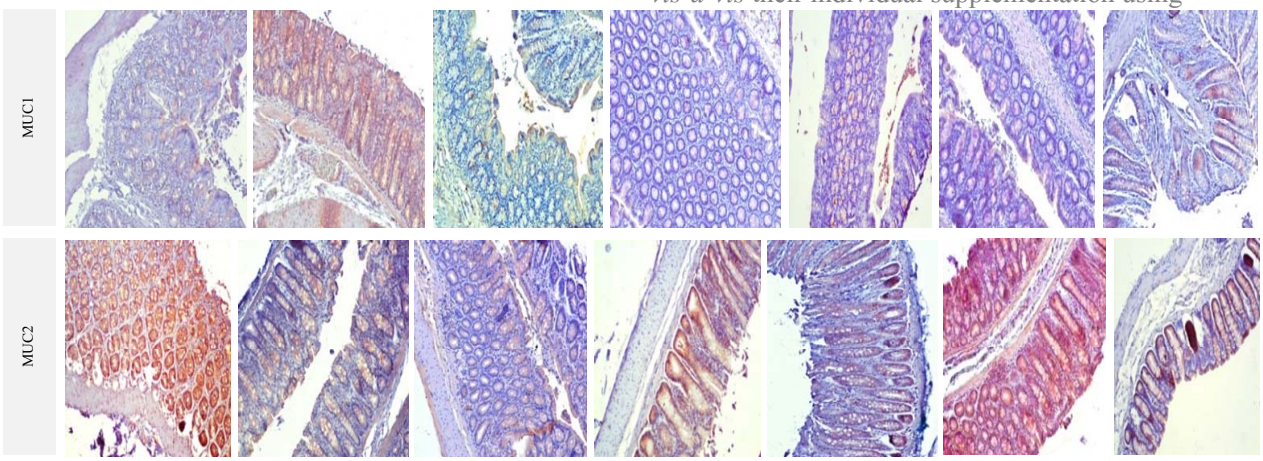
Effect of dietary nano-Zn on humoral immune response in goats

The *in vitro* evaluation of catalytic supplementation of alternate oil cakes

Results from an *in vitro* study indicated that use of unconventional cakes viz., *karanj*, *neem*, *mahua* seed cakes and castor bean meal reduced the methane production without affecting overall rumen fermentation. Further studies using various combinations of the two most promising cakes, namely *karanj* and neem seed cake in the ratio of 75:25 showed potential for further reduction of methane production *in vivo*.

Lactobacillus and polyphenolic bioactives combination for improved gut health

The gut health promoting ability of probiotic *Lactobacillus johnsonii* CPN23 was found accentuated by co-supplementation with select polyphenolic bioactives which was evident from improved immunity, mRNA expression of antioxidant genes and immunohistochemical assessment of mucin genes in rats with DSS-induced experimental colitis. Subsequently, the probiotic-polyphenol combination was evaluated *vis-à-vis* their individual supplementation using



Immunoreactivity of MUC1 and MUC2 genes in proximal colon tissues of different groups of Wistar rats with experimental DSS-induced colitis

adult healthy dogs. Results from the 60 days feeding trial reiterated the earlier findings observed in healthy and colitic rats. The co-supplementation of the probiotic with polyphenols resulted in positive changes in the fecal fermentation metabolites, select plasma metabolites, erythrocytic antioxidant indices and immunological attributes including peripheral lymphocyte sub-populations, serum levels of pro-inflammatory cytokines and immunoglobulins, and other parameters related to cell-mediated and humoral-immune response.

Jerusalem artichoke (JA) derived bioactives for augmenting gut health of dogs

Synergistic role of JA-polyphenols co-supplemented with JA-derived inulin was assessed in adult female dogs. The results indicated that dietary co-supplementation of the polyphenols and prebiotics augmented the fecal fermentation metabolites and Bifidobacterial population in a desirable manner. There were positive trends noted in terms of plasma lipid profile, erythrocytic antioxidants and peripheral lymphocyte subpopulations (CD4+ and CD8+), interleukins (IL-1β and IL-6) and immunoglobulins (IgA and IgG). While the antibody response to chicken erythrocytes showed an improvement in all the supplemented groups, the *in vitro* lymphocyte proliferation index was significantly improved with the co-supplementation. It is concluded that dietary co-supplementation of JA-derived prebiotics and polyphenols brings about a synergistic effects much like a synbiotic.

Methane mitigation using feed additives

A validation study was conducted using RM-3 as feed additive for reduction of methanogenesis. The results indicated that supplementation of RM-3 at 1.5% level did not have any influence on the nutrients digestibility and methane production. However, feeding of the additive during the 190 days feeding trial resulted in higher body weight gain in buffaloes. In another study, a mixture of extracts of garlic and ajwain was evaluated *in vitro* using buffalo rumen liquor as inoculum. However, there were no effects apparent in the substrate degradation attributes including methane production.

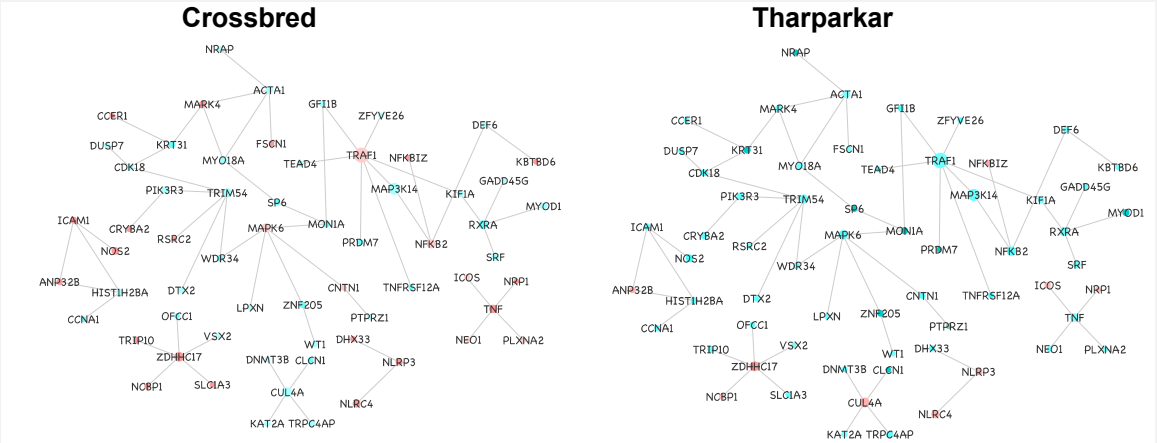
Isolation, characterization and identification of rumen microbes

Eight rumen bacteria from buffalo were isolated, characterized and were identified as *Streptococcus equinus* FDBB156, *Streptococcus equinus* BRB14, *Streptococcus equinus* BRB15, *Succinivibrio dextrinosolvens* BRB13, *Succinivibrio dextrinosolvens* FDBB155, *Clostridium difficile* AABB3, *Clostridium difficile* AABB5 with GenBank accession nos. MF370357, MF370358, MF370359, MF370360, MF370356, MF357879, MF357878, respectively and *Streptococcus bovis* BRB16. These isolates were submitted to Rumen Culture Collection Centre, NIANP, Bengaluru.

Effect of water deprivation in Tharparkar and crossbred cattle

To study the effect of 25% and 50% water deprivation (of the normal water intake) in Tharparkar and crossbred cattle, an experiments of 40 days was conducted on 10 Tharparkar and 10 crossbred bulls in natural climatic conditions in the months of mid-September and October, 2016 at the experimental shed complex of Physiology and Climatology Division of ICAR-Indian Veterinary Research Institute, Izatnagar. Before commencing the actual experiment, the animals were acclimatized for 15 days for their uniform feeding, watering schedule and housing, etc. Blood was collected in heparinized vaccutainer tubes at 05 days intervals for RNA isolation and for evaluation of hematological parameters. Blood was also collected in vaccutainer tubes without anticoagulant

Images of lymphocytes stimulated under phase contrast microscopy (10X) of dogs supplemented with JA-derived bioactives alone (JAI and JAE) and in combination (JAIE) compared to non-supplemented control (CON)



for serum. Effect of water deprivation on various physiological and hormonal profiles was already reported last year.

Two separate microarray experiments were carried out on Peripheral blood mononuclear cells (PBMCs) using Bovine (V2) Gene Expression Microarray, 4x44K (Agilent). Two biological replicates per genetic group were profiled. Further hybridization and other steps were done according to the manufacturer's instructions. The slides were scanned with an Agilent SureScan Microarray Scanner. The scanned images were analyzed with Agilent Feature Extraction Software 11.0.1. Data generated were analyzed by GeneSpring software version 13.0.

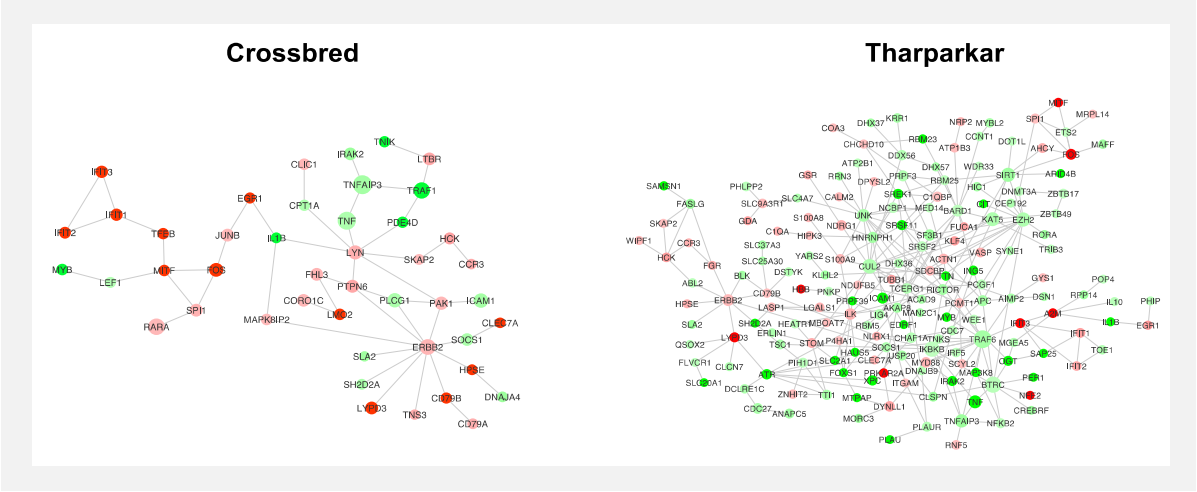
Water deprivation caused a sharp reduction in feed intake in crossbred cattle than in Tharparkar cattle. The T3, T4, cortisol and cholesterol concentrations did not differ significantly in both Tharparkar and crossbred cattle subjected to 25% water deprivation. The uric acid in Tharparkar and crossbred cattle increased on 5th and 10th day of 25% water deprivation. The creatinine concentration increased significantly ($P<0.05$) on 5th day in Tharparkar cattle. Sodium and potassium concentration increased significantly in Tharparkar and crossbred cattle on prolonged water deprivation. The body weight decreased linearly but non-significantly with time. The body weight was regained during recovery period.

In the microarray experiment among the common differentially expressed genes in both Tharparkar and crossbred, 18 genes were identified to be down-regulated in crossbred in comparison to the Tharparkar. This can be seen in the Differentially Expressed and Highly Connected (DEHC) network of these genes. TRAF and TNF involved in TNF signaling; TRAF1, ICAM1 and NFkB2 involved in NFKB signaling; NOS2 involved in calcium signaling; and several MAP kinases were down-regulated in crossbred and up-regulated in Tharparkar. Also ICAM1, NOS2 and TNF were found to be involved in reactive oxygen species metabolic and biosynthetic processes. The down-regulation of these genes in crossbred and upregulation in Tharparkar indicated better acclimatization of Tharparkar than the crossbred on the 5th day of 25% water deprivation. However, the dysregulation was found to be similar in both the genetic groups at 10th day of 25% water deprivation; and at 5th and 10th day of 50% water deprivation.

Effect of heat stress on Tharparkar and crossbred cattle at molecular level

In order to study the effect of heat stress on immunological, physiological responses of indigenous and crossbred cattle, 10 Tharparkar and 10 crossbred bulls of approximately 3 years of age were taken in the present study. Prior to experiment, the animals were acclimatized for 15 days outside the Psychrometric chamber. The experiment was conducted during the month of February and March when there was no environmental stress on the animals. Ten animals (5 Tharparkar and 5 crossbred) were exposed in Psychrometric chamber at 42 °C for six hours (Gr I) and 10 animals (5 Tharparkar and 5 crossbred) were used as control animals (Gr II). All the animals were fed with wheat straw and concentrate mixture in 60:40 ratio. Blood samples were collected from animals through jugular vein by using disposable syringe at 0, 7, 14, 21 and 28 days.

PBMCs were isolated from aseptically collected blood under cold conditions by density gradient centrifugation. Following RNA extraction, the library was prepared using Illumina kit following the manufacturer's protocol. Approximately, 10 µg of total RNA from control and heat stressed PBMCs was used to isolate mRNA using magnetic Oligo dT beads (Illumina) and the mRNA was



purified using mRNA purification kit (Invitrogen).The cDNA libraries prepared from both the control and heat stress samples were sequenced on Illumina HiSeq 2000 platform (Sandor LifeSciences, India).

In the RNA-Seq experiment on the 7th day of heat stress, 2706 and 3492 genes were differentially expressed in crossbred and Tharparkar, respectively. Out of these, 1464 and 1242 genes were up- and down-regulated in crossbred and 1782 and 1710 genes were up-and down-regulated in Tharparkar, respectively. Among these 1814 genes were found to be commonly differentially expressed in both Tharparkar and crossbred. Functional annotation of these DEGs resulted in identification of several biological pathways. To deduce meaningful interpretation knowledge based approach was followed and pathways governed by genes that having direct and indirect role in heat stress were selected for further analysis. These genes included *SPDEF*, *TRAF1*, *BCL2A1*, *PTGER*, *TNFAIP3*, *MAP3K8*, *HSP*, *HERUD1*, *CANX*, *TP53* and *DNAJ* that were reported to have a role in heat stress. Some of the important pathways governed by them were- response to stress, cellular metabolic processes, immune response, cytokine production, defense response, cell death etc. This approach identified 1604 DEGs in both the species. A network of these genes formed a dense hairball. To arrive at a meaningful conclusion, we narrowed down to differentially expressed and highly connected genes based on degree and fold change. A total of 118 and 283 genes were filtered as DEHC genes in crossbred and Tharparkar, respectively. We constructed the DEHC network of each species.

Effect of seasonal variation on indigenous and crossbred cattle

The experiment was conducted on 18 apparently healthy lactating cattle of 4-5 years of age viz., Sahiwal, Tharparkar and *Vrindavani* (Hariana× Holstien Friesian / Brown Swiss/ Jersey) which were being maintained under standard managerial conditions. The animals had *ad libitum* access to feed and good quality drinking water. The animals were divided in three equal groups of six animals each (Group I: Sahiwal, Group II: Tharparkar and Group III: Crossbreed) based on breed. The study was carried out during summer and winter season with average temperature-humidity index (THI) of 88.4±1.54 in summer and 64.75±0.97 in winter.

The physiological response data revealed that the rectal temperature varied significantly ($P<0.05$) between breeds during summer season with higher temperature in *Vrindavani* and lowest temperature was recorded in Sahiwal breed. However, no significant ($P>0.05$) variation was noticed during winter season. The data obtained between season within breed indicated that a significantly ($P<0.05$) higher temperature was recorded in summer as compared to winter in all the breeds. The similar trend was noticed on respiration rate.

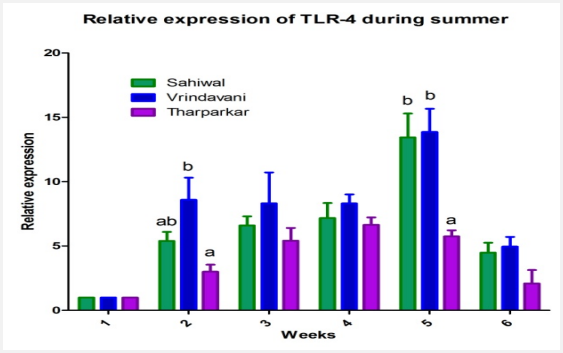
The total antioxidant capacity (TAC) did not vary significantly among breeds during summer and winter seasons. However, the TAC was higher in Tharparkar and lowest in *Vrindavani*. In all three breeds studied, the TAC activity was significantly ($P<0.05$) higher during summer as compared to winter in all breeds. The catalase activity was significantly ($P<0.05$) higher in Tharparkar cattle as compared to *Vrindavani* during summer season. No significant variation was noticed during winter season. Among seasons, the catalase activity was significantly ($P<0.05$) higher during winter season as compare to summer season in all three breeds. The serum SOD activity showed no variation during summer and winter season in all the breeds. The SOD activities was higher in *Vrindavani* cattle and lower in Tharparkar cattle during summer, however, the reverse trend was noticed during winter. The SOD and GSH levels were significantly

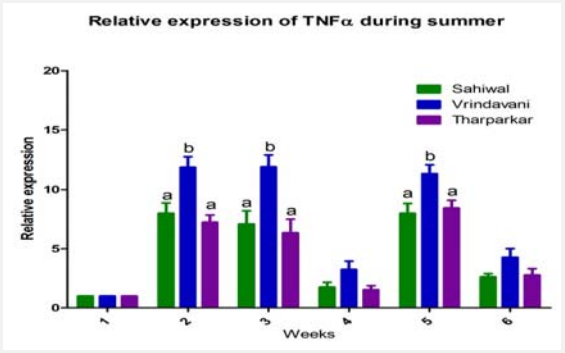
(P<0.05) higher during summer as compared to winter in respective breeds.

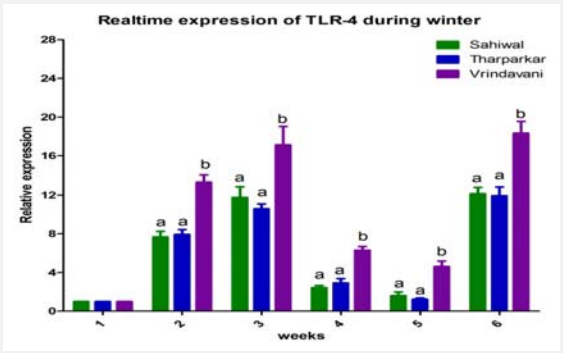
The results of phagocytic index (PI) and lymphocyte proliferation assay (LPA) revealed that it did not vary significantly (P>0.05) among breeds in both summer and winter season. The PI was significantly (P<0.05) higher in winter in Tharparkar cattle as compared to summer season. No change was recorded in PI between seasons in Sahiwal and *Vrindavani*. However, the LPA was significantly (P<0.05) higher during winter in *Vrindavani* as compared to summer season. No change in other two breeds was noticed.

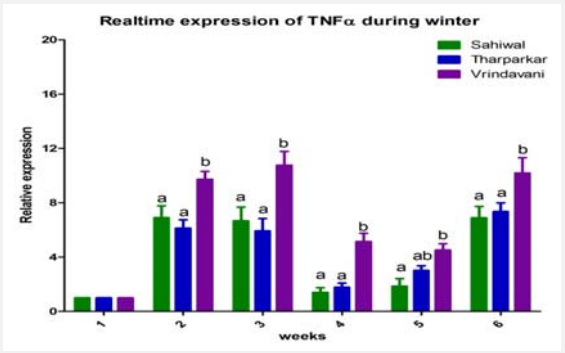
The real-time expression of various genes sensitive to heat stress (HSP70) and maintenance of adaptive immune response (Interleukins and TLRs) of animals were also studied in both summer and winter seasons. The expression of HSP70 was highest during second and third week of observation and very well correlated with Temperature-Humidity Index (THI) as it was highest during second and third week. The data revealed that the HSP70 expression was significantly (P<0.05) higher in *Vrindavani* group as compared to Tharparkar and Sahiwal group during all the observation point.

During winter season, the HSP70 was also significantly (P<0.05) higher in *Vrindavani* group at 2nd, 3rd and 6th week as compared to other two groups. During summer, the real-time expression of interleukins (IL-2, IL-6 and IL-10) indicated that, the IL-6 and IL-10 varied significantly (P<0.05) at 3rd week, however, IL-2 did not show any significant variation among groups. During winter, the IL-2 expression was significantly (P<0.05) higher in *Vrindavani* group as compared to Tharparkar group at 2nd and 3rd week. However, the IL-6 expression data indicated that the Tharparkar group had significantly (P<0.05) higher expression as compared to *Vrindavani* group and a non-significant difference was exist among Tharparkar and Sahiwal groups. Again the IL-10 expression was significantly (P<0.05) higher in *Vrindavani* group as compared to Tharparkar and Sahiwal group at II, III and VI weeks.









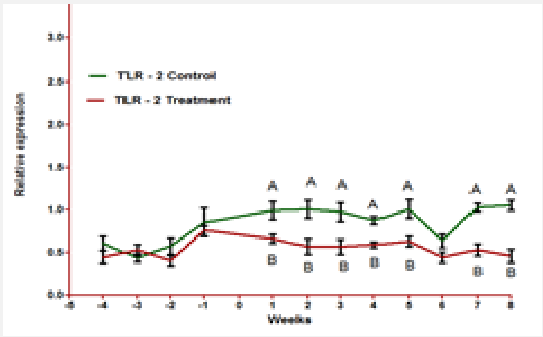
During summer, the TLR-2 expression indicated that its expression was significantly (P<0.05) higher in *Vrindavani* group as compared to other groups at 2nd and 3rd week. The TLR-4 showed highest expression in *Vrindavani* group at 2nd week, however, at 5th week the Sahiwal and *Vrindavani* groups had significantly (P<0.05) higher expression as compared to Tharparkar group. During winter season, the TLR-2 and TLR-4 expressions was significantly (P<0.05) higher in *Vrindavani* group. The TLR-2 expression was significantly (P<0.05) higher at 2nd and 3rd week, however, the TLR-4 showed a significantly (P<0.05) higher expression during each sampling time point in *Vrindavani* as compared to Sahiwal and Tharparkar groups. The TNFα expression during summer season showed the similar pattern as observed in TLR-2 expression and the winter TNFα data showed the similar pattern of expression as observed in TLR-4 expression during winter season.

3.14
Livestock Production and Management

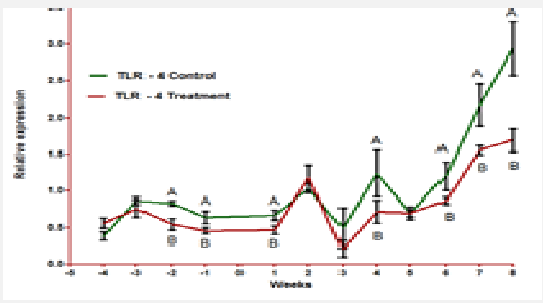
Physiological adaptation to peripartal stress in crossbred cows

Effect of supplementation of a trace mineral-vitamin (vitamin E, Se, Cu and Zn) combination during peri-partum period, and extra (20%) energy during post-partum period was studied in crossbred cows. The supplementation improved the body condition score (BCS) from 3rd week post-partum and onwards. It resulted in increased milk yield from 4th week onwards with reduced somatic cell counts.

The increased expression of IL-1 and IL-2 observed in the supplemented group during pre-partum was significantly lower during post-partum in addition



Relative expression of TLR-2 in control and treatment group



Relative expression of TLR-4 in control and treatment group

to a lower expression of TLR-2 and TLR-4. The supplementation strategy improved the reproductive performance as evident from reduced number of days for occurrence of first post-partum estrus (67 *vs*. 53.8 days), reduced service period (85.87 *vs* 68.5 days), and increased conception (80 *vs*. 100%) and pregnancy rate (80 *vs* 100%). The data indicated that the supplementation of vitamin E, Se, Cu and Zn along with the extra energy is useful in amelioration of peripartal stress in transition animals.

Performance and behaviour of dairy calves under modified shelter

A study was conducted on crossbred calves (*Vrindavani*) to compare the effect of roof modification on microclimate of sheds *vis-a-vis* growth, physiology and behaviour performance of calves reared under three different roofing types, viz., normal corrugated cement sheet roofing (control), corrugated cement sheet roofing painted white on upper and black on inner surface, and polycarbonate sheet roofing. The internal shed temperature reduced significantly in painted- and polycarbonate-roofing than control during summer months. The maximum average daily gain was exhibited by the calves under the painted roofing. The results of physiological parameters, viz., respiration rate and rectal temperature clearly indicated that the stress was lowest in painted roof followed by polycarbonate sheet. This trend was further corroborated by other behavioural parameters such as total moving time, and time spent on resting, feeding and rumination. The onset of first heat was also found to be earlier in the treatment groups than the control.

Effect of milking environment enrichment through music

Exposure of animals to instrumental music through flute and sitar, and *Gayathri* mantra during milking was studied using lactating *Vrindavani* cows along with a non-music control. The results indicated no differences in milk yield, respiration rate and rectal temperature of different groups. The preliminary investigations showed that the behaviour of animals exposed to music treatments was calmer as compared to control.

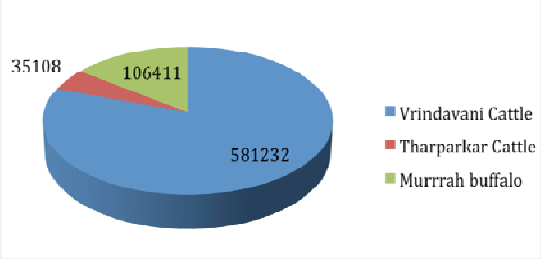
Multiplication and evaluation of synthetic crossbred cattle strain *Vrindavani*

Herd strength: The herd strength of *Vrindavani* cattle was 464 heads (77 males and 387 females). There was birth of 84 female and 92 male calves, death of 60 animals and 224 animals were transferred / auctioned. The overall mortality was 9.38%. The closing balance of the *Vrindavani* cattle herd was 356 cattle heads (29 males and 327 females).

Reproductive performance: The overall conception rate in the herd was 53.70%. The incidence of calving abnormalities was 20.44%,

(8.84% abortions, 2.76% unseen abortions, 1.10% dystocia, 4.97% retained placenta, 0.55% prolapse and 2.21% stillbirths). The average age at first calving, service period, dry period and calving interval was 930.40±17.48 days, 137.03±4.55 days, 87.72±6.99 days and 412.90±9.39 days, respectively.

Milk production performance: The herd produced 5,81,232 kg milk during the year. On an average, 78.37% of total adult females were in milk. Means for wet and herd averages were 9.65 and 7.62 kg, respectively. On the basis of analysis of 2206 milk samples, the overall fat, SNF and total solids contents were 4.22, 8.97 and 13.19%, respectively. Total lactation milk yield, total lactation length, 305 days milk yield, peak yield and weight at calving averaged 3060.7±88.0 kg, 310.8±6.3 days, 3374.8±87.9 kg, 17.24±0.32 kg and 393.4±4.6 kg, respectively.



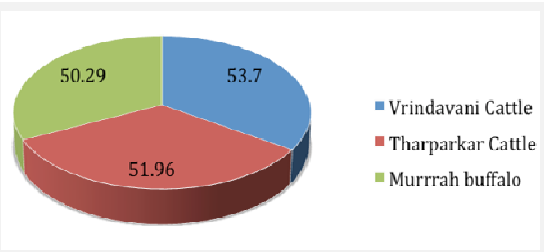
Breed-wise total milk production (kg) during the year 2017-18

Growth performance: Overall live weight at birth, and at 3, 6, 12, 18 and 24 months of age were 23.2±0.3, 50.3±0.8, 86.0±1.0, 140.5±3.0, 230.0±3.9 and 306.4±4.8 kg, respectively.

Genetic improvement, conservation and multiplication of Tharparkar native cattle

Herd Strength: The herd strength of Tharparkar cattle was 86 heads (15 males and 71 females). There was birth of 19 female and 22 male calves. In all, 48 animals were deleted from the herd due to various reasons, and 25 animals were added through purchase. The closing balance of the herd was 104 heads (20 males and 84 females). The overall mortality was 2.36%.

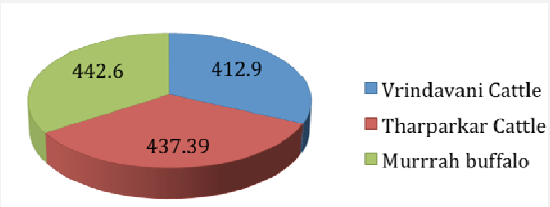
Reproductive performance: The overall conception rate was 51.96%. The incidence of calving abnormalities was 21.95% (12.20% abortions, 2.44% unseen abortions, 2.44% retained placenta and 4.88% stillbirths). The means for age at first calving, service period, dry period and calving interval were 1000.1±29.4 days, 158.8±28.6 days, 288.4±37.4 days and 437.4±30.5 days, respectively.



Conception rate (%) in different breeds during the year 2017-18

Milk production performance: The Tharparkar herd produced 35,108 kg milk during the year. Means for overall wet and herd averages were 4.50 and 1.68 kg, respectively, under suckling system of calf management. On an average, 38.17% of the total adult females were in the milk. On the basis of analysis of 220 milk samples, the overall fat, SNF and total solids contents were 4.25, 8.99 and 13.24 percent, respectively. The means for total lactation milk yield, total lactation length, milk yield per day of total lactation length, 305 days milk yield, peak yield, and weight at calving were 1666.2±142.2 kg, 265.2±14.7 days, 6.26±0.40 kg/d, 2441.8±307.5 kg, 8.01±1.01 kg/day and 395.8±12.5 kg, respectively.

Growth performance: The mean live weight at birth, and at 3, 6, 12, 18 and 24 months of age were 22.1±0.7, 51.4±1.6, 98.6±3.2, 164.4±7.7, 226.3±9.7 and 271.7±10.7 kg, respectively. The weight at first calving was 395.8±12.5 kg.



Calving interval (days) in different breeds during the year 2017-18

Strengthening of Sahiwal herd

Sahiwal herd was strengthened during the period under report. Opening balance of Sahiwal cattle was 58 heads (13 males and 45 females) which was increased to 63 (53 females and 10 males) at the year end. Best semen of meritorious bulls, available in the country is being used for the genetic improvement of the herd.

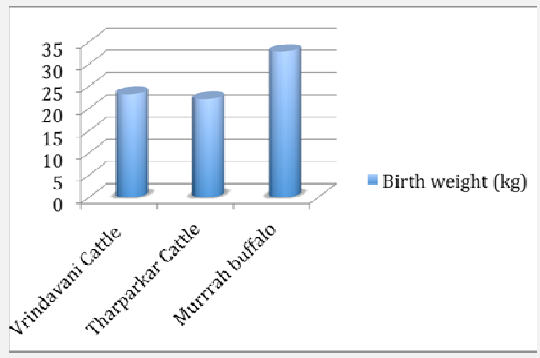
Genetic improvement of Murrah buffalo

Herd Strength: The herd strength of Murrah buffaloes was 202 heads (45 males and 157 females). There was birth of 24 female and 22 male calves. In all, 66 animals were deleted from the herd due to various reasons. The closing balance of the buffalo herd was 182 buffalo heads (146 females and 36 males). The overall mortality was 4.44%.

Reproductive performance: The overall conception rate was 50.29%. The incidence of calving abnormalities was 17.64%, which included 9.80% abortions and 7.84% retained placenta. The means for age at first calving, service period, dry period and calving interval were 37.6±1.1 months, 180.0±16.5 days, 158.5±11.2 days and 442.6±14.4 days, respectively.

Milk production performance: The buffaloes produced 1,06,411 kg milk during the year. Means for overall wet and herd averages were 5.77 and 3.72 kg, respectively. On an average, 64.52% of the total adult females were in the milk. The means for total lactation milk yield, average lactation length, average 305 days yield and peak yield were 2178.9±82.4 kg, 320.8±11.1 days, 2029.9±66.5 kg and 10.14±0.30 kg, respectively. The means for fat, SNF and total solid were 7.99, 9.89 and 17.89%, respectively (based on 554 samples).

Growth performance: The means for overall live weight at birth, and at 3, 6, 12, 18 and 24 months of age were 32.8±1.0, 77.7±1.5, 112.2±2.5, 196.5±4.6, 293.9±7.7 and 377.8±9.6 kg, respectively. The weight at first calving during the current year was 527.4±18.0 kg.



Birth weight (kg) in different breeds during 2017-18

All India Coordinated Research Project on Pigs

The total herd strength at farm was 275 including 265 crossbreds and 10 Landrace. During the year, 374 crossbred and 56 Landrace piglets were born. Furthermore, 377 pigs / piglets (366 crossbreds and 11 Landrace) were sold to farmers of different part of the country for strengthening / establishing their herd. The closing balance was 233 (186 crossbreds and 47 Landrace). The litter size at birth, litter weight at birth, litter size at weaning and litter weight at weaning was 7.46±0.38, 7.71±0.40 kg, 5.65±0.45 and 53.20±3.84 kg, respectively, in 75% crossbred sows. Average individual weight at birth and weaning was 1.04±0.03 and 6.90±0.63 kg, respectively, in 75% crossbreds. The overall mortality at the farm was 11.48 %.

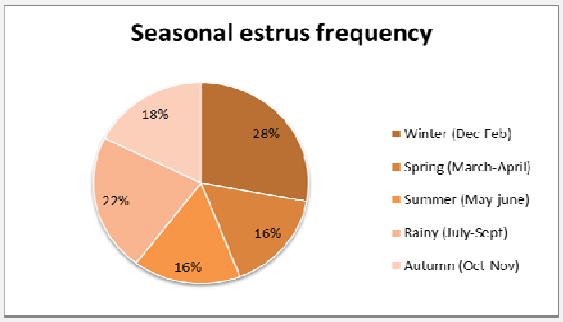
Production of laboratory animals

Four laboratory animal species are being maintained at LAR section i.e. rabbits (New Zealand and Angora breeds), rat (Wister strain), mice (Albino strain) and guinea pigs (Dunkin Hartley strain). The opening balance for rabbit, guinea pig, rat and mice were 58, 382, 820 and 1004 respectively, with the respective closing balance of 56, 362, 810, and 2366. A total 3812 mice, 3065 rats, 354 guinea pigs and 47 rabbits were produced during 2017-18 for supply to research laboratories. Additionally, 09 rabbits, 10 guinea pigs, 578 rats and 70 mice were supplied to other research organizations.
In addition, the laboratory animals section in Mukteswar Campus also maintains rabbits and guinea pigs.

Experimental Cattle Herd, Mukteswar Campus
Herd strength: The experimental dairy farm had a strength of 143 heads which was increased to 161 at the end of the year. A total of 43 calving (including 4 stillbirth /abortion) took place. Out of total calf born, 20 (51.2%) were male and 19 (48.71%) were female calves.

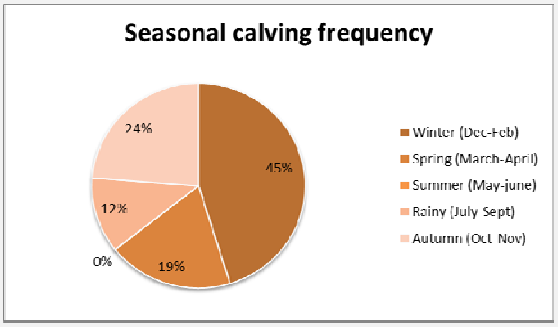
Milk production performance: Total annual milk production was 89,857 litres and the average milk production per day was 246.2 litre. Seasonal milk production revealed that the average milk production per cow per day was highest during the autumn season (October-November; 7.84 liters), followed by rainy season (7.72 liters), while it was lowest in the winter season (6.99 liters). During the year, total cow days were 12155, average cows in milk per day were 33.31 and average milk production per day was 7.39 liters. Average lactation yield and total lactation length in the herd was 2404.5±125.1 liters and 341.4±10.4 days, respectively. The wet and herd average milk production of the farm was 7.39 and 4.88 liters, respectively. Average dry period of herd was 97.21±19.42 days. Comparative analysis of the last ten years revealed that the total milk production and average milk production/cow/day is mostly dependent upon the number of productive cows in the herd.

Reproductive performance: During the period, 68 animals were detected in heat and artificial insemination (AI) was undertaken. Average number of AI required per conception was 1.58. Conception rate to first AI was 62.79% and overall conception rate to all AI was 63.23%**.** Wet: Dry cows' ratio in the herd was 66:34. Five heifers calved during the period and the age at first calving averaged 1294±71.2 days. Average dry period and inter-calving period in the herd was 97.21±19.42 days

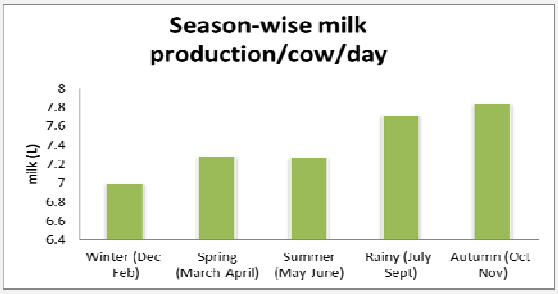


Season wise estrus percentage in 2017-18

and 456.27±23.73 days, respectively. The seasonal estrus frequency was highest during winter season (27.94%) and lowest in spring and summer (16.17%) season. Out of total 43 animals calved, highest calving frequency (44.18%) was during winter (Dec-Feb).



Season wise calving percentage in 2017-18



Average milk production per cow per day at Experimental Cattle Herd during different seasons

Experimental Goat Farm

The Experimental Goat Farm at Surmane had maintained an initial strength of 115 goats which increased to 145 at the year end. During the year, a total of 73 kids were born. Eight animals died due to various ailments and another lot of 35 animals were transferred.

AICRP on Goat Improvement

Himalayan hill goat unit under AICRP on Goat Improvement was started in 2014 with the aim of improvement of local Himalayan hill goats (Chaugarkha) at Kumaon hills of Uttarakhand. Three clusters namely, Lamkot of Lamgarha block, Khola and Gandhak of Dhauladevi block and Jur Kafun village of Hawalbagh block in Almora district have been adopted after surveying its breeding tract and distribution. In total, 47 farmers have been registered and 153 adult breedable does were maintained in these clusters along with 139 kids. The monitoring of the morphometric characters of these goats revealed that the average male body weight at 6, 9 and 12 months are 13.97±0.8, 17.04±0.97 and 20.95±0.58 kg, respectively. As nutritional scarcity and parasitic infestations are predominant in this area, a comprehensive study was conducted for controlling parasitic infection. In total, 123 faecal samples were screened for parasitic infections. The larval culture of the samples revealed that *Haemonchus contortus* and *Teladorsagia circumcincta* are predominant nematodes infecting goats of these clusters. Other important parasites affecting goats in the clusters include coccidia, *Moniezia* sp and ticks. One training programme on 'Health management of goat in hilly areas' was organized at Lamkot village with 14 participants. Eight animal health camps and two exposure visits were organized. Two superior bucks were distributed at Lamkot village after studying growth and morphometric parameters. Ten bucks of 3-6 months of age were procured from the cluster and maintained at the farm in order to select superior bucks.

National Mission on Sustaining Himalayan Ecosystems (NMSHE) TF-6

ICAR-IVRI as a partner institute worked on three objectives namely data base creation, monitoring system and capacity building. During 2017-18, mapping of livestock population density and production trend in Uttarakhand and Himachal Pradesh was carried out with help of ICAR-IISWC, Dehradun. Backyard poultry production in the hill region was monitored and integrated backyard poultry production for the temperate region was initiated with chicks of two breeds namely RIR (n=100) and Uttara fowl (n=100). Farming system incorporating poultry as a component was initiated at Jur Kafun village of Almora district.

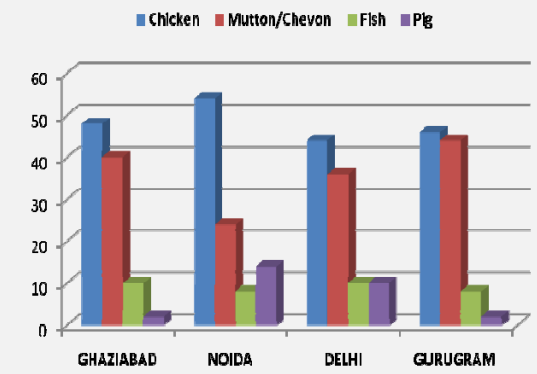
A pilot study for revalidation of technology on mineral mixture supplementation to lactating cows was carried at targeted intervention site.

One training programme on "Management of livestock under changing climatic scenario in hilly area" was organized at Sunkhiya village, Nainital with participation of 20 farmers.

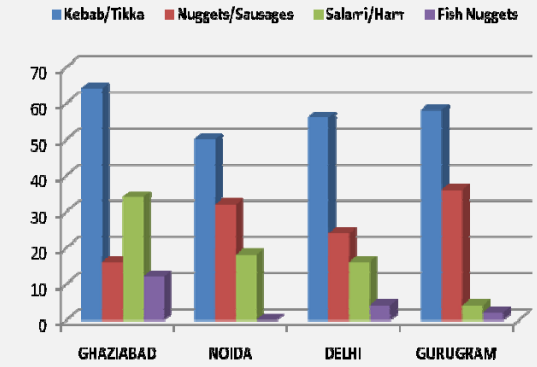
3.15 Processing and Value Addition of Livestock Products and By-Products

Analysis of market driven processing of meat to popularize convenience meat products

A survey work was carried out to assess the extent and types of meat processing with respect to convenience/traditional meat products prevailing in and around Delhi-NCR, Lucknow and Bareilly; and to use this information to improve quality and market acceptability of meat products developed by the institute. The survey work revealed that i) chicken was the most preferred meat type followed by mutton/chevon and fish, ii) taste, nutritional value, brand name of meat products were the most asked features during purchase by the consumers, iii) a combination of health and taste attributes of meat products are most preferred by the consumers during purchase, a significant portion of young health conscious consumers were identified who were demanding only boiled meat portions of chicken, iv) convenience meat products were more preferred than traditional counterparts in NCR but in Lucknow, the trend was reverse. Mutton/chevon *"Seekh Kebab"* was most preferred convenience meat product in Delhi-NCR, whereas in Lucknow, available traditional meat products like "*Tundey Kebab/Tikka"* were preferred than chicken nuggets/sausages, and v) maximum feedback score of consumer evaluation for products developed by the ICAR-IVRI was "Good" and most of the consumers suggested improvement with respect to existing texture and levels of spices in the meat products.



Preference (%) of meat species in Delhi

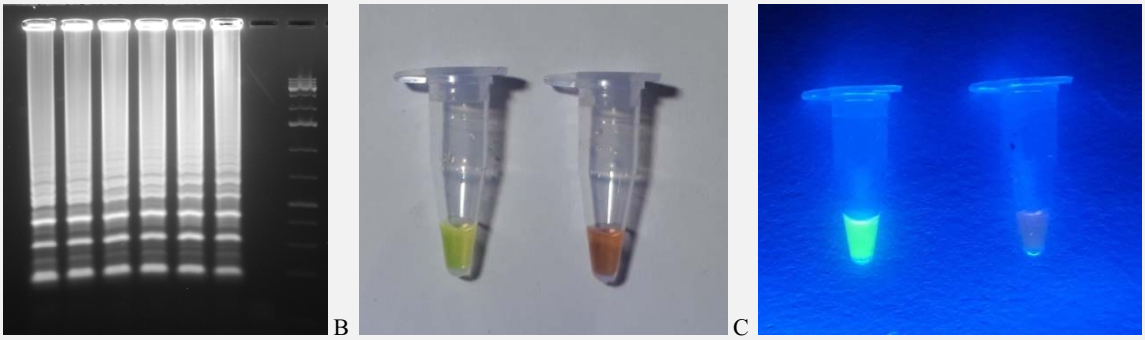


Preference (%) of different types of convenience meat products

Evaluation of essential oil (EO) blends in controlling microbial load and enhancement of shelf-life of meat nuggets

Selected essential oil blends (3 no.) were incorporated in meat nuggets (chicken and mutton nuggets) to evaluate their effect in controlling total microbial load and enhancing shelf-life. EO blends incorporation was found to be effective in controlling microbial load in meat nuggets in concentration dependent manner (0.125-0.5%). The EO blends incorporated meat nuggets obtained satisfactory sensory scores on 8 point hedonic scale in 5-10 x concentration (0.125-0.25%). No significant change in physicochemical parameters of meat nuggets spread was observed. Shelf-life of meat nuggets incorporated with EO blends was enhanced in concentration dependent manner. In 5x concentration (0.125% EO), about 5 days enhancement of shelf life of meat nuggets was observed under refrigerated storage conditions.


Essential oil blend incorporated meat nuggets



A B C

(A) Agarose gel electrophoresis of LAMP products of *C. Perfringens*. **(B)** Visual detection of amplified products by SYBR Green 1 dye. **(C)** Detection of amplified products by SYBR Green 1 dye under UV light.

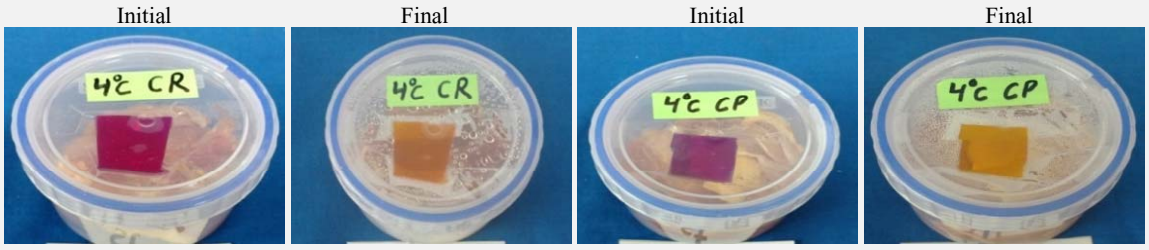
Development of intelligent packaging sensors for monitoring quality and safety of meat and meat products in supply chain

A series of trials was conducted with nine different dyes (D1-D9) for development of colorimetric quality indicator for real-time monitoring of quality of chicken meat during storage at 4°C, 10°C and 37°C. After correlating the quality changes of chicken meat with time taken to final colour change and colour visibility of indicators, D1 and D2 dyes were selected as optimum quality indicators. The response of colour change in indicator sensor was studied in stored chicken meat. The results revealed that the developed dye indicators can be successfully used for real time monitoring of quality of chicken meat during storage.

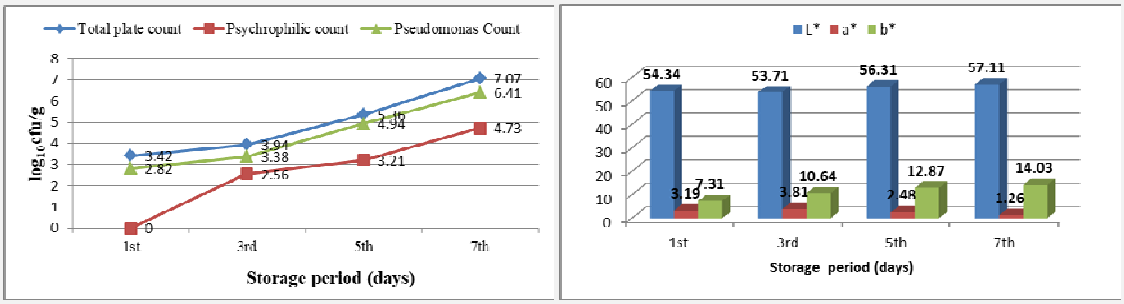
Tray packaging of fresh and processed meat products

A study was conducted to evaluate tray packaging of fresh and processed meat products using different material. The study revealed that products sealed with HDPE films were having better quality and superior consumer acceptability up to a period of 20 days in case of processed meat products and that up to 6 days in case of fresh meat cuts at refrigerated temperature. In the case of frozen storage there were no significant differences among the LDPE, LLDPE, PVC as well as HDPE films on

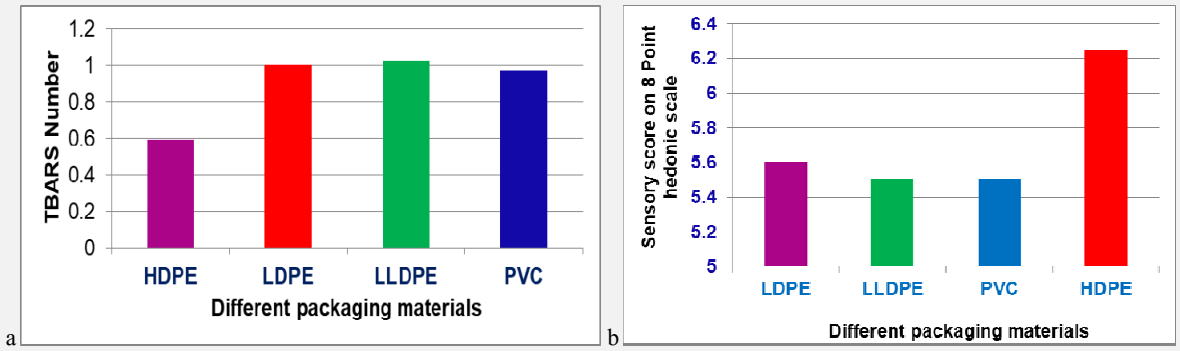
Chicken nuggets in polypropylene trays sealed with HDPE film



Changes in colour of dyes under different storage condition in chicken meat at 4±1°C.



(a) Microbiological parameters of chicken meat during storage at 4±1°C; (b) Change in color (lightness, L*; redness, a*; and yellowness, b*) values in chicken meat stored at 4±1°C



(a) TBARS values of chicken nuggets in trays at 4°C at 20th day of storage; **(b)** Overall acceptability of chicken nuggets in trays on 20th Day of storage at 4°C

the quality parameters of packaged fresh and processed meat products up to a period of 3 months at -18°C.

Rapid laboratory and field based assays for microbiological quality assessment of pork

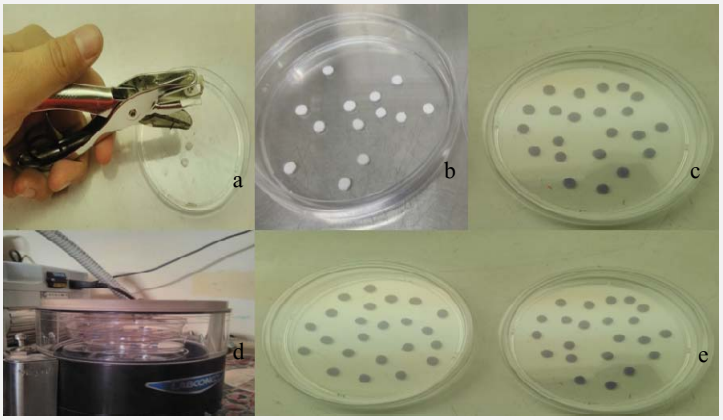
The LAMP assays were standardized for rapid detection of *Salmonella* spp. (inv A and his J), verotoxigenic *E. coli* (stx-1, stx-2 and entx gene), *S. aureus* (tuf and nuc), *Clostridium perfringens* (cpa) and *Clostridium botulinum* (type A and B) from the pork. These assays were evaluated for their sensitivity, specificity and diagnostic potential in meat by spiking studies.

Immunological assays for detection of staphylococcal enterotoxins

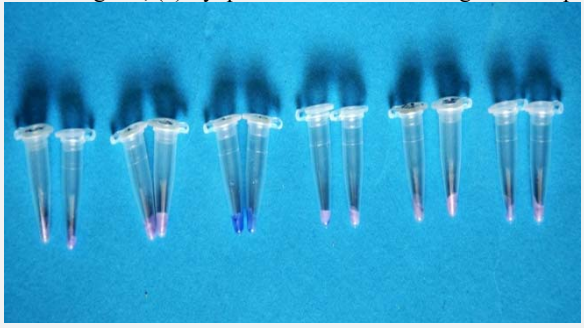
DOT-Blot and ELISA assays were developed for detection of SEA in food and were evaluated for their diagnostic potential by spiking studies in meat and staphylococcal culture supernatant.

Development of DNA based test for meat speciation

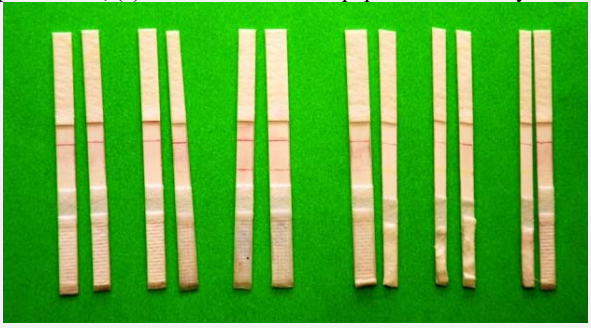
A study was conducted to evolve assays based on loop mediated isothermal amplification technique (LAMP) for identification of tissues of different species from food animals. Both kinds of tube and paper based LAMP assays were attempted. The evolved assays were laboratory validated on samples from known, coded, binary admixed and processed meat samples. Multiplex PCR assay



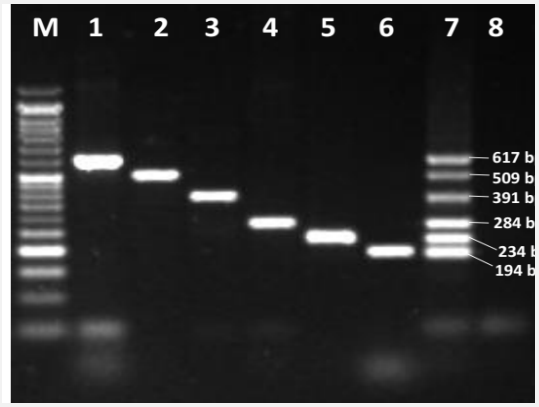
(a) Preparation of paper buttons with sample pad and punching machine, (b) Paper buttons, (c) Paper buttons pored with LAMP reagents, (d) Lyophilization of LAMP reagents over paper buttons, (e) Freeze dried LAMP paper buttons ready for use



Naked eye visualization of species-specific paper LAMP assays using HNB dyes (Purple-Negative, Dark Blue-positive)



Visualization of species-specific paper based LAMP-LFA assays (Single line -Negative, Double line- positive)



Gel electrophoresis of simplex and hexaplex PCR assays Lane M: 50 bp DNA ladder, Lane 1: Chevon (617 bp), Lane 2: Pork (509 bp), Lane 3: Carabeef (391 bp), Lane 4: Beef (284 bp), Lane 5: Mutton (234 bp), Lane 6: Universal (194 bp), Lane 7: Hexaplex reaction for Chevon, Pork, Carabeef, Beef, Mutton and Internal Control, Lane 8: NTC

capable of simultaneous detection of meat species of five different food animal species *viz*., cattle, buffalo, pig, sheep and goat was also standardized.

Development of milk based products with enhanced functionality

i. Crude extract from Indian curd as biopreservative

Experiments were conducted to estimate the antioxidant and antimicrobial activity of crude extract from Indian curd, it's partial characterization and further use in enhancement of shelf life of livestock products like paneer and raw chevon as a bio-preservative. Results of bioactivity assays indicated a significantly higher ($p<0.05$) activity in crude extract than its fractions. The results revealed that crude extract treated paneer and meat can be successfully stored under aerobic packaging conditions at 4±1°C for 12 and 7 days, respectively.

ii. Fermented milk powder enriched with antioxidants from sprouted legumes

Experiments were undertaken to standardize the processing conditions of Fermented Milk Powder (FMP) enriched with antioxidants from sprouted legumes and evaluate the quality during storage at ambient temperature (25±2°C). A total of 10 legumes (green gram, black gram, pigeon pea, cowpea (red), cowpea (white), lentil, soyabean, green pea, chick pea and kidney bean) were screened for their antioxidant activity. From the results obtained, it was concluded that ethanol was more suitable as solvent for extraction of phenolic compounds with antioxidant activity; and amongst the legumes screened, highest activity was observed in sprouted cowpea. It was incorporated at three levels 7%, 10% and 13% in 100 g of curd mass before freeze drying and 10% level was preferred

Storage experiments on paneer with crude extract from curd

on the basis of sensory evaluation.

Instant Chhachh from fermented milk powder (FMP)

Bio-prospecting of native cattle and goat milk for bioactive potential

a) Vitamin contents in local cow and goat milk

Vitamin C and E were estimated in indigenous cattle, crossbred cattle, *Gaddi* and local goat milk samples collected from remote areas of Chamba and surroundings of Palampur. Vitamin C contents were found to be lowest in *Gaddi* goat milk (0.88±0.06 mg/100 ml) and highest in Jersey crossbred cattle milk (1.45±0.10 mg/dL). Comparatively higher level of vitamin E was observed in indigenous cattle milk.

b) Antioxidant activities of cow and goat milk

Maximum DPPH percent inhibition was observed in indigenous cattle milk and minimum DPPH percent inhibition was recorded in local goat milk under various thermal treatments.

DPPH (percent inhibition) in whole milk, whey and casein protein fractions of indigenous and Jersey crossbred cattle

Sl. No.	Sample	Indigenous cattle	Jersey crossbred cattle
1	Whole milk		
	Fresh/raw milk	$28.17^{A}\pm2.75$	$20.62^{B}\pm1.95$
	Pasteurized milk at (63°C)	$28.47^{A}\pm2.64$	$20.82^{B}\pm1.96$
	Pasteurized milk at (72°C)	$29.60^{A}\pm2.43$	$20.37^{B}\pm1.60$
	Boiled milk	$28.02^{A}\pm2.55$	$23.37^{B}\pm2.34$
2	Whey fraction of milk		
	Fresh/raw milk whey	$17.03^{a}\pm1.71$	$19.32^{a}\pm0.98$
	Pasteurized milk whey (at 63°C)	$17.59^{a}\pm1.39$	$19.35^{a}\pm0.88$
	Pasteurized milk whey (at 72°C)	$17.74^{a}\pm1.23$	$20.09^{a}\pm0.88$
	Boiled milk whey	$14.33^{Bb}\pm1.23$	$18.18^{Ab}\pm0.82$
3	Casein fraction of milk		
	Fresh/raw milk casein	$17.67^{b}\pm0.71$	$16.34^{a}\pm0.94$
	Pasteurized milk casein (at 63°C)	$18.65^{Aa}\pm0.49$	$14.96^{Bb}\pm0.96$
	Pasteurized milk casein (at 72°C)	$19.28^{Aa}\pm0.65$	$16.21^{Ba}\pm1.05$
	Boiled milk casein	$16.51^{b}\pm0.44$	$15.25^{b}\pm0.82$

Different upper-case letters correspond to significant differences between the groups (P<0.05); Different lower-case letters correspond to significant differences within the same group (P<0.05)

DPPH (percent inhibition) in whole milk, whey and casein protein fractions of *Gaddi* goats and local goats

Sl. No.	Sample	*Gaddi* goat	Local goat
1	Whole milk		
	Fresh/raw milk	$18.32^{Ab}\pm1.28$	$10.49^{Bc}\pm0.89$
	Pasteurized milk (at 63°C)	$20.43^{Aa}\pm0.87$	$12.36^{Bb}\pm0.94$
	Pasteurized milk (at 72°C)	$18.81^{Ab}\pm1.02$	$13.76^{Ba}\pm0.88$
	Boiled milk	$17.43^{Ab}\pm1.14$	$10.67^{Bc}\pm0.87$
2	Whey fraction of milk		
	Fresh/raw milk whey	$14.87^{A}\pm0.76$	$10.14^{B}\pm1.11$
	Pasteurized milk whey(at 63°C)	$15.77^{B}\pm0.71$	$11.43^{A}\pm1.06$
	Pasteurized milk whey (at 72°C)	$14.83^{A}\pm0.84$	$11.69^{B}\pm1.11$
	Boiled milk whey	$14.72^{A}\pm0.84$	$10.41^{B}\pm0.98$
3	Casein fraction of milk		
	Fresh/raw milk casein	11.39 ± 0.51	$11.92^{b}\pm0.76$
	Pasteurized milk casein (at 63°C)	12.29 ± 0.52	$13.26^{a}\pm0.74$
	Pasteurized milk casein (at 72°C)	11.96 ± 0.53	$13.80^{a}\pm0.72$
	Boiled milk casein	11.59 ± 0.45	$11.97^{b}\pm0.69$

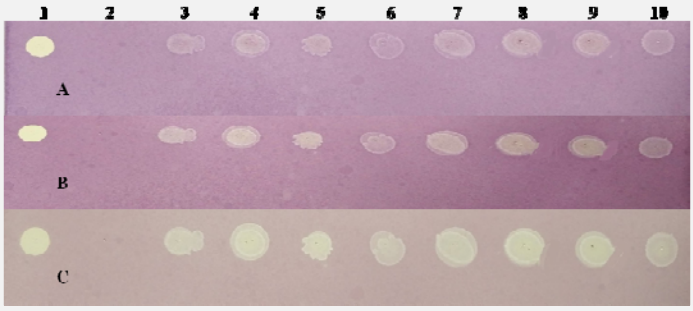
Different upper-case letters correspond to significant differences between the groups (P<0.05); Different lower-case letters correspond to significant differences within the same group (P<0.05)

c) Antimicrobial activities of cow and goat milk

Antimicrobial activities of milk and milk protein fractions obtained from various milk types under different conditions against *Escherichia coli, Staphylococcus aureus, Bacillus cereus, Rhodococcus equi and Shigella flexneri* were evaluated. Antimicrobial activity increased in digested milk of indigenous cattle against *Shigella flexneri*, and remained same in undigested and digested milk against *Bacillus cereus*.

d) Fatty acids profile in milk of different breeds

Fatty acids composition was analyzed in milk of indigenous & Jersey crossbred cattle and *Gaddi* & local goats. Higher amount of saturated fatty acids and lower or undetectable amounts of polyunsaturated fatty acids were present in indigenous cattle and local goat milk. In indigenous cattle milk, saturated palmitic acid (22.57%), stearic acid (15.92%) and monounsaturated oleic acid (26.17%) were present. The polyunsaturated fatty acid, α-linoleic acid was present in small amount only in milk of indigenous cattle (1.15%). In Jersey cross-bred cattle, higher amount of saturated myristic acid (18.42%), stearic acid (29.04%) and monounsaturated oleic acid (31.26%) were detected. Highest amount of palmitic acid (30.72%) in *Gaddi* goat might be responsible for intense flavour, but needs further research.



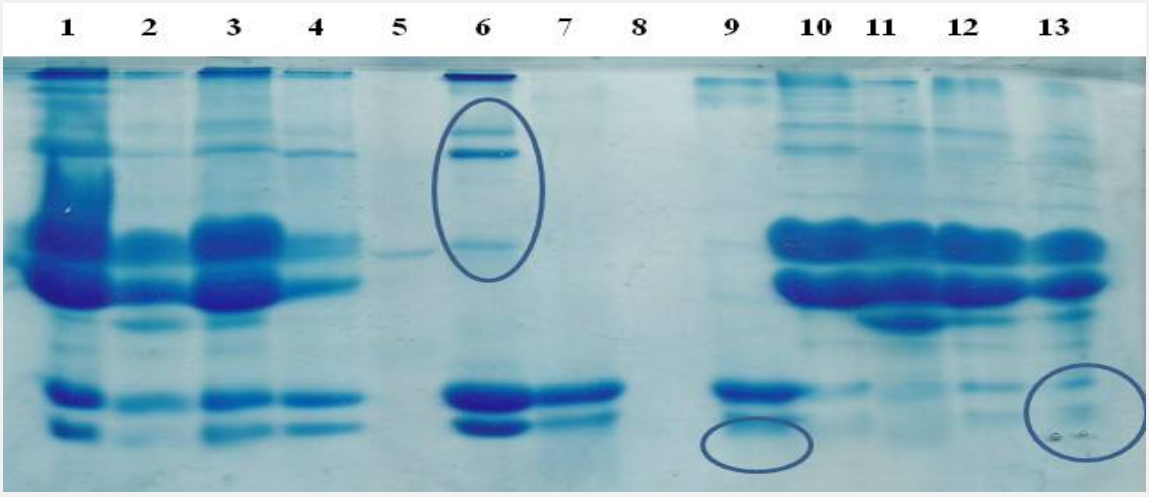
Antioxidant activity in indigenous cattle milk whey by qualitative DPPH test on F_{254} TLC plates (A= yellow spot just after spraying DPPH; B= yellow spot after 30 minutes; C= yellow spot after overnight). Lane 1: Ascorbic acid (+ve control)-10 µl, Lane 2: Methanol (-ve control)-10 µl, Lane 3: Raw milk whey-10 µl, Lane 4: 63°C Pasteurized milk whey-10 µl, Lane 5: 72°C Pasteurized milk whey-10 µl, Lane 6: Boiled milk whey-10 µl, Lane 7: Raw skimmed milk whey-10 µl, Lane 8: 63°C Pasteurized skimmed milk whey, Lane 9: 72°C Pasteurized skimmed milk whey-10µl, Lane 10: Boiled skimmed milk whey-10 µl.

e) Thin layer chromatography (TLC) analysis of antioxidant activity

DPPH was used to evaluate the antioxidant activity in milk whey. Pasteurized/boiled milk whey was able to reduce DPPH immediately with individual variations. Pasteurization or boiling of milk, casein and whey protein fractions did not destroy the antioxidant activity.

f) *In vitro* digestion of milk protein fractions

Protein profiles of undigested and digested milk samples were analyzed by SDS-PAGE. Higher molecular weight whey proteins completely disappeared after pepsin digestion (lanes 6 and 7). A variable number of peptides were released after *in vitro* digestion of milk.



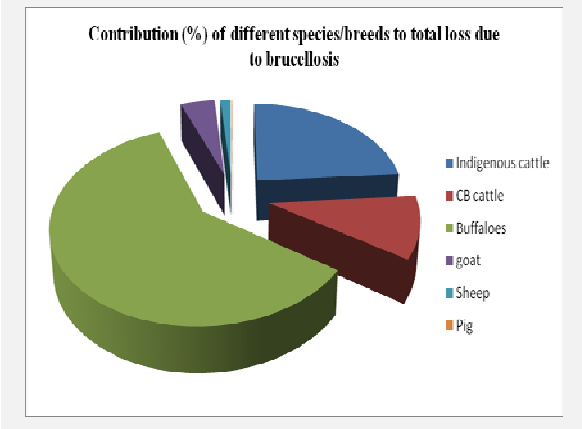
SDS-PAGE of *Gaddi* goat milk proteins*. Lane 1- Whole milk undigested; Lane 2- Whole milk digested 1a; Lane 3- Whole milk digested 1b; Lane 4- Whole milk digested 3; Lane 5- Marker; Lane 6- Whey undigested 1; Lane 7- Whey digested 1a; Lane 8- Whey digested 1b; Lane 9- Whey digested 3; Lane 10- Casein undigested; Lane 11- Casein digested 1a; Lane 12- Casein digested 1b; Lane 13- Casein digested 3

*(Digested 1a – Sample used after 1st step digestion (with Pepsin for half an hour, at pH–2.5); Digested 1b – Sample used after 1st step digestion (with Pepsin for half an hour, pH–7.5); Digested 3 – Sample used after 3rd step digestion (with Trypsin & Pancreatin for overnight)

3.16
Livestock Economics and Statistical Modeling

Economic effects of livestock disease burden in India and cost-benefit analysis of targeted interventions

Estimation of annual economic losses due to brucellosis in different livestock species in India was carried out using secondary data as obtained from published peer-reviewed literature and government reports. For some parameters, relevant data were obtained from a household survey in different agro-climatic regions of the country. Information on impact of brucellosis on important parameters was generated by holding extensive discussions with experts at ICAR-Indian Veterinary Research Institute. The various components of losses due to brucellosis as considered in the study were reproductive losses (losses due to abortions and losses due to increased infertility), production losses, mortality losses in aborted animals and draught power losses. Simple mathematical models were developed to estimate the component-wise losses due to brucellosis. The annual economic loss due to brucellosis in India was estimated at INR 10,336 crores. To take into account possibility of variation and uncertainty in various epidemiological and economic parameters as considered in the study, a sensitivity analysis was also carried out by considering two different scenarios, i.e. pessimistic and optimistic. In the pessimistic scenario, losses due to brucellosis go up to INR 20,770 crores, while in the optimistic scenario the annual losses due to brucellosis are restricted to INR 3,644 crores. The study has thus revealed that brucellosis, from policy perspective,



is one of the most important diseases when it comes to mitigating losses due to diseases in dairy animals.

Economic losses due to Classical Swine Fever (CSF) disease in India

During this year, one state each from northern (UP) and southern (Tamil Nadu) region of the country having largest pig population were surveyed to study the prevalence and economic loss due to CSF disease in pigs. Total number of pigs in the sampled area was 2365 from UP and 1505 in Tamil Nadu. It was observed that in both the states the majority of pig farmers belonged to scheduled castes (95.84% in UP; 92.62% in Tamil Nadu). On an average, each farmer reared about 20 pigs in UP and 12 pigs in Tamil Nadu.

The main findings from the study conducted so far revealed that the proportion of indigenous pigs (69.04% in UP and 83.78% in Tamil Nadu) in total sampled pig population was higher than exotic and crossbred pigs. Gender-wise, the proportion of females (UP: 69% and Tamil Nadu : 82.65%) was higher than males. Overall morbidity, mortality and case fatality rates estimated were 20.25, 18.69 and 92.27%, respectively in UP while in Tamil Nadu the corresponding estimates were 24.25, 21.86 and 90.14%, respectively. A meta-analysis study for period of 17-years since 1998 to 2015 on prevalence of CSF disease projected higher rate (45%) with significant heterogeneities among different studies about CSF prevalence in India. The total annual economic loss due to CSF disease worked out to be Rs 3.57 million and 3.50 million per annum, respectively, in sampled areas of UP and Tamil Nadu with corresponding annual economic loss (per pig) estimated as Rs 744.55 and 960.34, respectively.

Livestock healthcare delivery system and scope for its improvement in Uttar Pradesh

The study ascertained the present status of the pattern of animal healthcare services (AHS) by the livestock farmers and assessed the scope and impact of potential reforms in animal health delivery system (AHDS) in the state of Uttar Pradesh. Purposive and multistage random sampling technique was used to select 1338 households for the survey from all the nine agro-climatic regions of the state. Using multivariate data analytical techniques, on the basis of ownership of household and farm assets, households were categorized into poor (48%), medium (36.5%) and rich (15%) categories to

assess equity implications of potential reforms in AHDS. Analysis of use pattern of AHS revealed that private practitioners (quacks) were the predominant AHS providers, followed by para-veterinarians and government veterinary officers (GVOs).

Out of the total sample visits made by GVOs and para-vets, 58% and 66%, respectively, were attended at-home. The number of at-home visits by GVOs per household increased with increase in wealth status. As an attribute of AHS, proximity received a lower rating across all the wealth categories as compared to affordability and quality. Artificial Insemination (AI) (33%) and fever (30%) were the predominant reasons for availing the services of AHS providers, followed by reproductive problems. Richer households paid significantly higher prices per visit to AHS providers as compared to poor households. Even then, the average price paid by the poor households was substantially high (there were no significant differences in the amount paid to para-vets per at-home visit across different wealth categories). Farmers' preference for AHS provider shifted away from GVO to private practitioners with increasing distance from state AHS centres and decline in wealth status. Preference of farmers for GVO increased with ownership of crossbred cattle. Contingent valuation method used to elicit farmers' willingness to pay for animal healthcare services revealed that both the proportion of respondents who are willing to pay and the amount they are willing to pay increased with increase in wealth status. Analysis of factors influencing farmers' WTP revealed that lower wealth status and distance to market negatively influences the farmers' likelihood of willing to pay a higher amount. On the other hand, household head education, easy credit availability and scale of milk production positively influenced the probability that a farmer will be willing to pay a higher amount. Application of conjoint analysis to assess farmers' relative valuation of different AHS attributes revealed that 'place of service' was the most important attribute for all categories of respondents, closely followed by 'supply of medicines by service providers' and 'type of service provider'. 'Distance to AHS centre' was the attribute with relatively lower importance rate.

A total of 22 Veterinary Officers were interviewed to get supply-side perspectives regarding AHDS in the state. The major observations of the above survey are: maximum percentage of working time spent on curative services (mostly on in-centre treatment), followed by preventive services; most limiting supporting factors in AHS are laboratory support, availability of refrigeration facilities and training in post mortem; most important constraints in delivering of AHS are posting in distant/marginal areas, lack of infrastructure, and poor pay and incentives; The major factors hindering provision of AHS at farmers' doorsteps are: cases being reported late, farmers' unwillingness to pay, other administrative and reporting tasks, poor roads/inaccessible places and lack of staff. Potential reforms which will improve AHDS are cost recovery for treatment/curative services and establishment of strong Veterinary Association. Further, private sector delivery of curative services was considered to adversely affect provision of AHS.

Value chain approach to livestock disease risk management: A case of buffalo meat (carabeef) sector in Uttar Pradesh

The project aims to conduct a comprehensive analysis of buffalo meat value chain in Uttar Pradesh with the major objectives of identifying and characterizing different stakeholders in carabeef value chains (domestic *vis-a-vis* export-oriented) and map the linkages between them; assessing the performance of such value chains in terms of economic profitability of various stakeholders at different points and the distribution of benefits across actors in the chains, and carrying out risk analysis to identify the disease risk hotspots in the value chains. Analysis of secondary data has been carried out regarding production, consumption and trade of buffalo meat *vis-a-vis* other livestock products, and the overall importance of buffalo in the Indian economy. The first project workshop was organized at ICAR-NIAP, New Delhi during March, 2018. Sampling procedure has been finalized and questionnaires developed for specific actors in the value chains. Data has been collected from one export-oriented buffalo meat unit, one retail outlet for buffalo meat, municipality slaughterhouse and on livestock market. One training on 'Hygienic abattoir practices' has also been conducted at Marya Frozen Agro-Foods Pvt. Ltd. Bareilly.

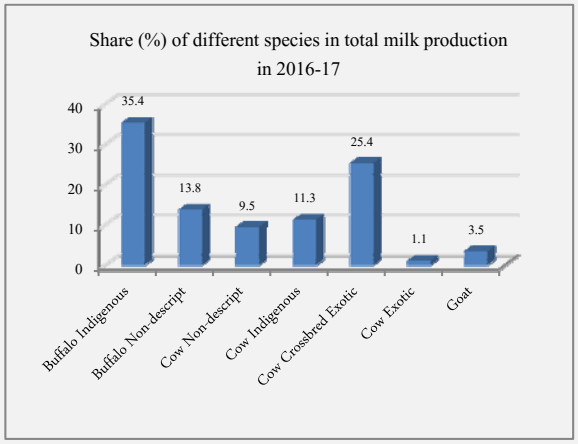
Livestock production statistics of the country

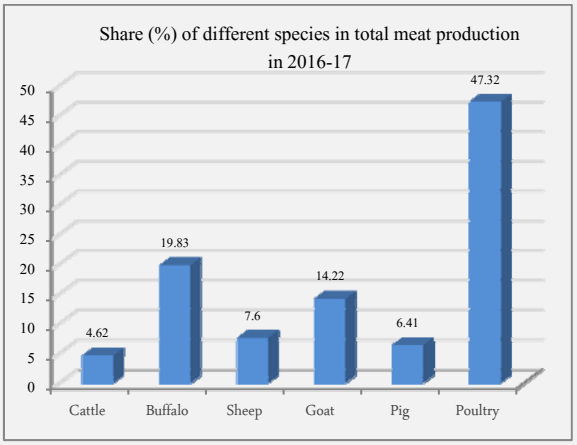
The milk production in the country was 17.0 million tonnes during 1950-51 and increased to 165.4 million tonnes during 2016-17. The per capita availability of milk was at 130 g/day in 1950-51 but the per capita availability has sharply increased to 355 g/day in 2016-17. Nearly 35.4% of the milk production is contributed by indigenous buffaloes followed by 25.4% by crossbred cattle. The indigenous cattle contribute 11.3% of the total milk production in the country whereas non-descript cattle contribute 9.5% milk production and non-descript buffaloes contribute 13.8% milk production. The largest producer of milk is Uttar Pradesh which produces 17.0 % of the total milk production in the country followed by Rajasthan (12.6%), Madhya Pradesh (8.2%) and Gujarat (7.8%).

The total meat production in the country was 7.4 million tonnes in the year 2016-17 which marks a significant progress in the meat production. The contribution of meat production from cattle, buffalo, sheep, goat and pig were 4.62%, 19.83%, 7.60%, 14.22% and 6.41%, respectively, and nearly 47.32% of meat production is contributed by poultry. The largest producer of meat is Uttar Pradesh which produces 18.23% of the total meat production in the country followed by Maharashtra (11.44%) and West Bengal (9.56%).

The total egg production in India was 1832 million in the year 1950-51 and reached 88,139 million in the year 2016-17. The per capita availability was 5 eggs per annum during the period 1950-56 and it reached to 69 eggs per annum in the year 2016-17. Improved fowls contributed 86.80% to the total egg production while it was 11.96% by *desi* fowls. The *desi* duck and improved duck contribute 0.96% and 0.28%, respectively, of total egg production. The largest producer of egg is Tamil Nadu which produces 18.9% of the total egg production in India followed by Andhra Pradesh (18 %) and Telangana (13.4%).

The total wool production in the country was at 27.5 million kg during 1950-51 and increased to 43.6 million kg during 2016-17. The analysis revealed that nearly 68.35% of the production of wool is contributed by ewe but ram/wether and lamb contributed only 16.71% and 14.94% respectively, to total wool production. Rajasthan is the largest producer of wool in India which produces 32.9% of the total wool production followed by Jammu & Kashmir (16.7%) and Karnataka (15.1%).





3.17
Extension Interventions in Livestock Production Systems

Enhancing livelihood security of farmers through livestock and crop integration

Based on a baseline survey, 1337 beneficiaries were selected in Majhgaon block of Bareilly district. A total of 17 technological intervention inputs involving crop, livestock, poultry and natural resource management were provided to the farmers for enhancing their livelihood. A total of 65 Barbari goats and 60 Muzaffarnagari sheep were multiplied through farmers' participatory approach. Besides, 54 Landrace (75%) piglets and 500 CARI Nirbheek chicken were introduced for the first time in three adopted villages for mixed farming. One hundred soil samples were collected for making soil map of nine adopted villages. Many other activities were undertaken through 20 scientist-farmers interface meetings, 5 trainings on improved livestock and poultry production practices, 10 exposure visits of farmers from adopted villages to create awareness and enrich their knowledge in crop production and animal husbandry in addition to celebration of special occasions like World Soil Health Day, Environment Day and *Kisan Diwas*. Improved seeds of high yielding varieties of wheat, paddy, black gram, mustard, lentil and barley were also provided to the farmers.

Enhancing livelihood opportunities through animal husbandry in Shivalik range of Uttarakhand

To assess the pathological changes in ecto-parasitism in goats, identified as the major health problem faced by the goat farmers in the project area, markers of oxidative stress and immune status were evaluated. Accordingly, the strategic management plan was formulated and field efficacy studies were conducted using commonly available ectoparasiticidal drugs in combination with biomodulators (antioxidants and immunomodulators). Deltamethrin with levamisole treatment in severely tick infested goats revealed the maximum therapeutic efficacy in terms of modulation of humoral immune response. Twenty herbs, selected based on the prevalent ITKs in the project area, were evaluated for their antioxidant potential. The aqueous, ethanolic and hydroethanolic extracts of all the selected plants were found positive for the presence of polyphenols on qualitative phytochemical screening. However, quantitative evaluation and *in vivo* investigations revealed that ethanolic extract of *Rhododendron aroboreum* bark possesses maximum antioxidant activity.

Livestock extension and human resource development programmes

During the year, various extension education programmes were carried out through which the information about various technologies and package of practices for livestock health, production and management were disseminated to various industries, farmers, veterinary officers and other clients. The details of the programmes are as follows:

Participation in exhibitions and farmers fair

A total of 17 exhibitions were put up by IVRI at different places of the country, as listed below:

- Exhibition and *Gosthi,* International Centre for Foot & Mouth Disease, Bhubaneswar (Odisha)
- Exhibition, *Krishi Mela*, Motihari (Bihar)
- *Pashu Aarogya Shivir/Mela*, Varanasi (Uttar Pradesh)
- Exhibition/*Goshthi*, Pt. Deen Dayal Dham, Mathura (Uttar Pradesh)
- Exhibition and *Kisan Mela* (*Krishi Kumbh*), GB Pant University of Agriculture and Technology, Pantnagar (Uttarakhand)
- Exhibition Kisan Mela at SVP University of Agriculture and Technology, Meerut (Uttar Pradesh)
- *Pashu Aarogya Shivir/Mela*, Kaanth, Shahjahanpur (Uttar Pradesh)
- *Pashu Aarogya Shivir/Mela*, Sarsaul, Kanpur (Uttar Pradesh)
- *Pashu Aarogya Shivir/Mela*, Motihari (Bihar)
- *Pashu Aarogya Shivir/Mela*, Chhajlet, Moradabad (Uttar Pradesh)
- *Pashu Mela* and Exhibition, Bilwa, Bareilly (Uttar Pradesh)
- *Pashu Mela* and Exhibition, Kalapur, Bareilly (Uttar Pradesh)
- Exhibition, CS Azad University of Agriculture and Technology, Kanpur (Uttar Pradesh)
- Exhibition, GB Pant University of Agriculture and Technology, Pantnagar (Uttarakhand)
- Exhibition, *Kisan Mela* IVRI Mukteswar (Uttarakhand)
- Exhibition, *Saras Mela*, Urban Haat, Bareilly (Uttar Pradesh)
- Exhibition, *Krishi Unnati Mela*-2018 at Pusa (New Delhi)



Technology demonstration
Demonstrations of technologies (Olinall, Crystoscope and Area-specific mineral mixture, fractured bone fixator, herbal ointment, herbal anti-diarrhoeal, herbal acaricide, herbal medicament, vermi-culture/ vermi-compost) were organized at 17 different places of the country.

Kisan Call Centre and Help line
A total of 173 queries were received during the year through Kisan Call Centre and Institute Help Line regarding livestock management, extension programmes, livestock feeding and nutrition, livestock diseases, goat husbandry, pet dog, poultry, fisheries, bee keeping, horticulture and other allied subjects of agriculture, which were duly addressed by different experts/ scientists of the Institute.

Interface meets with extension personnel
Two interface meets were organized this year at IGFRI, Jhansi and Navsari Agriculture University, Gujarat which was attended by a total of 200 and 114 participants, respectively. The officials participated in the meet included veterinary officers, SMS of KVKs, personnel of dairy development department, scientists and professors.

Visits
A total of 23,980 visitors visited the ATIC out of which 19,505 visitors came for technology product procurement, 498 visitors for consultancy and 3,974 visitors for exposure visits (83 visit groups). The visitors mainly included livestock owners/farmers, students and entrepreneurs, etc. The visitors also included 1798 school children, 1059 farmers, 50 field veterinarians, 221 other professionals, 813 college students and UG/PG scholars, and 30 academicians from various agriculture and veterinary universities. The visitors were shown dairy farm, poly-clinic, piggery farm, feed unit, KVK and various research divisions of the institute.

***Mera Gaon-Mera Gaurav* programme**
Forty-one multi-disciplinary groups (each consisting of 4 scientists) formed under *Mera*

Gaon-Mera Gaurav programme adopted 205 villages. Various activities were carried out in these villages by the groups including *Kisan Gosthi*, collection of soil samples, farm advisories to the farmers/ villagers, scientists-farmers interaction meets and distribution of farm literature, etc.

Training programmes

Six training programmes on *Unnat pashupalan*, *Dudharu pashu prabandhan*, *Vaigyanic pashudhan prabandhan*, *Vaigyanic pashu palan* were organized with the participation of 110 farmers/farmwomen and 21 extension professionals. These programmes were sponsored by ATMA located at Champawat (Uttarakhand), Bhojpur (Bihar) and Pakur (Jharkhand) besides two NGOs namely, HELP (Dehradun, Uttarakhand) and SAMETI (Lucknow, Uttar Pradesh).

Development of educational mobile Apps

Three mobile apps were developed during the year namely, IVRI-*Pashu Prajanan* (Animal Reproduction) App, IVRI-Pig Farming App and IVRI-Artificial Insemination App. The two educational apps viz. IVRI-*Pashu Prajanan* and IVRI-*Shukar Palan* Apps were released by Sh. Radha Mohan Singh, Hon'ble Union Minister of Agriculture & Farmers Welfare, on the occasion of Annual Conference of Vice- Chancellors of Agricultural Universities and Directors of ICAR Institutes at NASC Complex, New Delhi on 8th March 2018.

Extension at Mukteswar Campus

Technologies exhibition and dissemination

A *Kisan Mela* organized on 28th Feb 2018 at the campus was attended by over 250 farmers from adjoining districts of Uttarakhand. Various research institutes like ICAR-CITH, ICAR-DCFR, ICAR-VPKAS, ICAR-DFMD, ICAR-CARI and different departments of Izatnagar campus as well as Self-help group, and progressive farmers' producer group exhibited their technology/ products for the benefit of the participating farmers. Besides, scientists of the campus also participated in *Kisan mela* organized by GBPUAT, Pantnagar and ICAR-VPKAS, Almora.

At Mukteswar campus, World Veterinary Day was celebrated on the theme 'Antimicrobial resistance: From awareness to action'. Agriculture Education Day was participated by 70 students from three schools. Lectures and motivational speech were delivered by scientists of the campus.

Awareness-cum-animal health camps

A total of 29 awareness-cum-health camps were organized during the year at different locations in US Nagar, Nainital, Almora and Dehradun districts benefiting 769 farm families. During these camps, a total of 1937 animals and 4252 birds were treated for various ailments.

Extension activities at TEC, Pune

- Conducted 14 animal health camps in different villages of Maharashtra State wherein a total of 1865 animals belonging to 547 livestock farmers were treated for various ailments.
- One Interface Meet (with the state veterinary officers and staff of Vanbandhu College of Veterinary Sciences, Navsari, Gujarat) and three *Kisan Gosthies* were conducted in different parts of Maharashtra state. Six training programmes and five workshops/seminars were also organized.
- Assessment of antibiotic use, efficacy and its resistance at the field level was done through a survey of 217 veterinary officers of the state.

It was found that ampicillin and amoxicillin, oxytetracycline, cefotaxime and ceftriaxone, enrofloxacin, gentamicin, erythromycin, and ampicillin-cloxacillin combination were found most effective and frequently used in respective group of antibiotics. Effectiveness was the most important reason followed by easy availability for using the antibiotics.

Hands on training/workshop/demonstration of technologies

- Workshop on *Technologies in Animal Nutrition and Organic Animal Husbandry* was organized on 16th Jan 2018 at Phaltan, Satara (MH).
- Workshop on *Advanced Nutritional Technologies and Interventions for Dairy Animals* was organized on 17th Jan 2018 at Aundh, Pune.
- Hands-on training on *Techniques of Fracture Fixation in Animals* was organized during 22-25 Jan 2018, wherein 16 veterinary officers from Maharashtra and Telangana attended.

Evaluation and assessment of technologies

- UMMB blocks/powder was evaluated at farmers' level at five different locations in Pune, Satara, Narayangaon and Shirwal.
- Foldable animal restraining device was evaluated at Shirwal, Phaltan and Nashik.
- The IVRI fetal extractor was evaluated at 3 locations, Polyclinic, Aundh, Pune; KNP College of Veterinary Sciences, Shirwal; and at field level by a veterinarian (Satara District).
- The device for retention of prolapsed uterus was evaluated at 2 locations.
- Demonstration units for *Jai-Gopal* vermiculture were developed at College of Agriculture and Directorate of Floriculture for selling the vermiculture and vermicompost to farmers/ entrepreneurs.

Training materials developed

- Training manual on Techniques of Fracture Fixation in Animals
- Three leaflets/folders on:
  - Bilateral Linear External Fixation in Large Animals
  - Circular External Skeletal Fixation in Large Animals
  - Epoxy-pin External Skeletal Fixation in Animals

Tribal Sub Plan (TSP) activities

Tribal Sub Plan (TSP) as a development programme with the ultimate goal of diminution of poverty and unemployment in the rural tribal areas was undertaken by the institute through all of its five regional station/centers. The programme was implemented in buffer zone of BR hills (Karnataka), Sangti village of Kolkata (West Bengal), Sunkharikala village of U.S. Nagar, Talla Ghorpatta and Darkot villages of Pithoragarh (Uttarakhand), Garola and Ulansa villages in Palamapur (Himachal Pradesh), and Peint taluka in Nashik (Maharashtra). Interactive meets, animal health camps, farm establishment assistance with respect to piggery, poultry and goatry and associated farm equipment like feeders, waterers, shed construction etc., periodical trainings, *kisan mela*, farm visits and consultations were the programs undertaken under TSP by these centers. The major activities included 15 trainings / *gosthi*, 365 demonstrations (including input distribution) of various technologies/ package of practices and livestock/ birds for livelihood generation, 23 health camps/ exhibition and two exposure visits benefitting a total of 1427 tribal farmers/ farmwomen namely, 455 Mahadev Koli and Kokna, 135 Soliga, 530 Tharu, 48 Himachali tribal, 263 Santhal and Lodha tribal families.

ERS Kolkata

TSP Program was implemented in collaboration with Seva Bharati KVK at Jumbani and Jhargram area of West Bengal. Animal health camp cum awareness program, Kisan gosti, vaccination and deworming programs were organized in Kenduasuli, Rakhalmara and Mahulbani tribal villages benefiting 162 tribal farmers. Further, vaccination of animals against PPR and Ranikhet disease in poultry was carried out. A total of 1678 chicks were distributed among 263 tribal farmers of 9 villages of Jumbani and Binpur-II block of Jhargram, West Bengal.

Under the NEH programme, IVRI-ERS Kolkata organized animal health camps and awareness programmes and distributed piglets in the Lakhimpur, Baksa, Kokrajhar and Chirang of Assam, thereby benefitting 85 farmers of Ahom community.

Palampur Centre

Forty-eight BPL families of two villages, Garola and Ullansa in Bharmour sub-division, which remain cut-off during winter months due to heavy snowfall, were selected and provided with 48 Gaddi goats along with the required feed and fodder, mineral mixture and medicines, etc. The average

market price of goats, reared adopting semi-intensive and complete extensive system for a period of 10 months, increased from about Rs. 4500 to Rs. 6409. In another programme, 44 milch goats including 4 bucks were distributed to newly selected BPL class farmers of both the villages. In addition to the inputs, regular interactions with farmers and *Gosthis* were arranged time to time in both the villages. The farmers expressed their contentment with the services rendered.

Bengaluru Centre

Under TSP, a total of 88 goats were distributed among 44 families belonging to the *Soliga* tribe in buffer zone of B.R Hills, Karnataka. Further, two scientist–farmer interaction meets were also organized.

Pune Centre

The programme was carried out in *Gawandh* tribal village of Nashik district. During the year, 10 tribal farm women were given a unit consisting of four female goats and a male goat each (along with feed, feeder and waterer) for ensuring their livelihood security. Plastic tarpaulin was also supplied to the beneficiaries for proper roofing of animal sheds. Regular monitoring of goats distributed to 20 farmers (including last years' 10 families) was done

with interventions like nutritional supplementation, deworming and immunization and health check-up was done, and sick animals were treated. Mineral and vitamin mixture was supplied every month to keep the herd healthy and productive. Two *Kisan Mela/Gosthi* at Bordapara and Vinayaknagar tribal villages of Nashik district were organized benifiting 110 tribal families.

Mukteswar Campus

The programme was carried out mainly at three villages of U.S. Nagar block and one village of Kalsi block of Dehradun. The major activities undertaken included:

- Introduction of improved poultry rearing packages under backyard management among 53 tribal families with critical inputs like chicks (CARI Debendra), feed, chicken wire nets, feeders and drinkers.
- Nine animal health camps covering 199 animals and 4135 birds belonging to 386 families.
- Distribution of compact feed blocks among tribal families for dairy animals.
- Distribution of sickle among tribal families for harvesting fodder for their animals.

- A special training on 'Health management of cattle during winter' for 30 participants.
- Two field days and one farmers interface meeting with a total participation of 129 farmers and farm women.
- Field demonstration on acaricidal spraying covering 21 families, and demonstration of poultry shed disinfection covering 40 families.

Krishi Vigyan Kendra

Front line demonstrations

Front Line Demonstrations (FLD) of Pusa Basmati-1460, Pusa Basmati-1509 and Pusa-1592 under NEP in collaboration with ICAR-IARI, Pusa, New Delhi were conducted for paddy crop. The demonstrations in 4.66 ha area involving 12 farmers covering six villages, increased paddy yield by 14-19%. Cluster FLDs on pulses (green gram) were conducted under National Food Security Mission in the fields of 186 farmers in 72.26 ha area covering six villages, demonstrating a 19-26% increase in yield. Cluster FLDs on oilseeds (sesame), conducted under National Mission on Oilseeds and Oil Palm in the fields of 44 farmers covering 20.0 ha area in one village resulted in 20% increase in yield. Under horticultural crops, FLDs on low yield of mango due to dieback and gummosis, intercropping of coriander in sugarcane, introduction of CIM Kranti variety of menthe, and low yield of chilli due to attack of mites were conducted in the fields of 26 farmers in 4.85 ha area covering 16 villages of eight blocks. Under the

Home Science unit, four demonstrations were conducted on *paneer* press developed by ICAR-CIAE, Bhopal, besides value addition of tomatoes for 20 farm women.

On-farm testing

Six On-farm testing (OFT) were conducted on late sown variety of wheat (HD-3059), water conservation in sugarcane by use of Pusa Hydrogel, intercropping of vegetable pea in sugarcane (Azad Matar-3), control of mite in chilli, varietal

improvement in gladiolus and use of revolving stool for drudgery reduction for farm women during milking in the fields of 43 farmers of 20 villages.

Trainings for farmers, farm women, rural youth and extension functionaries

A total of 53 on-campus and 29 off-campus trainings were conducted during the year which were attended by 1587 and 528 participants,

respectively. Six trainings were organized for the extension functionaries of the Department of Agriculture and Animal Husbandry of Bareilly district with the participation of 104 Block Technology Manager, Assistant Technology Manager and the Livestock Extension Officers. Twenty-eight trainings including workshops sponsored by Agriculture Department of Bareilly were also organized during the year which witnessed the participation of 1263 participants. Further, 18 skill development trainings were also organized for 296 youth (212 boys and 84 girls).

Celebration of important days

To develop awareness among the farmers about various important issues and farm technologies for increasing the production and doubling the farm income, 15 important days, e.g. World Environment Day, World Veterinary Day, World Food Day, Agricultural Education Day, World Honey Day, World Soil Day, KVK Foundation Day etc. were celebrated at institute and field level, which were attended by 4596 participants. In addition to this, 6 specific programme/week/ workshop viz., campaign for eradication of parthenium, workshop on production of export quality of basmati, and awareness programme about Protection of Plant Varieties and Farmers Right Act, etc. were organized at the institute as well as at village level. A total of 5856 participants attended these programs. Further, under the programme of *Swachhata Hi Seva Hai,* a girls toilet in the Primary School of Faridapur Inayat Khan, village of Bithrichainpur block of Bareilly district was renovated with the cooperation and participation of the villagers, KVK staff and the scientists of the institute.

Other extension activities

- Under the *Swachh Bharat Mission*, 79 awareness programme (54 on-campus and 25 at village level) were organized by conducting

goshties, film shows, group discussion and demonstrations, etc. with the involvement of 2029 participants.

- Two Farm School on the theme *Doubling the Farm Income* and *Entrepreneurship Development in Agriculture* each of 13 episodes were organized in association with All India Radio, Rampur and Bareilly stations.
- Nine talks given by the SMSs of KVK were also recorded and broadcasted by Doordarshan, Bareilly.
- Three demonstrations were conducted for the empowerment of farm women which were attended by 80 rural women.
- Under the soil health programme, 417 soil samples of 390 farmers were analyzed and 1025 soil health cards were distributed to the farmers of Bareilly district. Further, to enhance the knowledge and upgrade the skill of farmers for *how to collect soil sample*, five soil health camps were also organized.
- Twelve video films of innovative and progressive farmers, farm women and rural youths were made and uploaded on YouTube. The YouTube channel of KVK Bareilly has been subscribed by 2,845 subscribers; these films have been watched by more than one lakh people.
- A WhatsApp group '*KVK IVRI Bareilly*' has been formed with 213 members which includes SMSs of KVK, Scientists, District officials, input dealers, and progressive farmers. On an average, 10-12 farm-related information is shared per day. Further, all the activities / events conducted by the KVK are also shared on facebook of 'KVK IVRI Bareilly' which has 173 followers.
- For the technological empowerment of the farmers and to solve their farm related problems, 3970 advisories were sent to them through mobile messages. Further, 28 film shows were conducted which were seen by 861 participants. Thirteen *Kisan gosthies* were organized with the participation of 2860 farmers and 72 extension functionaries. Five exhibitions put up by the KVK in Bareilly and Kanpur cities were visited by 1246 visitors.
- For increasing the production and improving the nutritional status of family members, a total of 7,065 saplings of fruits and vegetables, and 1,50,000 cuttings of Napier were distributed to the farmers. Further, under the seed production programme, 215.85 quintals of wheat and 96.45 quintals of paddy seeds were produced and supplied to the National Seed Corporation.
- The instructional and demonstration farm of KVK was visited by 3229 visitors. Further, 93 diagnostic visits, 10 field days and 6 group discussions were conducted on the farm of 277, 229 and 36 farmers, respectively.

A glimpse of *Sankalp Se Siddhi* programme chaired by Sri Santosh Kumar Gangwar, Hon'ble Union Minister of State for Finance, and Sri Dharmendra Kashyap, Hon'ble MP, Aonla. Web-cast of Hon'ble Prime Minister to the KVKs of country on 17th March, 2018

4.0
Research Publications

Animal Health Divisions/Sections

Bacteriology and Mycology

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5.0
Technologies and Patents

Technologies developed

1. Sub-viral particle-based Infectious Bursal Disease (Gumboro) vaccine

   The Sub-viral particle (SVPs)-based IBD vaccine is a lyophilized recombinant vaccine intended for use against IBD, also known as Gumboro disease of poultry. SVPs were produced by expressing the major capsid protein VP2 of IBDV in *Saccharomyces cerevisiae*. This subunit vaccine conferred 100% protection in SPF birds. It can be administered to day-old chickens and is effective even in the presence of maternal antibodies.

2. Bluetongue Indirect ELISA kit

   The indirect ELISA kit is useful for detection of group-specific antibodies to bluetongue virus (BTV) in sheep and goats. The kit uses insect cell expressed recombinant full length group-specific protein (VP7) of BTV as the capture antigen. The kit has a diagnostic sensitivity and specificity of 96.4% and 96.9% , respectively.

Technologies in pipeline

1. Carotenoids-based assay on meat samples to identify tissues originating from cattle.
2. Simplex, duplex and multiplex PCR assays for identification of tissues from cattle, buffalo and pig.
3. Essential oil incorporated emulsion-based meat nuggets with reduced microbial load and enhanced shelf life.
4. Plant-based Time Temperature Indicator (TTI) to monitor quality of meat and meat products during supply chain.
5. Plant-based quality indicator (QI) to monitor quality of meat during supply chain.

Patents Filed

Sl. No.	Application No.	Title of the patent	Inventors	Date of filing
1.	201711020314	Anti-tick phytomolecule for the management of acaricide resistant species infesting livestock	Srikanta Ghosh, Rajesh Kumar, Amol Bapurao Tayade, Gajanan Madhavrao Chigure, Ajay Kumar Singh Rawat, Gaurav Nagar, Sharad Srivastava, Pawan Kumar Agarwal and Suman Gupta.	09.06.2017

Patents granted

Sl. No.	Application No.	Title of the patent	Inventors
1	76/DEL/2008	A live attenuated Vero cell-based goatpox vaccine for protection against goatpox	Madhusudan Hosamani, Raj Kumar Singh, S K Bandopadhyay, S K Singh, Sukdev Nandi, B Mandal and M P Yadav
2	2452/DEL/2010	A phyto-pharmaceutical preparation for the control of acaricide resistant tick infestations in animals	Srikant Ghosh, Ajay Kumar Singh Rawat, Sharad Srivastava, Subha Rastogi, Debdatta Ray, Anil Kumar Sharma, Shashi Shankar Tiwari, Pallabh Chaudhuri and Amitabh Bandyopadhyay

Response to First Examination Reports (FERs) filed

Sl. No.	Patent Application No.	Title
1.	1964/DEL/2008	Development of a novel bilateral external skeletal fixation device for the management of long bone fractures in large animals
2.	1856/DEL/2010	Herbo-mineral acaricide formulations against *Boophilus* ticks in cattle
3.	2449/DEL/2010	A recombinant protein-based diagnostic reagent for the sensitive and specific detection of *Trypanosoma evansi*
4.	2452/DEL/2010	A phyto-pharmaceutical preparation for the control of acaricide resistant tick infestations in animals
5.	792/DEL/2011	Mineral-based technology for estrus induction and synchronization in bovines
6.	2195/DEL/2011	Attenuated *Pasteurella multocida* with determinant marker
7.	3805/DEL/2011	Pestivirus replicase-based self-replicating RNA-replicon vector for heterologous gene expression in mammalian cells
8.	790/DEL/2011	IVRI-anti diarrheal herbal formulation
9.	628/DEL/2012	Recombinant antigen-based sero-diagnosis of Newcastle disease

Submission to Hearing (Form 30) of Patent Application

Sl. No.	Patent Application No.	Title	Date of Hearing
1.	2722/DEL/2007	A process of preparing a bio-organo-mineral formulation for the therapy of skin ailments in animals	23.03.2018

Publication of Patent Applications

Sl. No.	Patent Application No.	Title	Date of Publication
1.	201611024016	Recombinant NS1-protein based indirect IGg ELISA for sero-surveillance of Japanese encephalitis and kit thereof	16.02.2018
2.	201611021466	Peptide-recombinant protein based antigen capture immunoassay for detection of rotavirus group A infection in animals	16.02.2018

Design registrations granted

Sl. No.	Application No. Date of registration	Title of the Design	Inventors	Design No. Date of grant
1.	286439 29.08.2016	Prepucial cleaning device for bulls	Jai Kishan Prasad, Subrata Kumar Ghosh, Goutam Kumar Das, Harish Chandra Yadav, Tanveer Ahmad	56898 07.08.2017

Copyrights for Mobile Apps registered

Sl. No.	Title of the Mobile App	Language	Application Number
1.	IVRI-Pashu Prajanan App	Gujarati	2989/2018-CO/L
2.	IVRI-Pashu Prajanan App	Bengali	2990/2018-CO/L
3.	IVRI-Pashu Prajanan App	Assamese	2991/2018-CO/L
4.	IVRI-Pashu Prajanan App	Tamil	5060/2018-CO/L
5.	IVRI-Artificial insemination App	English	5061/2018-CO/L

Copyrights for Mobile Apps granted

Sl. No.	Name of the Mobile App	Application No. Date	Registration No. Date
1.	IVRI-Pig farming (Shookar Palan) in Hindi language	22/2018-Co/L 01.01.2018	L-73383/2018 15.02.2018
2.	IVRI-Animal reproduction App	23/2018-Co/L 01.01.2018	L-73430/2018 16.02.2018
3.	IVRI-Pashu Prajanan in Punjabi language	21/2018-Co/L 01.01.2018	L-73889/2018 Dt. 09.03.2018
4.	IVRI-Pashu Prajanan in Hindi language	24/2018-Co/L 01.01.2018	L-74162/2018 Dt. 02.04.2018

Technologies commercialized

Sl. No.	Name of technology	Transferred/ Commercialized to	Date of licensing Receipt of revenue	Revenue earned (Rs.)
1.	Live attenuated Classical Swine Fever vaccine	Animal Husbandry Department, Government of Punjab (on MTA basis)	11.08.2017 --	Non-commercial exploitation of the technology
2.	PPR vaccine	M/s. Indian Immunologicals Ltd., Hyderabad	03.04.2017 (Royalty)	88,541.00
		M/s. Intervet India Pvt. Ltd., Pune	03.04.2017 (Royalty: 2014-15)	4,33,217.00
		M/s. Intervet India Pvt. Ltd., Pune	03.04.2017 (Royalty: 2015-16)	4,11,543.00
		M/s. Hester Biosciences, Ltd., Ahmedabad	28.04.2017 (Royalty)	7,60,904.40
		M/s. Biomed Pvt. Ltd., Ghaziabad	08.05.2017 (Royalty)	9,45,952.00

		M/s. Indian Immunologicals Ltd., Hyderabad	31.05.2017 (Royalty: 2015-16)	24,68,645.00
		M/s. Indian Immunologicals Ltd., Hyderabad	31.05.2017 (Royalty: 2016-17)	5,00,602.00
		M/s. Intervet India Pvt. Ltd., Pune	31.05.2017 (Royalty: 2015-16)	3,63,587.00
		M/s. Intervet India Pvt. Ltd., Pune	31.05.2017 (Royalty: 2016-17)	2,18,432.00
		M/s. Bio-Med Pvt. Ltd., Ghaziabad	27.10.2017 (Royalty)	1,89,617.00
		M/s. Hester Biosciences, Ltd., Ahmedabad	31.10.2017 (Royalty)	8,61,994.00
		Institute of Animal Health and Veterinary Biologicals, Hebbal, Bengaluru	08.02.2018 (2nd instal. of license fee)	7,18,750.00
		M/s. Intervet India Pvt. Ltd.	31.03.2018 (Royalty:Apr-Sep 2017)	2,19, 362.00
3.	Goat Pox vaccine	M/s. Hester Biosciences, Ltd., Ahmadabad	28.04.2017 (Royalty)	1,50,246.35
		M/s. Hester Biosciences, Ltd., Ahmedabad	31.10.2017 (Royalty)	16,936.00
		Institute of Animal Health and Veterinary Biologicals, Hebbal, Bengaluru	08.02.2018 (2nd instal. of license fee)	4,31,250.00
4.	Vero cell-based Sheep Pox vaccine	Institute of Animal Health and Veterinary Biologicals, Hebbal, Bengaluru	08.02.2018 (2nd instal. of license fee)	2,87,500.00
5.	Jai Gopal vermiculture	M/s. Belagachi Tea Co. Ltd., Siliguri- 734001	04.05.2017	23,000.00
		Divya Jyoti Jagrati Sansthan, New Delhi	18.05.2017	23,000.00
		Mr. Abhinav Goswami, Jarara Khair, Aligarh (UP)	26.9.2017	29,500.00
		Mrs. Urmila Agarwal	07.11.2017	29,500.00
		Mr. Karan Vir Singh Ghuman, Bazpur, Uttarakhand	05.01.2018	29,500.00
6.	Vegetable incorporated meat products	M/s. Chicken Express, Bareilly	28.3.2018	11,800.00
7.	Premium chicken soup	M/s. Chicken Express, Bareilly	28.3.2018	11,800.00
Total				**Rs. 92,25,179.00**

Technology demonstration at *Pt. Deen Dayal Upadhyay Pashu Arogya Mela*

A team of scientists attended *Pashu Arogya Mela* at Arajiline, Shahansapur, Varanasi on 23rd September 2017. Hon'ble Prime Minister, Sri Narendra Modi Ji, along with the Hon'ble Governor of U.P., Sri Ram Naik Ji and Hon'ble Chief Minister of U.P., Sri Yogi Adityanath Ji, interacted with scientists of the institute. The team demonstrated Rumenotomy surgery for removing polythene bags from the rumen of a cow and demonstrated ultrasonography for pregnancy detection, and other diagnostic tests.

Release of IVRI technologies by Hon'ble Union Minister of Agriculture & Farmers Welfare Shri. Radha Mohan Singh Ji

Hon'ble Union Minister of Agriculture & Farmers Welfare, Shri. Radha Mohan Singh Ji released one ELISA kit, a crossbred pig variety and two mobile apps developed by ICAR-Indian Veterinary Research Institute, Izatnagar at New Delhi on 8th March 2018.

ICAR-IVRI scientist interacting with Hon'ble Prime Minister Sri Narendra Modi Ji during Pashu Arogya Mela at Varanasi on 23rd September, 2017

IVRI-M PPRV Antigen Capture ELISA Kit

IVRI has developed improved recombinant N antigen-based sandwich ELISA (IVRI-M PPRV Antigen Capture ELISA Kit) with a more sensitive homologous capture antibody for diagnosis of PPR. This improves conventional diagnostic kits through recombinant technology and would help in saving money and time in diagnosing PPR.

Landlly: A crossbred pig variety for North India

IVRI developed a new variety of crossbred pig named Landlly, utilizing foundation stock of purebred Landrace and Bareilly local. These pigs maintain 75 % blood level of Landrace and 25 % blood level of Bareilly local. This variety of pig has performed well under farm and field conditions. The weight at marketable age of 8 months ranged between 73 to 90 kg. Also, Landlly can be reared successfully, with suitable replacement of concentrates, with kitchen waste, vegetable waste and agro-industrial by-products like sugarcane press mud etc.

IVRI-Pashu Prajanan (Animal Reproduction) App

IVRI-Pashu Prajanan (Animal Reproduction) App has been designed and developed in collaboration with ICAR-IASRI, New Delhi to impart knowledge and acts as a ready recokner for the graduating veterinarians, field veterinary officers and livestock entrepreneurs about reproductive problems of cattle and buffaloes and measures to treat and control them. It is an offline App with 13.5 MB size developed for Android platforms. The information contained in the App is in 7 languages viz., Hindi, English, Punjabi, Bangla, Assamese, Gujarati and Tamil.

IVRI-Shukar Palan (Pig Farming) App

The IVRI-Shukar Palan (Pig Farming) App, designed and developed by ICAR-IVRI, Izatnagar and IASRI New Delhi is targeted to impart scientific knowledge and skills to the graduating veterinarians, field veterinary officers, developmental organizations and entrepreneurs for promoting commercial pig farming. The App additionally provides support for development of commercial pig farming projects of various sizes. It is an offline App of 5.5 MB size developed for Android platforms. The information contained in the App is in Hindi language.

6.0
Research Projects

Sl. No.	Title of the project	Name of the PI & Collaborators	Duration	Funding
BACTERIOLOGY AND MYCOLOGY DIVISION				
1.	AINP on Neonatal Mortality in Farm Animals	Joint Director (Research) (PC); R.K. Agarwal (PI), Rajendra Singh, Y.P.S. Malik, M. Sankar, U.K. De, Abhishek, D.K. Sinha	Nov 2014 –Mar 2020	ICAR
2.	CctA and hyaluronidase gene mutants of *Clostridium chauvoei*: Construction and evaluation of vaccine potential	K.N. Viswas (PI)	Jul 2015 – Jun 2018	ICAR - NASF
3.	Assessment of a PPD tuberculin produced from the indigenous *Mycobacterium bovis* (3/86) strain for use in cattle	Rishendra Verma (PI)	Apr 2016 – Mar 2018	ICAR – Emeritus Scientist Scheme
4.	Development of a genetically engineered live vaccine against brucellosis for animals	Pallab Chaudhuri (PI), T.K. Goswami	Oct 2012 – Sep 2017	DBT
5.	Development of recombinant vaccine for control of salmonellosis in poultry	R.K. Agarwal (PI), D.K. Singh	Dec 2014 – Jun 2017	DBT
BIOLOGICAL PRODUCTS DIVISION				
6.	Efficacy of phage lysate of *Brucella abortus* in experimental animal and target host	Bablu Kumar (PI), Mayank Rawat, V.K. Chaturvedi, Lata Jain, Abhishek	Jun 2013– Jun 2017	Institute
7.	Development of field diagnostics for classical swine fever *Sub-project:* Development and standardization of spot diagnostic test for swine fever viral antigen in tissue samples	V.K. Chaturvedi (PI), P. Dhar, V. Upmanyu	Jun 2013– May 2017	Institute
8.	Introduction of innovative selected diagnostics/ biological products for up scaling and pilot scale production	R.P. Singh (PI), Bablu Kumar, Bina Mishra, C.L. Patel, D.K. Singh	Aug 2015– Mar 2018	Institute
9.	Development of nucleo-diagnostic techniques and understanding the receptor fidelity of canine distemper virus from wildlife origin	K.K. Rajak (PI), S. Chakravarti, Karikalan. M	Aug 2016– Jul 2018	Institute
10.	Establishment of Agri-Business Incubation (ABI) Centres for National Agriculture Innovation Fund	R.P. Singh (PI), Bablu Kumar, Sameer Srivastava, S.K. Singh, Puneet Kumar	Jan 2016 – Mar 2020	ICAR
11.	Development of recombinant sheeppox vectored *Peste des petits ruminants* (PPR) vaccine for small ruminants	Bina Mishra (PI), P.K. Gupta, C.L. Patel, Sonal, V.K. Chaturvedi	Nov 2013– Apr 2017	DBT

12.	Understanding the immune mechanism of host disease and development of marker vaccines and DIVA test for *Peste des Petits ruminants*	R.P. Singh (PI), Praveen Singh, V. Upamanyu, D. Muthuchelvan	Jul 2015 – Jul 2018	DBT - BBSRC
BIOLOGICAL STANDARDIZATION				
13.	Investigating viral causes of neonatal mortality in lab animals	Y.P.S. Mallik (PI), K. Dhama, Somendu Chakravarti, Ajay K. Tahlan, Upender Bhardwaj	Aug 2016 – Mar 2019	Institute
14.	National initiative on climate resilient agriculture (NICRA): Identification of unique traits/ factors in indigenous livestock making them resilient to climate change in relation to diseases and database development	A.K. Tiwari (PI), Puneet Kumar, K.P. Singh, G.V.P.P.S. Ravi Kumar, Dinesh Chandra, N.R. Sahoo	Apr 2011 – Mar 2020	ICAR-NICRA
15.	Veterinary type culture collection: Veterinary microbes component	A.K. Tiwari (Nodal Officer), Mayank Rawat (PI), Salauddin Quereshi	Apr 2014 – Mar 2020	ICAR
16.	Development of molecular platforms for point-of-care detection of major enteric viruses responsible for neonatal mortality in animals	Y.P.S. Malik (PI)	Nov 2014 – Nov 2019	ICAR – National Fellow Scheme
CADRAD				
17.	Epidemiological studies & clinical profiling of theileriosis in relation to various risk factors in cattle	Dinesh Chandra (PI), K.P. Singh	Jul 2016 – Jun 2018	Institute
18.	Novel nucleo-diagnostic platform for detection of pathogens transmitted through bovine semen	S. Nandi (PI), S. Chakrabartti, V. Chander, Gaurav Sharma	Jul 2016– Jun 2018	Institute
19.	*AICRP on* Animal Disease Monitoring and Surveillance	S. Nandi (PI), Vinodh Kumar O.R.	Sep 2015– Mar 2020	ICAR
20.	*AINP on* Bluetongue	V.K. Gupta (PC); K.P. Singh (PI), M.A. Ramakrishnan (PI-Mukteswar Unit), Vishal Chander, B. Mondal	Apr 2001 – Mar 2020	ICAR
21.	Development of diagnostic systems, reference collections and molecular epidemiology studies for important arboviral pathogens for livestock in India	K.P. Singh (PI)	Sep 2014 – Sep 2017	DBT - BBSRC
22.	Development and evaluation of medicinal plant based remedy for improving sexual behaviour and fertility in chemically-induced reproductive toxicity in male rats	Ranjeeta Mourya (PI), A.G. Telang (Mentor)	Oct 2016 – Oct 2019	DHR – MHFW (Women Scientist Scheme)
23.	Establishment of reverse genetics system for rescue of bluetongue virus of Indian origin	Gaurav K Sharma (PI), V.K. Gupta, A.K. Tiwari, K.P. Singh	Aug 2017 – Aug 2020	DST
EPIDEMIOLOGY				
24.	Epidemiology of emergence of antimicrobial drug resistance in bacteria of veterinary clinical importance	B.R. Singh (PI), Vinod Kumar O.R., A.M. Pawde, V.K. Gupta, U.K. De, D. Mondal	Aug 2016- Jul 2018	Institute

25.	Meta analysis of peste des petits ruminants (PPR) in India	D.K. Sinha (PI), B.R. Singh, Vinod Kumar, R.P. Singh, V.K. Chaturvedi, D. Bardhan	Sep 2017– Aug 2018	Institute
26.	Geospatial and meta analysis on bluetongue in small ruminants	Vinodh Kumar O.R. (PI), B.R. Singh, D.K. Sinha, K.P. Singh, D. Bardhan	Oct 2017– Nov 2018	Institute
IMMUNOLOGY				
27.	Development of a cell culture adapted vaccine and improvement of vaccination strategy for prevention and control of duck plague	S. Dandapat (PI), S. Nandi S.C. Giri (CARI, Bhubaneshwer)	Sep 2015– Aug 2018	Institute
28.	Development of novel antigens based sandwich ELISA for identification of ALV transmitter chickens	Alka Tomar (PI), K. Kumanan (TANUVAS, Chennai), A. Sonwane, V.K. Saxena (CARI, Izatnagar)	Aug 2017– Jul 2019	Institute
29.	Host pathogen interaction flagship programme			
	Sub project 1 (Bacterial component): Relevance of macrophage polarization towards M1 & M2 during pathogen interaction.	T.K. Goswami (PI), M.K. Singh	Sep 2017– Aug 2018	Institute
	Sub project 2 (Parasitic component): To probe the efficacy of recombinant GAPDH fragment of Haemonchus to include CMI in host species using in-vitro model.	Paritosh Joshi (PI)	Sep 2017– Aug 2018	Institute
30.	Exploration of Toll-like receptor agonist(s) as adjuvants and prophylactic agents in chicken	R. Saravanan (PI), T.K. Goswami, C. Madhan Mohan, Sohini Dey, Ajay Kumar	Mar 2017– Mar 2020	DBT
MEDICINE				
31.	Characterization and evaluation of antioxidant property of catechin loaded polymeric nanoparticles to ameliorate hepatopathies	D. B. Mondal (PI), S. K. Dixit, Praveen Singh , A.G. Telang, K.P. Singh	July 2015– Jun 2018	Institute
32.	Diagnostic and therapeutic interventions on gastritis & peptic ulcer disease (GPUD) in canines	S.K. Dixit (PI), D.B. Mondal, Umesh Dimri, M. Hoque, R.S. Rathore	Jul 2016– Jun 2018	Institute
33.	Improvement of therapeutic response against canine parvovirus infection using immunoglobulin and antioxidants.	U.K. De (PI), M.K. Singh, R. Raguvaran	Aug 2017– Jul 2019	Institute
34.	Outreach Programme on Ethno-veterinary Medicine	S. Dey (PC & PI), Anil Kumar Sharma, Mohini Saini, K. Mahendran, Sumit Mahajan	Apr 2009 – Mar 2020	ICAR
35.	Strategically enhancing livelihood opportunities to the very small and marginal farmers though small animal husbandry, emphasizing latest animal health technological interventions in Shivalik range of Uttarakhand	Umesh Dimri (PI), Vinodh Kumar O.R., U.K. De, B.H.M. Patel, A.C. Saxena, Anuj Chauhan	Jul 2015 – Jul 2018	DST
PARASITOLOGY				
36.	Immunoprophylactic evaluation of radiation attenuated *Trypanosoma evansi*	A.K. Tewari (PI), B.C. Saravanan, S. Dandapat	Jul 2016 – Jul 2018	Institute

37.	Recombinant protein and nucleic acid based diagnostic platform for canine haemoparasitic infections.	P.S. Banerjee (PI), Praveen Singh, Rajat Garg, O.K. Raina, Sameer Shrivastava	Aug 2017–Jul 2019	Institute
38.	Expression of recombinant antigens of Trichinella *sp.* for evaluation of serodiagnotic potential	Hira Ram (PI), P.S. Banerjee, M.K. Singh, M. Karikalan	Aug 2017–Jul 2019	Institute
39.	AINP on gastro-intestinal parasitism	B.P. Mishra (PC), Dinesh Chandra (PI), Rajat Garg, M Sankar, Hira Ram	Apr 2001–Mar 2020	ICAR
40.	Chemical, structural and functional characterization of identified anti-tick lead phytochemicals and optimization of delivery matrix for effective application of natural formulation for the control of acaricide resistant ticks	Srikant Ghosh (PI), B.C. Saravanan, G.V.P.P.S. Ravi Kumar, S. Dey	Jan 2017 – Jan 2020	ICAR- NASF
41.	Effect of ethno botanicals against GI parasites for mitigation of anthelmintic resistance	Arvind Prasad (PI)	Feb 2017–Jan 2020	ICAR – Emeritus Scientist Scheme
42.	Studies on role of endophytes in variation of acaricidal properties of two acaricide producing plant species from north eastern states	Srikant Ghosh (PI), B.C. Saravanan, G.V.P.P.S. Ravi Kumar	Jan 2017–Jan 2020	DBT
43.	Detection of acaricides resistance in cattle ticks population of Haryana State and Development of strategies to improve surveillance and their control	Srikant Ghosh (Mentor); Sachin Kumar (PI)	May 2017–May 2019	DST - NPDF
PATHOLOGY				
44.	Pathomorphological and molecular diagnosis of important viral induced respiratory diseases in poultry	M. Palanivelu (PI), S.D. Singh, K. Dhama	Jan 2014–Dec. 2017	Institute
45.	Flavivirus infections in pigs and bats with special reference to Japanese encephalitis	G. Saikumar (PI), Z.B. Dubal, S. Dandapat, G.V.P.P.S. Ravi Kumar, Tareni Das, K.K. Rajak	Jul 2015–Jun 2018	Institute
46.	Pathology of respiratory disease complex in ruminants	Vidya Singh (PI), Rajendra Singh, B.R. Singh, Ajay Kumar,Vishal Chander	Aug 2017–Jul 2019	Institute
47.	Prevalence and pathobiology of retroviral diseases in sheep and goats	Pawan Kumar (PI)	Dec 2016–Dec 2019	DST
48.	Development of pen-side diagnostic test/kit for diagnosis of Marek's disease in poultry	S.D. Singh (PI)	Feb 2017–Feb 2020	ICAR–Emeritus Scientist Scheme
PHARMACOLOGY & TOXICOLOGY				
49.	Evaluation of cardioprotective potential of isoflavonoids biochanin A and kaempferol in cardiomyopathy	T. U. Singh (PI), Dinesh Kumar, Subhashree Parida, Sumit Mahajan	Jul 2015-Jun 2018	Institute
50.	Evaluation of synergistic efficacy of curumin with hemin, bilirubin and deferoxamine in cutaneous wound healing by isobolographic studies in rats	Dinesh Kumar (PI), T.U. Singh, Madhu C.L, Amarpal	Jul 2016–Jun 2018	Institute

51.	Evalution of imipenem loaded nanoparticle for extended drug release and its applicability in polymicrobial sepsis.	Madhu C.L. (PI), T.U. Singh, Praveen Singh. Dinesh Kumar, M. Kesavan, Raghuvaran	Aug 2017–Jul 2019	Institute
52.	Outreach programme on monitoring of drug residues and environmental pollutants	B.P. Mishra (PC); A.G. Telang (PI), Praveen Singh, T.U. Singh, M. Kesavan	Apr 2009 – Mar 2020	ICAR
53.	Understanding the regulation of oxytocin signaling in obesity-induced dysfunctional labor	Subhashree Parida (PI), T.U. Singh, Manjit Panigrahi	Nov 2014–May 2018	DBT
54.	Lysophosphatidic acid (LPA) signaling in early pregnant buffalo uterus: Possible role in endometrial receptivity and embryo implantation	Subhashree Parida (PI)	Dec 2014–Mar 2018	DST
55.	Role of sigma-1 receptor in chronic kidney disease	Madhu CL	Aug 2017–Aug 2020	DST
SURGERY				
56.	Radiographic and ultrasonographic imaging for diagnosis of cardio-renal syndrome in dogs	A.C. Saxena (PI), M. Hoque, K. Mahendran, M.R. Verma	Jul 2016 – Jun 2018	Institute
57.	Tear based biomarkers for early detection of Keratoconjunctivitis Sicca (KCS) and prediction of corneal graft acceptance in KCS affected dogs	Kiranjeet Singh (PI), Aswathy Gopinathan, Mohini Saini, Ravi Kant, Pawan Kumar	Aug 2016–Jul 2018	Institute
58.	AINP on diagnostic imaging and management of surgical conditions in animals	B.P. Mishra (PC); Amar Pal (PI), M. Hoque, P. Kinjavdekar, A.M. Pawde, H.P. Aithal, Rekha Pathak, K. Singh, A.C. Saxena, A. Gopinathan	Nov 2014 – Mar 2020	ICAR
VETERINARY BIOTECHNOLOGY				
59.	Development of multiplex assay for detecting autoantibody signatures (Biomarkers) associated with canine mammary cancer	Sonal (PI), S.K. Maiti, A.K. Sharma, A.K. Tiwari, Bina Mishra, Naveen Kumar	Aug 2015–Jul 2018	Institute
60.	Detection of peptide biomarks and development of synthetic anti-microbial peptide hydrogels for bovine mastitis	Sameer Shrivastava (PI), G.K. Gaur, Mayank Rawat, Reena Mukherjee, Sonal	Jan 2017–Jan 2020	ICAR-NASF
61.	Centre for Agricultural Bioinformatics (CABin)	G.V.P.P.S. Ravi Kumar (PI), B.P. Mishra, Amit Kumar, Yash Pal Singh	Nov 2014–Mar 2020	ICAR
62.	Development and validation of peptides and peptide nucleic acid activated nano materials as reagents for detection/ quantitation of viruses to have affordable rapid visual tests	Satish Kumar (PI)	Nov 2015–Nov 2017	ICAR – Emeritus Scientist Scheme
63.	Development of recombinant protein based penside diagnostic kit for avian reovirus infection	Deepak Kumar (PI), K. Dhama, B.P. Mishra, Ajay Kumar	May 2014 – May 2017	DBT
64.	Sub viral particle based Infectious bursal disease vaccine: a way forward towards translation from lab to land	Sohini Dey (PI), R. Saravanan, C. Madhan Mohan	May 2016–Sep 2017	DBT

65.	Development and evaluation of DIVA-based vaccine utilizing an Indian isolate of Classical Swine Fever virus	P.K. Gupta (PI), Mohini Saini	Mar 2017– Mar 2020	DBT
66.	Development and evaluation of a genetically engineered vaccine against Newcastle disease and chicken infectious anaemia of chickens	C. Madhan Mohan (PI), Kuldeep Dhama, R. Sarvanan, Sohini dey	Dec 2017– Dec 2020	DBT
67.	Functional studies to evaluate the role of immune response gene(s) against *Peste des Petits Ruminants* virus using CRISPR/Cas9 and RNAi	G.V.P.P.S. Ravi Kumar (Mentor); Shikha Saxena (PI)	May 2017– May 2019	DST - NPDF
VETERINARY PUBLIC HEALTH				
68.	Outreach Programme on Zoonotic diseases	B.P. Mishra (PC); S.V.S. Malik (PI), D.K. Singh, R.S. Rathore, R.K. Agarwal, P.S. Banerjee, S. Samanta, T. Sabrinath, Z.B. Dubal, Himani Dhanze	Apr 2009 – Mar 2020	ICAR
69.	Programme support on translational research on molecular epidemiology of *Listeria monocytogenes*	S.V.S. Malik (PI)	May 2012 – May 2017	DBT
70.	Development of national *Brucella* repository and molecular characterization of brucella species of diverse origin	D.K. Singh (PI), A.K. Tiwari, A.P. Sahoo	Oct 2012 – Sep 2017	DBT
71.	Genotypic diversity of human, bovine and porcine group A rotaviruses	Z.B. Dubal (PI)	May 2016 – May 2020	DBT
72.	New Promising approaches for synergistic blocking of anthrax toxin at protective antigen interacting domains of the lethal factor and edema factor	Deepak B Rawool (PI), S.V.S. Malik	Jul 2016 – Jul 2019	DHR - MHFW
73.	Development and application of enzyme-linked immunosorbent assay for serological survey of Japanese encephalitis virus infection in equines	Himani Dhanze (PI)	Dec 2016 – Dec 2019	DST
ANIMAL GENETICS				
74.	Prediction of breed composition and genetic diversity of *Vrindavani* crossbred cattle	Manjit Panigrahi (PI), Bharat Bhushan, G.K. Gaur, G.V.P.P.S. Ravi Kumar	Jul 2016 – Jun 2018	Institute
75.	Genetic evaluation of economic traits of economic importance using pedigree information in SNPs marker in Murrah buffalo and crossbred cattle	Amit Kumar (PI), Triveni Dutt, A.K.S. Tomar, Manjit Panigrahi	Jul 2016 – Jul 2019	Institute
76.	Estimation of autozygosity in cattle and buffaloes by conventional and modern methods and their comparison	Subodh Kumar (PI), Anuj Chauhan, N.R. Sahoo, A.K.S. Tomar, Med Ram Verma	Aug 2016 – Jul 2018	Institute
77.	Development of transgenic goat expressing interferon tau in urine using testis-mediated gene transfer (TMGT) technology	Arvind Sonwane (PI), Subodh Kumar, C.L. Patel, M.K. Patra, A.C. Saxena	Jul 2016– Jun 2018	Institute

78.	Development of inbred strain of mouse using Swiss-albino out bred strain as foundation stock	Pushpendra Kumar (PI), Amit Kumar, Jai Prakash	Aug 2017–Jul 2020	Institute
79.	Enhancing livelihood security of farming community through livestock and crop integration using proven technologies	Ranvir Singh, Subodh Kumar, Om Singh, Anuj Chauhan, Rajiv Ranjan Kumar, Pachaiyappan K, O.K. Bharti, U.K. De, M.K. Patra	Oct 2016–Oct 2018	ICAR (Farmer First Programme)
80.	Development of RNA-guided recombinase (RGR) platform for targeted DNA integration	Arvind Sonwane (PI), Bina Mishra, C.L. Patel, Anuj Chauhan	Jun 2017–Jun 2020	DBT
ANIMAL NUTRITION				
81.	Feeding strategies to improve nutrient utilization, antioxidant status and immunity in captive Indian leopard (*Panthera purdus fusca)*	Asit Das (PI), M. Saini, A.K. Sharma	Aug 2015–Mar 2018	Institute
82.	Feeding strategies for economical growth in male buffalo calves	Putan Singh (PI), A.K. Verma, S.K. Saha, Sagar Chand, S.K. Mendiratta, A.K.S. Tomar	Sep 2017–Aug. 2019	Institute
83.	Effect of catalytic supplementation of promising unconventional oil cakes on the performance of calves	Subodh Kumar Saha (PI), L.C. Chaudhary, V.B. Chaturvedi	Sep 2017–Aug. 2019	Institute
84.	Methyl donors as feed supplement for pigs: An epigenetic approach to maternal programming	Asit Das (PI), A.K. Verma P. Singh, G.K. Gaur, N.R. Sahoo, M. Panigrahi, Arvind Soni	Sep 2017–Aug. 2019	Institute
85.	Studies on the interaction of rumen microbes with sulphur and its manipulation for improving livestock production	L.C. Chaudhary (PI), Anju Kala, V.B. Chaturvedi	Sep 2017–Aug 2019	Institute
86.	Nutrigenomic approaches to elucidate the role of zinc and selenium in animals under abiotic stress conditions	S.K. Jadhav (PI), A.K. Pattanaik, N. Dutta, R. Sarvanan, M. Panigrahi	Sep 2017–Aug 2019	Institute
87.	AICRP on Nutritional and physiological approaches for enhancing reproductive performance in cattle and buffalo	Narayan Dutta (PI), G.K. Das, K. Narayanan, S.K. Singh, V.P. Maurya, Mihir Sarkar, Gyanendra Singh, S.E. Jadhav	Apr 2014–Mar 2020	ICAR
88.	Niche Area of Excellence (NAE) on Nutrition and gut health: Probiotics, prebiotics and phytogenics as functional foods to augment gut health of dogs	A.K. Pattanaik (PI), S.E. Jadhav, N. Dutta, T.K. Goswami, A.M. Pawde, S. Dey	May 2014–Mar 2019	ICAR
89.	Veterinary type culture collection: Rumen microbes	L.C. Chaudhury (PI), D.N. Kamra, Anju Kala	Apr 2010 – Mar 2020	ICAR
90.	Role of plants as a modifier of rumen to reduce methane production and improve productivity in small animals	L.C. Chaudhury (PI), V.B. Chaturvedi, Anju Kala	Apr 2014 – Apr 2017	DBT
91.	Metagenomic analysis and manipulation of buffalo rumen ecosystem to improve fibre utilization and reduce methane production	D.N. Kamra (PI), L.C. Chaudhury	Jan 2013 – Jan 2018	ICAR – National Professor Scheme
92.	Nanoformulations of selenium and zinc as functional feed supplements to improve health and productivity of animals	A.K. Garg (PI; upto 31.08.2017); Narayan Dutta (PI; w.e.f. 01.09.2017), Sameer Shrivastava	Dec 2014 – Dec 2017	DBT

93.	*Kappaphycus alvarezii* and Red seaweed based formulations for improving productivity and health of dairy and poultry animals	Putan Singh (PI), Asit Das, V.B. Chaturvedi, J.K. Prasad	Mar 2016 – Mar 2018	CSIR
94.	Impact of seasonal variations and pollution load on aquatic environment and fish farming at micro level in different aquatic zones of river Ramganga	A.K. Garg (PI)	Jul 2014 – Jul 2017	UPCAR
95.	Evaluation of molasses based multi- nutrient liquid supplements for improving reproductive and productive performance in buffaloes	Putan Singh (PI), A.K. Verma, G.K. Das, G. Kandeepan, G.K. Gaur, S. Mehrotra, S.K. Dixit	Jul 2014 – Jul 2017	UPCAR
ANIMAL REPRODUCTION				
96.	Studies on partial deoxygenation of extender on bovine semen freezability of cattle and buffaloes	J.K. Prasad (PI), S.K. Ghosh S.K. Bhure	Jul 2015 – Jun 2018	Institute
97.	Epitope specific antibody based assay for early pregnancy diagnosis in bovine	S.K. Singh (PI), Sameer Shrivastava, Sonal, K. Narayanan, Harendra Kumar	Aug 2015 – Jul 2018	Institute
98.	Buffalo kisspeptin: Differential expression in hypothalamo-gonadal tissues and application in resumption of cyclicity during anestrus	M.K. Patra (PI), K. Narayanan G.K. Das, S.K. Singh, A. Sonwane	Aug 2016 – Jul 2018	Institute
99.	To design and develop a device “Fetal Lubricator” to be used for lubrication of fetus during handling of bovine dystocia	J.K. Prasad (PI), S.K. Ghosh, G.K. Das, H.C. Yadav, Harendra Kumar, Hemant Kumar	Jul 2017 – Jun 2018	Institute
100.	Effect of ω-3 Polyunsaturated Fatty Acid (PUFA) supplementation on pregnancy rate in repeat breeding cattle	Harendra Kumar (PI), K. Narayanan, M.K. Patra, N. Dutta	Aug 2017 – Jul 2018	Institute
101.	Assessment of certain factors for low success rate of artificial insemination in bovine under field condition	Neeraj Srivastava (PI), S.K. Srivastava, S. Mahmood, S. Mehrotra, M.R. Verma	Aug 2017 – Jul 2019	Institute
102.	To study the role of sire and male progeny based on exogenous and endogenous behaviour in relation to fertility and growth as a prediction model for selection of *Vrindavani* males	Sardar Mahmood (PI), Neeraj Srivastava, S.A. Kochewad	Aug 2017– Jul 2019	Institute
103.	Advances in the management of infertility in the cattle and buffalo	Harendra Kumar (PI), K. Narayanan	Jul 2014 – Jul 2017	UPCAR
104.	Synthetic Endometrium: A novel model to study early embryonic development and uterine health in ruminants	S.K. Singh (PI), A. Sonwane, K. Narayanan, M.K. Patra	Jan 2017 – Jan 2020	ICAR-NASF
105.	Effects of polyunsaturated fatty acid (PUFA) on the ovarian and uterine functions in goat	Harendra Kumar (PI), S.K. Singh, K. Narayan, Narayan Dutta, M. Sarkar	Dec 2014– Dec 2017	DBT
LIVESTOCK PRODUCTION MANAGEMENT				
106.	Multiplication and evaluation of synthetic crossbred cattle strain-*Vrindavani*	G.K. Gaur (PI), Triveni Dutt, S. Mehrotra, A.K.S. Tomar, S.K. Ghosh, Mukesh Singh, V.B. Chaturvedi, Narayan Dutta, V.K. Gupta, P.K. Bharti, Om Singh	Apr 2006– Long-term project	Institute

107.	Genetic improvement, conservation and multiplication of Tharparkar native cattle	A.K.S. Tomar (PI), S. Mehrotra, Narayan Dutta,G.K. Gaur, Mukesh Singh, S. Mendiratta, Triveni Dutt,V.K. Gupta, S.K. Ghosh, Om Singh	Aug 2010 – Jul 2019	Institute
108.	Performance and behaviour of growing dairy cattle under modified shelter using different roofing materials	P.K. Bharti (PI), Mukesh Singh, Triveni Dutt, G.K. Gaur, Gyanendra Singh, Putan Singh	Aug 2015 – Dec 2017	Institute
109.	Determination of primary sex ratio in crossbred boar semen	N.R. Sahoo (PI), G.K. Gaur, G.V.P.P.S. Ravikumar	Aug 2017– Jul 2018	Institute
110.	Effect of milking environment enrichment on production and behavior in cattle	S.A. Kochewad (PI), V.P. Maurya, P.K. Bharti	Aug 2017– Jul 2018	Institute
111.	AICRP on Pigs	G.K. Gaur (PI), B.H.M. Patel, N. Sahoo, S.E. Jadhav, U.K. De, A.M. Pawde, G.K. Das	Apr 1970– Mar 2020	ICAR
112.	Network programme on buffalo improvement	A.K.S. Tomar (PI), Triveni Dutt, Bharat Bhushan, Mukesh Singh, G.K. Gaur, N. Dutt, S. Mendiratta, S. Mehrotra, S.K. Ghosh, Om Singh, K. Narayanan, B.H.M. Patel, V.K. Gupta	Apr 2001– Long Term	ICAR
LIVESTOCK PRODUCTS TECHNOLOGY				
113.	Development of test for meat speciation: Based on carotenoid and DNA content	R.R. Kumar (PI), S.K. Mendiratta, Ravi K. Agarwal, S. Talukder	Jul 2014– Dec 2017	Institute
114.	Development of milk based products with enhanced functionality	Geeta Chauhan (PI), S.K. Mendiratta, Suman Talukder	Sep 2015– Aug 2018	Institute
115.	Analysis of market driven processing of meat to popularize convenience meat products.	Suman Talukder (PI), R.R. Kumar, Arvind Soni S.K. Mendiratta, D. Bardhan	Aug 2017– Jul 2019	Institute
116.	Tray with wrap films for packaging of fresh and processed meat products	I. Prince Devadason (PI), R.R. Kumar, S.K. Mendiratta, R.K. Agarwal	Jul 2017– Jul 2018	Institute
117.	Development of intelligent packaging sensors for monitoring quality and safety of meat and meat products in supply	S.K. Mendiratta (PI), Ravi Kant Agarwal, Suman Talukdar	Jul 2014– Dec 2017	MFPI
118.	Development of rapid laboratory and field based assays for micro-biological quality assessment of pork	Ravi Kant Agarwal (PI), S.K. Mendiratta	Jan 2017– Jan 2020	DBT
PHYSIOLOGY AND CLIMATOLOGY				
119.	Physiological adaptation and production stress in crossbred cows during peripartum period	V.P. Maurya (PI), Gyanendra Singh, S. Mehrotra, Narayan Dutta, G.K. Gaur	Aug 2015– Jul 2018	Institute
120.	Regulation of placental function by locally produced angiogenic growth factors in water buffaloes (*Bubalus bubalis*)	Vikrant Singh Chouhan (PI), Mihir Sarkar, Vikash Chandra	Jul 2015 – Jun 2018	Institute
121.	Flagship stem cell project			
	(A) Bioactive meshes generation: An innovative exploration for its feasibility in stem cell	G. Taru Sharma (PI), Amar Pal, Vikash Chandra	Sep 2017– Aug 2018	Institute
	(B) Evaluation of mesenchymal stem cell with or without EGF and HGF for liver regeneration in rat model.	S.K. Maiti (PI), Naveen Kumar, M. Hoque, D.B. Mondal, K.P. Singh, Ajay Kumar, S. Bag	Sep 2017– Aug 2019	Institute

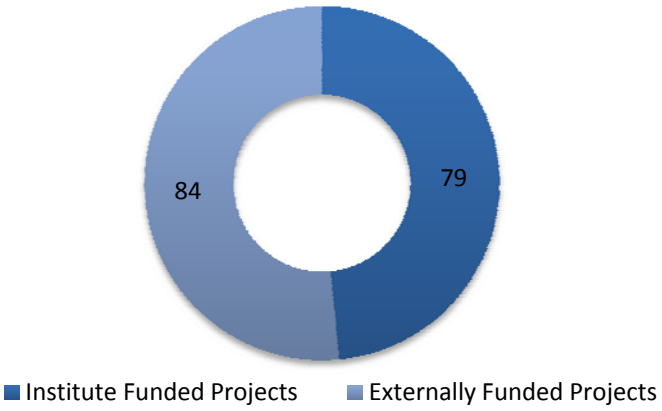
122.	Therapeutic potential of caprine bone marrow derived mesenchymal stem cell conditioned media	Vikash Chandra (PI), G. Taru Sharma, Amarpal	Jul 2014–Jul 2017	UPCAR
123.	Studies on characterization and functional validation of gametes generated from bone marrow derived mesenchymal stem cell (Fast Track Scheme)	Kuldeep Kumar; Sadhan Bag (Mentor)	Oct 2015–Oct 2018	DST
BIOCHEMISTRY				
124.	Characterization of membrane transporters for urate secretion in avian renal tubular epithelium for their role in drug induced nephrotoxicity	Mohini Saini (PI), P. Joshi P.K. Gupta, Asit Das	Jul 2015–Jun 2017	Institute
125.	Studies on phytocompounds as inhibitors of matrix metalloproteases as noval therapeutic agent for cancer	Meena Kataria (PI), Madhu C.L	Aug 2016–Mar 2018	Institute
126.	Role of lipid raft-P2X7r axis in mitochondrial side of autophagy regulation	Mukesh Kumar (PI), Meena Kataria	Aug. 2017–Jul 2018	Institute
127.	Study of oxidatively damaged proteins and the measures to reduce the protein damage due to cryopreservation in buffalo (*Bubalus bubalis*) semen	S.K. Bhure (PI), Ajay Kumar S.K. Ghosh, Mihir Sarkar, G. Taru Sharma	Aug 2017–Jul 2019	Institute
128.	Manipulating the anaerobic respiration to attenuate the pathgenecity of *Salmonella typhimurium*	Ajay Kumar (PI), R. Saravanan	Jan 2017–Jan 2020	DBT
129.	Role of carbonylated proteins in the virulence of Salmonella	Manish Mahawar (PI), Abhishek, T.K. Goswami	Jul 2017–Jul 2020	DBT
130.	Application of bovine herpesvirus-1 (BoHV-1) derived glycoprotein D (gD) and latency related (LR) protein as a diagnostic(s)	Ajay Kumar (Mentor); Barkha Ratta (PI)	May 2017–May 2020	DBT (Bio-CARe Scheme)
JD (EE)/EXTENSION EDUCATION / KVK				
131.	Development and assessment of educational mobile Apps for improving livestock health and production.	Rupasi Tiwari (PI), Mahesh Chander, Triveni Dutt, Amar Pal, Sanjay Kumar, J.K. Prasad, Bina Mishra, Putan Singh, Mahendran, Bablum Kumar, B.H.M. Patel (IVRI, Bangaluru), Sudeep Marwaha (IASRI) Soumin Pal (IASRI), Mukesh Kumar (IASRI)	Apr 2017–Mar 2019	Institute
132.	Popularization and adaptation of bajra Napier Hybrid (BN Hybrid) for improving green fodder availability at farmers' field : an action research	B.P. Singh(PI), Mahesh Chander, R.S. Suman, D. Bardhan, Rakesh Pandey, Yash Pal Singh	Sep 2017–Aug 2019	Institute
LIVESTOCK ECONOMICS, STATISTICS AND INFORMATION TECHNOLOGY / ARIS CELL				
133.	Economic losses due to classical swine fever (CSF) disease and influencing factors for its prevalence in India	Dinesh Kumar (PI), Sanjay Kumar, M.R. Verma	Sep 2017–Aug 2019	Institute
134.	Assessment of livestock healthcare delivery system and scope for its improvement in Uttar Pradesh	D. Bardhan (PI), Sanjay Kumar	Jul 2014–Jul 2017	UPCAR

135.	Network Project on 'Policy imperatives for promoting value chain of agricultural commodities in India'	D. Bardhan (PI), Sanjay Kumar, Suman Talukdar	Dec 2017–Mar 2020	ICAR
CENTRE FOR WILDLIFE				
136.	Assessing the safety to vultures (*Gyps* sp.) of non-steroidal anti-inflammatory drug in veterinary use in India (MoEF)	A.K. Sharma (PI), A.G. Telang, M. Kesavan, K. Mahendran, M. Karikalan, Chandra Mohan S.	Apr 2016–Apr 2019	MoEF
137.	National Referral Centre on Wildlife Healthcare	A.K. Sharma (PI), M. Karikalan, S. Chandramohan	Aug 2007–Mar 2022	CZA
NATIONAL MUSEUM OF VETERINARY AND ANIMALS SCIENCES (NMVAS)				
138.	Establishment of national educational museum of animal and veterinary sciences	R. Somvanshi (PI)	Nov 2015–Nov 2017	ICAR-Emeritus Scientist Scheme
REGIONAL STATIONS/CAMPUS				
IVRI CAMPUS, MUKTESWAR				
139.	Understanding the molecular basis of *Peste-des-Petits Ruminants* virus (PPRV) mediated host immune modulation for the development of next generation vaccine	S. Chandra Sekar (CCPI), D. Muthuchelvan	Apr 2017–Mar 2020	ICAR-NASF
140.	Serosurveillance, isolation and molecular characterization of bluetongue virus in sheep and goats of Tripura and Assam states	S.K. Biswas (PI), K. Chand, D. Muthuchelvan	Dec 2014–Dec 2017	DBT
141.	Assessment of anti-proliferative effect of selected herbal extracts in animal cancer cell lines and their effect against bovine papilloma-virus induced tumors in experimental model	Chandrakanta Jana (PI), M.A. Ramakrishnan, M. Sanker, A. Gaurav, S. Gautam, P. Kumar	Aug 2017–Jul 2018	Institute
142.	Study of behavioural and production alterations in crossbred cows by floor modification in Tie stall system	Deepak Upadhyay (PI), G. Amol Ramdas, S.S. Dangi	Aug 2017–Jul 2019	Institute
143.	Ethnoveterinary study, phytochemical analysis and evaluation of veterinary medicinal plants commonly used as herbal remedies for cold stress by local tribes of Pithoragarh district of Uttarakhand	Gurav Amol Ramdas (PI), D.B. Mondal, M.A. Ramakrishnan, S.S. Dangi, C. Jana	Aug 2016–Jul 2018	Institute
144.	AICRP on Himalayan Goat	A.K. Sharma (PI) (up to 22.09.2017); C. Jana (w.e.f. 23.09.2017), Chandrakant Jana (up to 22.09.2017), Amol G Ramdas; S.S. Dangi, Deeepak Upadhyay, S. Gautam (w.e.f. 20.6.2017)	Mar 2014–Mar 2020	ICAR
145.	Himalayan agriculture under National Mission for Sustaining the Himalayan Ecosystem (NMSHE)	Chandrakant Jana (PI)	Mar 2015 – Mar 2020	DST
ERS, KOLKATA				
146.	Occurrence of common zoonotic pathogens and heavy metals *vis-a-vis* productivity in fish in integrated pig-cum-fish farming system	S.C Das (PI), Samiran Bandyopadhya, U.K. Bandyopadhya, P.K. Nanda, A.K. Das, S. Naskar	Jul 2015-Jun 2018	Institute

147.	AICRP on Pigs	S. Naskar (PI), Subhashish Bandyopadhyay, T.K. Biswas	Apr 2014–Mar 2020	ICAR
148.	AICRP on Animal Disease Monitoring and Surveillance	B. Mondal (PI), P. Dandapat	Jul 2013–Mar 2020	ICAR
149.	Evaluation of physiogenomic responses to heat stress and development of potential marker(s) for assessment of stress in pigs	B.C. Das (PI), S. Naskar	Mar 2014–Aug 2017	DBT
150.	Expression of truncated penicillin binding protein 2a (PBP2a) of methicillin resistant Staphylococcus aureus (MRSA) and development of a recombinant PBP2a based agglutination test for detection of MRSA in milk and dairy products	Samiran Bandyopadhyay (PI), B. Mondal, P. Dandapat	May 2014–May 2017	DBT
151.	Crohn's disease in India: A multicentric study from a country where intestinal tuberculosis as well as Johne's Disease is Endemic	P. Dandapat (PI)	Mar 2015–Mar 2018	ICMR
IVRI CAMPUS, BENGALURU				
152.	Characterization of fidelity variants of foot and mouth disease virus isolated *in vitro* in the presence of nucleoside analogues	V. Umapathi (PI), A. Sanyal, G.R. Reddy	Aug 2015–Jul 2017	Institute
153.	Evaluation of laboratory mice as alternate animal model for potency testing of FMD vaccine	R.P. Tamil Selvan (PI), V. Bhanuprakash, B.H.M. Patel, P. Krishnamoorthy	Apr 2016–Mar 2018	Institute
154.	Determination of 146S content in FMD oil adjuvanted vaccine by chemical extraction methods and sandwich ELISA	P. Saravanan (PI), V. Umapathi	Jul 2016–Jun 2018	Institute
155.	Comparative analysis of host responses to foot and mouth disease virus infection in indigenous and crossbred cattle	S.H. Basagoudanavar (PI), B.P. Sreenivasa, Aniket Sanyal	Aug 2016–Jul 2018	Institute
156.	Development and evaluation of MAb based ELISA system for detection of antibody/antigen against FMDV	V. Bhanuprakash (PI), R.P. Tamil Selvan, Subodh Kishore	Aug 2016–Jul 2018	Institute
157.	Development and characterisation of thermo-stable foot-and-mouth disease virus like capsid as diagnostic antigen and vaccine candidate	H.J. Dechamma (PI), S.H. Basagoudanavar, P. Saravanan	Aug 2016–Jul 2018	Institute
158.	Evaluation of selected foot-and-mouth disease virus strains for their potential as vaccine-(Inter-institutional project between IVRI, Bengaluru and D-FMD, Mukteswar	B.P. Sreenivasa (PI), J.K. Biswal, Aniket Sanyal, S. Saravanan, Rajeev Ranjan	Aug 2016–Jul 2018	Institute
159.	CRP on Vaccines and Diagnostics	Aniket Sanyal (Coordinator); B.P. Sreenivasa (Sector coordinator), M. Hosamani, Subodh Kishore, B.P. Sreenivasa, D.K. Singh, P. Dandapat, P.	Nov 2014–Mar 2020	ICAR

		Dhar, D. Muthuchelvan, Sanchay K. Biswas, Aniket Sanyal (All PIs); B.P. Sreenivasa, R.P. Tamilselvan, T. Sabarinath, V. Bhanuprakash, K. Ganesh, S.H. Basagoundanavar, Subodh Kishore, R.P. Singh, Bablu Kumar, Vikramaditya Upmanyu, S. Bandyopadhaya, A.K. Tiwari, M. Hosamani, S. Chandrasekar, P. Saravanan, Karam Chand, V. Umapati, H.J. Dechamma (All Co-PIs)		
160.	Attenuation of FMDV serotypes/strains to develop stable and effective live attenuated vaccine	G.R. Reddy (PI), H.J. Dechamma, K. Ganesh	Jan 2014–Jul 2018	DBT-BBSRC
IVRI REGIONAL STATION, PALAMPUR				
161.	Bio-prospecting of native cattle and goats milk for therapeutic potential	Gorakh Mal (PI), R. Bhar, B. Singh, A. Kannan,V.K. Agnihotri, B.G. Mane	Jul 2015–Jun 2018	Institute
162.	*In vitro* evaluation of saponins from North-western Himalayas as adjuvant in veterinary vaccine	Rinku Sharma (PI), Upendra Sharma, M.K. Singh Birbal Singh Devi, Gopinath, R. Bhar	Aug 2017–Jul 2019	Institute
TEC, PUNE				
163.	Field evaluation and validation of user friendly technologies	H.P. Aithal (PI), K.N. Bhilegaonkar, S.K. Das, J.K. Prasad, Ran Vir Singh, Rohit Kumar, Putan Singh, Harish Yadav, Neeraj Srivastava	Aug. 2016–Jul 2018	Institute

SUMMARY OF THE ON-GOING PROJECTS AND THEIR SOURCES OF FUNDING



S.No.	Funding Agency	No. of Projects
1	ICAR	35
2	Department of Biotechnology	23
3	Department of Science and Technology	11
4	UPCAR	5
5	DHR-MHFW	2
6	Central Zoo Authority	1
7	Ministry of Food Processing Industries	1
8	Indian Council of Medical Research	1
9	Central Science and Industrial Research	1
10	Ministry of Environment and Forests	1
11	DBT-BBSRC (International)	3

SERVICE PROJECTS

S.No.	Project Title		Name of PI/Associate (s)
ANIMAL GENETICS			
1.	Production of laboratory animals		Amit Kumar (PI)
2.	Animal and farm waste management through vermibiotechnology		Ran Vir Singh (PI)
ANIMAL NUTRITION			
3.	Assessment of variability in nutrient composition of livestock feed ingredients for quality assurance		A.K. Verma (PI), L.C. Chaudhary, Putan Singh, A.K. Pattanaik, Narayan Dutta, V.B. Chaturvedi, S.K. Saha, Asit Das, S.E. Jadhav, Anju Kala
4.	Development of mechanized device for collection and processing of fallen leaves and mowed grasses		Putan Singh (PI), A.K. Verma, H.C. Yadav, S.S. Tripathi
ANIMAL REPRODUCTION			
5.	Studies on reproductive problems in livestock		Harendra Kumar (PI), S.K. Srivastava, S. Mehmood, S.K. Ghosh, G.K. Das, J.K. Prasad, K. Narayanan, S.K. Singh
6.	Production & supply of quality frozen semen from crossbred and buffalo bulls		S.K. Ghosh (PI); J.K. Prasad
ARIS CELL/COMPUTER CENTRE			
7.	Electronic data processing and networking		Sanjay Kumar (PI) and Yash Pal Singh
BACTERIOLOGY & MYCOLOGY			
8.	Diagnosis of bacterial and mycotic diseases of animals and birds and maintenance of bacterial and mycotic agents		R.K. Agarwal (PI), P. Chaudhuri, R. Rana, K.N. Viswas, Abhishek, T. Sabrinath
BIOLOGICAL PRODUCTS			
9.	Technological improvement/ production and standardization of bacterial vaccines, diagnostic antigens and sera		
	9.1	Production and standardization of purified protein derivatives (PPD) of bovine tuberculin, johnin and mallein	P. Das (PI)
	9.2	Production and standardization of *Brucella* diagnostic antigens, vaccines and sera	Bablu Kumar (PI)
	9.3	Production and standardization of *Salmonella* antigens and sera	V.K. Chaturvedi (PI)
	9.4	Production of H.S. Oil adjuvant and Entertoxaemia vaccines	V.K. Chaturvedi (PI)
BIOLOGICAL STANDARDIZATION			
10.	Standardization and quality control of veterinary biologicals and nodal agency in veterinary type culture		A.K. Tiwari (PI), A.B. Pandey, Mayank Rawat, P. Dhar, Y.P.S. Malik, S. Qureshi, V. Upmanyu
	10.1	Standardization and quality control of veterinary immunodiagnostic antigens and antisera	Mayank Rawat (PI)
	10.2	Standardization and quality control of bacterial vaccines	Mayank Rawat (PI), Salauddin Qureshi
	10.3	Standardization and quality control of PPR and swine fever viral vaccines	P. Dhar (PI), V. Upmanyu
	10.4	Standardization and quality control of rabies and sheeppox vaccines	V. Upmanyu (PI); P. Dhar
	10.5	Standardization and quality control of poultry vaccines	V. Upmanyu (PI)
	10.6	Standardization and quality control of bluetongue vaccines	Y.P.S. Malik (PI)

	10.7	Veterinary type culture for production and testing of veterinary biologicals, research and training	Mayank Rawat (PI), Salauddin Qureshi
CADRAD			
11.	Disease investigation		
	11.1	Investigation and diagnosis of viral diseases of livestock	S. Nandi and Vishal Chander
	11.2	Investigation, identification and characterization of bacterial agents from clinical/morbid materials of animals	R. Rathore and Chandan Prakash
	11.3	Investigation and control of parasitic diseases of livestock	Dinesh Chandra
	11.4	Pathomorphological diagnosis of animal diseases	K.P. Singh
	11.5	Field investigation and diagnosis of toxicosis in animals	A.G. Telang
LIVESTOCK PRODUCTS TECHNOLOGY			
12.	Handling, processing, quality evaluation and disposal of livestock products and by-products		S.K. Mendiratta (PI); Geeta Chauhan, Rajiv Ranjan Kumar, Suman Talukder
LIVESTOCK PRODUCTION MANAGEMENT			
13.	Development of biogas plant for utilization of cattle bio-waste		Mukesh Singh (PI), H.C. Yadav, P.K. Bharti, G.K. Gaur
LIVESTOCK ECONOMICS AND STATISTICS & IT			
14.	To provide methodology in livestock economics & biostatistics and livestock related statistics to post-graduate & divisional research projects of the Institute		M.R. Verma (PI); Dinesh Kumar
MEDICINE			
15.	Clinical diagnosis, treatment and prophylaxis of animal diseases		U. Dimri (PI); S. Dey, Reena Mukherjee, D.B. Mondal, S.K. Dixit, V.K. Gupta, U.K. De, Vinodhkumar O.R., K. Mahendran
PARASITOLOGY			
16.	Diagnosis/Identification of parasitic diseases/parasite specimen		P.S. Banerjee (PI), S. Ghosh, S. Samanta, O.K. Raina, A.K. Tewari, Rajat Garg, B.C. Saravanan, Hira Ram
PATHOLOGY			
17.	Studies on mortality pattern and causes of death among livestock, poultry and wildlife and maintenance of veterinary pathology museum		Rajendra Singh (Coordinator)
	17.1	Buffaloes	Vidya Singh (PI)
	17.2	Cattle, Canine, Equine and Wildlife	A.K. Sharma (PI)
	17.3	Swine	G. Saikumar (PI), Tareni Das
	17.4	Caprine	Monalisa Sahoo (PI)
	17.5	Ovine	Pawan Kumar (PI)
	17.6	Poultry	K. Dhama, M. Palanivelu, M. Asok Kumar
	17.7	Vet Pathology Museum	M. Saminathan
18.	Establishment of National Veterinary Science Museum		M. Saminathan (PI)
19.	Digitalisation of museum specimens for development of e-learning tool in veterinary pathology		M. Saminathan (PI), Rajendra Singh, Pawan Kumar, M. Ashok Kumar, Yash Pal
20.	Revival, bulk production and supply of poultry viral vaccines		Asok Kumar M (PI); Kuldeep Dhama

SURGERY		
21.	Treatment of surgical cases, preparation of animal models, collection of biopsies and radiological diagnosis	Amarpal (PI), A.K. Sharma, M. Hoque, P. Kinjavdekar, Naveen Kumar, A.M. Pawde, S.K. Maiti, Rekha Pathak, Kiranjeet Singh, A.C. Saxena and A. Gopinathan
VETERINARY PUBLIC HEALTH		
22.	Maintenance and supply of stock strains, disease diagnosis and investigation of food and water borne diseases	S.V.S. Malik (PI), D.K. Singh, R.S. Rathore, Deepak B. Rawool, Z.B. Dubal, Himani Dhanze
IVRI CAMPUS, BENGALURU		
23.	Foot and mouth disease vaccine quality control & assurance	V. Bhanuprakash (PI), Subodh Kishore
24.	Fodder production at farm and distribution of fodder root slips to farmers	B.H.M. Patel (PI), Siddaraju M, Aniket Sanyal
IVRI REGIONAL STATION, PALAMPUR		
25.	Investigation on diseases, sero-prevalence and animal husbandry practices in NWHHR	R. Bhar (PI), U.S. Pati, Rinku Sharma, A. Kannan, B. Singh, G. Mal
IVRI- MUKTESWAR CAMPUS, TEMPERATE ANIMAL HUSBANDRY		
26.	Disease diagnosis, treatment and health management of livestock	A.K. Sharma (PI up to 5.8.17), C. Jana (PI wef 6.8.17), M. Sankar, Gurav A. Ramdas, S.S. Dangi
27.	Maintenance and enhancement of productivity of experimental livestock	A.K. Sharma (PI up to 5.8.17), C. Jana (PI wef 6.8.17), M. Sankar, Gurav A. Ramdas, S.S. Dangi
28.	Fodder production and development of fodder bank for fulfilling the fodder requirement of dairy farm of Mukteshwar Campus and improving fodder production in Eastern Himalayan Region	P.K. Mukherjee (PI)
IVRI- MUKTESWAR CAMPUS, VIROLOGY		
29.	Diagnostic services, supply of diagnostics for viral diseases of livestock and maintenance of repository of virus/serum/clones.	M.A. Ramakrishnan (PI), D. Muthuchelvan, S. K. Biswas; V. Gnanavel; S. Chandra Sekar; Karam Chand ; Amit Kumar
TRAINING AND EDUCATION CENTER, PUNE		
30.	Human resource development and livestock technology dissemination	K.N. Bhilegaonkar (PI), H.P. Aithal, Bhaskara Rao

7.0
Education

The mission of ICAR-IVRI Deemed to be University (DU) is to undertake pioneering research in Veterinary and Animal Sciences adopting a holistic approach to promote quality education and training, develop systems and technologies for better animal healthcare and production, and their dissemination to end-users with an ultimate goal of acting as an effective instrument for nutritional security, poverty alleviation and rural reconstruction. This university is offering excellent education in a host of areas of veterinary and animal sciences to undergraduate and postgraduate students.The specific objectives of this DU are:

1. To develop technologies in a proactive manner to solve the immediate problems of the livestock farmers on priority and to enhance the productivity of livestock, reduce the cost of production and to increase production in a sustainable manner.
2. To impart UG and PG education to meritorious candidates in different disciplines of Veterinary and Animal Sciences while making veterinary and animal science education responsive to the growing and changing needs of the society.
3. To train highly skilled and competent manpower to address the issues in the novel and emerging areas of veterinary and animal science.

Enormous infrastructure, adequate modern laboratory facilities, and highly competent trained and experienced manpower in the fields of veterinary and animal sciences are the major strengths of the ICAR-IVRI Deemed to be University. The university has performed exceedingly well with its glorious scientific and academic heritage as a school of higher learning, with a number of awards and excellent placement opportunities for students both within and outside the country. The University offers Master's programme in 19 disciplines and Doctoral programme in 17 disciplines. The University admits students to its PG programmes through rigorous screening under three categories, namely open competition, sponsored candidates and foreign students. Out of the total admitted students, 42% are female students, while 45% of the students belong to rural areas.

New initiatives

During the year under report, several new initiatives have been undertaken in the university to improve the competence and overall personality development of the students. These include:

1. To make the collaboration with State Agricultural & Veterinary Universities more widespread, MOUs were signed with Assam Agricultural University (Jorhat), Kamdhenu University (Gujarat), Chattishgarh Kamdhenu University (Durg), Rajasthan University of Veterinary & Animal Science (Bikaner), Maharashtra Animal& Fishery Science University (Nagpur), and Bihar Agriculture Sciences University (Patna).
2. The Ministry of Human Resource Development (MHRD) has launched NationalAcademic Depository (NAD) to store educational certificates in digital format from 2016-17. The NAD is a unique digital initiative, and has been established to ensure a 24x7 digital and safe electronic store house of all academic awards viz. certificates, diplomas, degrees, and mark-sheets, etc. It allows academic institutions to lodge and upload the academic awards which are authenticated and validated. University Grants Commission has been designated as an authorized body to operationalize NAD. The IVRI has been registered and is now on-board with NAD and has started lodging academic awards digitally; the records from 2017-18 onwards will be deposited in NAD. The DU has signed a MOU with CDSL Ventures Limited (CVL) for the purpose.
3. SWAYAM (Study Webs of Active-Learning for Young Aspiring Minds) is a programme initiated by Government of India and designed to achieve the three cardinal principles of the

education policy viz., access, equity and quality. It will provide any one, anytime and anywhere the required learning.The IVRI DU has taken approval from competent authority for the courses of SWAYAM.

4. The SWAYAM PRABHA is a group of 32 DTH channels devoted to telecasting of high-quality educational programmes on 24x7-basis using the GSAT-15 satellite. The contents are provided by NPTEL, IITs, UGC, CEC, IGNOU, NCERT and NIOS. The INFLIBNET Centre maintains the web portal. The DTH channels are covering curriculum-based course contents at post-graduate and under-graduate level covering diverse disciplines. All courses would be certification-ready in their detailed offering through SWAYAM, the platform being developed for offering MOOCs courses. The IVRI DU is on-board with Swayam Prabha Channels.
5. The MHRD, Government of India, has launched *Unnat Bharat Abhiyan* (UBA), a national program with the vision to involve professional and other higher educational institutions of the country in the development process of Gram Panchayats so as to enable village clusters to achieve sustainable development and better qualityof life.The mission of UBA is to enable higher educational institutions to work with the people of rural India in identifying development challenges and evolving appropriate solutions for accelerating sustainable growth. It also aims to create a virtuous cycle between society and an inclusive academic system by providing knowledge and practices for emerging professions and to upgrade the capabilities of both the public and the private sectors in responding to the development needs of rural India. The IVRI DU has selected five villages under UBA and identified the technological studies to be broadened over there.
6. Centre for Advanced Agricultural Science and Technology (CAAST) is a lead platform of ICAR under the National Agricultural Higher Education Program (NAHEP) funded by the World Bank. The IVRI DU has successfully bagged an Advanced Centre for Livestock Health under the CAAST. The program is initially approved till March 2021 with a total budget outlay of Rs. 1998.5 lakh. The broad objective of the program,for strengthening the agricultural higher education, includes translate of advanced knowledge in the field of livestock health for skill and entrepreneurship development among students and faculty, and empowering other stakeholders,to augment knowledge generation of students and faculty in the advanced areas of vaccinology, (*rDNA, reverse genetics, combined vaccine*), diagnostics (*biosensor*), therapeutics (*herbal, nanoparticles, antimicrobial peptides*), immune nutrition (*prebiotics, probiotics, polyphenols*) and genomics (GWAS) for skill development. Capacity building of students and faculty through sandwich program, national and international training, visiting professorship, lecture series, new courses, e-learning (ICT tools/ simulation modules) and certificate/short term courses along with industry collaboration for enhancing skill, entrepreneurship and employability are the major thrust areas of CAAST to develop globally.

Faculty strength

The faculty strength of the DU is 182 at the Izatnagar campus, 38 in campuses and regional stations of IVRI, and 65 in other 19 ICAR Institutes. The average age of faculty is 48.3 years. The discipline-wise faculty strength is given below:

Discipline wise faculty strength at ICAR-IVRI Deemed to be University

Discipline-wise faculty at a glance					Total
Sl.No.	Discipline	Faculty at IVRI, Izatnagar	Faculty at campuses/ regional stations of IVRI	Faculty at other ICAR Institute	
1	Animal Biochemistry	7	3	2	12
2	Animal Biotechnology	16	3	3	22
3	Veterinary Microbiology	25	16	8	49
4	Veterinary Public Health & Epidemiology	9	2	4	15
5	Veterinary Medicine	9	2	4	15
6	Veterinary Parasitology	9	2	2	13
7	Veterinary Pathology	8	2	5	15
8	Veterinary Pharmacology	4	0	0	4

9	Veterinary Surgery & Radiology	11	1	0	12
10	Animal Genetics & Breeding	12	1	13	26
11	Animal Nutrition	9	1	7	17
12	Livestock Production & Management	6	2	3	11
13	Livestock Products Technology	4	1	5	10
14	Veterinary Physiology	8	1	5	14
15	Veterinary Gynaecology& Obstetrics	11	0	3	14
16	Poultry Science	23	1	2	26
17	Biostatistics	2	0	0	2
18	Livestock Economics	4	0	1	5
19	Veterinary Extension Education	5	0	2	7
Total		**182**	**38**	**69**	**289**

Master's Degree programme

All India written entrance examination was conducted by the ICAR on 11th June 2017 for admission in M.V.Sc. courses and 98 students (58 boys, 40 girls) were admitted after online counseling. The average age of M.V.Sc. students on rolls was 25 years. The outturn of students in M.V.Sc. programme during Academic Year-2017 was 121. The average time taken by students for completion of the M.V.Sc. programme is 2 years and 6 months. Discipline-wise list of students admitted and degrees awarded in the Academic Year-2017 is as follows:

M.V.Sc. Programme				
Sl. No.	Disciplines	Students on roll	Students Admitted	Degree Awarded
1	Animal Biochemistry	8	4	6
2	Animal Biotechnology	5	4	4
3	Veterinary Microbiology	15	15	0
4	Veterinary Public Health & Epidemiology	7	7	0
5	Veterinary Medicine	13	6	5
6	Veterinary Parasitology	13	6	6
7	Veterinary Pathology	19	6	3
8	Veterinary Pharmacology	10	3	6
9	Veterinary Surgery & Radiology	13	6	6
10	Animal Genetics & Breeding	15	6	9
11	Animal Nutrition	16	7	8
12	Livestock Production & Management	11	4	2
13	Livestock Products Technology	8	3	5
14	Veterinary Physiology	12	4	8
15	Veterinary Gynaecology& Obstetrics	13	5	7
16	Poultry Science	17	4	8
17	Biostatistics	2	2	3
18	Livestock Economics	7	3	5
19	Veterinary Extension Education	10	3	4
20	Veterinary Bacteriology	5	0	4
21	Veterinary Virology	8	0	8
22	Veterinary Immunology	6	0	7
23	Epidemiology	2	0	2
24	Veterinary Public Health	8	0	5
Grand Total		**243**	**98**	**121**

Doctoral Degree programme

A written entrance examination for admission to the Ph.D. programme was conducted by the DU on 7th May, 2017, and 83 students (45 boys, 38 girls) were admitted including sponsored students from different States/UTs of India. The average age of Ph.D. students on rolls was 29 Years and 7 months. The outturn of students in Ph.D. courses during academic year was 75, and the average time taken for completion of the Ph.D. programme was 3 years and 5 months for regular students and 5 years and 3 months for students who have taken temporary dropping. Discipline-wise list of students admitted and degrees awarded in the academic year is as follows:

Ph.D. Programme

Sl. No.	Disciplines	Students on roll	Students Admitted	Degree Awarded
1	Animal Biochemistry	27	4	1
2	Animal Biotechnology	24	4	6
3	Veterinary Microbiology	14	14	0
4	Veterinary Public Health & Epidemiology	7	7	0
5	Veterinary Medicine	24	5	4
6	Veterinary Parasitology	21	5	6
7	Veterinary Pathology	33	5	3
8	Veterinary Pharmacology	12	2	3
9	Veterinary Surgery	19	5	4
10	Animal Genetics & Breeding	22	5	4
11	Animal Nutrition	23	6	4
12	Livestock Production & Management	12	4	4
13	Livestock Products Technology	15	3	3
14	Veterinary Physiology	23	4	3
15	Veterinary Gynaecology& Obstetrics	20	4	8
16	Poultry Science	26	3	4
17	Biostatistics	0	-	0
18	Livestock Economics	0	-	0
19	Veterinary Extension Education	19	3	5
20	Veterinary Bacteriology	20	0	2
21	Veterinary Virology	22	0	5
22	Veterinary Immunology	7	0	3
23	Epidemiology	0	0	0
24	Veterinary Public Health	16	0	3
	Grand Total	406	83	75

Under Graduate programme

The undergraduate programme leading to Bachelor of Veterinary Sciences and Animal Husbandry (BVSc & AH) degree was initiated at ICAR-IVRI DU, Izatnagar from the academic session 2015-16. At present two batches (one in second year and another in third year) are pursuing their Bachelor Degree programme. The average age of the students at the time of admission is 21 years and 9 months.

Fellowships/Scholarships to UG and PG students

The students admitted in DU are given financial assistance in the form of different fellowships. A total of Rs. 7,41,20,233 was disbursed to 575 students (227 M.V.Sc. and 326 Ph.D.) and 22 undergraduate students (BVSc & AH) during 2017-2018 as fellowship/scholarship and contingency grant. Out of the total number of 575 students, 298 (51.8%) received Institute scholarship, 135 (23.4%) received ICAR fellowship, and remaining 142 (24.6%) received fellowships from other agencies, viz. CSIR, ICMR, DST, UGC, Indo-Africa and Indo-Afghan Fellowships. Categorization of sources or agencies providing the scholarship/fellowship showed that 46.8% of the total was the Institute fellowship, while ICAR fellowship accounted for 29.3% and fellowship from other agencies was 23.9%.

Institute scholarship was given to 208 Ph.D. students amounting to Rs. 2,59,45,827 along with

contingency. The remaining students availed ICAR-SRF (8 students, Rs. 15,99,342). Fellowship from external agencies was given to 110 students amounting Rs. 1,74,13,288 along with contingency. The CSIR-JRF/SRF was given to 5 students amounting to Rs.3,00,000 along with contingency. The ICMR-JRF/SRF was given to 36 Ph.D. students amounting to Rs.69,38,763 along with contingency. The DST-INSPIRE Fellowship was given to 13 Ph.D. students amounting to Rs. 10,24,288 along with contingency. The DBT-JRF/SRF was given to 7 Ph.D. students amounting to Rs.9,02,961 along with contingency. The UGC-JRF/SRF was given to 45 Ph.D. students amounting to Rs. 76,98,943 along with contingency. The UGC-RGNF JRF/SRF was given to 28 Ph.D. students amounting to Rs. 78,91,588 along with contingency and Indo-Africa Fellowship was given to one student amounting to Rs. 1,32,000.

A total of Rs. 2,85,18,190 was given to 225 M.V.Sc. students as Fellowship/Scholarship along with contingency. During this period, ICAR-JRF was given to 127 students amounting to Rs. 1,95,16,170 along with contingency. Institute scholarship was given to 98 M.V.Sc. students amounting to Rs. 87,38,685 along with contingency. Indo-Afghanistan and Indo-Africa fellowship was given to 2 students amounting to Rs. 2,63,335.
The National Talent Scholarship (NTS) and Merit Scholarship was given to 22 UG students amounting to Rs. 6,43,586.

Statement of various Fellowships/Scholarships to UG & PG Students (2017-18)

S. No.	Fellowship/Scholarship	No. of Students	Expenditure		
			Fellowship/ Scholarship	Contingency	Total
M.V.Sc.					
1.	ICAR-JRF	127	18649462	866708	19516170
2.	Institute Scholarship	98	8270677	468008	8738685
3.	Indo-Afghanistan Fellowship	1	120000	11335	
4.	Indo-African Fellowship	1	132000		
	Total (M.V.Sc. Fellowship)	227	27172139	1346051	28518190
Ph.D.					
1.	ICAR-SRF	8	1494481	104861	1599342
2.	Institute Scholarship	208	25204274	741553	25945827
3.	CSIR-JRF/SRF	5	300000		17413288
4.	ICMR-JRF/SRF	36	6899992	38771	
	ICMR-JRF/SRF (Temporary Dropping)	4	548333		
5.	DST-INSPIRE Fellowship	13	1006947	17341	
6.	DBT-JRF/SRF	7	773841	129120	
7.	UGC-JRF/SRF	42	7200003	32273	
	UGC-JRF/SRF (Temporary Dropping)	3	466667		
	Total	110	17195783	217505	
	Total (Ph.D. Fellowship)	326	43894538	1063919	44958457
BVSc & AH					
1.	National Talent Scholarship (UG)	16	352000		643586
2.	Merit Scholarship	6	291586		
	Total Students	22	643586		
	Total Fellowships/Scholarships	**575**	**71710263**	**2409970**	**74120233**

Strengthening and Development of AU's (Development Grant)

Funds utilized for the infrastructural support in the DU under the plan scheme "Strengthening and Development of Higher Agricultural Education in India" of Agriculture Education Division of ICAR during the year 2017-18 was as follows:

Components	Funds Received	Expenditure
CAPITAL		
Minor Works : Repair/ Refurbishing/ Renovation and Modernization of Educational Structure; viz. Hostels/ Laboratories/ Libraries/ Class Rooms	37421000	36933490
Total A (Capital)	37421000	36933490
REVENUE		
Research and Operational Expenses		
Curriculum Development and Delivery: Contingency grants for UG/PG practical and preparation of quality instructional/ practical manuals.	5000000	3120482
Strengthening of UG/PG Teaching: Participation of faculty / Ph.D. students in seminars /conferences /trainings including/ educational tour within the country.	5900000	176195
Student and faculty amenities: Tutorials for SC/ST students; students counselling and placement cell; health facilities; personality development; recreation facilities	6500000	984768
Best Teacher Award; Guest and adjunct faculty	703000	0
Support to Nodal Cell: Facilitating and coordinating activities of agricultural education division at University Level	515000	102342
Support to DEAN: Development and strengthening of facilities required for improving higher agricultural education;	6900000	4577342
Support for examination cell	6400000	793561
Total B (Revenue)	31918000	9754690
Total A+ B (Capital + Revenue)	69339000	46688180

Library

The National Library of Veterinary Sciences (NLVS) plays a pivotal role in providing scientific and technical information to the students, faculty and staff. The support under library strengthening from Agricultural Education Division of ICAR enriched the library by procuring computers worth Rs. 9,60,000. The NLVS has also created its own database of theses. The online access to the literature under CeRA also ensures equity and availability of learning resources in the main campus as well as other campuses and regional stations. The library also conducts Library and Information Services Audit course (LIS-401) for M.V.Sc. and Ph.D. students of DU. During the year 2017-18, 93 titles of printed books comprising of 782 copies amounting to Rs.21,26,823 were purchased. A total of 1961 M.V.Sc. theses were digitized and an amount of Rs.1,31,897 was utilized.

Extracurricular activities

In accordance to the extracurricular activities calendar framed for the year 2017-18, several sports, cultural and literary activities were organized by the office of the Students Welfare.

- Thirty students from the DU participated in the All India Inter Agricultural Universities Sports and Games Meet 2017-2018 organized by Gandhi Krishi Vigyan Kendra, Bengaluru from Jan 30 to Feb 3, 2018.
- Our students got runners-up award in English language and Best Rebuttal award in Hindi language in the Inter-University National Debate held at G.B. Pant University of Agriculture and Technology, Pantnagar during Jan 14-15, 2018.
- Extempore competition related to mother language was organized on the occasion of *Matrubhasha Diwas* (International Mother Language Day) celebrated in the institute on Feb 21, 2018.
- Eight students from IVRI participated in the All-India Veterinary University Badminton and Table Tennis Championship, organized at Pantnagar from Mar 15 to 17, 2018.
- International Yoga Day was also celebrated on Jun 21, 2017 in the institute in which students and staff members participated and learnt different yoga exercises.
- Dr. Rajendra Prasad, National Agricultural Education Day was celebrated on Dec 3, 2017 to commemorate the birth anniversary of the first President of India, in which awareness programme for school students and poster competition for IVRI students were held.
- Sardar VallabBhai Patel National Unity Day (*Rashtriya Ekta Diwas*) was celebrated on Oct

31, 2017 at the institute by organizing different types of extempore and quiz competitions for the students.

- On the occasion of the 128th Foundation Day of IVRI, various games and sports activities were organized during Dec 7-9, 2018 for the students along with many cultural activites, and a *Kavi Sammelan*.
- Many students of the DU won awards in the events of one-act play, skit, literary activities, fine arts and cultural performances in the REVERIE-2018, a three-day event organized by NDRI, Karnal during Mar 23 to 25, 2018.
- Organized a live web telecast of the address of the Hon'ble Prime Minister on the occasion of inaugurating the Krishi Unnati Mela on Mar 17, 2018.
- The students also participated in the World Veterinary Day celebrations wherein lectures on animal health and vaccination and antimicrobial resistance were organized in addition to a clinical case competition.

National Diploma Course

Besides teaching programmes for PG students, the DU is also imparting National Diploma courses of 10-months duration in 10 disciplines viz., Preventive Veterinary Medicine, Animal Husbandry, Veterinary Biological Products, Animal Reproduction, Poultry Husbandry, Equine Husbandry, Medicine and Surgery, Zoo and Wild Animal Health Care and Management, Meat and Meat Products Technology, Fodder and Feed Technology and Animal Welfare. The National Diploma in Equine Husbandry, Medicine and Surgery is mainly offered to army officers to appraise the latest advances in health, breeding and management of equines to the armed forces. Following National Diploma Course was conducted by the University during this period.

Course Name	Admitted (No.)	Awarded (No.)
National Diploma in Equine Husbandry, Medicine and Surgery (NDEHMS)	04	04
Total	04	04

Short-term training courses

Highly specialized short-term training courses are also conducted in different disciplines to provide the recent advances and hands-on training to the students and in-service candidates. The following short term training courses were held during this period.

Sl. No	Name of course	Division	Period	Sponsoring authority	Candidates
1.	Diagnosis and control of important parasitic disease	Parasitology	21.8.17 to 26.8.17	Dept.of AHLF&VS, Govt. of Sikkim	07
2.	Practical approaches in livestock diseases diagnosis by using clinical pathological & molecular techniques	Pathology	21.8.17 to 30.8.17	IVRI, Izatnagar, Directorate of AH, Port Blair, Dept. of AH,Vijaywada	24
3.	Diagnosis & Control of Emerging and Important Zoonotic Diseases	Veterinary Public Health	4.12.17 to 18.12.17	Bhutan Embassy	01
4.	Basic Epidemiology for Veterinarians	Epidemiology	11.9.17 to 14.9.17	Director A.H, Mizoram	01
5.	Hands on Training on Production and Standardization of Bacterial Vaccine and Diagnostics	Biological Products	3.11.17 to 30.11.17	Director AH. Guwahati	02
6.	Standardization and Quality Control of Vety. Biologicals	Standardization	15.11.17 to 12.12.17	CARI, B.P, Medicine, CADRAD, Biotechnology, B&M Divisions	07

During the period, following Meetings of Board of Management, Academic Council, Standing Committees on Course Curricula and Academic Affairs were held for running the University Programmes smoothly and important agendas regarding Institute's upliftment may be taken with the guidance of senior outside professors.

Sl. No.	Name of Meeting	Date
1.	52nd meeting of Board of Management	01.07.2017
2.	60thmeeting of Academic Council	05.05.2017
3.	Meeting of Standing Committee on Course Curricula & Academic Affairs, Equivalence of Degree/ Courses	01.05.2017

Placement of Students

A total of 201 students got placement in various Government and private agencies. Twenty of the IVRI students were selected in ARS in Animal / Veterinary Science during 2017-18. Out of 81 Ph.D. students who have completed their degree, 72 (89%) students were placed in 2017-18. In addition, out of 127 M.V.Sc. students who have completed their degree, 109 (87%) students got placement in different organizations.

8.0
Training and Capacity Building

Training/workshop/short course organized

For Scientists

1. ICAR sponsored summer school on Livestock welfare under changing climate scenario for improved productivity, 07-27 Jun., 2017, Division of Livestock Products Technology.
2. CAFT short course on "Upstream reproductive technologies for augmentation of livestock production", 1-21 Sep., 2017, Division of Physiology and Climatology.
3. Advances in Animal Nutrition for Improving Livestock Productivity, 6-26 Sep., 2017, Division of Animal Nutrition.
4. Basic Epidemiology for Veterinarians, 11-14 Sep., 2017, Epidemiology Division.
5. Short course on Laboratory Diagnosis on Animal Diseases and Zoonoses, 13-20 Sep., 2017, ERS Kolkata.
6. Working with MS Excel, 26-28 Oct., 2017, ARIS Cell.
7. Hands on training on Production and standardization of bacterial vaccines and diagnostics, 3-30 Nov., 2017, Division of Biological Standardization.
8. Short term training course on 'Diagnosis and Control of Emerging and important Zoonotic Diseases', 4-18 Dec., 2017, Division of Veterinary Public Health.
9. Professional Attachment Training for ARS Scientist, 13th Nov. 2017 to 12th Feb., 2018, LPT division.
10. Basic Epidemiology for Researchers, 24-25 Nov., 2017, Division of Epidemiology.
11. Basic Statistical Computing Procedures for Analysis of Experimental Data, 27-30 Jan., 2018, Division of LES & IT.
12. Training on Real Time PCR data analysis, 7-9 Mar., 2018, Division of Biotechnology.
13. Working with MS Excel, 7-9 Mar., ARIS Cell.
14. Training on Handling of microbial culture and biosafety aspect, 16-17 Mar., 2018, ICAR-IVRI, Izatnagar.
15. Basic Epidemiology for Researchers, 22-24 Mar., 2018, Epidemiology Division, IVRI Izatnagar.
16. Basic Statistical Computing Procedures for Analysis of Experimental Data, 22-24 Mar., 2018, Division of LES & IT.

For Technical staff

1. Working with MS Excel, 21-23 Dec., 2017, ARIS Cell.
2. Holistic Approaches to Laboratory Animals Handling, Care and Ethics, 7-9 Feb., 2018, Division of Veterinary Medicine and LAR section, Animal Genetics Division.
3. Working with MS Excel, 7-9 Mar., 2018, ARIS Cell.

For Administrative staff

1. Working with MS Excel, 21-23 Dec., 2017, ARIS Cell.
2. Working with MS Excel, 7-9 Mar., 2018, ARIS Cell.

For skilled supporting staff

1. Handling of Laboratory Animal: An Overview - for Skilled Support Staff, 10-11 Oct 2017, Division of Vet Medicine, LAR section and Animal Genetics Division.

For field veterinarians, farmers and others

1. Promotion of Entrepreneurship Development in Livestock Sector, 23-26 May 2017, TEC, Pune.
2. Training on Basic Cell Culture - for Scientists/Officials of the Institute of Veterinary Biological Products (IVBP), 02-03 Jun., 2017, TEC, Pune.
3. Basics of Cell Culture 29th May to 3rd Jun., 2017, IVBP, TEC, Pune.
4. Advances in the management of infertility in cattle and buffalo, 24-31 July 2017, Division of Animal Reproduction.
5. Hands on training on quality testing of FMD vaccine to the officers of CCSNIAH, Baghpat, 16-30 Aug., 2017.
6. Short Term Training Course on Practical Approach in Livestock Diseases Diagnosis by using Clinical, Pathological and Molecular Techniques, 21-30 Aug., 2017.
7. Short Term Training Programme on Diagnosis and Control of Important Parasitic Diseases for the Veterinary Officers of Sikkim and Himachal Pradesh, 21-26 Aug., 2017.
8. Recent Advances in Animal Disease Diagnosis and Treatment, 03-10 Oct., 2017, CADRAD.
9. Diagnosis of toxicities/ poisoning in animals, 9-14 Oct., 2017, CADRAD.
10. Diagnosis of viral diseases, 9-14 Oct., 2017, CADRAD

11. *Dudharu Pashu Prabandhan,* 10-14, Oct., 2017.
12. Goat farming for livelihood improvement 9th Nov., 2017, TEC, Pune.
13. Recent Advances in Animal Disease Diagnosis and Treatment, 1-8 Nov., 2017 CADRAD.
14. Hands on Training on "*In vitro* fertilization", 13th Nov. - 3rd Dec., 2017, Division of Physiology & Climatology.
15. Management of Livestock under changing climatic scenario in hilly area Sunkhiya village, Nainital DST-NMSHE, 14-17 Nov., 2017.
16. Short Course on Advances in Livestock Production Management Technologies, 23-30 Nov., 2017, ERS Kolkata.
17. Hands on Training on "*In vitro* fertilization", 18th Dec., 2017 - 7th Jan., 2018, Division of Physiology & Climatology.
18. *Vaigyanic Pashudhan Prabandhan,* 3-5 Jan., 2018.
19. CAFT short course on "Recent Advances in Stress genomics for Livestock Production", 9 - 29 January 2018, Division of Physiology & Climatology.
20. Capsule Course on Fracture Management in Animals AINP-DIMSCA, 15-20., 2018, Division of Surgery.
21. Advanced nutritional technologies and interventions for dairy animals on 17th Jan., 2018, TEC Pune.
22. Techniques of Fracture Fixation in Animals, 22-25 Jan., 2018 TEC, Pune.
23. *Vaigyanic PashupalanTakniki*, 29 Jan.,-2 Feb., 2018, Division of Extension Education.
24. Capsule Course on Radiology and Ultrasonography in Animals AINP-DIMSCA, 29 Jan to 3 Feb 2018, Division of Surgery.
25. Recent Advances in Animal Disease Diagnosis and Treatment, 30 Jan-16 Feb., 2018, CADRAD.
26. Nutrition for Health: Advances in the Science of Animal Nutrition, 07-27 Feb., 2018.
27. Hands on Training on "*In vitro* fertilization", 9th Mar - 8th Apr., 2018, Division of Physiology & Climatology.
28. Hygienic Meat Production, 26th Mar., 2018, LPT Division.
29. One day training programme for wildlife veterinarians and field staffs for biological samples: Collection, processing and shipment, 26th Mar., 2018, Wildlife Section.

Training at the Bioinformatics Centre

DADF Sponsored Training on *in Vitro* Fertilization Techniques

Training Skilled Supporting Staff of the institute on Lab Animal Handling

Training on MS-Excell to Adminstrative Staff of the Institute

9.0
Participation in Conferences and Symposia

Sl. No.	Name of Symposium/ Seminar/ Workshop/ Meet	No. of Scientist attended
International		
1.	International workshop (ASM CME) on "Antibiotic Resistance: Renewed Fears 2017" organized by the American Society for Microbiology, 16th April, 2017, New Delhi.	1
2.	Peste des petits ruminants Global Eradication Programme (PPR GEP) Advisory Committee Launch meeting, 29th June, 2017, OIE HQ Paris, France	1
3.	International Conference on "Virus Diseases: One Health - One World", Kuching, Sarawak, Malaysia from 25-27 July 2017	1
4.	FAO-APHCA / OIE Regional Technical Workshop on the Prevention and Control of Animal Brucellosis and Tuberculosis in Asia, 11-13 September, 2017, held in Bangkok (Thailand)	1
5.	ICMSF workshop on "The Role of Food Safety and Stability in Assuring Global Food Security" and Annual Meeting of International Commission on Microbiological Specifications for the Foods (ICMSF), 2-12 October, 2017, Vlaardingen, . Netherlands.	1
6.	Workshop on One-Health approach for Brucellosis control in India, 26th October, 2017, Sponsored by ILRI, South Asia Regional Office, New Delhi.	1
7.	International workshop on "Genomic Selection for Genetic Improvement in Indian Dairy Animals", 28-29 November, 2017, BAIF Development Research Foundation and Department of Animal Husbandry, Dairying & Fisheries, BAIF Pune	1
8.	Workshop on Thermo-tolerant PPR Vaccine, 11-12 Dec., 2017, FAO HQ, Rome, Italy.	1
9.	International Workshop on "Accelerating Scientific Outputs" organized by International Livestock Research Institute, 22-25 Feb, 2018, Guwahati.	1
National		
10.	17th Indian Veterinary Congress & XXIV Annual Conference of Indian Association for the Advancement of Veterinary Research (IAAVR) & National Symposium; on 8-9 April, 2017;. Indian Veterinary Research Institute, Izatnagar, Bareilly (UP).	16
11.	II National Conference of SVAHE: Technological Interventions for Sustainable Livestock Productionat,10-12 April, 2017, SKUAST, Jammu	3
12.	Workshop on *Badalte Parivesh Mein Hindi ki Mahtta*, 11th April 2017, Rajbhasha Anubhag, IVRI, Izatnagar.	1
13.	XXIII Annual Convention of ISVIB and National conference on "Challenges in livestock and poultry production-Solutions with Biotechnology"; 17-19 April, 2017. KNPCVS, Shirwal, Maharashtra.	1
14.	Interactive meeting with Subject Matter Divisions / Institutes of Indian Council of Agricultural Research (Animal Science) on terms of reference including scientific and social impacts, resources and reforms, 24th April, 2017, New Delhi.	1
15.	Meet on Genomic Selection in Cattle and Buffaloes, 27 April 2017, ICAR, New Delhi	1
16.	Workshop on IRRI-ICAR Collaborative Research on Extension and Delivery Systems for Impact Acceleration, , 4-5th May, 2017, NASC , New Delhi	1
17.	National seminar on Livestock Resource Management under changing Climate Scenario, 17-19th May 2017, Srinagar.	1
18.	State level national livestock mission meet, 18.05.2017, Secretariat Dehradun.	1
19.	II Annual convention of Society of Veterinary Biochemists and Biotechnologists of India , 2-3rd June , 2017, Veterinary College, Hebbal, Bengaluru.	5
20.	Modern Pig production, India - Canada Seminar, 3rd June, 2017, NRC on PIG, Guwahati.	1
21.	Workshop on Toxicological data requirement and its scrutiny process and background of registration of pesticides, 8th June, 2017, CIB&RC, Faridabad.	1
22.	Brainstorming meeting on antibiotic use in animals/livestock, 22nd June, 2017, New Delhi.	1
23.	Expert meet on research priorities on AMR in animal health, 5-6th July, 2017, NIVEDI Bengaluru	1
24.	Expert in FAO - ICAR meeting to finalize operational mechanism of INFAAR, at CIFE - Mumbai during 13 -15th July, 2017	1
25.	Workshop on "Development of Surveillance Framework for Antimicrobial Resistance in Food Animals and Environment", 3rd - 4th August, 2017, CSE, New Delhi	1

26.	Brainstorming workshop on "*New India Manthan - Sankalp se Siddhi*", 24th August, 2017, ERS, ICAR-NDRI, Kalyani	3
27.	Brain storming meeting on "Bovine Tuberculosis and Paratuberculosis", 18-19th September, 2017, DBT. New Delhi	1
28.	Entrepreneurship Development Workshop and Institute-Industry Interface, 26th September, 2017, IVRI, Izatnagar.	1
29.	XV annual conference of IAVPHS & National Symposium on Intersectoral approaches to combat zoonoses: strategies and challenges, 11-13th October 2017, College of Veterinary Science, Tirupati.	4
30.	Industry-Academia Interaction Meet in the "India International Science Festival-2017", 13-16th October, 2017, IIT Madras, Chennai from	1
31.	International Conference and Expo on Biotechnology and Healthcare", 26-27th October, 2017, Telangana State Agricultural University, Hyderabad, India	1
32.	National Seminar on "Food Adequacy and Climate Change: Strategies for Sustainable Food Production" and 3rd Convention of Association of Meat Scientists & Technologists. 3-4th November, 2017, Thrissur, Kerala	1
33.	XVI Convocation cum Scientific Convention of NAVS(I) on Advancement in Veterinary Sciences: Impact on Enhancing Farmers Income, 4-5th November, 2017, Sri Venkateswara Veterinary University Tirupati, A.P.	1
34.	XXV Annual Conference of Agricultural Economics Research Association (India), 7-9th November 2017, NAARM, Hyderabad.	1
35.	Organic Animal Husbandry Conference as Pre-Conference on Animal Husbandry at the 19th Organic World Congress, 7-8th November, 2017, New Delhi	3
36.	Pre-Conference on Role of Livestock in Sustainable Agriculture, 19th Organic World Congress India, 07-08th November 2017, National Centre of Organic Farming, Ghaziabad, U.P.	1
37.	National Seminar on Small Ruminants: National scope on up-scaling production to products value addition and their safety, 9-10th November, 2017, ICAR-CIRG, Makhdhoom.	4
38.	National Seminar conducted by the Association of Meat Scientists & Technologists (AMST) on 3-4th November, 2017, Thrissur, Kerala.	1
39.	XXXIV annual conference of Indian association of veterinary pathologists and international seminar on "Emerging horizons in diagnosis of animal and poultry diseases: towards sustainable production in Asian countries, 9-11th November, 2017; Hebbal, Bengaluru.	13
40.	Workshop on Impact assessment of ICAR technologies, 13th November, 2017, National Institute of Agricultural Economics and Policy Research, New Delhi.	1
41.	XVI Convocation cum Scientific Convention of NAVS (I) on "Advancement in veterinary sciences: Impact on enhancing farmers income", 14-15th November 2017, SVU, Tirupati.	1
42.	Workshop on Integrated One Health approach for Cysticercosis control in India and Nepal organized by Global Alliance for Livestock Veterinary Medicines (GALVmed) on 16th -17th November 2017 at The Surya, New Friends Colony, New Delhi.	1
43.	58th Annual Conference of AMI and & International Symposium on "Microbes for Sustainable Development: Scope & Applications (MSDSA-2017)", 16-19th November, 2017, Babasaheb Bhimrao Ambedkar University, Raebareli Road, Lucknow (UP).	1
44.	Indian Poultry Science Association Conference, 28-30th Nov. 2017, ICAR-NIANP, Bengaluru	2
45.	XV Biennial Conference and National Symposium of Indian Association of Women Veterinarians (IAWV-2017) "Role of Women Veterinarians in Enhancement of Livestock Productivity, Health and Welfare ", 21-22nd November 2017, College of Veterinary Science, Rajendranagar, P.V.Narsimha Rao Telangana Veterinary University, Hyderabad.	2
46.	71th Annual National Conference of Indian Society of Agricultural Statistics, 25-27th Nov. 2017, Directorate of Rapeseed-Mustard Research, Sewar, Bharatpur, Rajasthan.	1
47.	41st Annual Congress of ISVS and National Symposium, December 2017, COVSc, SVVU, Tirupati (AP)	4
48.	XXIV Annual Convention and National Symposium of ISVIB on "Recent Trends in Veterinary Immunology and Biotechnology for Doubling Farmers income through Livestock Health and Production", 5-7th December 2017, College of Veterinary Sciences, MAFSU, Parbhani, Maharashtra.	2
49.	26th Annual Conference of Indian Virological Society-VIROCON, 7-9th Dec. 2017, Mangaluru, Karnataka.	2
50.	Workshop on Laboratory Biosafety and Biosecurity, 12-13 th December 2017, ICAR-National Institute of High Security animal Diseases, Bhopal.	2
51.	Workshop on Hindi, 15th December 2017, Rajbhasha Anubhag, IVRI, Izatnagar.	1
52.	Workshop on Standardization of Veterinary Hospitals, 15th December 2017, RAJUVAS, Bikaner.	2
53.	II National Modernized Agriculture and Animal Husbandry Seminar, 15th Dec., 2017, FPO M/s Invictus Farmers Producers Co. Ltd., Gaziabad (UP).	2
54.	XVII Annual Conference of Indian Society of Veterinary Pharmacology and Toxicology and National Symposium on "Combating antimicrobial resistance", 20-22nd December, 2017, Department of Veterinary Pharmacology and Toxicology, CVSc, LUVAS, Hisar.	1

55.	XXVI Annual Conference of Society of Physiologists of India and National Symposium on "Physiological innovations to forecast the impact of climate change and to evolve strategies for sustainable livestock production, 21-22nd December 2017, Veterinary College, Bidar, Karnataka.	5
56.	National Meet on Formulation of Livestock Breeding Policy for Uttar Pradesh, 5th January 2018, UPLDB, Lucknow.	1
57.	Workshop on Collaboration of ICAR and TCS for Digital Agricultural Extension Services, 7th Jan, 2018, NASC , New Delhi,	1
58.	Workshop on Principles of Computed Tomography and its Applications in Veterinary Diagnostic Imaging under AINP-DIMSCA project, 12-13 th January 2018, COVS, RAJUVAS, Bikaner (Rajasthan).	2
59.	Workshop on Technologies in Animal Nutrition and Organic Animal Husbandry, 16th January, 2018, Phaltan, Satara, Maharashtra.	2
60.	Workshop on Advanced Nutritional Technologies and Interventions for Dairy Animal, 17th January 2018, Head quarters of Animal Husbandry Commissioner, Pune, Maharashtra.	2
61.	XXXI Annual convention of Indian Association of Veterinary Microbiologists, Immunologists and Specialists in Infectious Diseases and National Symposium on "Innovations in animal health - current challenges and future prospective, 29-31st January, 2018. Tirupati.	3
62.	NCDC/IVRI joint orientation workshop on "Zoonotic diseases of public health importance for medical and veterinary professionals" organized on 28-30th Jan. 2018 at National Centre for Disease Control (NCDC), New Delhi.	1
63.	36th annual convention of ISVM and national symposium on animal health service delivery- the priorities of the professionals for enhancing farmer's income, 1-3rd Feb, 2018, College of Veterinary Science & AH, OUAT, Bhubaneswar.	2
64.	International Conference on Advances in Biosciences and Biotechnology, 1-3rd February 2018.	1
65.	XVII Biennial Conference on Nutritional Challenges for Raising Animal Productivity to Improve Farm Economy, 1-3rd February, 2018, College of Veterinary Science and Animal Husbandry, Junagadh Agricultural University, Junagadh, Gujarat	7
66.	36th Annual Convention of ISVM & National Symposium, on "Animal Health Service Delivery - The Priorities of the Professionals for Enhancing Farmers' Income, 1-3rd February, 2018, College of Veterinary Science and Animal Husbandry, Orissa University of Agriculture and Technology, Bhubaneswar.	6
67.	National awareness cum workshop on National Academic Depository (NAD), 5th Feb. 2018 , conducted by UGC at AICTE, New Delhi.	1
68.	Workshop on Big Data Analytics in Agriculture, 8-9th February 2018, NAARM, Hyderabad.	1
69.	National Symposium on Sustainable Management of Livestock and Poultry Diversity for enhancing the Farmers' Income & XV Annual Convention of Society for conservation of Domestic Animal Biodiversity (SOCDAB), 8-10th Feb. 2018, RAJUVAS.	2
70.	XXXIII National symposium & Annual Convention of Indian Society for the Study of Animal Reproduction, 9-11th Feb. 2018, Kolkata (W.B).	5
71.	IAAVP-2018 National congress and Symposium" 12-14th February, 2018, College of Veterinary and Animal Sciences, Navaina, Vallabnagar, Udaipur.	1
72.	27th National Congress of Veterinary Parasitology, 12-14th Feb. 2018, Udaipur (Rajasthan).	2
73.	Farmers Conclave, organized by ICAR Institutes, 16-17th Feb. 2018, ICAR-NIANP, Bengaluru	6
74.	18th Indian Veterinary Congress and XXV Annual Conference of Indian Association for Advancement of Veterinary Research (IAAVR), 23-24th February 2018 College of Veterinary Science, Sri Venkateshwara Veterinary University, Tirupati, Andhra Pradesh India.	2
75.	World conference on reproductive health with emphasis on family planning and assisted reproductive technology & 28th annual meeting of ISSRF, 23-25th Feb. 2018, MHRT, Hyderabad.	2
76.	Biosangam-2018: An international conference on Innovation and Translational Dimensions: Food Health & Environmental Biotechnology, 9-11th March, 2018, MNNIT, Allahabad.	
77.	Fiduciary and Orientation Workshop of NAHEP, 14th March 2018, NASC Complex, New Delhi	1
78.	Workshop on Festival of innovation and entrepreneurship, 22nd March 2018, organized at Rashratapati Bhawan, New Delhi.	4
79.	36th Convention of Indian Society of Veterinary Medicine and National Symposium on 'Animal Health Service Delivery - The priorities of professionals for enhancing farmers' income', 1-3rd February 2018, College of Veterinary Science and Animal Husbandry, Odisha University of Agriculture and Technology, Bhubaneswar.	1

10.0
Awards and Recognitions

National/International Awards

1. Dr Rupasi Tiwari (ICAR-Bahrat Ratna Dr C. Subramaniam Award).
2. Dr Ashok K. Tiwari and team (Hari Om Ashram Trust Award).
3. Dr D.B. Rawool [ICMR-International Fellowship-2017-18 (Young Biomedical Scientists category)].
4. Dr Mukesh Kumar (Netaji Subhash-ICAR International Fellowship 2017-18).
5. Dr N.R. Sahoo [SREB, DST Travel Grant (2017)].

Dr Rupasi Tiwari receiving the award from President, ICAR

Fellow Admittance/Membership

1. Dr G. Taru Sharma (Fellow, NAAS).
2. Dr Putan Singh (Fellow, NAAS, UPAAS).
3. Dr Ashok K. Tiwari (Fellow, NAVS, IAAVR).
4. Dr Umesh Dimri (Fellow, ISVM).
5. Dr S. K. Maiti (Fellow, ISACP).
6. Dr S. Ghosh (National Fellow, IAAVP).
7. Dr Rupasi Tiwari (Fellow, ISEE).
8. Dr Med Ram Verma (Fellow, Academy for Environment and Life Sciences).
9. Dr K. Dhama (Associateship, NAAS).
10. Dr Gnanavel Venkatesan (Associateship, NAAS).
11. Dr Amit Kumar (Associateship, NAAS).
12. Dr B.H.M. Patel (Fellow, Indian Society of Animal Production Management).
13. Dr S.K. Mendiratta (Fellow, NAVS).
14. Dr Y.P.S. Malik (Fellow, ISVIB, NABS).

Editor/Associate Editor of Research Journals

1. Dr Y.P.S. Malik (Editor-in-Chief: J. Immunol. Immunopathol.; Editor: Frontiers in Veterinary Sciences, Adv. Anim. Vet. Sci., Virus Research News; Regional Editor: Asian J. Anim. Vet. Adv., Res. J. Vet. Sci, Int. J. Virol. and Pakistan J. Biol. Sci.; Technical Editor: J. Exp. Biol. Agric. Sci.; Member, Editorial Board: World J. Vet. Sci.).
2. Dr Amarpal (Chief Editor: Indian J. Vet. Surgery; Chief Editor Research: Opinions Anim. Vet. Sci.; Associate Editor: Indian J. Canine Practice; Guest Editor: J. Experiment. Biol. Agri. Sci.).
3. Dr K.N. Bhilegaonkar (Editor: J. Vet. Public Health).
4. Dr H.P. Aithal (Editor: Indian Journal of Veterinary Surgery).
5. Dr S. Dey (Editor: Indian J. Vet. Med.).
6. Dr D.B. Mondal (Associate Editor: Indian J. Vet. Med.).
7. Dr K.P. Singh (Managing Editor: IJVP).
8. Dr Z.B. Dubal (Assoc. Editor: J. Vet. Publ. Health).
9. Dr Vinodh Kumar, O.R. (Member Editorial Board: Int. J. Res. Vet. Pract., J. Anim. Health Prod., Research Journal for Veterinary Practitioners, SciFed Journal of Applied Microbiology).
10. Dr Sumit Mahajan (Assist. Editor: Indian J. Vet. Med.).
11. Dr T.U. Singh (Associate Editor: Journal of Veterinary Pharmacology and Toxicology; Member, Editorial Board: HSOA Journal of Toxicology: Current Research).
12. Dr Reena Mukherjee (Member, Editorial Board: Indian J. Field Veterinarian).
13. Dr Rinku Sharma (Member, Editorial Board: Vet. Res. Int.).
14. Dr Gorakh Mal (Member, Editorial Board: Indian J. Anim. Res.).
15. Dr Mahesh Chander (Assoc. Editor: Organic Agriculture Journal).
16. Dr D.B. Rawool (Associate Editorial Member: Frontiers in Microbiology-Host-Pathogen Interaction).
17. Dr G. Venkatesan (Associate Editor: SciFed Journal of Virology).

Best Thesis/Research Paper/Poster Presentation Awards

1. Dr Ranjitha H.B. (Young Scientist Award, Society of Veterinary Biochemists and Biotechnologists of India, Guide: Dr S.H. Basagoudanavar).

2. Dr Lijo John (Best Oral Presentation Award, Society of Veterinary Biochemists and Biotechnologists of India, Guide: Dr G. R. Reddy).
3. Dr Harikrishna Pillai (Best Poster Presentation Award, Indian Society for the Study of Reproduction and Fertility).
4. Drs Shikha Tamta and others (Best Oral Presentation Award, IAVPHS).
5. Drs Sivakumar M. and others (Best Poster Presentation Award, IAVPHS).
6. Dr Sanjiv Kochewad (Young Scientist Award from Biologix Research and Innovation Center Pvt. Ltd.).
7. Drs Rana, P. and others (Best Oral Presentation Award, Association of Meat Scientists and Technologists).
8. Drs Kumar, R.R. and others (Best Oral Presentation Award, Indian Society of Sheep and Goat Production and Utilization).
9. Drs Devadason, I. P. and others (Best Oral Presentation Award, Indian Society of Sheep and Goat Production and Utilization).
10. Drs Vishwakarma A. and others (Best Oral Presentation Award, Indian Society of Veterinary Pharmacology and Toxicology).
11. Drs Sultan F. and others (Best Poster Presentation Award, Indian Society of Veterinary Pharmacology and Toxicology).
12. Dr Sarvesh K. Rai (Prof. P.K.R. Iyer Memorial Best M.V.Sc. Thesis Award, 2016, Guide: Dr R. Sharma).
13. Drs Sharma R. and others (A. K. Bhargava Memorial Award-2015).
14. Drs Kumar R. and others (Appreciation Award, Indian Society for veterinary Surgery).
15. Drs Arun K. Das and others (Best Research Paper Award in National Seminar on "Small Ruminants: National Scope on Upscaling Production to Products Value addition and their Safety").
16. Drs Dayamoy Mondal and others (Second Best Poster Award, Indian Society for Veterinary Medicine).
17. Dr Abhishek (Young Scientist Award, IAAVR).
18. Drs Rohit Kumar and others (Best Paper Presentation, ISVS).
19. Dr Manu Mathew (Young Scientist Award, IAVP).
20. Dr Karthika S. (Prof. S. Ramachandran Memorial Award, IAVP).
21. Dr S. Kombiah (Dr Ram Raksha-Kiran Shukla Award, IAVP).
22. Dr Monalisa Sahoo (Best Ph. D. Thesis Award, IAVP; Best Poster Award, ASVP).
23. Dr K. P. Singh (Best Poster Award, IAVP; President's Poster Award, IAVP).
24. Dr Rupasi Tiwari (Best Article Award "IInd Prize" Kheti magazine, DKMA, ICAR, New Delhi).
25. Drs Raguvaran and others (First Prize, Indian Society for Veterinary Medicine).
26. Drs. G. E. Chethan and others (Third Best Presentation Award, ISVM).
27. Drs Sachin Kumar and others (Best Paper Award, ISACP).
28. Drs Chaurasia and others (Best Paper Award, ANSI).
29. Drs Maurya and others (Best Paper Award, ANSI).
30. Drs Khan and others (Best Paper Award, ANSI).
31. Drs Jose and others (Best Paper Award, ANSI).
32. Drs Perween and others (Best Paper Award, ANSI).
33. Dr Shafiya Imtiaz Rafiqi (Dr J. P. Dubey Young Scientist Award, IAAVP, Guide: Dr Rajat Garg).
34. Drs S. Sircar and others (Best Poster Presentation Award, Indian Virology Society).
35. Drs Manu M. and others (Best Poster Award, VIRACON-2017).
36. Dr Minhas S. K. (Young Scientist Award, VIRACON-2017).
37. Drs G. Venkatesan and others (Best Poster Presentation, VIRACON-2017).
38. Drs Sharma P. and others (Best Poster Presentation, 12th Uttarakhand State Science and Technology Congress).

Association/Society Awards/Recognitions

1. Dr Amarpal (Dr R. P. S. Tyagi Oration Award, Indian Society for Veterinary Surgery).
2. Dr R. K. Agarwal (Life Time Achievement Award, IAVPHS).
3. Dr R. K. Agarwal (President, IAVPHS).
4. Dr Med Ram Verma (Dr D. N. Memorial Lecture Award, Indian Society of Agricultural Statistics).
5. Dr R. Singh (Treasurer and Registrar IAVP).
6. Dr K. P. Singh (Secretary General, Indian Association of Veterinary Pathologists (IAVP); General Secretary, Association of Indian Zoo and Wildlife Veterinarians (AIZWV)).
7. Dr Rupasi Tiwari (Innovative Extension Educationist Award, SVAHE).
8. Dr Rupasi Tiwari (Innovative Extension Researcher Award, Society of Veterinary & Animal Husbandry Extension).
9. Dr Akhilesh Kumar (Certificate of Appreciation for contribution as a Member of Scientific Advisory Board of IJLR in year 2017-18).

10. Dr A.K. Verma (President, ANA)
11. Dr Narayan Dutta (General Secretary, ANA).
12. Dr L.C. Chaudhary (Vice President (Central Zone), ANSI).
13. Dr S.K. Saha (Executive Body Member, NAVS).
14. Dr Asit Das (Executive Body Member, ANSI; Member, Health Evaluation Committee, Lucknow Zoo).
15. Dr V.B. Chaturvedi (Executive Body Member, ANSI).
16. Dr Saminathan M. (Certificate of Excellence-2016-17, International Journal of Livestock Research).
17. Dr Rajat Garg (Dr D. P. Banerjee Memorial Oration Award, IAAVP).
18. Dr G. Venkatesan (Outstanding Contribution in Reviewing Certificate, Helion and Journal of Virological Methods, Elsevier, Netherland).
19. Dr Mashidur Rana (Selected for four months Newton-Bhabha Ph.D. Placement Programme 2017-18 at London School of Hygiene and Tropical Medicine, London).
20. Dr B.C. Saravanan (Executive Council Member, IAAVP).
21. Dr T.U. Singh (Joint Secretary, Indian Society of Veterinary Pharmacology and Toxicology).
22. Dr Y.P.S. Malik [Joint Secretary, Indian Society for Veterinary Immunology and Biotechnology; Joint Secretary and Treasurer, Indian Association of Veterinary Microbiology, Immunology and Infectious Disease Specialist (IAVMI); Secretary, Indian Virological Society (Animal Virology)].
23. Dr Ashok K. Tiwari (General Secretary, Indian Association of Veterinary Microbiology, Immunology and Infectious Disease Specialists (IAVMI).
24. Dr A.B. Pandey (Vice-President, Indian Virological Society).
25. Dr A.B. Pandey (Executive Committee Member, IAVMI).

Members of Expert Committees

1. Dr A.B. Pandey (Member, CPCSEA, Ministry of Environment, Forest and Climate Change, Govt. of India)
2. Dr A.B. Pandey (Member, Institute Management Committee, Directorate FMD, Mukteswar).
3. Dr G. Taru Sharma (Member, QRT, NRC on Yak, Dirang, Arunach Pradesh)
4. Dr G. Taru Sharma (Member, RAC, NIANP, Bengaluru)
5. Dr A.B. Pandey (Member, Institute Biosafety Committee, DCFR, Bhimtal).
6. Dr G. Taru Sharma (Member, DBT Task Force on Anumal Biotechnology & NER)
7. Dr Harendra Kumar (Expert Member-SERB, DST).
8. Dr Premanshu Dandapat (Invited as National Expert on Tuberculosis in animals in AO-APHCA/OIE Regional Technical Workshop on the Prevention and Control of Animal Brucellosis and Tuberculosis in Asia).
9. Dr K.N. Bhilegaonkar (Member, International Commission of Microbiological Specifications for Food; Scientific Panel on 'Biological Hazards', Food Safety and Standards Authority, India; Scientific Panel on 'Meat and Meat Products including Poultry", Food Safety and Standards Authority, India; State Level Committee of Maharashtra State for nominations of 'Gopalratna and Kamdhenu' awards; State Level Committee of Maharashtra State for nominations of ''Best Veterinarian and Best AI worker'' awards; Chairman, State level implementation Committee of Prevention and Control of Infectious Diseases Act in Maharashtra State).
10. Dr Mahesh Chander (Member, Organic Products, FSSAI & APEDA, ICAR Organic Agriculture Curriculum Committee, International Advisory Board, EU-funded Organic Plus Project).
11. Dr Y.P.S. Malik (CPCSEA nominee, IAEC of GBPUAT, Pantnagar, Uttarakhand; IAEC of Sri Guru Ram Rai Mehant Medical College, Dehradun, Uttarakhand; IAEC of Pharmacy College, Rudrapur, Uttarakhand; Member, International Committee on Taxonomy of Viruses (ICTV) on Birnaviridae and Picobirnaviridae Study Group).
12. Dr S. Qureshi (CPCSEA Nominee, IAECs of CARI, Izatnagar, CDRI, Lucknow, Kumaon University, Nainital, SRMS College of Engg. & Tech. (Pharmacy), Bareilly, IFTM, Moradabad)
13. Dr Ashok K. Tiwari (Member, Veterinary Expert Committee of Indian Pharmacopoeia; National Agricultural Education Accreditation Board (NAEAB) of ICAR; GMP committee of PVVI, Ludhiana; Institute Biosafety Committee of CARI, Izatnagar; Review Committee formed by DAHDF, MoA for reviewing use of exotic FMD strains for vaccine production; Panel for monitoring FMD Vaccine Manufacturing Unit in the country made by DAHDF, MoA; Committee constituted by Govt. of Punjab for developing GMP facility for Punjab Veterinary Vaccine Institute; DBT nominee, Institute Biosafety Committee of DCFR, Bhimtal).
14. G. Venkatesan (Reviewer/Member of Science and Engineering Research Board (SERB), Department of Science and Technology (DST), Ministry of Science and Technology, GOI).

11.0
Distinguished Visitors

IVRI Campus, Izatnagar

1. Sri Santosh Kumar Gangwar, Hon'ble Union Minister of State for Finance
2. Sri Dharmendra Kashyap, Hon'ble MP, Aonla
3. Sri R.K. Sinha, MP (Rajya Sabha)
4. Hon'ble Sri Surya Pratap Sahi, Min. of Agriculture, Govt. of U.P.
5. Dr Arun Kumar, M.L.A., Bareilly
6. Dr Trilochan Mohapatra, Hon'ble Director General, ICAR and Secretary, DARE
7. Sh. R.P. Singh, Hon'ble member, Governing Body, ICAR, New Delhi
8. Dr M.P. Yadav, Former Director, IVRI & VC, SVP Univ. of Agric. & Tech., Meerut, U.P.
9. Dr K.M.L. Pathak, Vice Chancellor, DUVASU, Mathura
10. Dr PK Uppal, Advisor, DAH, Govt. of Punjab, Chandigarh
11. Dr Man Mohan Singh, VC, SVVU, Tirupati
12. Dr K.M. Bujarbaruah, VC, AAU, Assam
13. Dr C. Renuka Prasad, Former VC, KVA & FSU, Bidar & Member, RAC
14. Dr N.K. Mishra, Vice Chancellor, Kamdhenu Vishwavidyala, Durg, Chhattisgarh
15. Dr Dev Swaroop, Joint Secretary, UGC and Former VC, University of Rajasthan
16. Dr S. Tomar, VC, CSA, Kanpur
17. Prof. A.C. Varshney, Former VC, DUVASU, Mathura
18. Dr S.K. Singh, Director, DKMA, ICAR, New Delhi
19. Prof. Gaya Prasad, VC, SVPUA&T, Meerut
20. Dr Sanjeev Saxena, ADG(IP&TM), ICAR, New Delhi
21. Dr S.K. Garg, Former VC, DUVASU, Mathura
22. Prof. B. Mishra, Former VC, SKUSAT, Jammu
23. Dr D.T. Mourya, Director, NIV, Pune
24. Dr B. Pattanaik, Director, DFMD, Mukteswar
25. Dr R.R.B. Singh, Director (Actg.), NDRI, Karnal
26. Dr B.N. Tripathi, Director, NRCE, Hisar
27. Dr A.K. Rawat, Director, DBT, New Delhi
28. Dr R.N. Chatterjee, Director, DPR, Hyderabad
29. Dr A.S. Panwar, Director, IIFSR, Modipuram, Meerut
30. Dr Arjava Sharma, Director, NBAGR
31. Sh. Hriday Nath Singh, Minister BJP Sangathan
32. Prof. Maheswar Sapkota, Director, Nepal Polytechnic Institute, Purbanchal University, Nepal
33. Dr Satya Parida (IAH, Pirbright, UK)
34. Dr Subeer Majumdar, Director, NIAB, Hyderabad
35. Dr C.S. Prasad, former Director, NIANP, Bengaluru
36. Dr Dharmeswar Das, Former Joint Director (Acad.), IVRI


Dr Trilochan Mohapatra, DG, ICAR & Secretary, DARE

37. Dr Dhinakar Raj, Project Director, TRPVB, TANUVAS & Member, RAC
38. Dr P. Birthal, National Professor, NCAP, N. Delhi & Member, RAC
39. Dr Ashok Kumar, ADG (AH), ICAR, New Delhi
40. Dr B.S. Prakash, ADH (ANP), ICAR, New Delhi
41. Dr Amarjeet Singh, Director, Department of Animal Husbandry, Govt. of Punjab
42. Sri Prashant Kumar, Addl. Director, Deptt. of Agriculture, UP Govt., Lucknow
43. Dr G.C. Chaturvedi, Dean, MTF College of Veterinary and Animal Sc., Jaipur

IVRI Campus, Bengaluru

1. Dr PK Uppal, Advisor, DAH, Govt. of Punjab, Chandigarh (Former Director, NRCE, Hisar)
2. Dr H.K. Pradhan, Former Joint Director, HSADL (IVRI), Bhopal
3. Dr Joykrushna Jena, Deputy Director General (Animal Science), ICAR, New Delhi
4. Dr Ashok Kumar, ADG (AH), ICAR, New Delhi

5. Dr Pratipal Singh, Deputy Director, Punjab Veterinary Vaccine Institute, Ludhiana, Punjab
6. Mr. V.P. Kothiyal, Director (Works), ICAR, New Delhi
7. Dr Susanne Munstermann, OIE Mission Team
8. Dr Howard Batho, OIE Mission Team
9. Dr Suresh S. Honnappagol, Animal Husbandry Commissioner, DADF, GoI, New Delhi
10. Dr M. Nadeem, Dean, PGS, KVAFSU, Bidar, Karnataka

Training and Education Centre, Pune

1. Dr MP Yadav, Former Director, IVRI & VC, SVP Univ. of Agric. & Tech., Meerut, UP
2. Dr Ashok Kumar, ADG (AH), ICAR, New Delhi.
3. Dr E.B. Chakurkar, Director, CCARI, Goa
4. Dr D.M. Chavan, Additional Commissioner (AH), Govt. of Maharashtra
5. Dr Lakhan Singh, Director, ATARI, Pune

ERS Kolkata

1. Dr Parimol Roy, Director, ICAR-NIVEDI, Bengaluru
2. Dr D. K. Sarma, Ex-Director, ICAR-NRC on Pig, Guwahati

IVRI Campus, Mukteswar

1. Dr Joykrushna Jena, Deputy Director General (Animal Science), ICAR, New Delhi

Shri R P Singh, Member, ICAR Governing Body

Experts from the OIE at IVRI Bengaluru

Delegates from Argentina exploring technical exchange

Dr Arun Kumar, MLA, Bareilly

12.0
Important Meetings

Composition of 51st Meeting of Board of Management of ICAR-IVRI

Sl. No	Composition	Name & Designation	Status
1.	Rule No.2.01(i) Director, ICAR-IVRI	Dr R.K. Singh	Chairman
2.	Rule No.2.01(ii) Joint Director (Acad.)	Dr Triveni Dutt	Member
3.	Rule No.2.01(iii) Two members of Governing Body nominated by the President	1. Vacant 2. Vacant	Member Member
4.	Rule No.2.01(iv) Jt. Directors/Head of Division of related groups of disciplines and Project Coordinators to be nominated by the President of the Society for a period of two years total numbers not to exceeded to eight	1. Vacant 2. Vacant 3. Vacant 4. Vacant 5. Vacant 6. Vacant 7. Vacant 8. Vacant	Member Member Member Member Member Member Member Member
5.	Rule No.2.01(v) Joint Director (Research)	Dr B.P. Mishra	Member
6.	Rule No.2.01(vi) Joint Director (Ext. Edu.)	Dr A.K. Garg	Member
7.	Rule No.2.01(vii) Vice Chancellor of Agril. Univ.	Vacant	Member
8.	Rule No.2.01(viii) One Representative from ICAR	DDG (AS), ICAR, Krishi Bhawan, New Delhi	Member
9.	Rule No.2.01(ix) Director, IARI/NDRI	Dr R.R.B. Singh, Director(Actg.), NDRI, Karnal	Member
10.	Rule No.2.01(x) Animal Husbandry Commissioner, Deptt. of Agril., Min. of Agril.	AHC, DADF, Krishi Bhavan, New Delhi. [Tele: 011-3384146]	Member
11.	Rule No.2.01(xi) One Eminent Scientists in the field of Research	Vacant	Member
12.	Rule No.2.01(xii) One Eminent Educationist concerned with the Research	Vacant	Member
13.	Rule No.2.01(xiii) Two non-official persons representing agriculture interest	Vacant Vacant	Member
14.	Rule No.2.01(xiv) Financial Advisor, ICAR or his nominee	Financial Advisor, ICAR	Member
15.	Rule No.2.01(xv) Commissioner, Rohilkhand Division	Commissioner, Rohilkhand Division, Bareilly	Member
16.	Rule No.2.01(xvi) Joint Director (Admn.)	Sri Rakesh Kumar, Joint Director (Admn.)-cum-Registrar	Member Secy.

Composition of 60th Meeting of Academic Council of ICAR-IVRI

Sl. No	Composition	Name & Designation	Status
1.	Director, ICAR-IVRI	Dr R.K. Singh	Chairman
2.	Jt. Director (Acad.)	Dr Triveni Dutt	Vice-Chairman
3.	Jt. Director (Res.)	Dr B.P. Mishra	Member
4.	Jt. Director (EE)	Dr A.K. Garg	Member
5.	Four Eminent Scientist from Outside the IVRI distinguished in the field of Edn. Including Animal Science Education	1. Dr. Amresh Kumar, Former Dean, College of Vety. Sci., Pantnagar &Director General (KCMT),35, Green Park,Bisalpur Road,Bareilly-243006 2. Dr. G.K. Singh, Dean, Faculty of Veterinary Science,G.B. Pant University of Agriculture & Technology,Pantnagar - 263145, Dist. Udham Singh Nagar,Uttarakhand. 3. Dr. Surender Lal Goswami , Vice Chancellor, Banda University of Agriculture and Technology, Near New Circuit House, Banda, Uttar Pradesh 210001. 4. Dr. K.S. Palaniswami, Director of Research (Retd.), TANUVAS,W-145, Annanagar West Extension, Chennai- 600 101 (TN).	Member Member Member Member
6.	One Sr Scientist from each of the Division	1. Dr G. Taru Sharma, HD/P&C 2. Dr P.S. Banerjee, HD/Para 3. Dr Amar Pal, HD/Surgery 4. Dr Mahesh Chander, HD/EE 5. Dr Rajendra Singh, HD/Path. 6. Dr R.K. Agarwal, HD/B&M 7. Dr Bharat Bhushan, HD/AG 8. Dr Dinesh Kumar, HD/P&T 9. Dr Sanjay Kumar, HD/LES 10. Dr A.K. Tiwari, HD/Stand. 11. Dr P.P. Goswami, HD/Biotech. 12. Dr U. Dimri, HD/Medicine 13. Dr S.K. Mendiratta, HD/LPT 14. Dr A.K. Verma, HD/AN 15. Dr Harender Kumar, HD/AR 16. Dr Meena Kataria, HD/Biochemistry 17. Dr B.R. Singh, HD/Epid. 18. Dr R.P. Singh, HD/BP 19. Dr S.V.S. Malik, HD/VPH 20. Dr Ramakrishnan M.A.,HD/Virology 21. Dr T.K. Goswami, I/c Immunology 22. Dr G.K. Gaur, I/c LPM	Member Member
7.	Director, CARI	Dr J.M. Kataria	Member
8.	Master of Halls	Dr K.P. Singh, PS and Chief Hostel Warden	Member
9.	Two Repr. from P.G. Faculty	1. Dr Sadhan Bag, PS, P&C Division 2. Dr Ajay Kumar, Scientist Biochemistry Division	Member Member
10.	The student representative to AC	1. Dr. Vineetha S., Ph.D. Student 2. Dr. Dushyant Yadav, Ph.D. Student	Member
11.	DDG (Edn.) or his nominee	DDG (Edn.), ICAR	Member
12.	Jt. Director (Adm.)-cum-Registrar	Sri Rakesh Kumar	Member Secy.

Composition of the Research Advisory Committee (RAC)

Rule No. & Position	Designation	Name Approved by the Authority
71 A(a)1 An eminent Scientist from outside the ICAR System nominated by DG, ICAR	Chairman	Dr K.M. Bujarbaruah, Vice Chancellor, Assam Agricultural University, Assam
71 A(a)2 4-5 External Members (including retired scientists of ICAR) representing the major areas of research & development programme of the Institute nominated by DG, ICAR	Member	**1.** Dr C. Renuka Prasad, Former Vice Chancellor, KVA&FSU, Bider, 7, 5th Block, 3' Main, Kumara Park West, Bengaluru-560020 **2.** Dr D.T. Mourya, Director, NIV, 20/A, Dr Ambedkar Road, Post Box No.11, Pune-411001 **3.** Dr C.S. Prasad, Former Director, NIANP, 144/1, 8th Main 14th Cross, Opp. Canara Union, Malleswaram, Bangalore — 560003 **4.** Dr D. Das, Former Joint Director, IVRI, House No.1, Saturbhuj Path, Jayanagar, Khanapara, Guwahati-781022, Assam **5.** Dr Dhinakar Raj, Project Director, Translational Research Platform for Veterinary Biologicals, CAHS, TANUVAS Madhavaram Milk Colony, Chennai -600051 **6.** Dr P. Birthal, Pr. Scientist, National Centre for Agricultural Economics and Policy Research (NCAP), P.O.Box.No.11305, D.P.S.Marg, Pusa, Librarian Avenue, New Delhi-**110 012**
71 A(a)3 Directors of the Institute	Member	Director, IVRI, Izatnagar
71 A(a)4 DDG, concerned with the Institute in case of IARI, IVRI, NDRI & NAARM in case of other Institutes ADG concerned with Institute	Member	DDG (AS)
71 A(a)5 Two persons representing Agril./Rural interest of the IMC to the Institute in terms of rules 66 (a)5 for a period of their membership of the IMC	Member	To be nominated by President, ICAR on the BOM of IVR
71 A(a)6 One Sr. level scientist of the concerned Institute nomi-nated by the Director of the Institute	Member Secretary	Joint Director (Research), IVRI

Composition of Institute Research Committee

Sl. No.	Composition	Name & Designation	Status
1.	Dr R.K. Singh	Director, IVRI	Chairman
2.	Dr B.P. Mishra	Joint Director (Res.)	Member Secretary
3.	I/C PME Cell & Heads of Divisions , including all the scientists of IVRI		Members

Composition of the Extension Council

Rule			Name
6.01	(i)	Director, IVRI, Chairman	Dr Raj Kumar Singh
	(ii)	Jt. Director (Research), Member	Dr B.P. Mishra
	(iii)	Jt Director (Academic), Member	Dr Triveni Dutt
	(iv)	Jt. Director (CADRAD), Member	Dr V.K. Gupta
	(v)	Jt. Director (Extn. Edu,), Member	Dr Mahesh Chander (Acting)
	(vi)	DDG(AE) or his nominee, Member	Dr A.K. Singh, DDG(AE), ICAR
	(vii)	Head, Division of Extension Education-Member Secretary	Dr Mahesh Chander

	(viii)	Four Scientists in Management position of the Institute, Members	Head, Division of Parasitology Head, Division of Medicine Head, Division of Surgery Head, Division of Animal Reproduction
	(ix)	Five Scientists of IVRI nominated by Board of Management as Members for 2 years (Proposed)	Dr A.M. Pawde, PS, Div. of Surgery Dr B.P. Singh, PS, I/c KVK Dr K. Mahendran, Scientist, Div. of Medicine Dr Putan Singh, PS, Div. of A.N. Dr Himani Dhanze, Scientist, Div. of VPH
	(x)	One Scientist from the Regional Research Station as Member for 2 years	Dr C.K. Jana, Sr. Scientist, IVRI, Mukteswar
	(xi)	One Representative of Ministry of Agriculture, Govt. of India, Member	Animal Husbandry Commissioner, Ministry of Agriculture, GOI
	(xii)	One Project Coordinator for 2 yrs, Member	Project Coordinator, GIP
	(xiii)	Two Representatives of Sate Govt., Members	i. Dy. Director (AH), Bareilly ii. Jt. Director (Agriculture), Bareilly
	(xiv)	One Extension Scientist representing NDRI / IVRI nominated by BOM as Member for 2 years (Proposed)	Dr K. Ponnusamy, Pr. Scientist, NDRI. Karnal
	(xv)	Director (Farm Information), Ministry of Agriculture, Government of India, Member	By designation
	(xvi)	Joint Director (Administration), Member	Sri Rakesh Kumar

Committee Meetings Convened

Board of Management

The 52st meeting of Board of Management was held on 1.7.17 at IVRI Izatnagar. Dr R.K. Singh, Director and Chairman of the Board of Management extended welcome to distinguished members of BOM and briefly presented the research achievements of IVRI especially in the sphere of technology development, research schemes, works, patenting and transfer of these technologies to industries for the benefit of end-users, i.e. livestock farmers. He also briefed on the recent contributions of IVRI to animal health and production and sought the help of BOM in furthering development at the Institute.

Dr R.R.B. Singh, Dr Suresh S. Honnappagol and Dr Ashok Kumar appreciated the progress made by the Institute and wished that the Institute would keep up this tempo.

Dr Suresh S. Honnappagol further said that currently, livestock is one of the fastest growing agricultural subsectors in developing countries. The demand for livestock products is rapidly increasing in most developing countries. However, many developing countries have feed deficits. New unconventional alternate feed resources such as fruit and vegetable wastes could play an important role in meeting this deficit. Such unconventional resources can act as an excellent source of nutrients and help to bridge the gap between demand and supply of feedstuffs for livestock.

BOM approved the proposal for utilization of Type V quarter as Girls Hostel at IVRI, Bengaluru.

Research Advisory Committee

The meeting of XX Research Advisory Committee (RAC) was held on 13-14th Feb 2018 at ICAR-IVRI, Izatnagar under the chairmanship of Dr K M Bujarbaruah, VC, Assam Agriculture University and other Honb'le members which included, Dr C Renuka Prasad, Dr D T Mourya, Dr C S Prasad, Dr D. Das, Dr Dhinakar Raj and Dr P. Birthal. Dr B P Mishra, Joint Director (Res) and Member Secretary RAC presented the agenda for approval by the committee. Director, ICAR-IVRI presented the significant achievements made by the institute during the past one year with respect to research publications and technology development and its transfer to stake holders. The chairman RAC appreciated the progress made and laid emphasis on the urgent need for technologies for application by the farmers. He also felt that human resources available with the institute should be continuously trained in suitable laboratories in the country and abroad where cutting-edge science is being conducted. Other members suggested the need for more attention towards various prevailing diseases, development of diagnostics and vaccines for their control and a comprehensive assessment of their impact. More robust platforms for quicker dissemination of technology related information to the field and research in collaboration with industry was also suggested.

Academic Council

The 60th meeting of the Academic Council was held on 5th May 2017, at IVRI, Izatnagar, under the Chairmanship of Dr RK Singh, Director, IVRI. Dr Triveni Dutt Vice-Chairmen of the 60th Meetings welcomed the Chairman and all the distinguished members.

Dr Triveni Dutt, Vice Chairman and Joint Director (Academic) elaborated in detail on the functioning of the Institute and Deemed University & importance of this Academic Council meeting. The Vice Chairman informed that a nodal cell of education division and office of ELP coordinator and students welfare have been established for improving teaching and training activities of the university. The UG syllabus has been revised as per recommendation of OIE and VCI-MSVE, 2016 for improving the competence of graduating veterinarians to assure National Veterinary Service of quality. Two new disciplines have been created viz., Veterinary Microbiology (VMC) by merging Veterinary Bacteriology, Virology and Immunology and Veterinary Public Health & Epidemiology (VPE).

The VC further emphasis that there is need to reorganize PG National Diploma and introduce new Diploma courses. Efforts would also be made to start diploma in Distance and online mode to meet the challenges and demand of state Governments and Industry.
Dr R.K. Singh, Director and Chairman of the Academic Council welcome to the distinguished members of AC. He briefed the House about the challenges and changing scenario of the academics in the present day times. He informed the House that IVRI will collaborate and sign MoU with reputed Universities abroad. He called upon the faculty to move towards excellence in higher education.
Dr Amresh Kumar, Dr K.S. Palaniswami, Dr G.K. Singh and Dr K.L. Khurana appreciated the work done by IVRI in field of education and research especially when there is very limited scientific manpower and stressed the need to have more collaboration with other Institutes/universities.

Various decisions taken during the meeting included-proposal to restart of system of internal preliminary examination for Ph.D. scholars, proposal to restart the interview of qualifying candidates who have declared successful in the written entrance examination from 2017-18 to meet the requirement of UGC 2009 Regulations, the creation of Veterinary Microbiology by merging Veterinary Bacteriology, Veterinary Virology and Veterinary Immunology for degree nomenclature, the merger of Veterinary Public Health and Epidemiology degree as Veterinary Public Health & Epidemiology (VPE) and compulsory Elementary Statistics Course to all the student in each discipline, etc.

Extension Council

The XVII Meeting of the Extension Council of IVRI was held on 12th March, 2018 at IVRI Izatnagar under the Chairmanship of Dr RK Singh, Director IVRI. Dr Mahesh Chander, HDEE & Member Secretary welcomed the Hon'ble Chairman and members of the Extension Council and briefed about the earlier meetings of Extension Council of IVRI. The extension activities organized by the institute during 2017-18 were reviewed by the Chairman and the action plan for 2018-19 was decided in the meeting attended by 24 members including special invitees.

The Director ICAR-IVRI briefing the Research Advisory Council

13.0

Empowerment of Women and Mainstreaming Gender Issues

Empowerment of women, especially rural women, is an important issue in the strategies of balanced development with social justice. As far as agriculture and animal husbandry is concerned, most of the physical work is done by rural women, but their role remains invisible, as they are not involved much in decision making even at family level. To get their role recognized, they are to be awakened, educated and empowered. This can create a win-win situation for the women and these sectors.

ICAR-IVRI and women empowerment

IVRI is a very well recognized institute of international repute in the field of Veterinary Sciences. Along with the excellent research and academic achievements, it has always paid attention to the service of villagers, farmers and women farmers via various activities organized round the year. The institute has always shown a great devotion in execution of mission mode and flagship programs of Government of India and ICAR policies and women empowerment is an integral part of these. These empowerment programs and activities are being taken up by the institute and its campuses and regional stations through its various compartments such as research, academics, extension, administration and social.

Protection of women's interests at the institute

ICAR-IVRI is a premier research institute and Deemed University as well. It has a large number of women employees including women scientists, officers, clerical and supporting staff and trainees involved in research, academics, extension and trainings at main campus and other regional stations. Besides, there are large number of female students admitted every year for pursuing their B.V.Sc, M.V.Sc and Ph.D. degree. Thus, institute has a great responsibility of taking care of their welfare needs and protection of interests. For the purpose, the institute has a women cell with different committees like Internal Complaint Committee (ICC) and a Task Force including senior officers and a lady scientist as Chairperson. The aim of these committees is to monitor the existing arrangements, security and protection of women at workplace and wellbeing of women employees and girl students of the institute. The cell follows the guidelines from UGC and ICAR by default and the UGC is kept informed about the major activities under the guidance of University Vice-Chancellor. Further, other sub-committees are also formed as per the requirement to take care of the complaints about the matters not covered under these two.

Krishi Vigyan Kendra (KVK) activities for Rural/Farm women

The mandate of KVK is to cater the training needs of farmers, entrepreneurs, financial institutions, extension functionaries and voluntary organizations. It is involved in imparting trainings, awareness and education to farm women, rural girls and youth through various on-campus and off-campus programmes and events. Rural women and girls are being empowered through beneficial trainings related to animal husbandry activities and technologies in terms of demonstrations and on-farm trials.

Since more than three decades, KVK is acting as a window of the institute and plays a significant role in First Line Extension of research output to the field thereby improving the socio-economic conditions of farmers, farm women and rural youth. Besides, rural families are surveyed from time to time, to pin point the technological gaps and social needs of farm women and rural girls. Accordingly, trainings are planned to cater to their requirements. The efforts have resulted in many success stories to share with.

Some of the important women specific activities taken up by the KVK during the period under report are as follows:

Technology refinement

Problem definition: High physiological stress and drudgery among rural women due to milking of animals sitting in squatting position.
Technology assessed: Use of revolving stool for drudgery reduction during milking of animals by farm women (Source of technology: GBPUA&T, Pantnagar).

Five rural women from a village of Nawabganj block of Bareilly district, who are engaged in milking of their animals, were identified to assess and test the feasibility of the revolving stool in terms of time taken and comfort. During local practice of milking of animal, farm women used to sit in squatting/bending position for a

long time, which leads to pain in lower back, knees, ankles and calf muscles. The results revealed that the women could milk one litre of milk in 1.5 minutes using a revolving stool as compared to 1.59 minutes with their traditional method of milking. The women further reported about comfort, accessibility and feasibility of revolving stool on a five point scale as 4.6, 3.2 and 4.4 respectively as compared to 4.00, 4.2 and 4.2 while using traditional method, sitting in squatting position while milking the animal.

Frontline Demonstrations

Thematic area & Technology	Participants
Paneer making with the help of paneer press developed by CIAE, Bhopal	10
Tomato sauce making	10
Detergent Making	60
Total	80

Training for Practicing Farm Women, Rural girls and Extension functionaries

Thematic area	Days	Participants
Practicing Farm Women		
On campus		
Household food security by kitchen gardening and nutrition gardening	2	20
Design and development of low/minimum cost diet	2	18
Value addition	3	14
Total	7	52
Off Campus		
Storage loss minimization techniques	1	23
Women and child care	1	13
Women empowerment	2	105
Household food security by kitchen gardening and nutrition	2	35
Gender mainstreaming through SHGs gardening	2	31
Total	8	207
Rural girls (youth) (On campus)		
Value addition in mangoes	4	15
Hand Embroidery	4	15
Detergent Making	3	20
Fruits and vegetable preservation	4	17
Fruits and vegetable preservation	4	11
Preparation of milk products	4	15
Preparation of soya products	4	22
Total	27	87
Extension functionaries (Aanganwadi workers)		
Care of pregnant and lactating women	1	18
Low cost and nutrient efficient diet designing	1	15
Total	2	33

Women participation in other KVK activities

Besides above mentioned training programmes for women, efforts were made to facilitate more and more participation of rural women in other activities organized at KVK. During the period under report, 95 women participated in the World Environment day celebrated on 5th June, 2017 at the institute. Various other Programmes

organized at ICAR-IVRI such as *Sankalp se Samridhdhi*, Parthenium week and *Baansmati chaval export hetu gunvatta sudhar* witnessed the participation of 472, 37 and 103 women, respectively.

Women Farmers Day

KVK organized Women Farmers Day in the institute on 15th October, 2017. It was attended by more than 250 farm women from 10 different villages of Bareilly district. Mrs. Shaubhagyavati Gangwar, a Social worker and chairperson, Bharat Seva Trust was the chief guest for the programme. On this occasion, KVK trained women were honoured for their outstanding work in the field of dairy, poultry production, goatery, piggery, organic manure, fashion designing, pickle production and mushroom production.

Two women were honoured for their Self Help groups. Besides, various activities like mehndi, singing and home gardening competitions were also arranged. Women farmers were advised to take advantage of Government schemes and adopt the scientific methods of agriculture and animal husbandry and go for organic farming to enhance their income.

Tribal women empowerment

Special emphasis was given to the empowerment of tribal women, under the Tribal Sub Plan (TSP) programme taken up at various campuses and regional stations of the institute. It was undertaken by IVRI through its five regional station centers viz. Mukteswar, Kolkata, Bangalore, Palampur and Pune campuses. The program was implemented in buffer zone of BR hills, Karnataka, Sangti village of Kolkata, Sunkharikala village of Sitarganj block of U. S. Nagar, Talla Ghorpatta and Darkot villages of Munsiyari block of Pithoragarh, Garola and Ulansa villages in Palamapur and Peint taluka in *Nashik* district of Maharashtra. Interactive meets, animal health camps, farm establishment assistance with respect to piggery, poultry, goatry and associated farm equipment like feeders, waterers, shed construction etc., periodical trainings, kisan melas, farm visits and consultations were conducted.

At Training and Education Centre, ICAR-IVRI, Pune, under TSP programme, 10 tribal farm women were given a unit of four female goats

A group photograph of participants of the training programme on goat farming

and a male goat each in *Gawandh* tribal village of Nashik district for the livelihood security. These are under regular supervision and health care by experts of the TEC, Pune. Training programmes on Goat Farming benefitting 39 tribal women were conducted under TSP. Besides, 90 women farmers attended the Progressive Farmers' Meet/Kisan Goshti jointly organized by TEC-IVRI, and Navsari Agricultural University in September 2017 at Navsari, Gujarat.

Under TSP, ERS Kolkata conducted base line survey in tribal villages at Kapgari area under Jumbani and Binpur-II Block of Jhargram district of West Bengal and various activities such as animal health camp-cum-awareness programme, kisan gosthi, vaccination and deworming programmes were organised in three tribal villages namely Kenduasuli, Rakhalmara and Mahulbani of Jhargram District, benefitting 162 tribal farmers/farm women. Further, a total of 1,678 chicks were distributed among 263 tribal farmers of 9 villages of Jumbani and Binpur-II Block of Jhargram, West Bengal.

Academic empowerment

IVRI Deemed University is fully determined towards the needs and care of a good number of girl students admitted every year in B.V.Sc, M.V.Sc. and Ph.D. degree course programme. A cordial atmosphere is maintained at the institute to develop the independency in girl students. There are hostel wardens deputed for all the girl hostels and further, to keep a close watch, a Master of Halls (girls) has been nominated.

University has student welfare officers separately for boys and girls. Presently, the Assistant Registrar is also a lady officer. The representation of men and women is 1:1 in University Academic Council. There is no gender discrimination in Student's Council and in the student development facilities related to library, sports and cultural activities. Participation of girls in sports and cultural programmes organized at the institute is worthy of emulation.

Empowerment through social activities

The officer's ladies club of ICAR-IVRI was established with 36 women members on 26th January, 1967, under the presidentship of Mrs. C.M. Singh, the then first lady of the institute. During the last 50 years, the club has been engaged in various extracurricular and social activities for the upliftment of the women in the society.

On 7th April, 2017, the first lady of ICAR, Mrs. Kalpana Mohapatra recorded her presence at the club premises along with Mrs. Kanti Yadav, the former president of the club. The club organized a fun filled social evening with light cultural programme to honour their presence and guidance. On the occasion, a Sandal wood plant was planted by the first lady of ICAR in the club premises.

The day of 22nd April, 2017 was devoted to the elderly people, when the club members spent time with the inmates of old-age home located at Bareilly and offered a high tea programme there. Yoga camp was organized by the club and on the occasion, medicines were distributed to the inmates of Kushthashram, Bareilly. Mother's day was organized by club on 9th May, 2017 with various activities like musical programmes, poetry recitation etc. Plantation activities were organized on the special occasions, as fruit plants were planted on the occasion of World Environment day, 6th June, 2017 and plantation was done in club premises on Independence Day, 15th August, 2017. A blood donation camp was organized by the club at Human Hospital, ICAR-IVRI, and many members of the club donated blood also. Fancy dress competition with historical and social icon theme and essay competition with Superstitious beliefs as subject were other social awakening activities.

On 8th November, 2017, the officer's ladies club organized its Golden Jubilee Celebrations as a historical event by inviting former presidents and members from different parts of the country. A message sent by the first president of the club, Mrs. C.M. Singh was read on the occasion. A series of activities were organized on the day, to name a few as sports activities, poetry recitation and cultural programmes. Children from the Government Primary School located at the institute's campus were invited to become the part of this occasion. They participated in various activities and items of daily use and snacks were distributed among them.

The club participated in the Institute's Annual Day celebrations on 9th December, 2017 by organizing various activities at its level. These include games and sports events for the children of orphanage and distribution of utility items such washing machine, pressure cooker, chairs and bed sheets etc. The Annual magazine of the club was released on the occasion.The work of the club was recognized and the Director IVRI felicitated club members by a special award on the occasion of 2nd October, 2017.

14.0
Other Relevant Information

Engineering Section, Izatnagar

The Unit-I of the Engineering Section is responsible for providing basic services like electricity, generator supply and EPABX, etc. to the whole campus including residential buildings.

Following major works are undertaken departmentally during the year:

1. Running maintenance and operation of (3150+3150) KVA, 33/11 KV sub-station (one), 11/ 0.433 KV substation - (seven)
2. Maintenance of external services, overhead lines, street lights and compound light of the whole campus.
3. Maintenance of internal electrical installations and fans in residential and non- residential buildings.
4. Maintenance of electrical and electronic appliances/equipments including P.A. system of all laboratories and offices.
5. Running maintenance and operation of eight D/G sets (1250 KVA, 11 KV, 320 KVA 440 Volt, 250 KVA 440 Volt, 200 KVA, 180 KVA, 125 KVA) in the campus.
6. Running maintenance and operation of 600 lines EPABX of the campus.
7. Running maintenance and operation of sewage pump behind fish pond (KVK farm).

Above services have been provided to whole campus throughout the year successfully through the available man power.

In addition to the above, this section has provided all the related services and infrastructure for organization of symposia and seminars, etc. held from time to time by different Divisions of the institute.

The number of complaints attended by different wings of this section during the year of report or as under:

1. Electrical wing (internal + substation) - 3842+815 = 4657
2. Instrumentation wing- 530
3. EPABX wing - 713

The Unit-II of the Engineering Section is entrusted with the responsibility of providing basic services like water supply, air conditioning, carpentry work, minor repair work of laboratory equipments, mechanical jobs, and civil and plumbing work. The refrigeration unit repaired refrigerators, deep freezers, water coolers and BOD incubators, maintained the AC plant at NRL, BP Division, LAR and Pathology, and looked after the cold room and deep freezer room at BP Division, LPT Division, and the chilling plant at Dairy Technology section.

During this year, this section attended 315 mechanical repair jobs, 653 carpentry repair jobs, 1170 plumbing repair jobs, 360 masonry repair jobs, 68 white washing, painting and masonry repair jobs of the official and residential buildings of whole campus. Refrigeration wing has also attended 398 complaints of repair of ACs and 116 complaints regarding repair of refrigerators, deep freezer and others refrigerated equipments of the campus.

Engineering Unit, Bengaluru

The following important infrastructure related works were carried out throughout the year at Bengaluru:

- New video conferencing system has been introduced in the campus.
- About 1.5 km of damaged underground street light cable and damaged electricity feeder pillar have been replaced at Yelahanka campus.
- The effluent treatment plant at isolation unit, Yelahanka has been renovated completely by replacing damaged, choked flow lines, painting the storage tanks (4); the ETP water lifting pump has been replaced in place of old damaged one along with water lifting pipe lines.
- Boiler (3) servicing at Hebbal and Yelahanka campus, insulation/cladding of steam line for boiler/ET plant at Yelahanka campus and servicing of boiler pumps and replacement of boiler header at Hebbal campus have been completed.
- LED street lights have been provided at both Hebbal and Yelahanka campuses and in the cattle shed of Yelahanka campus.
- Main Lab sump pump motor with starters has been replaced in place of damaged one at Hebbal campus.

Isolation Unit, Yelahanka

- Two water harvesting points/ponds have been created near healthy animal shed and near bio-containment entry gate.

- Two loading and unloading ramps have been constructed to facilitate the experiments.
- Around 4 acres of land is cleaned and prepared for maize fodder cultivation along with fencing.
- New water line near healthy animal shed and sprinkler arrangement has been made to facilitate fodder production.
- New underground sump of 45,000 litre capacity has been constructed to store the water.

Farm Section, Izatnagar Campus

The Fodder Farm of the institute is spread in an area of 298 acres of land and is divided into 15 sub-plots. Most of the plots have quick and efficient drainage system with underground irrigation facility and concrete roads.

Main objective of the fodder farm is to produce nutritious lush green fodder throughout the year to provide to the animals of Cattle & Buffalo farm and 17 experimental animal sheds of the institute. The farm section has grown crop like maize, cowpea, sorghum (single and multi-cut), bajra, guar and perennial hybrid Napier (CO-4, CO-5) in summer and rainy Kharif season; oat, berseem and Chinese cabbage in Rabi Season. Also, a seed production program, in collaboration with the NSC, Bareilly has been undertaken to produce high yielding varieties (HYVs) seed of wheat and other crops. The section also produced seeds of oat, bajra and Chinese cabbage for sowing in the next season and excess seeds of oats which have been issued as animal feed to Feed Technology Section of Animal Nutrition Division.

Under agro forestry, the Farm Section is maintaining about 5000 teak, 69 grapefruit and 50 lemon plants present along the farm road sides, and at field No. 09 & 10. Farm section is also maintaining 1000 square meter of lawns at field No. 9, 11 and farm office. Further, the section has planted 23.38 acre of perennial hybrid Napier grass (CO-4 & CO-5 varieties) along road side of the farm for the purpose to reduce the cost of input and to ensure green fodder availability throughout the year and also during the scarcity of green fodder.

The section has three concrete underground silo-pits with total capacity of more than 15,000 q. These pits are permanently covered by tubular steel and G.I. sheet structure to ensure availability of safe and secure storage even during rainy season. The Farm Section has 10 deep boring irrigation tube wells, 12 tractors and 10 two-wheeled and 03 four-wheeled trolleys.

The section has a small workshop to look after the repair and maintenance of farm machinery, tractors, and tube-wells etc.

The details of the farm produce and revenue generated at farm section during 2017-18 are as under:

Fodder and other crop production

A total of 1,02,390.15 q of green fodder consisting of oat, berseem, Chinese cabbage, maize, cowpea, bajra, jowar, hybrid Napier grass, guinea grass and other grasses and 721.85 q of dry fodder, oat and wheat was produced. Sown area under various crops was 791.68 acres, harvested area was 876.90 acres and balance crop area was 268.50 acres. The cropping intensity was 265.46 per cent. Net area under fodder cultivation and other crops was 298.00 acres.

Seed production and revenue generation

The section has produced 627.95 q oat seed and generated an amount of Rs. 3,51,450.00 through the sale of oat/wheat bhoosa, wheat, paddy, mustard and through farm services rendered to the employees of the Institute. This revenue mainly included sale of mustard (Rs. 6,400.00), paddy seed (Rs 9,600.00) and wheat (Rs 3,23,450.00).

Feed Technology Unit

In order to ensure animal feed of desired quality in a dedicated manner required for the research activities undertaken round the year, the feed manufacturing plant was established during 1973-77. A total of about 8,900 q of various types of animal feed for research animals like cattle, buffalo, sheep, goat, pig and laboratory animals was prepared and supplied.

Farm Machinery and Power Workshop

Farm Machinery & Power Workshop basically provides engineering service and support to different research programs of the institute while maintaining machineries and equipments like tractors, centrifugal pumps, grass cutters and agricultural equipments used by Farm Section, Livestock Production & Management Section, Horticulture Section, Sanitation Section and Krishi Vigyan Kendra. Also, the submersible pump sets in 19 deep tube wells meant for irrigation and drinking water supply were maintained by the workshop. The section is also responsible for the round the clock operation of drinking water tube wells. The workshop undertook major overhauling works of all types of tractors and agricultural machinery while having minimum dependency for outside repairs.

Horticulture and Sanitation Section

The Estate Unit (Horticulture and Sanitation Section) of the institute has been entrusted to maintain the responsibility of approx. 700 acres of lands including institute building, cattle, pig and buffalo farms. The unit has 2 tractors, 2 water tankers, 2 trolleys, 1 shrub masters, 8 electrical lawn mowers, 1 mount harrow and 2 brush cutters to maintain the daily needs of the works.

Main objective of the Estate Unit is to maintain whole campus clean and green. The Horticulture Section of the unit has well developed nursery and has provided seasonal flowers as well as perennial plants to different sections/division of the institute during the year. A total of 30 lawns including sport stadium have also been maintained by this section. The section also maintained 2,800 hybrid rose plants, during the year under report.

During the year, about 15,000 seasonal and perennial plants of various species have been planted, and surplus was provided to different sections/divisions. Horticulture section has also planted 549 varieties of plants like mango, paras peepal, jamoon, neem, bail, champa, etc. in different areas of the institute like C&B farm, Pig farm, LPT road, GP Center, Main Road No. 1. It also collected dung and organic wastes from the sheds of all the divisions/sections, residential areas, and placed in dumping ground for making farm yard manure and compost.

Under *Swachh Bharat Abhiyan*, the Sanitation Section has organized several campaigns inside the institute as well as in surrounding areas of the institute with the collaboration of various divisions/sections. A special campaign was also organized for the eradication of parthenium from IVRI campus during the period under report.

Scientists and staff participate in the *Swachh Bharat Abhiyan* to keep the institute premises clean

National Library of Veterinary Sciences, Izatnagar

The library at IVRI houses about 59,237 books, 6,137 theses, 4,297 reports, 2,02,108 bound volumes as well as issues of journal and other serial publications. This year, 817 books, 136 theses, 536 issues of journal were added to the holding of the library. The library remained open from 9.00 am to 9.00 pm daily and from 09.00 am to 4.00 pm on holidays except for the three national holidays, holi and deepawali festivals. There are 157 scientists, 29 BVSc & AH, 331 M.V.Sc., 366 Ph.D. students and 136 other staff members as library members. Library conducts non credit compulsory course on Library & Information Services (LIS-401) for M.V.Sc. and Ph.D. students.

Acquisition of publications

Library subscribed 55 foreign and 70 Indian journals while 04 of the titles were received on exchange/gratis basis during the year. The library also purchased 800 new books during the year 2017-18.

Library automation

The library has been using "KOHA" library automation software for providing automated library services. This automation software can also be accessed on internet through institute's website. All the books, theses, bound volumes of journals and other publications have been bar-coded. The bar-coded photo identity cards are being provided to the library members. The circulation work is automated using laser bar-code reader.

CD-ROM services

A CD-Mirror Hybrid Server is being used for CD-ROM services and the service is being provided on LAN. The various databases i.e., Agris CD, Beast CD, Biological Abstracts, Biotechnology Abstracts, FSTA, Medline Express and Vet CD databases are available on CD Mirror Server. About 136 users were trained for using the CD-ROM services themselves.

Resource management

About 26,778 users consulted the library and about 6,345 publications were issued on loan to the members. Besides, a large number of students and scientists from various SAUs and institutions consulted the library. The library provided inter-library loan services and inter-library exchange services. In order to regulate the distribution of publications, a penalty system is used, an amount of Rs. 24,944/- was collected as penalty from various users.

Reprography services

During the period photocopy services were provided to the students and staff members at nominal charges in the Reading Hall. In this, Rs. 51,885/- exposures were taken and an amount of Rs. 18,965/- was received from the users.

E-mail and internet facilities
This library has been providing e-mail and internet facilities on 24 terminals to its users. In addition to this, wi-fi connectivity is provided in the Reading Halls and students can use their laptops in the library.

Auditorium services
The library also maintains an air-conditioned auditorium which has been used for many functions/programmes of the institute as well as of other government and private organizations have been organized from time to time.

Electronic surveillance
Digital video recording based close circuit TV system with 22 cameras is being used in the various sections of the library for electronic surveillance.

Membership of e-CeRA
This library is a member of CeRA, (Consortium for e-Resources in Agriculture) set up under NAIP, ICAR along with other institute and SAU libraries. Under e-CeRA, the institute is getting access to about 3000+ full text online journals. Access to 1174 e-books of Elsevier Science publisher has also been provided during this period. Necessary services are being exchanged with the member libraries under the consortium.

AGRICAT
AGRICAT, a union catalogue, has been created by the 38 libraries of various ICAR institutes and SAUs and the books and other publications of this library are available in AGRICAT. Digital institutional depository "*Krisikosh*" of National Agricultural Research System (NARS) has been uploaded on the server of AGRICAT placed at IARI, New Delhi, and services are being used by the users of the NARS.

ARIS Cell, Izatnagar
ARIS Cell provided internet facility to the users connected with IVRI LAN. It also managed the webmail services of the institute and provided email facility to the staff and students. Institute website and Facebook profile was also maintained and updated on regular basis by the cell. It also made the IVRI website compliant as per the Govt. Guideline for Indian Website and STQC. Institute's YouTube channel was also created during this year by the cell and a total of 24 videos were uploaded on the channel. In addition to these activities, the cell also managed the video conferencing facility of the institute. Three trainings were provided to 58 staff comprising of scientific, technical and administrative cadre on "Working with MS Excel" under the in-house HRD program.

The cell also conducted ICAR-ARS-2017 (Preliminary) and NET (I)-2018 examination from 6-10th April, 2018 (attended by 1642 candidates) and on 22nd April 2018 (attended by 35 candidates). The cell also provided statistical support and consultancy to the scientists and students of the institute. ARIS Cell also developed two mobile applications for 'Organic Livestock Farming' and "पशुओं में परजीवी संक्रमण व बचाव". Organic Livestock Farming application provides information on different aspects of organic livestock farming where as "पशुओं में परजीवी संक्रमण व बचाव" application provides information on ectoparasites and endoparasites of livestock.

Mobile applications: 'Organic Livestock Farming' and "पशुओं में परजीवी संक्रमण व बचाव"

Bioinformatics Centre, Izatnagar
The centre provides support in the bioinformatics aspects for all life science streams, especially veterinary and animal sciences. The Major activities of the centre during the year 2017-18 are detailed below:

1. The Bioinformatics Centre has provided bioinformatics support to over hundred students for their Ph.D. and M.V.Sc. research work.
2. Scientists and students of the institute and other organizations were trained as and when required in handling bioinformatics databases and tools for sequence analysis, primer designing, probe searching, microarray analysis and phylogenetic analysis, etc.
3. Bioinformatics facilities were also extended for conducting practical of the course 'Bioinformatics in Biotechnology'. More than 50 students of Animal Biotechnology and other disciplines registered the course.

4. The Centre has organized one National Workshop-cum-Training program on "Computational Approaches in Biotechnology for Beginners" from February 06-10, 2017 wherein 35 students participated.
5. The Centre has organized one training program on "Use of Bioinformatics Tools in Animal Science Research: Basic & Fundamentals" for the Master's and doctoral students of IVRI. Total 30 students were trained in Bioinformatics during the year.
6. The Centre has organized another training program on "Real Time PCR Data Analysis" for the scientists of IVRI during the year wherein 20 scientists participated.

Infrastructure facilities

1. Computer and Communication Facility: Bioinformatics Centre has almost all modern facilities with 2 mbps VSAT connectivity, wi-fi, broadband, fax, 20 Windows computer terminals and one Apple computer with Mac operating system.
2. Scientific Software Packages: CLC Workbench (CLCBio), Lasergene (DNASTAR), Genocluster Software (IGIB Jalaja), ClustalW, Rasmol, Gene Designer, Emboss, Geneious, SeqTools, Oligos, Open Bable, Chemsketch, Oligo Analyzer, Mega5.0, Autodock (MGL Tools), Sequin etc.

Collaborative works/initiative

Institute has different national/international projects where bioinformatics tools are used. Centre is providing all possible supports in these research projects.

National Animal Science and Veterinary Education Museum

The museum received a variety of 728 new exhibits depicting or related with animals/birds. These included national and international currency notes and coins (137), national and international postage stamps/ special covers (445), handicrafts (14), souvenirs and souvenir mugs (5), laboratory apparatus / equipments (22), terracotta figurines and biological specimens (22), miscellaneous items (22), publications (7), and display sun boards (48), etc. Museum exhibits received were continuously face lifted, maintained and displayed suitably. Photography of all new exhibits was done and proper bilingual titles were prepared/old labels were replaced and put in standee along with exhibits. Inventory and e-inventory of museum was continuously updated. Indian and International coins (201) were cleaned, identified and an album was prepared and displayed in a show case. During the period 48 sun boards on profile of Ministry of Agriculture and Farmers Welfare, ICAR, Animal Science Division, DADHF and ICAR Animal Science Institutes, etc. were developed, displayed in the museum. Maintenance and supervision was done for better landscape, cleanliness of lawns, hedges and flower plants in museum premises.

Sea Snail Fossil or Bembexia

Museum celebrated 'International Museum Day' on 18th May 2017. On this occasion an open day was kept for visitors and a special lecture was arranged. A total of 3,538 IVRI/ICAR visitors including distinguished guests, farmers, families and children etc. visited the museum. Museum was also visited by more than 71 groups of student/trainee from veterinary/agriculture and medical Colleges from 9 different states.

The growing fame of the museum attracted a total of 29 groups of government and private school children from Bareilly and adjoining districts; some of the school trips were organized through District Science Club, Nature Club and Office of the District Inspector of Schools.

Sale and Disposal of Livestock Products by LPT Division

Handling, processing and sale of milk and milk products (Dairy Technology Section)

Milk received from LPM Section was pasteurized, evaluated, packed and sold to the employees or processed into different products. During the one-year period the total milk received by DT section was 7,35,845 kg, and the revenue realized through sale of milk and milk products (paneer, skimmed milk, and ghee) was Rs. 2,44,30,816.

Slaughtering, processing and disposal of meat (Experimental Abattoir)

Experimental animals of different Divisions/Sections were slaughtered and carcass characteristics were evaluated. After fulfilling the research requirements, surplus meat was sold. The revenue generated was Rs. 78,502.

Processing and quality evaluation of meat products (Pilot Plant)
Pilot-scale meat processing for different experimental products was done. After quality evaluation, surplus experimental products were sold to staff and students of the institute. The revenue generated was Rs. 29,060.

Handling and disposal of hides and skins (Hide and Skin Section)
Hides and skins obtained from dead and fallen animals of the institute were preserved and disposed at regular intervals generating a revenue of Rs.11,267.

Agricultural Technology Information Centre (ATIC), Izatnagar

A total of 23,685 visitors visited ATIC, out of which 19,213 visitors came for technology/product procurement, 498 for consultancy and 3,974 for exposure visits (83 visit groups). The visitors mainly included livestock owners/farmers, students, and entrepreneurs and distinguished persons. During visits, the visitors were shown dairy farm, polyclinic, piggery farm, feed unit, Krishi Vigyan Kendra and various research divisions of the institute. The visitors included 1,798 School children: 1059 farmers, 50 field veterinarians, 224 other professionals, 813 college students (UG/PG scholars), and 30 academicians from various agriculture and veterinary universities.

Kisan Call Centre and Help Line

A total of 173 queries regarding livestock management, extension programs, livestock feeding and nutrition, livestock diseases, goat husbandry, dog, poultry, fisheries, bee keeping, horticulture and other allied subjects of agriculture were received through Kisan Call Centre and Institute Help Line which were duly addressed by different experts/scientists of the institute.

Communication Centre, Izatnagar

The centre provided services in the area of publication, printing, photography, art, photocopying, editing, typing, binding, press and media coverage, etc. as a central facility. Various assignments carried out by the centre were as follows:

- Photography coverage of 227 jobs related to research, teaching, extension and other activities of the institute were undertaken.
- Hindi press releases (206) were prepared and sent for publication in different national/local newspapers. Press conferences were arranged and executed.
- Publications of 168 time-bound advertisements of the institute in 126 editions of national/local newspapers including Indian Trade Journal and Employment News.
- About 150 spiral binding jobs related to different division/sections were undertaken and executed.
- Printing of about 96,500 copies of different forms, and proformas, etc. were completed.
- A total of 424 certificate writings related to various programs of the institute were undertaken.
- Photocopying of about 8,292 copies were undertaken and executed.

Besides, 22 printing jobs of books, manuals and compendium, etc., and 19 other jobs (registers, proformas, etc.) were successfully done. Besides, 180 I-cards of newly admitted students, and 180 I-cards of IVRI employees and pensioners were also prepared.

Infrastructure Facilities for *'DIVYANGJAN'*

The persons with disabilities (*Divyangjan*) in the institute are: 01 scientific, 04 technical, 10 administrative and 8 supporting staff. For the benefit of differently abled persons, the institute has constructed ramps/railing in major office buildings *viz.,* central office, university building, MLB building, IGH guest house, bio-engineering building, polyclinic and kendriya vidyalaya. Further efforts will be made to increase such facilities in the remaining buildings in the coming years.

Human Hospital, IVRI, Izatnagar

Human hospital, an integral part of IVRI, extends optimum medical facilities to the staff of IVRI and CARI with a focus on preventive healthcare, treatment, awareness and health education. The facility has clinical pathology lab, nursing care, dressing room, day care short term indoor facility, emergency care room and pharmacy. The hospital is equipped with nebulizer, biochemistry auto-analyzer, short-wave diathermy, urine chemistry analyzer, electrocardiogram, pulse oxymeter and ambulance facility.

During the year, the hospital attended 43,244 cases, besides 231 emergency and 330 indoor cases. Vaccination coverage was extended to 1,770 subjects, which included tetanus (763), measles (7), oral polio (21) and anti-rabies (373). The clinical investigations included 1,500 ECG and diathermy, and 8,587 clinical pathology examinations. A total of 1,500 dressing cases, 20 minor surgical cases and 06 plaster cases were attended. Ambulance was used to carry patients to other advanced hospitals in the city and out-station.

Blood donation camps were organized on 15-8-2017 and 18-8-2017, and total 212 donations were (a record) done with support of IMA, Bareilly.

Blood donation camp at Human Hospital, IVRI, Izatnagar

Staff Dispensary, Bengaluru

The Staff Dispensary of IVRI Bengaluru campus is rendering services to the employees and their dependents of IVRI and other neighbouring ICAR Institutes such as NIVEDI, NBAIR, ZPD, NBSS & LUP and ZPD by offering comprehensive health care services. Further, pensioners (senior citizen) who have retired from various ICAR institutes within and outside the perimeter of the Bengaluru are also being registered and treated.

The staff dispensary has a total of 2,000 registered subjects including employees and pensioners.

Services provided

- Comprehensive health care services through primary health care approach
- Comprehensive geriatric health care services of the aged and age related problems
- Comprehensive maternal child health and family planning services
- Emergency and referral services
- Information and education and communication (IEC) activities
- Overall supervision of the environmental sanitation and hygiene of the campus to prevent any outbreak of diseases

Awareness programmes

- Free HbA1c camp
- Free eye screening camp
- Free diabetes screening camp
- Lecture on 'stress management for working women' on the eve of International Women's Day
- Participation in Pulse Polio immunization program.

jkt Hkk"kk vuHkkx

भारत सरकार की राजभाषा क्रियान्वयन नीति से सम्बन्धित समय–समय पर जारी विविध आदेशों/निर्देशों का अनुपालन करते हुए अपने सभी दायित्वों को पूरा करने के लिए राजभाषा अनुभाग सतत रुप से प्रयास कर रहा है। इसी क्रम में अनुभाग द्वारा वर्ष 2017–18 के दौरान किये गये कार्यो का संक्षिप्त विवरण निम्नानुसार है:

lLFkku jkt Hkk"kk dk;kUo;u lfefr dh =ekfld cBdk dk vk;kstu

अनुभाग द्वारा भारत सरकार तथा भारतीय कृषि अनुसंधान परिषद से समय–समय पर प्राप्त निर्देशों के अनुसार प्रत्येक तिमाही की समाप्ति पर राजभाषा सम्बन्धी त्रैमासिक बैठकों का आयोजन किया गया। इन सभी बैठकों की अध्यक्षता निदेशक एवं अध्यक्ष, संस्थान राजभाषा कार्यान्वयन समिति द्वारा की गई तथा संस्थान के विभिन्न विभागों के विभागाध्यक्ष एवं वरिष्ठ अधिकारियों ने समिति के सदस्य के रुप में सहभागिता की। इन बैठकों में संस्थान के कामकाज में राजभाषा कार्यान्वयन हेतु विभिन्न मदों पर चर्चा की गई तथा लिए गये निर्णयों का अनुपालन सुनिश्चित किया गया।

jkt Hkk"kk foHkkx }kjk fu/kkfjr ik#i e: =ekfld fjikVZ dk ldyu

संस्थान के विभिन्न विभागों/अनुभागों द्वारा हिन्दी में किये जा रहे कार्यो की प्रगति रिपोर्ट निर्धारित प्रोफार्मा में हर त्रैमास पर मॉगी गई। सभी विभागों/अनुभागों से प्राप्त रिपोर्ट को संकलित कर समेकित रिपोर्ट तैयार की गई तत्पश्चात समेकित रिपोर्ट भारतीय कृषि अनुसंधान परिषद, भारत सरकार के राजभाषा विभाग तथा नगर राजभाषा कार्यान्वयन समिति को अग्रिम कार्यवाही हेतु भेजा गया।

Hkkjr ljdkj dk jkt Hkk"kk okf"kZd dk;Øe dk vuqikyu

गृह मंत्रालय राजभाषा विभाग से प्राप्त वार्षिक कार्यक्रम द्वारा निर्धारित लक्ष्यों की प्राप्ति हेतु वार्षिक कार्यक्रम में दिये गये निर्देशों के अनुसार कार्यवाही की गई तथा सभी विभागों/अनुभागों को इन निर्देशों से अवगत कराया गया और सं0रा0का0स0 की बैठक में भी वर्ष 2017–18 के वार्षिक कार्यक्रम पर विचार–विमर्श किया गया।

fofHkUu fgUnh izkRlkgu ;kstukvksa dk ykxw djuk

राजभाषा विभाग द्वारा जारी निर्देशों एवं राजभाषा वार्षिक कार्यक्रम के अनुरुप विभिन्न हिन्दी प्रोत्साहन योजनाएं जैसे–सरकारी कामकाज मूलरुप से हिन्दी में करने की योजना, वैज्ञानिकों/अधिकारियों के लिए हिन्दी डिक्टेशन योजना, अंग्रेजी टाइपिस्टों के लिए हिन्दी में टाइपिंग का प्रोत्साहन भत्ता देने की योजना चलाई गई। इन सभी योजनाओं में सहभागिता करने वाले अधिकारियों एवं कर्मचारियों को निर्धारित पुरस्कारों से पुरस्कृत किया गया। इसी के साथ विभागों/अनुभागों के लिए अधिकाधिक हिन्दी में कार्य करने के लिए हिन्दी शील्ड योजना भी चलाई गई।

vxzsth fo"k; oLrq dk fgUnh vuqokn

संस्थान के विमिन्न विभागों/अनुभागों से प्राप्त विभिन्न प्रकार की वैज्ञानिक एवं प्रशासनिक विषय–वस्तु का अनुवाद किया गया। इसमें विभिन्न

प्रकार के फार्म आदि भी शामिल है। विभिन्न प्रकार के गोपनीय कागजातों का प्राथमिकता के आधाार पर अनुवाद कर संबन्धित अनुभागों को उपलब्ध करवाया गया । संस्थान में सामान्य रुप से प्रयोग होने वाले 81 फार्मो की 5 पुस्तक तैयार की गई और हिन्दी में मुद्रित सभी फार्मो को संस्थान की वेब साइट पर अपलोड कराया गया।

संस्थान के वैज्ञानिक, अधिकारी तथा कर्मचारी अपना दैनिक सरकारी कामकाज बिना किसी झिझक के अधिक से अधिक हिन्दी में संपादित कर सकें इसके लिए राजभाषा विभाग के निर्देशों के अनुसार हिन्दी कार्यशालाओं का आयोजन किया गया। इस अवधि में आयोजित कार्यशालाओं का संक्षिप्त विवरण निम्नानुसार है:–

fgUnh dk;Z'kkykvksa dk vk;kstu

Ø-l-	dk;Z'kkyk dk fo"k;	vk;kstu dh frfFk	izfrHkkfx;ksa dh l[;k
1.	बदलते परिवेष में हिन्दी की महत्ता	11.04.2017	116
2.	संस्थान में कार्यरत अधिकारियों/कर्मचारियों को तिमाही हिन्दी प्रगति रिपोर्ट को पूर्ण करने हेतु एक दिवसीय हिन्दी कार्यशाला	11.08.2017	26
3.	अहिन्दी भाषा छात्रों के लिए प्रारंभिक एवं बोलचाल की हिन्दी	28.08.2017 से 30.08.2017	65
4.	राजभाषा कार्यान्वयन एवं प्रयोग	15.12.2017	67

jkt Hkk"kk Lekfjdk dk izdk'ku

वर्ष 2017 में अनुभाग द्वारा राजभाषा स्मारिका का प्रकाशन करवाया गया जिसमें संस्थान के वैज्ञानिकों/अधिकारियों एवं कर्मचारियों द्वारा लिखित वैज्ञानिक लेख, सामान्य लेख प्रकाशित किये गये। इसमें अधिकारियों/कर्मचारियों द्वारा स्वरचित कविताओं का भी समावेश किया गया है।

fgUnh i[kokM+k dk vk;kstu

इस वर्ष हिन्दी पखवाड़े का आयोजन किया गया जो कि दिनांक 14.09.2017 से 29.09.2017 तक की अवधि में आयोजित किया गया। इसके अंतर्गत विभिन्न प्रकार के कार्यक्रम एवं प्रतियोगितायें आयोजित की गईं।

jkt Hkk"kk vuHkkx cxy#

oSKkfud xfrfof/k;k¡

1. वैज्ञानिक गतिविधियों से सम्बन्धित अंग्रेजी शोध–पत्रों एवं आठ स्नातकोत्तर/विद्या वाचस्पति शोध–विद्यार्थियों के शोध प्रबन्धों के मिनि एबस्ट्रेक्ट एवं उनके मुख्य पृष्ठ का हिन्दी अनुवाद सम्पन्न
2. संस्थान के बेंगलूरु परिसर की वार्षिक रिपोर्ट 2016–17 का हिन्दी अनुवाद एवं प्रकाशन सम्पन्न
3. अटारी (आई.सी.ए.आर.–कृषि प्रौद्योगिकी अनुप्रयोग अनुसंधान संस्थान) (एग्रीकल्चरल टेकनोलोजी एप्लीकेशन रिसर्च इंस्टीटयूट हेब्बाल बेंगलूरु) की वार्षिक रिपोर्ट का भी उचित माध्यम द्वारा हिन्दी अनुवाद सम्पन्न एवं प्रकाशन

¼v½ fgUnh dk;kZUo;u xfrfof/k;k¡ ,oa miyfC/k;k¡

- सामान्यतया, धारा 3(3) का शत–प्रतिशत अनुपालन सुनिश्चित
- हिन्दी में प्राप्त पत्रों और हिन्दी में हस्ताक्षित पत्रों का उत्तर अनिवार्य रूप से हिन्दी में सुनिश्चित
- हिन्दी के मूल पत्राचार के अंतर्गत "क", "ख" और "ग" क्षेत्रों में स्थित केन्द्रीय सरकारी कार्यालयों को भेजे गए पत्रों के निर्धारित–लक्ष्य से अधिक की प्राप्ति अर्थात "क" क्षेत्र में 55% से अधिक, और "ग" क्षेत्र में 70% से अधिक लक्ष्य की प्राप्ति
- फाइलों की नोट–शाट्स पर लिखी गई हिन्दी टिप्पणियों का प्रतिशतः 40% से अधिक
- रा.भा.का.स. की चारों बैठकें समय पर सम्पन्न
- बेंगलूरु नगर राजभाषा कार्यान्वयन समिति (नराकास) की दोनो बैठकों में उपस्थिति सुनिश्चित
- सभी 19 कम्प्यूटरों में हिन्दी यूनीकोड में काम करने की सुविधा उपलब्ध
- फाइल–कवरों के अन्दर छोटी–छोटी टिप्पणियां अंग्रेजी–हिन्दी के द्विभाषीय रूप में उपलब्ध
- हिन्दी की तिमाही प्रगति रिपोर्ट्स का ऑन–लाइन सम्प्रेषण
- 80% से ज्यादा कर्मचारी वृन्द को हिन्दी का कार्यसाधक ज्ञान प्राप्त होने के कारण, यह कार्यालय नियम 10(4) के अंतर्गत राजपत्र में अधिसूचित कराया गया।
  पत्र–शीर्ष और अर्द्ध–शासकीय पत्र–शीर्ष द्विभाषा में उपलब्ध
- संस्थान के नाम के दोनो बोर्ड, त्रिभाषीय–सूत्र (कन्नड–हिन्दी–अंग्रेजी) में तैयार कराए गए
- द्वार–पट्ट/नाम–पट्ट द्विभाषा में तैयार कराए गए
- स्टाफ–वाहनों पर विवरण द्विभाषीय रूप में उपलब्ध
- सभी रबर की मोहरें द्विभाषा में उपलब्ध

¼c½ fo'k"k xfrfof/k;k ,oa miyfC/k;k

1. डॉ. डी.पी. सिंह, सहायक मुख्य तकनीकी अधिकारी एवं प्रभारी अधिकारी, हिन्दी अनुभाग को, दिनांक 06 से 10 मार्च, 2017 के दौरान, केन्द्रीय हिन्दी प्रशिक्षण उपसंस्थान, केन्द्रीय सदन, कोरमंगला, बेंगलूरु द्वारा आयोजित, "कम्प्यूटर पर हिन्दी में काम करने का बेसिक–प्रशिक्षण" दिलाया गया।
2. दिनांक 21.06.2017 को संस्थान के बेंगलूरु परिसर में, "अंतर्राष्ट्रीय योग–दिवस" का उद्देश्यात्मक आयोजन किया गया, जिसमें सभी अधिकारियों एवं कर्मचारियों द्वारा स्वेच्छा से भाग लेकर कथित कार्यक्रम को सफल बनाया गया।
3. बेंगलूरु परिसर में दिनांक 15.08.2017 को मनाए गए, "स्वतंत्रता दिवस समारोह" के पावन अवसर पर, डॉ अनिकेत सान्याल, संयुक्त निदेशक महोदय के कर–कमलों द्वारा, "ध्वजारोहण" उपरांत, सभी उपस्थित सभासदों को हिन्दी में उद्बोधित किया गया। इसके अलावा, "वृक्षारोपण" और "स्वच्छ भारत अभियान" जैसे अन्य विविध कार्यक्रमों का भी उद्देश्यात्मक सफल आयोजन किया गया।
4. संस्थान के निदेशक–महोदय की अनुमति से, दिनांक 11.08.2017 को, आई.सी.ए.आर.–आई. आई.एच.आर., हेस्सरघट्टा, बेंगलूरु में आयोजित, "प्रशासन/प्रबन्धन की दक्षता एवं प्रभाव बढाने और राजभाषा नीति का प्रभावी कार्यात्वयन" नामक "राष्ट्रीय सम्मेलन" में डॉ. डी.पी. सिंह, सहायक मुख्य तकनीकी अधिकारी एवं प्रभारी अधिकारी, हिन्दी अनुभाग और श्रीमती बी. दाक्षायणी, सहायक प्रशासनिक अधिकारी द्वारा प्रतिभागिता सुनिश्चित की गई।
5. संस्थान में दिनांक 14 से 16 सितम्बर, 2017 के दौरान, "तीन दिवसीय हिन्दी कार्यशाला एवं हिन्दी दिवस समारोह" के उपलक्ष्य में, "हिन्दी–टिप्पण लेखन पर कार्यशाला", "लिखित परिक्षा", "हिन्दी भाषण–स्पर्धा" के अलावा, "कुशल सहायक कर्मचारियों के लिए उनके दैनिक कार्योंसे सम्बन्धित मौखिक प्रश्नोत्तर" जैसे विविध रंगारंग कार्यक्रमों का उद्देश्यात्मक सफल आयोजन किया गया।
6. दिनांक 26.10.2018 की श्री टेकचन्द, उपनिदेशक (राजभाषा–कार्यान्वयन), केन्द्रीय सदन, कोरमंगला, बेंगलूरु द्वारा संस्थान के बेंगलूरु परिसर की हिन्दी प्रगति का निरीक्षण किया गया।
7. दिनांक 08.12.2017 को, विशाखापट्टनम (आन्ध्र–प्रदेश) में आयोजित, "दक्षिण एवं दक्षिण–पश्चिम राजभाषा सम्मेलन" में, संस्थान के बेंगलूरु परिसर को, वर्ष 2016–17 राजभाषा कार्यान्वयन के क्षेत्र में सराहनीय कार्य–निष्पादन के लिए, राजभाषा विभाग, भारत सरकार के, माननीय गृह राज्य मंत्री, "श्री किरण रिजीजू" के कर–कमलों द्वारा, "द्वितीय पुरस्कार शील्ड", बेंगलूरु परिसर के प्रतिनिधि, डॉ. डी.पी. सिंह राजभाषा अधिकारी एवं प्रभारी, हिन्दी अनुभाग, द्वारा साभार पूर्वक प्राप्त की गई।
8. दिनांक 10.01.2018 को, इसरो मुख्यालय, न्यू.बी. ई.एल. रोड, बेंगलूरु द्वारा प्रायोजित एवं आयोजित, "विश्व हिन्दी दिवस समारोह–2017" में डॉ. डी.पी. सिंह, सहायक मुख्य तकनीकी अधिकारी एवं प्रभारी अधिकारी, हिन्दी अनुभाग द्वारा प्रतिभागिता सुनिश्चित की गई।
9. दिनांक 14.03.2018 को, एच.ए.एल., बेंगलूरु में, आयोजित, नराकास (कार्यालय–2) के "राजभाषा सम्पर्क अधिकारियों की बैठक" में डॉ. डी.पी. सिंह, सहायक मुख्य तकनीकी अधिकारी एवं प्रभारी अधिकारी, हिन्दी अनुभाग द्वारा प्रतिभागिता सुनिश्चित की गई।

15.0 Personnel

ADMINISTRATION

IZATNAGAR CAMPUS

1. Dr R.K. Singh, Director & Vice-Chancellor
2. Dr B.P. Mishra, JD (Research)
3. Dr V.K. Gupta, JD (CADRAD)
4. Dr A.K. Garg, JD (Extension) (up to 31.08.2017)
5. Dr Triveni Dutt, JD (Academic)
6. Dr Mahesh Chander, Actg Joint Director (Extension) (w.e.f. 01.09.2017)
7. Dr S.V.S. Malik, Scientific Secretary to Director
8. Dr G. Saikumar, In-charge, PME Cell
9. Dr A.K. Sharma, Controller of Examinations (up to 31.07.2018)
10. Dr O.K. Raina, Controller of Examinations (w.e.f. 01.08.2017)
11. Sri Rakesh Kumar, JD (Adm.) cum Registrar
12. Sri Radhey Sham, Comptroller
13. Sri Debasis Moitra, CAO (Adm.)
14. Sri A. Ghosh, SAO (up to 31.08.2017)
15. Sri Pankaj Kumar, SAO
16. Sri Ravindra Kumar, F&AO (up to 12.06.2017)
17. Sri G.D. Amola, F&AO (up to 31.12.2017)
18. Smt S. Goswami, F&AO (w.e.f. 09.08.2017)
19. Sri D.S. Bisht, F&AO (w.e.f. 05.01.2018)
20. Smt Sujatha Jethi, Dy. Director (Official Language)
21. Dr (Smt.) Shashi Rani Saxena, Asst Professor (English)
22. Sri Panchoo Lal, AO (w.e.f. 03.04.2017 up to 19.12.2017)
23. Ms. Neha Cahudhary, AO
24. Sri Hartesh Kaushik, AO (w.e.f. 13.12.2017)
25. Sri David Wheeler, Private Secretary (up to 31.12.2017)
26. Sri B.N. Pal, Private Secretary
27. Sri K.C. Chauhan, Private Secretary
28. Sri A.K. Saxena, Private Secretary
29. Sri Sushil Kumar, Private Secretary
30. Sri K.K. Tiwari, Private Secretary
31. Sri D.K. Joshi, Private Secretary
32. Sri B.P. Tiwari, Private Secretary (w.e.f. 01.01.2018)
33. Sri P.S. Jina, AAO (up to 30.11.2017)
34. Sri S.N. Singh, AAO
35. Sri J.D. Suntha, AAO
36. Sri Anil K. Joshi, AAO
37. Sri B.S. Rana, AAO
38. Sri Chandra Prakash, AAO
39. Sri M.K. Saxena, AAO (up to 31.01.2018)
40. Sri M.S. Lawal, AAO
41. Sri Karunesh Shukla, AAO
42. Sri D.K. Sapra, AAO
43. Sri Sarvar Ali, AAO
44. Sri Avinash Kumar, AAO
45. Smt Meena Agarwal, AAO
46. Sri Naseer Ahmad, AAO
47. Smt Sahana Begum, AAO (up to 31.05.2017)
48. Sri Balvir Singh, AAO
49. Sri Manish Srivastava, AAO
50. Sri A.K. Sharma, AAO
51. Sri Rajeev Kumar Saxena, AAO
52. Smt Alka Rani, AAO
53. Sri Mohd. Wasim, AAO (w.e.f. 01.06.2017)
54. Sri S.S. Rawat, AAO (w.e.f. 29.03.2018)
55. Sri S.S. Saxena, AAO (w.e.f. 29.03.2018)
56. Sri J.C. Arya, AF&AO
57. Sri Sayed Mohsin Ali, JAO

MUKTESWAR CAMPUS

1. Dr A.K. Sharma, Actg Station In-charge (up to 05.08.2017)
2. Dr M.A. Ramakrishnan Actg Station In-charge (w.e.f. 06.08.2017)
3. Sri Omveer Singh, AF&AO
4. Sri G.S. Danu, Private Secretary
5. Sri Manish Srivastava, AAO

BENGALURU CAMPUS

1. Dr Aniket Sanyal, Joint Director
2. Smt. G.S. Rajalaxmi, Private Secretary
3. Dr S. Srinivas, Medical Officer
4. Smt B. Dakshyani, AAO
5. Smt S. Kusuma, AF&AO

REGIONAL STATION, PALAMPUR

1. Dr R. Bhar, Pr. Scientist & Station In-charge (upto 30.01.2018)
2. Dr Gorakh Mal Pr. Scientist & Station In-charge (w.e.f. 31.01.2018)

EASTERN REGIONAL STATION, KOLKATA

1. Dr S. Bandyopadhyay, Pr. Scientist & Station In-charge
2. Sri J.S. Nayal, AAO

TRAINING & EDUCATION CENTRE, PUNE

1. Dr K.N. Bhilegaonkar, Pr. Scientist & Station In-charge

DIVISIONS/ SECTIONS - MAIN CAMPUS, IZATNAGAR

Bacteriology and Mycology

1. Dr R.K. Agarwal, M.V.Sc., Ph.D., Pr. Scientist & Acting Head
2. Dr P. Chaudhuri, M.V.Sc., Ph.D., Pr. Scientist
3. Dr Rajneesh Rana, M.V.Sc., Ph.D., Pr. Scientist
4. Dr K.N. Viswas, M.V.Sc., Ph.D., Pr. Scientist
5. Dr Sabarinath T., M.V.Sc., Ph.D., Scientist (Sr. Scale)
6. Dr Abhishek, M.V.Sc., Ph.D., Scientist (Sr. Scale)
7. Dr Prasad Thomas, M.V.Sc., Scientist (Sr. Scale) (on study leave)
8. Dr Sophia Inbaraj, M.V.Sc., Scientist (w.e.f. 07.04.2017)

Biological Products

1. Dr R.P. Singh, M.V.Sc., Ph.D., Pr. Scientist & Head
2. Dr V.K. Chaturvedi, M.V.Sc., Ph.D., Pr. Scientist
3. Dr P. Das, M.V.Sc., Ph.D., Pr. Scientist
4. Dr Bina Mishra, M.V.Sc., Ph.D., Pr. Scientist
5. Dr Bablu Kumar, M.V.Sc., Ph.D., Sr Scientist
6. Dr K.K. Rajak, M.V.Sc., Ph.D., Sr Scientist
7. Dr C.L. Patel, M.V.Sc., Ph.D. Scientist (Sr. Scale)
8. Dr S. Chakravarti, M.V.Sc., Scientist (Sr. Scale)

Biological Standardisation

1. Dr A.K. Tiwari, M.V.Sc., Ph.D., Pr. Scientist & Head
2. Dr A.B. Pandey, M.V.Sc., Ph.D., Pr. Scientist
3. Dr P. Dhar, M.V.Sc., Ph.D., Pr. Scientist
4. Dr Mayank Rawat, M.V.Sc., Ph.D., Pr. Scientist
5. Dr Y.P.S. Malik, M.V.Sc., Ph.D., Pr. Scientist & ICAR-National Fellow
6. Dr Salauddin Qureshi, M.V.Sc., Ph.D., Sr Scientist
7. Dr Vikramaditya Upmanyu, M.V.Sc., Ph.D., Scientist (Sr. Scale)

Centre for Animal Disease Research and Diagnosis

1. Dr V.K. Gupta, M.V.Sc., Ph.D., Joint Director
2. Dr K.P. Singh, M.V.Sc., Ph.D., Pr. Scientist
3. Dr Dinesh Chandra, M.V.Sc., Ph.D., Pr. Scientist
4. Dr A.G. Telang, M.V.Sc., Ph.D., Pr. Scientist
5. Dr S. Nandi, M.V.Sc., Ph.D., Pr. Scientist
6. Dr Rajesh Rathore, M.V.Sc., Ph.D., Pr. Scientist
7. Dr Vishal Chander, M.V.Sc., Scientist (Sr. Scale)
8. Dr Chandan Prakash, M.V.Sc., Scientist (On study leave)
9. Dr Gaurav Kumar Sharma, M.V.Sc., Ph.D., Scientist (w.e.f. 06.05.2017)

Technical Staff:

1. Sri Durga Dutt Sharma, MSc, STO

Epidemiology

1. Dr Bhoj Raj Singh, M.V.Sc., Ph.D., Pr. Scientist & Acting Head
2. Dr D.K. Sinha, M.V.Sc., Ph.D., Pr. Scientist
3. Dr Vinodh Kumar O.R., M.V.Sc., Ph.D., Scientist

Immunology

1. Dr T.K. Goswami, M.V.Sc., Ph.D., Pr. Scientist & In-charge
2. Dr Alka Tomar, M.V.Sc., Ph.D., Pr. Scientist
3. Dr S. Dandapat, M.V.Sc., Ph.D., Pr. Scientist
4. Dr R. Saravanan, M.V.Sc., Ph.D., Sr Scientist
5. Dr Mithilesh Singh, M.V.Sc., Ph.D., Scientist (Sr. Scale)

Medicine

1. Dr U. Dimri, M.V.Sc., Ph.D., MBA, Pr. Scientist & Actg. Head
2. Dr S. Dey, M.V.Sc., Ph.D., Pr. Scientist
3. Dr Reena Mukherjee, M.V.Sc., Ph.D., Pr. Scientist
4. Dr D.B. Mondal, M.V.Sc., Ph.D., Pr. Scientist
5. Dr S.K. Dixit, M.V.Sc., Ph.D., Pr. Scientist
6. Dr K. Mahendran, M.V.Sc., Scientist (Sr. Scale)
7. Dr Sumit Mahajan, M.V.Sc., Ph.D., Scientist
8. Dr R. Raguvaran, M.V.Sc., Scientist
9. Dr K. Karthika, M.V.Sc., Scientist
10. Dr Akhilesh Kumar, M.V.Sc., Ph.D., Scientist (w.e.f. 14.06.2017)

Parasitology

1. Dr P.S. Banerjee, M.V.Sc., Ph.D., Pr. Scientist & Actg Head
2. Dr S. Ghosh, MSc, Ph.D., Pr. Scientist
3. Dr S. Samanta, M.V.Sc., Ph.D., Pr. Scientist
4. Dr O.K. Raina, MSc, Ph.D., Pr. Scientist
5. Dr A.K. Tewari, M.V.Sc., Ph.D., Pr. Scientist
6. Dr Rajat Garg, M.V.Sc., Ph.D., Pr. Scientist
7. Dr B.C. Saravanan, M.V.Sc., Ph.D., Pr. Scientist
8. Dr Hira Ram, M.V.Sc., Ph.D., Sr Scientist

Pathology

1. Dr Rajendra Singh, M.V.Sc., Ph.D., Pr. Scientist & Actg Head
2. Dr A.K. Sharma, M.V.Sc., Ph.D., Pr. Scientist
3. Dr G. Saikumar, M.V.Sc., Ph.D., Pr. Scientist
4. Dr K. Dhama, M.V.Sc., Ph.D., Pr. Scientist

5. Dr M.R. Reddy, M.V.Sc., Ph.D., Pr. Scientist (w.e.f. 09.10.2017)
6. Dr Monalisa Sahoo, M.V.Sc., Scientist
7. Dr Pawan Kumar, M.V.Sc., Ph.D., Scientist
8. Dr Palanivelu M., M.V.Sc., Scientist
9. Dr Asok Kumar M., M.V.Sc., Ph.D., Scientist
10. Dr Saminathan M., M.V.Sc., Scientist
11. Dr Tareni Das, M.V.Sc., Scientist

Technical Staff:

1. Mr. V.K. Khokar, STO

Pharmacology and Toxicology

1. Dr Dinesh Kumar, M.V.Sc., Ph.D., Pr. Scientist & Head
2. Dr Thakur Uttam Singh, M.V.Sc., Ph.D., Sr Scientist
3. Dr Subhashree Parida, M.V.Sc., Ph.D., Scientist (Sr. Scale)
4. Dr Madhu C.L., M.V.Sc., Ph.D., Scientist
5. Dr Kesavan M., M.V.Sc., Scientist

Surgery

1. Dr Amarpal, M.V.Sc., Ph.D., Pr. Scientist & Head
2. Dr A.K. Sharma, M.V.Sc., Ph.D., Pr. Scientist (up to 31.07.2017)
3. Dr M. Hoque, M.V.Sc., Ph.D., Pr. Scientist
4. Dr P. Kinjavdekar, M.V.Sc., Ph.D., Pr. Scientist
5. Dr Naveen Kumar, M.V.Sc., Ph.D., Pr. Scientist
6. Dr A.M. Pawde, M.V.Sc., Ph.D., Pr. Scientist
7. Dr S.K. Maiti, M.V.Sc., Ph.D., Pr. Scientist
8. Dr Rekha Pathak, M.V.Sc., Ph.D., Pr. Scientist
9. Dr Kiranjeet Singh, M.V.Sc., Ph.D., Sr Scientist
10. Dr A.C. Saxena, M.V.Sc., Ph.D., Scientist
11. Dr Aswathy Gopinathan, M.V.Sc., Ph.D., Scientist
12. Dr Rohit Kumar, M.V.Sc., Ph.D., Scientist

Referral Veterinary Polyclinic

1. Dr Amarpal, M.V.Sc., Ph.D., Pr. Scientist & Coordinator
2. Dr K. Narayanan, M.V.Sc., Ph.D., Pr. Scientist
3. Dr Kiranjit Singh, M.V.Sc., Ph.D., Sr Scientist
4. Dr U.K. De, M.V.Sc., Ph.D., Scientist (Sr. Scale)
5. Dr A.C. Saxena, M.V.Sc., Ph.D., Scientist

Veterinary Biotechnology

1. Dr P.P. Goswami, MSc, Ph.D., Pr. Scientist & Actg Head
2. Dr P.K. Gupta, M.V.Sc., Ph.D., Pr. Scientist
3. Dr Praveen Singh, MSc, Ph.D., Pr. Scientist
4. Dr Sohini Dey, M.V.Sc., Ph.D., Pr. Scientist
5. Dr C. Madhan Mohan, M.V.Sc., Ph.D., Pr. Scientist
6. Dr GVPPS Ravi Kumar, MSc, Ph.D., Pr. Scientist
7. Dr S.K. Dhara, M.V.Sc., Ph.D., Pr. Scientist
8. Dr Sameer Srivastava, M.V.Sc., Ph.D., Sr Scientist
9. Dr Deepak Kumar, M.V.Sc., Ph.D., Scientist (Sr. Scale)
10. Dr Sonal, M.V.Sc., Ph.D., Sr Scientist
11. Dr Aditya P. Sahoo, M.V.Sc., Scientist (up to 07.07.2017)
12. Dr (Mrs.) Sonalika Mahajan, M.V.Sc.., Ph.D., Scientist
13. Dr Basavaraj Sajjanar, M.V.Sc., Ph.D., Scientist (w.e.f. 01.07.2017)

Technical Staff:

1. Sri Surendra Nath, MSc, CTO
2. Sri Narsingh Prasad, MSc, ACTO

Veterinary Public Health

1. Dr S.V.S. Malik, M.V.Sc., Ph.D., Pr. Scientist & Acting Head
2. Dr D.K. Singh, M.V.Sc., Ph.D., Pr. Scientist
3. Dr R.S. Rathore, MVPH, Ph.D., Pr. Scientist
4. Dr Deepak B. Rawool, M.V.Sc., Ph.D., Sr Scientist
5. Dr Z.B. Dubal, M.V.Sc., Ph.D., Sr Scientist
6. Dr Himani Dhanze, M.V.Sc., Ph.D., Scientist

Centre for Wildlife

1. Dr A.K. Sharma, M.V.Sc., Ph.D., Pr. Scientist & In-Charge
2. Dr M. Karikalan, M.V.Sc., Scientist
3. Dr S. Chandra Mohan, M.V.Sc., Scientist

Animal Genetics

1. Dr Bharat Bhushan, MSc, Ph.D., Pr. Scientist & Acting Head
2. Dr Ajay Kumar Sharma, M.V.Sc., Ph.D., Pr. Scientist (w.e.f. 06.08.2017)
3. Dr Pushpendra Kumar, MSc, Ph.D., Pr. Scientist
4. Dr Subodh Kumar, MSc, Ph.D., Pr. Scientist
5. Dr Ashwani Kr. Pandey, M.V.Sc., Ph.D., Pr. Scientist (w.e.f. 22.06.2017)
6. Dr Ran Vir Singh, MSc, Ph.D., Sr Scientist
7. Dr Amit Kumar, MSc, Ph.D., Sr Scientist
8. Dr Arvind Sonwane, M.V.Sc., Ph.D., Sr Scientist
9. Dr Anuj Chauhan, M.V.Sc., Ph.D., Scientist (Sr. Scale)
10. Dr Manjit Panigrahi, M.V.Sc., Ph.D., Scientist (Sr. Scale)

Technical Staff:

1. Sri Jai Prakash, MSc, STO

Animal Nutrition

1. Prof D.N. Kamra, MSc, Ph.D., National Professor (up to 15.01.2018)
2. Dr A.K. Verma, MSc (Ag), Ph.D., Pr. Scientist Head-cum-Director, CAFT
3. Dr A.K. Garg, MSc (AH), Ph.D., Pr. Scientist (up to 31.08.2017)
4. Dr L.C. Chaudhary, MSc (Ag), Ph.D., Pr. Scientist
5. Dr Putan Singh, MSc (AN), Ph.D., Pr. Scientist
6. Dr A.K. Pattanaik, M.V.Sc., Ph.D., Pr. Scientist
7. Dr Narayan Dutta, MSc (Ag), Ph.D., Pr. Scientist
8. Dr V.B. Chaturvedi, MSc (Ag), Ph.D., Pr. Scientist
9. Dr S.K. Saha, M.V.Sc., Ph.D., Pr. Scientist
10. Dr Asit Das, M.V.Sc., Ph.D., Pr. Scientist
11. Dr S.E. Jadhav, M.V.Sc., Ph.D., Sr Scientist
12. Dr Anju Kala, M.V.Sc., Scientist

Technical Staff:

1. Dr Avneesh Kumar, MSc, Ph.D., CTO
2. Sri R.K. Mishra, BSc (Ag &AH), CTO

Animal Reproduction

1. Dr H. Kumar, M.V.Sc., Ph.D., Pr. Scientist & Head
2. Dr S. Mahmood, M.V.Sc., Ph.D., Pr. Scientist
3. Dr S.K. Srivastava, M.V.Sc., Ph.D., Pr. Scientist
4. Dr S.K. Ghosh, M.V.Sc., Ph.D., Pr. Scientist
5. Dr G.K. Das, M.V.Sc., Ph.D., Pr. Scientist
6. Dr J.K. Prasad, M.V.Sc., Ph.D., Pr. Scientist
7. Dr S.K. Singh, M.V.Sc., Ph.D., Pr. Scientist
8. Dr Neeraj Srivastava, M.V.Sc., Ph.D., Sr Scientist (w.e.f. 01.06.2017)
9. Dr Brijesh Kumar, M.V.Sc., Ph.D., Scientist (w.e.f. 11.09.2017)

Livestock Production & Management Section

1. Dr G.K. Gaur, MSc, Ph.D., Pr. Scientist & In-charge
2. Dr V.K. Gupta, M.V.Sc., Ph.D., Pr. Scientist
3. Dr Mukesh Singh, M. Tech, Ph.D., Pr. Scientist
4. Dr A.K.S. Tomar, MSc, Ph.D., Pr. Scientist
5. Dr Sanjeev Mehrotra, M.V.Sc., Ph.D., Pr. Scientist
6. Dr Om Singh, MSc (Agro.), Ph.D., Sr Scientist
7. Dr Nihar Ranjan Sahoo, M.V.Sc., Ph.D., Sr Scientist
8. Dr H.O. Pandey, M.V.Sc., Scientist (on study leave)
9. Dr P.K. Bharti, M.V.Sc., Ph.D., Scientist
10. Dr M.K. Patra, M.V.Sc., Ph.D., Scientist
11. Dr Sanjeev Kr. Kochewad, M.V.Sc., Ph.D., Scientist (w.e.f. 01.07.2017)

Technical Staff:

1. Sri D. Sahi, BSc (Ag), CTO
2. Sri S.B. Singh, MSc (AH), CTO
3. Dr Omvir Singh, MSc (Ag. Ext.), ACTO
4. Sri Rajesh Bhasin, BSc, BEd, MA, ACTO
5. Sri Ashok Kumar, MSc (Ag), STO
6. Sri N.K. Singh, MSc (Ag), STO

Livestock Products Technology

1. Dr S.K. Mendiratta, M.V.Sc., Ph.D., Pr. Scientist & Head
2. Dr Geeta Chauhan, MSc, Ph.D., Pr. Scientist
3. Dr Ravi K. Agarwal, M.V.Sc., Ph.D., Sr Scientist
4. Dr I. Prince Devadason, M.V.Sc., Ph.D., Sr Scientist
5. Dr Rajiv R. Kumar, M.V.Sc., Ph.D., Scientist (Sr. Scale)
6. Dr Suman Talukder, M.V.Sc., Scientist
7. Dr Sagar Chand, M.V.Sc., Scientist
8. Dr Arvind, M.V.Sc., Scientist

Technical Staff:

1. Sri Ranvir Singh, MSc, STO

Physiology & Climatology

1. Dr G. Taru Sharma, MSc, Ph.D., Pr. Scientist & Head-cum-Director, CAFT
2. Dr Puneet Kumar, MSc, Ph.D., Pr. Scientist
3. Dr V.P. Maurya, MSc, Ph.D., Pr. Scientist
4. Dr Sadhan Bag, M.V.Sc., Ph.D., Pr. Scientist
5. Dr Mihir Sarkar, MSc, Ph.D., Pr. Scientist
6. Dr Gyanendra Singh, M.V.Sc., Ph.D., Pr. Scientist
7. Dr Vikash Chandra, M.V.Sc., Ph.D., Sr Scientist
8. Dr Vikrant Singh Chauhan, M.V.Sc., Ph.D., Scientist
9. Dr Hari Abdul Samad, M.V.Sc., Ph.D., Scientist

Technical Staff:

1. Sri M.C. Pathak, MSc (Env. Sci.) ACTO

Biochemistry

1. Dr P. Joshi, MSc, Ph.D., Pr. Scientist
2. Dr (Mrs) M. Kataria, MSc, Ph.D., Pr. Scientist & Acting Head
3. Dr Mohini Saini, MSc, Ph.D., Pr. Scientist
4. Dr S.K. Bhure, M.V.Sc., Ph.D., Pr. Scientist
5. Dr Manish Mahawar, M.V.Sc., Ph.D., Sr Scientist
6. Dr Ajay Kumar, M.V.Sc., Ph.D., Scientist (Sr. Scale)
7. Dr I. Karuna Devi, M.V.Sc., Scientist (on study leave)
8. Dr Mukesh Kumar, M.V.Sc., Scientist

Technical Staff:
1. Dr Meeta Saxena, MSc, Ph.D., ACTO
2. Sri Piyush Kumar, MSc, STO

Joint Directorate of Extension Education
1. Dr A.K. Garg, MSc & AH, Ph.D., Joint Director (up to 31.08.2017)
2. Dr Mahesh Chander, MSc, Ph.D., Pr. Scientist & Actg Joint Director (w.e.f. 01.09.2017)
3. Dr B.P. Singh, MSc, Ph.D., Pr. Scientist
4. Dr Rupasi Tiwari, MSc, Ph.D., Pr. Scientist

Technical Staff:
1. Dr R.B. Bind, MSc, Ph.D., ACTO

Extension Education
1. Dr Mahesh Chander, MSc, Ph.D., Pr. Scientist & Head
2. Dr B.P. Singh, MSc, Ph.D., Pr. Scientist
3. Dr Rupasi Tiwari, MSc, Ph.D., Pr. Scientist
4. Dr P.K. Mukherjee, MSc, Ph.D., Sr Scientist
5. Dr R.S. Suman, MSc (Ag), Ph.D., Sr Scientist (w.e.f. 03.07.2017)
6. Dr Pachaiyappan K., M.V.Sc., Scientist

Krishi Vigyan Kendra (KVK)
1. Dr B.P. Singh, MSc, Ph.D., Pr. Scientist & Programme Coordinator

Technical Staff:
1. Sri Rakesh Pandey, MSc (Ag), SMS
2. Sri Ranjeet Singh, MSc (Hort.), SMS
3. Dr Ranjana Gupta, MSc, Ph.D., Training Associate
4. Sri Manish Tomar, MSc (Agri. Ext.), SMS

Livestock Economics, Statistics & Information Technology
1. Dr Sanjay Kumar, Ph.D., Pr. Scientist & Acting Head
2. Dr Med Ram Verma, Ph.D. (Statistics), Pr. Scientist
3. Dr D. Bardhan, M.V.Sc., Ph.D., Pr. Scientist
4. Dr Dinesh Kumar, Ph.D. Scientist (Sr. Scale)

Technical Staff:
1. Sri Ajay Shukla, MSc, CTO

REGIONAL STATIONS/CENTRES/ CAMPUSES

Division of Virology, Mukteswar
1. Dr M.A. Ramakrishnan, M.V.Sc., Ph.D., Principal Scientist & Actg Head (w.e.f. 19.01.2017)
2. Dr D. Muthuchelvan, M.V.Sc., Ph.D., Pr. Scientist
3. Dr S.K. Biswas, M.V.Sc., Ph.D., Scientist (Sr. Scale)
4. Dr Gnanavel V., M.V.Sc., Ph.D., Scientist (Sr. Scale)
5. Dr Chandra Sekar, M.V.Sc., Ph.D., Scientist
6. Dr Karam Chand, M.V.Sc., Scientist
7. Dr Amit Kumar, M.V.Sc., Scientist

Technical Staff:
1. Sri D.C. Joshi, Diploma (Elect. Eng.) CTO
2. Dr Manu Malviya, MBBS, CTO, (MO)
3. Sri R.L. Banker, MLib Sci, BEd & Dip (Agri) STO

Temperate Animal Husbandry, Mukteswar
1. Dr A.K. Sharma, M.V.Sc., Ph.D., Pr. Scientist & In-charge (up to 05.08.2017)
2. Dr C. Jana, M.V.Sc., Ph.D., Sr Scientist (w.e.f. 06.08.2017)
3. Dr M. Sankar, M.V.Sc., Ph.D., Sr Scientist
4. Dr A.R. Gurav, M.V.Sc., Ph.D., Scientist
5. Dr S.S. Dangi, M.V.Sc., Ph.D., Scientist
6. Dr Deepak Upadhyay, M.V.Sc., Ph.D., Scientist
7. Dr Sidharth Gautam, M.V.Sc., Scientist

IVRI Campus, Bengaluru
1. Dr Aniket Sanyal, M.V.Sc., Ph.D., Joint Director
2. Dr Subodh Kishore, M.V.Sc., Ph.D., Pr. Scientist
3. Dr G.R. Reddy, M.Sc., Ph.D., Pr. Scientist
4. Dr V. Bhanuprakash, M.V.Sc., Ph.D., Pr. Scientist
5. Dr K. Ganesh, M.V.Sc., Ph.D., Pr. Scientist
6. Dr B.P. Sreenivasa, M.V.Sc., Ph.D., Pr. Scientist
7. Dr H.J. Dechamma, M.V.Sc., Ph.D., Pr. Scientist
8. Dr V. Umapathi, M.V.Sc., Ph.D., Sr Scientist
9. Dr B.H.M. Patel, M.V.Sc., Ph.D., Sr Scientist
10. Dr P. Saravanan, BVSc, MSc, Ph.D., Pr. Scientist
11. Dr Madhusudan Hosamani, M.V.Sc.,Ph.D., Pr. Scientist
12. Dr S.H. Basagoudanavar, M.V.Sc., Ph.D., Pr. Scientist
13. Dr R.P. Tamil Selvan, M.V.Sc., Ph.D., Sr Scientist
14. Dr Priyanka Uppe, M.V.Sc., Ph.D., Scientist (w.e.f. 29.05.2017)

Technical Staff:
1. Sri A. Rajendran, MSc (Zool.), CTO
2. Dr Sakey Srinivas, MBBS, MD, CTO, Medical Officer
3. Sri S. Krishnamurthy, BE, ACTO (Instrument)
4. Sri V.C. Hiremath, BE (Civil), JE (Civil), STO
5. Sri Siddaraju, BSc (Ag), STO
6. Sri D.P. Singh, BA, BEd, MA (Eng.), MA (Hindi), STO

Eastern Regional Station, Kolkata

1. Dr S. Bandyopadhyay, M.V.Sc., Ph.D., Pr. Scientist & Station In-charge
2. Dr U.K. Bandyopadhyay, M.V.Sc., Ph.D., Pr. Scientist
3. Dr S.C. Das, M.V.Sc., Ph.D., Pr. Scientist
4. Dr R.Bhar, M.V.Sc., Ph.D., Pr. Scientist (w.e.f. 31.01.2018)
5. Dr Dayamoy Mondal, M.V.Sc., Ph.D., Pr. Scientist
6. Dr B. Mondal, M.V.Sc., Ph.D., Pr. Scientist
7. Dr S. Naskar, M.V.Sc., Ph.D., Pr. Scientist
8. Dr B.C. Das, M.V.Sc., Ph.D., Pr. Scientist
9. Dr P. Dandapat, M.V.Sc., Ph.D., MVM, Principal Scientist
10. Dr P.K. Nanda, MFSc, Ph.D., Pr. Scientist
11. Dr S. Bandyopadhyay, M.V.Sc., Ph.D., Sr Scientist
12. Dr Arun K. Das, M.V.Sc., Ph.D., Scientist
13. Dr Tapas K. Biswas, M.V.Sc., Ph.D., Scientist

Technical Staff:

1. Sri A.K. Ghosh, MSc, STO

Regional Station, Palampur

1. Dr R. Bhar, M.V.Sc., Ph.D., Pr. Scientist & In-charge (up to 30.01.2018)
2. Dr Gorakh Mal, MSc, Ph.D., Pr. Scientist & In-charge (w.e.f. 31.01.2018)
3. Dr Birbal Singh, MSc, Ph.D., Pr. Scientist
4. Dr U.S. Pati, M.V.Sc., Ph.D., Sr Scientist
5. Dr A. Kannan, M.V.Sc., Ph.D., Pr. Scientist
6. Dr Rinku Sharma, M.V.Sc., Ph.D., Scientist (Sr. Scale)
7. Dr Devi Gopinath, M.V.Sc., Ph.D., Scientist

Technical Staff:

1. Mrs. Jyoti Babu Dhar, MSc, STO

Training and Education Centre, Pune

1. Dr K.N. Bhilegaonkar, M.V.Sc., Ph.D., Pr. Scientist & Station In-charge
2. Dr S.K. Das, M.V.Sc., Ph.D., Pr. Scientist
3. Dr H.P. Aithal, M.V.Sc., Ph.D., Pr. Scientist

Technical Staff:

1. Sri D. Bhaskara Rao, MSc, Technical Officer

Joint Directorate of Research

1. Dr B.P. Mishra, M.V.Sc., Ph.D., Joint Director (Res.)
2. Dr G. Saikumar, M.V.Sc., Ph.D., Incharge, PME Cell
3. Dr Pallab Chaudhuri, M.V.Sc., Ph.D., Pr. Scientist
4. Dr G.V.P.P.S. Ravi Kumar, M.V.Sc., Ph.D., Pr. Scientist
5. Dr D. Bardhan, M.V.Sc., Ph.D., Pr. Scientist (upto 18.10.2017)

Technical Staff:

1. Sri Ashutosh Soni, MSc, PGDCA, CTO
2. Dr (Mrs) Bina Singh, MSc (HSc), Ph.D., CTO

Deemed University

1. Dr Triveni Dutt, Joint Director (Acad.)
2. Dr A.K. Sharma, M.V.Sc., Ph.D., Controller of Examination (up to 31.07.2017)
3. Dr O.K. Raina, MSc, Ph.D., Controller of Examination (w.e.f. 01.08.2017)
4. Dr J.K. Prasad, M.V.Sc., Ph.D., Academic Coordinator
5. Dr Rajat Garg, M.V.Sc., Ph.D., Coordinator (UG)

Agricultural Research Information System (ARIS) Cell

1. Dr Sanjay Kumar, MSc, Ph.D., Pr. Scientist & In-charge
2. Sri Yash Pal Singh, MCA, Scientist (Sr. Scale)
3. Sri G.S. Deorane, MSc (Stat.), STO

National Library of Veterinary Sciences (NLVS)

1. Dr G.Taru Sharma, MSc, Ph.D., Coordinator

Technical Staff:

1. Sri S.S. Rawat, MA, M Lib Sci., CTO & Officer-In-charge
2. Sri Alok Kumar, MSc, M Lib Sci, CTO
3. Dr K.N. Kandpal, MSc (IT), M Lib Sci., MCA, Ph.D., CTO
4. Sri Sushil Marandi, BA, M Lib I Sc, ACTO
5. Sri L.K. Singh, MA, M Lib I Sc, STO

Communication Centre

1. Dr A.K. Garg, MSc, Ph.D., JD (Ext. Edn.) & Coordinator (up to 31.08.2017)
2. Dr Mahesh Chander, MSc, Ph.D., Actg JD (Ext Edn) (w.e.f. 01.09.2017)

Technical Staff:

1. Sri B.K. Panwar, MA, BEd, BMC, ACTO & Officer In-charge
2. Sri P.S. Jakhwal, Diploma in Photography, M.J. (C), STO

Agricultural Technology Information Centre

1. Dr Rupasi Tiwari, MSc, Ph.D., In-charge

Estate Unit (Horticulture & Sanitation Sections)

1. Dr S.K. Mendiratta, Administrative Controller

Technical Staff:

1. Sri R.L. Sagar, MSc (Agroforestry), CTO, Coordinator
2. Sri H.K. Meena, MSc (Agri.), ACTO, In-charge

Bioinformatics Centre

1. Dr Ravi Kumar GVPPS, M.V.Sc., Ph.D., Project Coordinator
2. Dr K.N. Kandpal, MSc (IT), M Lib Sci, MCA, Ph.D., Information Officer

Farm Section

1. Dr Putan Singh, MSc, Ph.D., Pr. Scientist & Coordinator

Technical Staff:

1. Sri R.L. Sagar, MSc (Ag), CTO
2. Sri Mithlesh Kumar, BSc (Ag), STO
3. Sri Rajbal Singh, BSc (Ag), STO

Farm Workshop

1. Dr H.C. Yadav, M Tech, Ph.D., STO & In-charge

Feed Technology Unit

1. Dr A.K. Verma, Head (Anim. Nut. Div.) & Coordinator

Technical Staff:

1. Er. S.S. Tripathi, MSc (Ag. Eng.) CTO & In-charge

Engineering Section

1. Sri Rakesh Kumar, Joint Director (Adm.) & Administrative Controller

Technical Staff:

1. Sri Rajeev Kumar, BE, CTO & In-charge (U-I & U-II)
2. Sri S.K. Alekar, G.D. Arch, Dip. (Arch. Asst.), CTO (up to 31.08.2017)
3. Sri B.K. Pandey, Diploma (Elect.), CTO
4. Sri A.K. Singh, BE (Civil), CTO
5. Sri J.C. Nogai, Dip. (Elect.), ACTO
6. Sri Rajneesh Yadav, AMIE (Elect.), STO

IVRI Human Hospital

1. Dr A.K. Verma, MSc., Ph.D., Coordinator

Technical Staff:

1. Dr Neerav Koherwal, BSc, MBBS, MHA, Medical Officer & I/C
2. Dr (Smt.) Bharti Singh, MBBS, MD, Medical Officer
3. Dr Amitabh Mishra, MBBS, D. Ortho, Medical Officer
4. Dr Anupam Goel, MBBS, Medical Officer

Games and Sports Cell

1. Dr Rajendra Singh, M.V.Sc., Ph.D., Office-Incharge
2. Dr A.K.S. Tomar, M.V.Sc., Ph.D., Secretary

Central Instrumentation Facility

1. Dr G. Saikumar, M.V.Sc., Ph.D., Pr. Scientist & In-charge, CIF (MLB)
2. Dr Praveen Singh, MSc, Ph.D., Pr. Scientist & In-charge, CIF (Biotech)

List of Scientists Promoted

S.No.	Name of the Scientist	Next Higher Grade Pay	w.e.f.
1.	Dr J.K. Prasad	Rs.37400-67000+Rs.10000	12.01.2013
2.	Dr (Mrs) Rekha Pathak	Rs.37400-67000+Rs.10000	04.02.2016
3.	Dr (Mrs) Geeta Chauhan	Rs.37400-67000+Rs.10000	08.05.2014
4.	Dr V.K. Gupta	Rs.37400-67000+Rs.10000	11.02.2016
5.	Dr Med Ram Verma	Rs.37400-67000+Rs.10000	21.12.2015
6.	Dr Pramod Kumar Nanda	Rs.37400-67000+Rs.10000	22.11.2014
7.	Dr Premanshu Dandapat	Rs.37400-67000+Rs.10000	03.03.2016
8.	Dr Madhusudan Hosmani	Rs.37400-67000+Rs.10000	29.09.2015
9.	Dr Rajesh Rathore	Rs.37400-67000+Rs.10000	24.11.2014
10.	Dr K.N. Viswas	Rs.37400-67000+Rs.10000	21.01.2016
11.	Dr P. Sarvanan	Rs.37400-67000+Rs.10000	29.09.2015
12.	Dr G.V.P.P.S. Ravi Kumar	Rs.37400-67000+Rs.10000	24.01.2013
13.	Dr D. Muthuchelvan	Rs.37400-67000+Rs.10000	16.09.2016
14.	Dr S.H. Basagoudanavar	Rs.37400-67000+Rs.10000	15.04.2016
15.	Dr M.A. Ramakrishnan	Rs.37400-67000+Rs.10000	17.04.2016
16.	Dr A. Kannan	Rs.37400-67000+Rs.10000	25.03.2017
17.	Dr K. Narayanan	Rs.37400-67000+Rs.10000	01.04.2017
18.	Dr S.K. Dhara	Rs.37400-67000+Rs.10000	26.07.2017
19.	Dr D. Bardhan	Rs.37400-67000+Rs.10000	17.08.2016
20.	Dr B.C. Saravanan	Rs.37400-67000+Rs.10000	07.01.2016
21.	Dr Hira Ram	Rs.37400-67000+Rs.9000	01.01.2017
22.	Dr Amit Kumar	Rs.15600-39100+Rs.8000	12.06.2016
23.	Dr N.R. Sahoo	Rs.15600-39100+Rs.8000	12.06.2016
24.	Dr Samiran Bandyopadhyay	Rs.15600-39100+Rs.8000	27.06.2015
25.	Dr S.K. Das	Rs.15600-39100+Rs.8000	05.09.2014
26.	Dr M. Shankar	Rs.15600-39100+Rs.8000	07.01.2017
27.	Dr Vikas Chandra	Rs.15600-39100+Rs.8000	07.01.2017
28.	Dr K.K. Rajak	Rs.15600-39100+Rs.8000	07.01.2017
29.	Dr R. Saravanan	Rs.15600-39100+Rs.8000	07.01.2017
30.	Dr R.P. Tamilselvan	Rs.15600-39100+Rs.8000	08.01.2016
31.	Dr S.K. Biswas	Rs.15600-39100+Rs.8000	08.01.2017
32.	Dr T.U. Singh	Rs.15600-39100+Rs.8000	07.01.2017
33.	Dr Sonwane Arvind Asaram	Rs.15600-39100+Rs.8000	07.01.2017
34.	Dr Sonal	Rs.15600-39100+Rs.8000	26.06.2017

Promotion of Administrative Staff

Sl.No.	Officer	Date of Promotion
1	Sri Mohd. Wasim, Asstt. promoted to AAO	01.06.2017
2	Sri S.S. Rawat, Asstt. promoted to AAO	29.03.2018
3	Sri Shekhar Saxena, Asstt. promoted to AAO	29.03.2018

Scientists / Officers Superannuated

S.No.	Scientist/Officer	Date of Retirement
1.	Sri Afsar Khan, T.O.	30.04.2017
2.	Sri K.C. Joshi, T.O.	31.05.2017
3.	Smt. Sahana Begum, AAO	31.05.2017
4.	Sri Naveen Chandra.T.O.	30.06.2017
5.	Sri V.K. Suri, T.O.	31.07.2017
6.	Sri Rakesh Kumar, T.O.	31.07.2017

7.	Dr A.K. Sharma, Pr.Scientist	31.07.2017
8.	Dr A.K. Garg. Pr.Scientist	31.08.2017
9.	Sri S.K. Alekar, CTO	31.08.2017
10.	Sri Ashok Ghosh, SAO	31.08.2017
11.	Sri R.H. Yadav, T.O.	30.09.2017
12.	Sri Rajeev Gupta, T.O.	30.09.2017
13.	Sri K.R. Arya, T.O.	30.11.2017
14.	Sri P.S. Jina, AAO	30.11.2017
15.	Sri David Wheeler, Pri. Secy	31.12.2017
16.	Sri G.D. Amola, F&AO	31.12.2017
17.	Sri M.K. Saxena, AAO	31.01.2018
18.	Sri C.P. Saini, T.O.	29.02.2018

List of Technical Personnel Promoted

Sl. No.	Name of the candidate	Existing grade	Promoted to	Date of Promotion
1.	Sri Kishan Ram Arya	T.O.	S.T.O	01.01.2017
2.	Sri Jagdeep Kumar Saxena	T.O.	S.T.O.	01.01.2010
3.	Sri Bhim Sen, Retd	T.O.	S.T.O.	01.01.2010
4.	Sri R.C. Joshi	T.O.	S.T.O.	01.01.2010
5.	Sri K.C. Pant	T.O.	S.T.O.	01.01.2010
6.	Sri M.S. Negi	T.O.	S.T.O.	01.01.2010
7.	Sri H.C. Pandey	T.O.	S.T.O.	01.07.2010
8.	Sri Jagdeep Kumar Saxena	S.T.O.	A.C.T.O.	01.01.2015
9.	Sri R.C. Joshi	S.T.O.	A.C.T.O.	01.01.2015
10.	Sri K.C. Pant	S.T.O.	A.C.T.O.	01.01.2015
11.	Sri M.S. Negi	S.T.O.	A.C.T.O.	01.01.2015
12.	Sri H.C. Pandey	S.T.O.	A.C.T.O.	01.07.2015
13.	Sri Rajesh Bhasin	T.O.	S.T.O.	09.06.2012
14.	Sri Rajesh Bhasin	S.T.O.	A.C.T.O.	09.06.2017
15.	Dr R.B. Bind	S.T.O.	A.C.T.O.	07.01.2017
16.	Dr (Mrs) Meeta Saxena	S.T.O.	A.C.T.O.	14.01.2017
17.	Dr C. Nagabhushan	T.O.	S.T.O.	07.01.2017
18.	Dr Omvir Singh	S.T.O.	A.C.T.O.	14.01.2017
19.	Sri Sushil Marandi	S.T.O.	A.C.T.O.	14.07.2017

Scientists Deputed Abroad

Sl. No.	Name of the Scientist	Country visited	Time of Visit
1.	Dr Mahesh Chander, Head, Ext. Edn Division	South Korea	April 23-29, 2017
2.	Dr R.P. Singh, Head, B.P. Division	Paris, France	June 29, 2017
3.	Dr Y.P.S. Malik, National Fellow	Malaysia	July 25-27, 2017
4.	Dr Mahesh Chander, Head, Ext. Edn Division	Kathmandu, Nepal	July 24-27, 2017
5.	Dr Mahesh Chander, Head Ext. Edn	Australia	Sept.10-15, 2017
6.	Dr Premanshu Dandapat, Pr. Scientist	Thailand	Sept. 11-13, 2017
7.	Dr K.N. Bhilegaonkar, Pr. Scientist	The Netherland	Oct. 02-12, 2017
8.	Dr Mahesh Chander, Head, Ext. Edn Division	Rome, Italy	Oct. 7-14, 2017
9.	Dr Soumendu Chakravarti, Scientist (for pursuing Ph.D. programme)	U.K.	01.11.2017 to 31.10.2020
10.	Dr A.K. Tiwari, Head, Bio-Standardization	China	Nov.7, 2017
11.	Dr A.K. Sharma, Pr. Scientist	Dhaka	Nov.19-23, 2017
12.	Dr R.P. Singh, Head, B.P. Division	Rome, Italy	December 11-12, 2017
13.	Dr Basavaraj Sajjanar, Scientist	Germany	01.01.2018 to 31.12.2018
14.	Dr K.P. Singh, Pr. Scientist	U.K.	March 15-16, 2018

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