ICAR · DPR

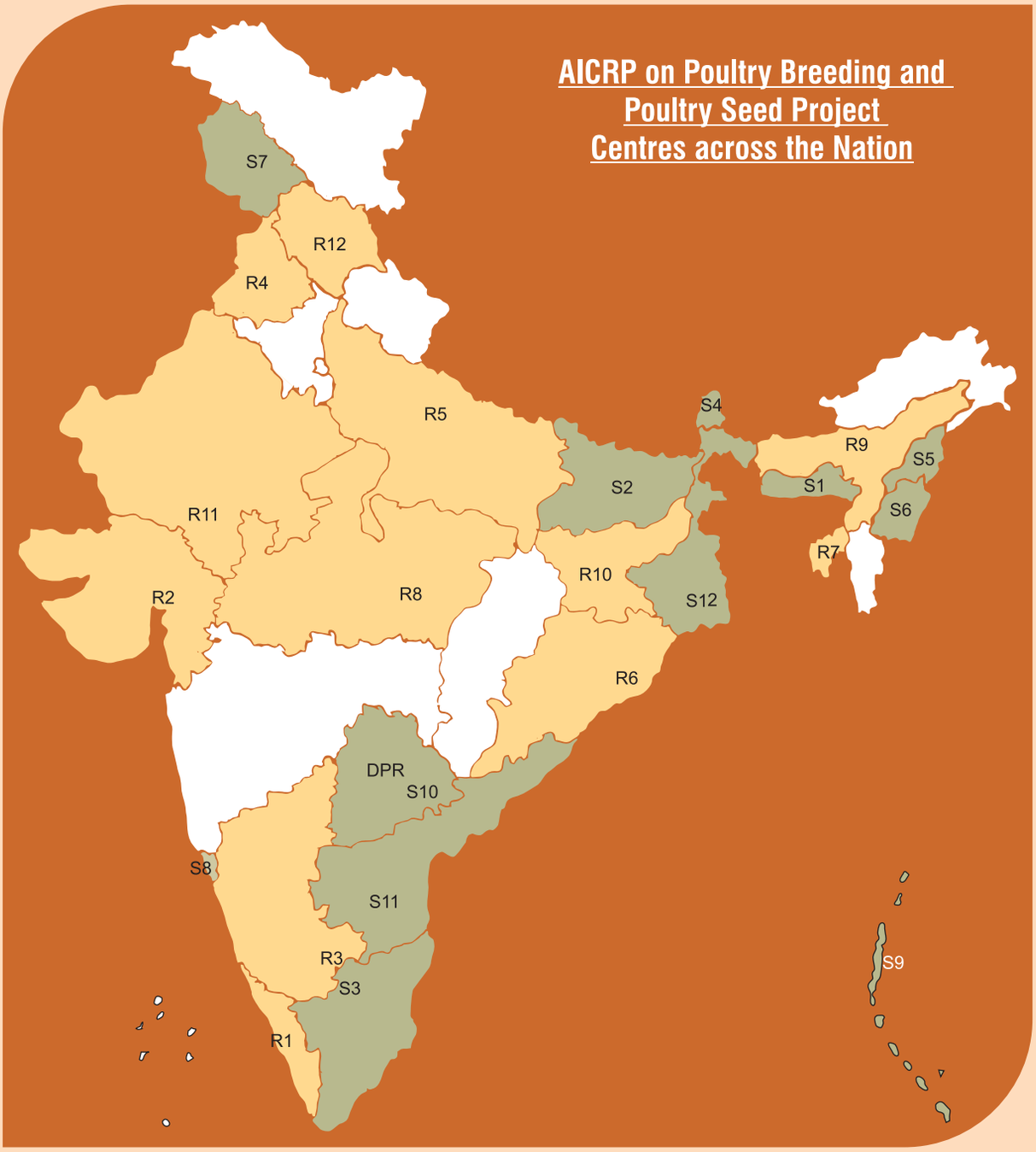
Annual Report 2020

भाकृअनुप - कुक्कुट अनुसंधान निदेशालय

ICAR-Directorate of Poultry Research

ISO 9001 - 2015

Rajendranagar, Hyderabad - 500 030 India



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R1	KVASU, Mannuthy
R2	AAU, Anand
R3	KVAFSU,Bengaluru
R4	GADVASU, Ludhiana
R5	ICAR-CARI, Izatnagar
R6	OUAT, Bhubaneswar
R7	ICAR-RC, Agartala
R8	NDVSU, Jabalpur
R9	AAU, Guwahati
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R11	MPUAT, Udaipur
R12	CSKHPKVV, Palampur

PSP Centres	
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S2	BASU, Patna
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S4	ICAR-NOFRI, Sikkim
S5	ICAR-RC, Nagaland
S6	ICAR-RC, Manipur
S7	SKUAST, Srinagar
S8	ICAR-CCARI, Goa
S9	ICAR-CIARI, Port Blair
S10	PVNRTVU, Warangal
S11	SVVU, Tirupati
S12	WBUAFS, Kolkata

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ANNUAL REPORT 2020

ICAR - Directorate of Poultry Research

ISO 9001:2015

Rajendranagar, Hyderabad - 500 030, Telangana, India

www.pdonpoultry.org

Citation

ICAR-DPR 2020. Annual Report 2020. ICAR-Directorate of Poultry Research, Rajendranagar, Hyderabad, Telangana, India. Pages 1-105

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Native chicken breeds of ICAR-DPR, Hyderabad

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Printed at

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Preface

I am happy to present the Annual Report of ICAR-Directorate of Poultry Research, Hyderabad for the year 2020. The year 2020 was unprecedented in terms of challenges and difficulties posed by the COVID-19 pandemic to successfully carry out the mandated research work of the Institute. Despite the challenges, it is heartening to know that our Institute made remarkable progress in all the research activities. The improved chicken germplasms were continued to be supplied throughout the country for catering to the needs of various stake holders. Improvement of productivity of backyard poultry is the need of the hour to meet the growing demands for meat and eggs. By recognizing the efforts of the Institute, the ICAR has given additional responsibility to work on ducks by transferring the Regional Station of ICAR-CARI, Bhubaneswar to ICAR-DPR, Hyderabad w.e.f. July 2020. This has expanded the scope for research work on diversified poultry species at the Directorate.

The pedigreed populations of 18 pure lines and five native chicken germplasm are being maintained and improved for various economic traits of interest. The native chickens are characterized for their unique characteristics. During the period, three crosses were produced and evaluated at the Institute farm, while two crosses for broiler purpose were produced and evaluated at farmers' field. It was interesting to know that egg production of *Vanaraja* and *Gramapriya* has improved in the latest evaluation as compared to their earlier performance. Furthermore, three crosses of layers were produced and are being evaluated at the institute.

The transgenic chicken expressing human interferon, hINFA2b was successfully developed. A protocol to knockdown the expression of inhibin α gene in chicken using CRISPR/Cas9 technology was developed. A knockdown chicken for suppressing the expression of ACACA and SREBP-1 genes that are involved in the de novo lipid biosynthesis was developed using RNAi-mediated gene silencing technique. The genome of ten Indian native chicken breeds were sequenced using next generation sequencing technology to identify the SNPs present in the whole genome with an aim to develop native chicken specific SNP chip. Generation of whole genome assembly of Kadaknath chicken is also under progress.

The nutritional profile of Black soldier fly larvae meal was characterized. Various nutritional strategies to overcome the heat stress in chicken were explored. Diversity of core microbiome of guts of Nicobari, Ghagus and Aseel and commercial broiler was studied. Iron enriched eggs were developed through dietary manipulations and nano mineral production using green technology was standardized. Cryopreservation of semen of various lines of the Institute was standardized. Vermicomposting of

poultry litter mixed with dry leaves or saw chips/ dust was carried out. Experiments to utilize Moringa leaves and earthworm meal as alternative feeding material for chicken in a simulated integrated farming system were initiated. Under Rashtriya Krishi Vikas Yojana (RKVY), a demonstration unit of integrated farming was established.

Differential diagnosis of diseases is important in poultry production. The multiplex PCR technique for rapid and simultaneous detection and differential diagnosis of MD, ALV and REV infections was developed.

The Regional Station of the Institute, which is mandated to work on duck species, has made significant progress in various aspects of duck farming through development and evaluation of a cross, nutritional interventions and integrated farming.

The Directorate actively coordinated and monitored the All India Coordinated Research Project on Poultry Breeding, which has 12 centres maintaining elite layer, broiler and rural germplasm. Besides, the Directorate monitored the 12 Poultry Seed Project centres spread all over the country and supplied the improved germplasm to the needy farmers.

It is heartening to share that two technologies developed at this Directorate having commercial value and practical application in poultry industry were approved and submitted to Agrinnovate India Limited, New Delhi, for commercialization. One patent application for the technology invented at ICAR-DPR was filed with the Indian Patent office.

The institute has conducted several meetings and training programmes under DAPSC, STC, and Skill development programmes. Despite the pandemic, the institute has also participated in exhibitions, melas, and farmers field programmes and showcased the technologies by following the COVID-19 appropriate measures. A total of 2.98 lakhs germplasm including 20,602 parents were distributed by the Directorate to various beneficiaries. A total of Rs. 233.96 lakhs revenue was generated during the year. The AICRP centres and PSP centres supplied 6.40 and 4.19 lakhs germplasm, respectively, with a revenue generation of Rs. 166.67 lakhs and Rs. 132.79 lakhs, respectively.

I am extremely grateful and indebted to Dr. Trilochan Mohapatra, Secretary, DARE and Director General, ICAR for the unstinted support and guidance extended for the development of this Directorate. I express my sincere gratitude to the Secretary, ICAR and Financial Advisor, ICAR for their support. I am thankful to Dr. B. N. Tripathi, DDG (AS), Dr. V. K. Saxena, ADG (AP&B), Dr. Vineet Bhasin, Principal Scientist (AG&B) and other scientific and administrative staff of ICAR headquarters for their constant help and support rendered to this Directorate. I also place on record my appreciation to the scientific, technical, administrative and supporting staff of this Directorate and also those working in the AICRP and PSP centres, who have been sincerely working for the welfare of poultry farmers. I am sure that with unrelenting cooperation and efforts, we will be able to successfully march ahead to achieve the mandated objectives of this Directorate. I congratulate the editorial team for the commendable job in bringing out this Annual report in a noteworthy manner.

With a heavy heart, I share the news of the sad demise of the founder Director of our institute Dr. S.C. Mohapatra and one of our young scientists Dr. Chandan Paswan during the year.

Date: 25th June, 2021

(R.N. Chatterjee)
Director

Contents

Abbreviations

AAU	Anand Agricultural University/Assam Agricultural University
AICRP	All India Coordinated Research Project
ARS	Agricultural Research Service
AFE	Age at first egg
AGP	Antibiotic growth promoters
AMR	Antimicrobial resistance
ASM	Age at Sexual Maturity
BW	Body Weight
BWG	Body weight gain
CARI	Central Avian Research Institute
CBH	Cutaneous Basophile Hypersensitivity
CD	Control diet
CMI	Cell mediated immunity
CP	Crude Protein
CPCSEA	Committee for the Purpose of Control and Supervision of Experiments on Animals
CPDO	Central Poultry Development Organization
CRIDA	Central Research Institute for Dryland Agriculture
d	Day(s)
DARE	Department of Agricultural Research and Education
DBT	Department of Biotechnology
DNA	Deoxyribonucleic Acid
DPR	Directorate of Poultry Research
DST	Department of Science and Technology
EM	Egg mass
EP	Egg Production
EW	Egg Weight
FCR	Feed Conversion Ratio
g	Gram(s)
GP	Glutathione Peroxidase
GR	Glutathione Reductase
H:L ratio	Heterophyl : Lymphocyte Ratio
HDEP	Hen Day Egg Production
HHEP	Hen Housed Egg Production
IAEC	Institutional Animal Ethics Committee
IBSC	Institute Bio-safety Committee
ICAR	Indian Council of Agricultural Research

IMC	Institute Management Committee
IPSA	Indian Poultry Science Association
IRC	Institute Research Committee
IU	International Unit(s)
IVRI	Indian Veterinary Research Institute
KVK	Krishi Vignan Kendra
LC	Layer Control
LP	Lipid Peroxidation
MANAGE	National Institute of Agricultural Extension Management
MD	Marek's Disease
ME	Metabolizable Energy
mm	Millimeter(s)
NAARM	National Academy of Agricultural Research Management
NAIP	National Agricultural Innovation Project
NCBI	National Center for Biotechnology Information
NDV	Newcastle Disease Virus
NGO	Non-Governmental Organization
NIRDPR	National Institute of Rural Development & Panchayat Raj
Nos.	Number
NPP	Non-Phytate Phosphorus
NRC	National Research Centre
OUAT	Odisha University of Agriculture and Technology
PCR	Polymerase Chain Reaction
PDP	Project Directorate on Poultry
PHA-P	Phytohemagglutinin-P
PJTSAU	Professor Jayashankar Telangana State Agriculture University
ppm	Parts Per Million
QRT	Quinquennial Review Team
RAC	Research Advisory Committee
RC	Rural Control
RBC	Red Blood Cell
RTC	Ready to cook
SAU	State Agricultural University
SL	Shank Length
PVNRTVU	P.V. Narasimha Rao Telangana Veterinary University
SEP	Survivors' Egg Production
SERB	Science and Engineering Research Board
SVU	State Veterinary University
SVVU	Sri Venkateswara Veterinary University
TSA	Total Sulfur-containing Amino Acids
U	Unit(s)
wks	Weeks

Executive Summary

The ICAR-Directorate of Poultry Research, a premier Institute under Indian Council of Agricultural Research, is mandated to carryout basic and applied research to enhance productivity of poultry, develop new germplasm for rural poultry husbandry and capacity building. The Directorate also undertakes short term research projects sponsored by other funding agencies and contract research programs under PPP mode. The salient achievements for the year 2020 are summarized below.

Research at the Directorate

Genetics and Breeding

The research in genetics and breeding focuses on improvement of pure lines and development of varieties for rural poultry production, conservation and improvement of indigenous chicken germplasm, and maintenance and evaluation of layer, broiler and gene lines.

Germplasm for rural poultry farming

Two male lines, PD-1 (*Vanaraja* male line) and PD-6/GML (*Gramapriya* male line) and two female lines, PD-2 (*Vanaraja* female line) and PD-3 (*Gramapriya* female line) have been improved and used in production of rural chicken varieties.

The genetic and phenotypic response in 6-week shank length of PD-1 line was 2.53 and 1.05 mm, respectively per generation over the last 11 generations. A total of 2053 chicks of GML (S-10) were produced using 44 sires and 250 dams, which were selected for higher shank length at 6 weeks. The fertility was 83.4% and hatchability on TES and FES was 77.6 and 92.8%, respectively. In PD-2 line (S-16), the body weight, egg weight, egg production and egg mass up to 72 weeks of age were 2728±0.44 g, 55.75±0.004 g, 138.6±0.02 eggs and 7898±2.01 g, respectively. The egg mass showed improvement of 451g over previous generation. The S-17 generation was reproduced utilizing 50 sires and 250 dams, which were selected for higher egg mass up to 52 weeks. The fertility was 81.4% and hatchability on TES and FES was 73.3 and 90.0%, respectively. Total number of chicks produced were 3,516.

In PD-3 line (S-8), the part period egg production and egg mass up to 40 weeks of age increased considerably from the previous generation. The heritability estimates for production traits were low to high from sire and dam components of variance. The PD-3 line (S-9) was regenerated using 50 sires and 250 dams in a pedigreed mating. A total of 4870 chicks were produced. The fertility was 87.4% and hatchability on FES and TES was 91.3 and 80.0%, respectively. The body weight at 2, 4 and 6 weeks of age was 89.0±0.32, 202.8±0.90 and 341.0±1.65 g, respectively in S-9 generation. The body weight improved from the last generation.

Variance and covariance components of growth and production traits were analysed employing REML animal model to assess PD-3 population utilizing seven generations data. The generation and hatch had significant effect on juvenile growth traits. All the production traits were significantly influenced by generation and hatch. Maternal effects were higher at an early age, decreased with age, and remained present until 20 weeks of age. The heritability estimates were low to moderate in magnitude for all the growth traits ranging from 0.02±0.03 to 0.19±0.03. The maternal heritability was high at hatching (0.35±0.06) and gradually decreased until the end of the 4th week (0.02±0.01). The heritabilities of

EP40 (0.11±0.03) and EM40 (0.12±0.04) were low. The direct additive genetic correlations (ra) between BW2, BW4, BW6 and SL6 were high and positive. The EBV of EM40 (0.48 kg) at the end of seventh generation was significant and increased linearly as a response to selection in PD-3 line. The average genetic and phenotypic response was 0.08 and 0.11 kg per generation for EM40, the primary trait of selection. ASM decreased significantly with an increment of one day in each generation. The breeding value of EP40 showed an increasing trend with a genetic gain of 1.87 eggs per generation. The EW28 and EW40 increased linearly.

Native chicken populations

Vanashree, evolved from Aseel (PD-4), is being improved for body weight through individual selection in males and for egg production up to 40 weeks of age through independent culling level of selection in females. A total of 1148 good chicks (S-11) were hatched by mating 50 sires with 150 dams. The fertility was 86.4%, while hatchability was 85.9 and 74.2%, respectively on FES and TES. Selection differential and intensity of selection for 8 weeks body weight was 36.5 g and 0.41σ, respectively, while those for 40 weeks egg production were 2.23 eggs and 0.11σ. There was increase in body weight of cocks at 20 and 40 weeks (128 and 93 g) in the present generation. The 40 weeks body weight of hens increased by 45 g in this generation. Also, there was increase in 20 and 40-weeks shank length of cocks (2.2 and 0.4 mm). There was increase in egg weights recorded at 28 (1.28), 32 (2.34), 36 (2.43) and 40 (2.95 g) weeks. Liveability of males and females during 21-40 weeks was 99.0 and 97.8%, respectively.

Ghagus, an indigenous chicken breed has been selected for higher body weight at 8 weeks of age. There was an improvement of 10.84, 8.61 and 11.71 eggs, respectively in survivors'(SEP), hen housed (HHEP) and hen day (HDEP) egg production. HHEP, HDEP and SEP recorded up to 72 weeks were 117.8±3.13, 122.9 and 118.8±3.19 eggs, respectively. The egg weight and body weight at 72 weeks were 52.65±0.39 g and 2288±54.5 g, respectively. A total of 875 good chicks of Ghagus were hatched (S-3) with the fertility of 85.3% and hatchability of 94.1 and 80.2% on FES and TES, respectively. There was improvement of 87.6 g in 8 weeks body weight and 3.59 mm in 8 weeks shank length in this generation. Furthermore, there was an improvement of 125 and 89 g in 20 weeks' body weight of males and females, respectively.

A pedigreed random bred population of Nicobari chicken is being maintained. There was an improvement of 153 and 94 g in 20 weeks body weight of male and females, respectively. Similarly, there was improvement of 1.6 and 1.58 mm in 20 weeks shank length of male and female birds, respectively. There was improvement in HDEP (74.7) in this generation. Better egg mass (3456±83.32) up to 40 weeks was observed. The Nicobari hens were evaluated for feed intake, feed efficiency, FCR and production performance during 24 to 40 weeks. The G-8 generation of Nicobari was produced (765 good chicks) by mating 50 sires with 150 dams. The fertility was 87.1%, while hatchability on FES and TES was 86.4 and 75.3%, respectively. Heritability estimates of juvenile growth traits were moderate to high in Nicobari breed.

In Kadaknath, a total of 1,623 good chicks were produced by pedigreed random mating of 50 sires with 150 dams. Fertility was 91.7% and hatchability on TES and FES was 83.1 and 90.6%, receptively. The body weight at 0 day, 4 and 8 weeks was 29.5, 124.4 and 403.7 g, respectively. There was an improvement in 8 weeks body weight. Body weight of males and females at 16 weeks was 1097 and 846 g, respectively. ASM was 176.2 days while 40 weeks egg production was 76.27 eggs. Egg weight at 28 and 40 weeks was 40.6 and 45.8 g, respectively. Body weight of cocks and hens at 40 weeks was 2173 and 1485 g, respectively.

A total of 1199 chicks of Aseel were regenerated (G-7). The fertility was 82.7% and hatchability was 88.2 and 73.0%, respectively on FES and TES. The body weight of Aseel hens at 20 and 40 weeks of age was 1322 and 1942 g, respectively. The body weight of Aseel cock at 40 weeks was 3246 g. The 40 weeks egg production (22.0 eggs) improved by 4 eggs in this generation.

Evaluation of crosses

Aseel crosses for broiler purpose

A total of 10 farmers of Telangana state were provided with 100 chicks of Aseel crosses involving Aseel X PD-1 or GML (PD-6). Two

farmers were provided each with 100 chicks of Aseel x PB-2 cross for evaluation. Farmers were advised to rear chicks under full feeding with commercial broiler feed up to 12 weeks of age. At 12 weeks of age, the Aseel cross with PD-1/ PD-6 recorded body weight of 1661g, while the Aseel cross with PB-2 attained 2249 g body weight at the same age under field conditions.

Evaluation of *Janapriya, Vanaraja* and *Gramapriya*

The three varieties/crosses were evaluated under intensive system at the institute's farm. *Janapriya*, a promising dual-purpose chicken variety developed by crossing PD-1 with PD-4 recorded body weight of 1525 g at 12 weeks, while the annual egg production was 176.4 with egg weight of 60.5 g. The body weight at 14 weeks of age was 2187±30.15 and 1650±36.46 g in *Vanaraja* and *Gramapriya*, respectively. The ASM was reduced compared to earlier period of their development. The annual egg production was 189 eggs in *Vanaraja* and 240 eggs in *Gramapriya*, which are higher than the those reported in previous evaluations.

Broiler populations

A total of 1563 good chicks of PB-1 line (S-29) were hatched. Fertility was 89.3% and hatchability on TES and FES was 84.9 and 95.0%, respectively. Body weight at 4, 5, 6 weeks of age was 582, 918 and 1162 g, respectively. Shank length at 5 weeks was 78.8 mm. Improvement in growth performance was observed compared to previous generation. To increase the variability and improve the juvenile growth traits of PB-1 line, a total of 1467 good chicks were hatched (S-0) from eggs brought from Bengaluru centre of AICRP on Poultry Breeding. Fertility was 74.6%. Hatchability on TES and FES was 65.6 and 88.98 %, respectively. The body weights at 4, and, 6 weeks, and shank length at 5 weeks were 743, 1102, 1404 g and 84.3 mm, respectively. The ASM, 40 weeks egg weight and 40 weeks egg production, respectively were 171.7 days, 60.9 g and 59.82 eggs. In S-1 generation, a total of 1733 chicks were produced by mating 50 sires and 207 dams selected for higher 5 weeks body weight and 40 weeks egg production. Fertility was 82.5% and hatchability on TES and FES was 73.8 and 89.5%, respectively.

The pedigreed random bred control broiler (CB) population was evaluated for production traits up to 40 weeks (G-18). The ASM, 40 weeks egg weight and 40 weeks egg production, respectively were 182.0±0.66 days, 56.9±0.32 g and 46.8±1.49 eggs. The G-19 generation (1207 good chicks) of the CB was generated using randomly selected 50 sires and 250 dams. Fertility was 88.8%. Hatchability on TES and FES was 79.7 and 89.8%, respectively.

PB-2 line of DPR (S-29) and Bengaluru centre (S-0) were evaluated. Body weight at day old, 2, 4 and 5 weeks were 43.99, 264.2, 670.3 and 951 g, respectively while shank length and breast angle at 5 weeks were 80.2 mm and 80.7° in PB-2 line (S-0) of Bengaluru centre. Body weight at day old and 5 weeks was 40.21 and 920.3 g, respectively (S-29) of PB-2 line of DPR. The ASM was 184.5 days, which increased compared to the last generation. Naked Neck (*Na*) and Dwarf (*Dw*) gene lines (S-17) were evaluated for performance traits. The 40 weeks egg production in *Dw* and *Na* line was 78.28±1.94 and 51.91 eggs, respectively.

Layer populations

Three layer lines viz; IWH, IWI and IWK are under selection for higher egg numbers up to 64 weeks of age, whereas IWD, IWF and Layer Control (LC) are under random breeding programme. Regeneration of the six-layer lines (S-15 of IWK and LC, S-7 of IWH and IWI, G-2 of IWD and IWF) was completed. Three crosses: Kadaknath x IWH, IWF x IWH and IWH x IWF were produced. The 16 weeks body weight increased in IWH, IWI and IWD lines, while it decreased in IWK and layer control compared to their respective previous generations. The 20 weeks body weight increased in the IWD, IWF and layer control lines, while it decreased in the IWH, IWI and IWK lines. The ASM reduced significantly in IWH and IWD lines, whereas in other lines it remained almost stable. The EW28 increased in IWI and IWK lines, while it deceased in the IWH line. The EP40 showed significant increase in the IWI and IWD lines, while it decreased in IWF line compared to previous generation.

Molecular genetics

Under the DBT funded project on development of transgenic chicken, the human INFA2b clone was expressed in chicken magnum cells and the hINFA2b protein was detected. The PGC

mediated method of transgenesis was standardized to produce transgenic chicken. The PGCs were characterized with alkaline phosphatase staining, PAS staining and immuno-cytochemistry. PGCs were transfected with recombinant GFPpACGFP1-C1 construct and transplanted to the recipient sterile embryos. A total of 3 positive live transgenic chicks were developed where percentage of obtaining live positive birds was 8.3%.

A study was designed to knockdown the inhibin α gene in chicken. The CRISPR/Cas9 tool was employed to create targeted mutagenesis of both the exons of the inhibin α gene. The mutation was successfully appreciated and had generated stop codons in exon 1, thereby hampering the gene expression and in exon 2 has created a frameshift mutation resulting in the expression of faulty protein. The expression of edited group of cells of exon1 and exon 2 was 7.12% and 5.47% lower, respectively in comparison with the control group of cells, thus validating the mutagenesis. Thus a protocol for inducing targeted mutagenesis of inhibin α gene in chicken was developed.

In an experiment, gene silencing by RNAi was adopted to produce knock-down chicken. shRNA molecules for acetyl Co-A carboxylase type A (ACACA) and sterol repeat element binding protein 1 (SREBP-1) genes were designed and synthesized to analyse their effect under *in vitro* cell culture. Using this molecule, a knock down chicken for these two genes, involved in *de novo* lipid biosynthesis was developed. The knock down birds showed 20.2 and 24.8% lower serum cholesterol and triglycerides content as compared to normal birds. In case of ACACA knock down, the alkaline phosphatase increased by 13.5% in the knock down group, while in case of SREBP-1 gene knock down, 54% reduction in alkaline phosphatase activity was observed. All the knock down birds of 1st generation for both ACACA and SREBP1 genes were females, which were used further as female parents for back crossing with control broiler birds as male parents to produce back cross progenies. Finally, two positive knock down chicks, where shRNA constructs were detected, were hatched.

In ten Indian native chicken breeds, SNPs present in the whole genome were explored with an aim to develop native chicken specific SNP chip. The whole genomes of all these breeds were sequenced and SNPs analysed. From the results, nucleotide diversity within the breeds could be observed. Estimation of SNP-wise genetic differentiation in terms of Nei's GST, Htmax, Gstmax and Hedrick's GST were done. All the populations were clustered on the basis of SNP diversity through Principal Component analysis. The phylogenetic relationship was also explored among the breeds. The breed signature of the native chicken breeds encompassing unique SNPs of each breed was identified. The SNPs detected in the mitochondrial genome of all the breeds were validated. It is concluded that the Indian native chicken breeds are genetically diverse with respect to whole genome.

For the generation of whole genome assembly of native Kadaknath chicken and its annotation, blood and different tissue samples were collected and processed. The gDNA was isolated and quality was assessed using different methods. A template library was prepared and sequencing of the product is under progress.

The external egg quality of IWI and IWK lines was evaluated at 40 and 64 weeks of age. The egg shell calcium content in IWI was lower compared to IWK. There was no effect of age on the egg shell calcium content. The egg shell thickness was higher during both the ages in IWK in comparison to IWI. The egg shell thickness was affected by age of the birds. The expression of genes ATP1A1, ATP1B2, CA2 and CLCN2 related to transcellular calcium transportation in different tissues in the two lines at 40 and 64 weeks of age was studied through qPCR. The line and age were found to affect the expression of the studied genes.

Nutrition

The body weight gain and feed efficiency improved, and stress indices reduced in commercial broiler chicken with supplementation of methyl donors like betaine (0.2%), B_{12} (0.1 mg), folic acid (4 mg) or biotin (1.5 mg/kg) in diet having no supplemental methionine. Three different prebiotics, i.e. Fructose oligosaccharide (FOS), Galactose oligosaccharide (GOS) and Mannan oligosaccharide (MOS) were tested in AGP-free broiler diet at 1000, 125 and 500 g/T, respectively and in combination at 33% of the dose. Body weight gain in groups fed MOS and combinations of the 3 prebiotic compounds was similar to those fed the AGP supplemented diet.

In commercial broilers fed diets supplemented with graded concentrations (75, 125, 250 and 500 g/Ton feed) of GOS, the body weight gain and feed intake were not affected, while the feed conversion efficiency was improved at all the levels of GSO with the best FCR being observed at 250 g/T. Different probiotic strains [*B. amyloliquifaciencs*, BA (100 g/T), *B. pumilus*, BP (100 g/T), *B. velezensis*, BV (100 g/T), their combination (each at 33%) and *B. coagulans* and *B. pumilus* combination¸ BC-BP (100 g/T)] were evaluated in broiler diet *vis-a-vis* antibiotic growth promoter (BMD). The FCR in BA and BC-BP groups was similar to those fed the AGP fed control group.

A bacteriophage product consisting of a cocktail of four selected lytic bacteriophages which target *Salmonella* was supplemented in drinking water of broiler chicken (0.02 ml/bird) on alternate days from day 1 to 42. Significantly improved performance, ready to cook yield and breast meat yield, and reduced Salmonella count in the gut were observed in broilers with bacteriophage supplementation. Evaluation of prevalence of antimicrobial resistance genes in chicken gut samples (96) collected from broiler chickens indicated presence of AMR genes for beta lactamase and fluoroquinolone resistance.

Samples of Black soldier fly larvae meal procured from different production sources in the states of Maharashtra, Gujarat and Karnataka were found to be rich in protein (49.8-59.6%) and fat (22.1-38.4%) with good amino acid profile. Lauric acid was found to be the predominant fatty acid (62%) in the insect meal. The nutrient profile and feeding value of different cultivars of bajra, developed at ICRISAT, Patancheru, were evaluated. The amino acid profile indicated higher concentration of lysine, methionine, methionine+cysteine and threonine in bajra cultivars in comparison to maize. The performance of broiler chicken was not affected by replacing maize (100%) with the different bajra cultivars.

Characterization of differential abundance, alpha and beta diversity, identification of core microbiome and breed or line specific biomarker microbes in the gut of three indigenous chicken breeds (Nicobari, Ghagus and Aseel) and a commercial broiler line (Vencobb 400) were carried out. The amplicon sequencing results emphasizes more similarity of the microbiota within the gut lumen of indigenous breeds as compared to the broiler strain. Further, existence of breed or line specific core microbial as well as across-breed or line core microbiome was observed, besides the occurrence of beneficial and potentially opportunistic pathogenic microbes as part of the core microbiome. The feed additives supplementation showed significant improvement in delayed type hypersensitivity along with significant increase in gene expression of intestinal immunity related genes.

The supplementation of ascorbic acid (0.3 g/kg) and methionine (2.5 g/kg) to the diet of White Leghorn layers (25 wks old) during summer season only marginally improved the egg iron contents over and above the egg iron content of iron supplemented groups without either of them. The Zn content of eggs could be increased by 20.7 to 28.9% in layer chicken by supplementing inorganic Zn and by 27.1 to 31.0% by organic Zn at 40 to 160 ppm of supplementation. Research has been initiated in collaboration with NIANP, Bengaluru to biosynthesize nano minerals using plant extracts and their use in poultry diet. Zinc oxide nano particles could be synthesized using moringa and neem leaf extract with average particle size of 10.84 and 8.27 nm, respectively. A study was conducted to determine the effect of feeding Quality protein maize (Shaktiman) and normal maize-based diets with or without lysine supplementation on *Vanaraja* chickens. Lysine supplimentation significantly increased body weight gain on par with normal maize. Linseed oil supplementation in diet (6%) lead to lowered egg production and higher feed intake in WL layers and the effects on egg fatty acid profile are being evaluated.

Physiology

Supplementing yeast-enriched selenium in diet differentially influenced plasma and magnum amino acid concentration in *Vanaraja* and Aseel hens. Similarly, Se supplementation affected the expression of amino acid transporters in jejunum and magnum differentially among the *Vanaraja* and Aseel hens. The ghrelin and melatonin receptors gene expression in jejunum of *Vanaraja* hens was downregulated, whereas in Aseel it was upregulated.

White Leghorn layer (IWH) cryopreserved semen using 4% DMSO produced around 5% fertility. IWH hens supplemented with different concentrations of organic zinc in feed did not improve fertility after insemination with cryopreserved semen. Dietary supplementation of iron and vitamin C in diet of IWH hens during hot climatic conditions did not improve fertility from cryopreserved semen. Cryopreservation of PB-2 semen was explored using 8% Ethylene Glycol (EG) and 6% dimethylformamide (DMF) in Beltsville Poultry Semen Extender (BPSE). A fertility of 30.2 and 46.6% was obtained from 8% EG and 6% DMF respectively. Control broiler semen was cryopreserved with 8% EG, 8.2% dextran 10 kDa + 9% dimethylacetamide (DMA) or 8.2% dextran 20 kDa + 9% dimethylacetamide (DMA) in Sasaki diluent (SD). Very low fertility rates ranging from 2.34-3.14% were obtained from the different treatments. Supplementing betaine and tempol in the semen cryopreservation mixture did not improve the post-thaw semen parameters or fertility in PD-1 chicken.

Vermicompost was prepared using poultry litter mixed with dry leaves as supplement with C/N ratio of 35:1 and 25:1. Compost was also prepared using poultry litter mixed with saw chips/dust with C/N ratios of 35:1, 30:1 and 25:1 in a duration of 70 days showing the feasibility of cage poultry litter generated in poultry farms successfully converted into compost. Experiments were initiated to utilize Moringa leaves and earthworm meal as alternative feeding material for chicken to simulate an integrated farming system. Under Rashtriya Krishi Vikas Yojana (RKVY), a demonstration unit was setup in which *Gramapriya* and a cross of White Leghorn and Kadaknath were raised in Moringa plantation plot with night shelter for the birds.

Health

A total of 3,153 birds, which included PB-2 (132), PB-1 (513), IWD (230), IWH (451), IWF (220), PD-4 (394), Kadaknath (338), PD-2 (517), Naked neck (189) and Dwarf (169) were screened for ALV infection by p27 antigen ELISA. The overall positivity of ALV carriers was 15.6% (492/3153). Kadaknath was having the highest percentage of ALV shedders.

Avian tumor diseases such as Marek's disease (MD), Avian leukosis (AL) and Reticuloendotheliosis (RE) are common in poultry and no commercial vaccine is available for protection against ALV and REV infection. The only method adapted is to identify and cull the virus carriers in breeder flocks. The multiplex PCR technique was developed, optimized and validated with field clinical samples for rapid and simultaneous detection and differential diagnosis of MD, ALV and REV infections.

The caecal microbial diversity of *Krishibro* broiler chicken supplemented with and without antibiotic growth promoters revealed functional categories of carbohydrates, clustering based subsystems and protein metabolism as the predominant categories with >10% abundance. Further functional analysis to the sub-categorical level showed central carbohydrate metabolism as the predominant category in both the groups, followed by one-carbon metabolism in AGP supplemented groups and Di- and Oligo saccharides in AGP-free group.

Extension

Due to COVID-19 pandemic, there was great impact on poultry sector. Large poultry farmers in India saw a 13% reduction in flock strength, whereas small poultry farmers found 49% reduction. There was decrease in net income of 44.8% at small farms, while bigger farms lost up to Rs. 72/kg live weight during early phases of lockdown. The backyard poultry chicken sale price (per kg) declined from 1.5 to 15.2%, whereas price of eggs reduced by 44 to 50% in different parts of the country during the lockdown period due to COVID 19 pandemic. There was significant decrease in consumption of chicken by 26.9% and eggs by 28% during lockdown period.

Regional station, Bhubaneswar

The Station is mandated to work on ducks. Under the DBT project, heritability estimate of body weight (8 weeks) in S1 generation of indigenous Kuzi ducklings was high in magnitude and those of conformation traits were moderate to high in magnitude. Genetic correlations between body weights and conformation traits were positive and moderate to high in magnitude. There was improvement of about 100 g in 8 weeks body weight in S-1 generation compared to S0 generation. Egg production up to 40 weeks of age was more than 100 and was 182 up to 60 weeks

of age. Ducklings of S-2 generation were hatched along with two crosses; Khaki Campbell (K)X Kuzi (D) and DXK.

Three levels of energy viz. 2700, 2900 and 3100 kcal of ME per kg diet were evaluated in White Pekin ducks during 0-6 weeks and 2900 kcal ME per kg was found optimum. Wheat could be completely replaced by broken rice in the diets of white Pekin ducks during second year of laying without affecting the metabolisability of various nutrients. Replacement of fish meal by soybean meal adversely affected the egg production and FCR of Khaki Campbell (KC) laying ducks. A floor space of 350 sq cm per duckling (KC) during brooding period (0-2 wks) and 475 sq cm floor space during 3-5 weeks of age was found optimum for growth and better liveability. Ginger (1 g/kg) supplementation in feed of grower White Pekin ducks was found beneficial in ameliorating arsenic-induced hematobiochemical, oxidative and histopathological perturbation. The average mortality recorded among the duck populations was approx. 1.76%. Breed wise highest mortality was recorded in Khaki Campbell (360) and White Pekin (280), followed by Desi–Pati (109) and Muscovy Moti (31), respectively.

In the integrated model experimentation farm of ICAR-NRRI, Cuttack, two varieties of ducks (Khaki Campbell & Kuzi variety) were introduced and performance was evaluated. Kuzi ducks gained higher body weight in comparison to KC ducks. In four villages of Cuttack district, 800-day old chicks (*Vanaraja* and Kadaknath from CPDO, Bhubaneswar) and 400 day old ducklings (KC and Kuzi variety) were supplied along with necessary inputs. The economic return from sale of Kadaknath birds for meat purpose was the highest in comparison to other varieties tested.

Under the RKVY project, training on backyard duck farming was imparted to 74 farmers of Papadahandi. Ducklings, chicks and other inputs were distributed to 51 farmers of Papadahandi and Nabarangpur block. The net profit from duck farming up to 6 months of age from a unit of 20 ducks varied from Rs. 1000 to 6400 and in chicken unit varied from Rs. 1,750 to 12,000. Overall impact for backyard chicken and duck farming in Nabarangpur district was very encouraging and farmers were happy to go for backyard duck and chicken farming. In the year, more than 50 farmers contacted through phone and e-mail to know about various aspects of duck farming, besides these, more than 20 farmers visited the Station to know about the duck farming. One skill training programme was conducted on 14th December, 2020 at the Station to 16 rural youth on duck rearing and management, which was organized by KVK, ICAR-NRRI, Cuttack.

A National Workshop on "Entrepreneurship development through duck farming" was held virtually on 22nd July 2020 in which a total of 442 participants participated. The DDG (AS) and ADG (AP&B) addressed the participants on this occasion. Training about duck health management was imparted to farmers in a workshop on "Integration of duck farming with fish farming", which was organised on 17th November 2020 at Dasbidyadharpur, Satyabadi, Puri by Siddha Development Research and Consultancy Pvt. Ltd.

AICRP on Poultry Breeding

The year 2020 saw AICRP on Poultry Breeding completing its 50 years of research successfully, thus, marking the Golden Jubilee year of launch of AICRP on Poultry Breeding. The AICRP is being operated at twelve centres viz. KVASU, Mannuthy; AAU, Anand; KVAFSU, Bengaluru; GADVASU, Ludhiana; OUAT, Bhubaneswar; CARI, Izatnagar; ICAR RC for NEH Region, Agartala; NDVSU, Jabalpur; AAU, Guwahati; BAU, Ranchi; MPUAT, Udaipur and CSKHPKVV, Palampur. The main objectives of the project are development of location specific chicken varieties; conservation, improvement, characterization and application of local native, elite layer and broiler germplasm and development of package of practices for village poultry and entrepreneurships in rural, tribal and backyard areas. In addition, KVASU, Mannuthy and AAU, Anand centres are to maintain two elite layer germplasm (IWN and IWP). KVAFSU, Bengaluru; GADVASU, Ludhiana; OUAT, Bhubaneswar and ICAR-CARI, Izatnagar are to maintain four elite broiler germplasm (PB-1, PB-2, CSML and CSFL).

Pedigreed random bred control populations (control layer and control broiler) were maintained at the Directorate. Samples of hatching eggs from these populations were sent to different centres of AICRP to measure the genetic progress. During the year, a total of 6,40,999 chicken germplasm was distributed to

the farmers (4,127) from different centres. An amount of Rs. 166.67 lakhs revenue was generated through distribution and propagation of the improved chicken germplasm.

The Mannuthy centre has evaluated the native chicken (S-5). Egg production of native chickens up to 40 weeks was 78.96 eggs with an average egg weight of 43.91 g. The centre distributed a total of 1,28,339 number of germplasms to 520 beneficiaries and generated revenue of Rs. 14.69 lakhs. The AAU, Anand centre evaluated *Ankleshwar* and White Leghorn strains (IWN, IWP, IWD and IWK). The 40 weeks egg production of *Ankleshwar* (S-2) was 76.38 eggs. The 72 weeks egg production in IWN and IWP strains (S-1) was 307.2 and 317.5 eggs, respectively. Egg production of IWD and IWK strains (S-8) up to 64 weeks was 226.5 and 218.1 eggs in, respectively. The centre supplied a total of 62,794 chicken germplasm and generated the revenue of Rs. 24.87 lakhs.

Bengaluru centre evaluated PB-1 (S-11) and PB-2 (S-25) lines. Raja II (commercial strain) chicks were distributed to the farmers. The centre has supplied 1,45,023 germplasm to the farmers with a revenue of Rs 49.32 lakhs. A total of 301 farmers benefitted during the period. GADVASU, Ludhiana centre evaluated PB-1, PB-2 and native chickens. The body weight at 5, 20, 40 weeks of age was 1150, 1065 and 799 g in PB-1, PB-2 and HBC, respectively. The FCR at 5 weeks for PB-1, PB-2, and HBC was 1.98, 1.96 and 2.00, respectively. The body weight in Punjab Brown (native birds) at 4, 8, 16, 20 and 40 weeks of age was 480, 696, 1423, 1984 and 2683 g, respectively. A total of 77,295 germplasm was supplied to 295 farmers. The revenue generation was Rs. 19.79 lakhs.

Bhubaneswar centre maintained *Hansli*, CSML, CSFL and their crosses, but all the flocks were liquidated due to the outbreak of Avian Influenza. During the year, 190 birds were distributed to the farmers. ICAR-CARI, Izatnagar centre evaluated the native chicken, CSML and CSFL. The average five-week body weight of CSFL and CSML was 1012±11.03 and 1198±4.07 g, respectively. The germplasm supply was 21,322 with revenue of Rs. 4.42 lakhs. A total of 26 farmers were benefited.

Udaipur centre evaluated *Mewari,* RIR, CSFL and *Pratapdhan* populations. The germplasm supply was 38,877 and centre has generated revenue of Rs. 7.64 lakhs. A total of 311 farmers were benefited. Jabalpur centre evaluated Kadaknath, Jabalpur colour and *Narmadanidhi* populations. JBC females matured at 151 days and produced 161 eggs up to 52 weeks. Kadaknath hens matured at 166 days and produced 93.7 eggs. *Narmadanidhi* birds produced 170 eggs up to 72 weeks in field with egg weight of 45.0 g. A total of 12,454 germplasm was distributed to 195 farmers with a revenue of Rs. 5.79 lakhs.

Guwahati centre evaluated native, Dahlem Red, PB-2 and BN populations up to 52 weeks and *Daothigir* breed up to 40 weeks. The 52 weeks egg production of native chicken was 68.6 eggs with egg weight of 40.8g. The HHEP of *Kamrupa* up to 40 and 52 weeks was 49.9 and 91.3 eggs in the farm and corresponding values in the field were 44.3 and 74.8 eggs, respectively. The HHEP of *Daothigir* up to 40 weeks was 18.1 eggs. The centre supplied a total of 42,487 germplasm to 266 farmers with a revenue receipt of Rs. 5.31 lakhs. Palampur centre evaluated native germplasm, Dahlem Red and *Himsamridhi*. The HDEP up to 40 weeks and 52 weeks was 45.95 and 80.16 eggs, respectively in native chicken. The 40 weeks-HDEP was 63.97 eggs in Dahlem Red. The HDEP up to 40 and 52 weeks was 53.61 and 92.35 eggs, respectively in *Himasamridhi*. A total of 53,679 germplasm was distributed to 466 farmers. Rs. 15.71 lakhs revenue was generated.

Ranchi centre evaluated native chicken, Dahlem Red, PB-2 and *Jharsim* populations. The HDEP up to 72 weeks of native chickens was 91.51 (G-7). The body weight at day old and 4 weeks was 28.08±0.12 and 166.3±0.87 g in native chickens. The Centre supplied 21,995 *Jharsim* chicks among 125 stake holders. The revenue receipt was Rs. 6.14 lakhs. Tripura centre evaluated Tripura black, Dahlem Red, broiler dam line and their crosses. The 40 week-egg production of BND cross (E4) was 53.77 and 42.95 eggs under farm and field conditions, respectively. The body weight at 8, 20 and 40 weeks of age was 515.8, 1605 and 1964 g at farm and 435.2, 1532 and 1772 g, respectively at farmers' field. A total of 36,544 chicks were supplied to 516 farmers of Tripura with a revenue receipt of Rs. 12.95 Lakhs.

Poultry Seed Project

The Indian Council of Agricultural Research has initiated Poultry Seed Project (PSP) during the XI Five-year Plan. The main objective of this project is local production of improved chicken germplasm and supply to various stake holders in the remote areas to target production enhancement of egg and meat for augmenting rural poultry production, socio-economic condition of the target groups and linking small scale poultry producers with organized market.

The PSP centres are located at BASU, Patna; ICAR-RC for NEH Region, Umiam; ICAR-RC for NEH region, Jharnapani; ICAR-RC for NEH region, Imphal; ICAR-NOFRI, Gangtok; TANUVAS, Hosur; ICAR-CCARI, Panaji; ICAR-CIARI, Port Blair; PVNRTVU, Warangal; SVVU, Tirupati; SKUAST, Srinagar and WBUAFS, Kolkata. The Directorate as a coordinating unit, supplied parent chicks, co-ordinated and monitored the activities of different centres to enable them to achieve the set targets for each centre. The target set for supplying chicks for mainland and north-east centres during the year 2020 was between 0.3 and 1.0 lakhs chicks per annum and to collect feedback on the performance of the germplasm under backyard farm conditions. A total of 4,19,477 chicks of improved chickens were distributed in their respective regions/states with a revenue receipt of Rs. 132.79 lakhs during the year.

A total of 55,953 *Vanaraja* chicken germplasm was distributed to the farmers by the Bihar centre with an amount of Rs. 16.19 lakhs revenue. Nagaland centre distributed a total of 52,528 improved chicken germplasm to farmers of Nagaland and neighbouring states. A total of Rs. 21.01 lakhs revenue was generated. ICAR-NOFRI, Gangtok, Sikkim distributed a total of 76,208 *Vanaraja* birds to 2090 farmers with an amount of Rs. 30.7 lakhs revenue.

A total of 24,367 improved chicken germplasm was distributed to the farmers by the Manipur centre. The Centre has generated Rs. 13.57 lakhs of revenue. A total of 78,049 improved rural chicken (*Vanaraja* and *Gramapriya*) germplasm was distributed to 884 farmers in Tamil Nadu by Hosur Centre and generated revenue of Rs. 17.87 lakhs. Goa centre distributed a total of 41,696 improved chicken germplasm to 1342 farmers with revenue generation of Rs. 4.76 lakhs. Port Blair centre distributed a total of 2,283 improved chicken germplasm to farmers in Andaman & Nicobar Islands with revenue of Rs. 83,774.

The ICAR-RC for NEH Region, Umiam, distributed a total of 13,414 improved chicken germplasm to the farmers in Meghalaya and generated Rs. 9.52 lakhs of revenue. Two batches of *Vanaraja* parents were maintained at SVVU, Tirupati, Andhra Pradesh. A total of 26,083 chicks were supplied to the farmers and generated Rs.3.62 lakhs as revenue. Three batches of parents of *Gramapriya* and two batches of *Vanashree* were reared at PVNRTVU, Warangal, Telangana. A total of 32,769 improved chicken germplasm was distributed to the farmers. The centre has generated revenue of Rs. 8.67 lakhs. Srinagar centre reared one batch of *Vanaraja* parents. A total of 16,127 chicks were distributed to 1210 farmers. An amount of Rs. 6.05 lakhs revenue was realized.

Technologies transferred

The Directorate propagated the technologies and varieties developed at the institute with modest activities due to the pandemic restrictions. Events were organized to create awareness about the rural and commercial poultry production to different stake holders. Two contract research projects were also under operation during the period. Two technologies developed at this Directorate having commercial value and practical application in poultry industry were submitted to Agrinnovate India Limited, New Delhi, for commercialization. One patent application for the technology invented at ICAR-DPR was filed with the Indian Patent office. A total of 79,018 hatching eggs, 1,96,274 day-old chicks, and 2,690 grown-up birds of *Vanaraja, Gramapriya, Srinidhi, Vanashree, Krishibro,* native chickens, etc. were supplied by DPR, to the farmers and different organizations including Government agencies across the country. In addition, 20,602 parent chicks of different varieties were also supplied.

From the AICRP and Poultry Seed Project centres, another 6,40,999 and 4,19,477 numbers of germplasm, respectively were supplied. Through functional linkages with line departments and other agencies, the Directorate has been playing a pioneering role in promoting rural poultry production in the country.

ICAR-DPR implemented the Development Action Plan for SC (DAPSC) in Telangana, Bihar and Madhya Pradesh during the year. Under the plan, four On-field training programs were organized and 188 farmer families were trained on different aspects of backyard poultry farming. Eight input distribution plans were also organized in these three states to start "Backyard Poultry Farming" to improve livelihoods and nutritional security of SC families.

The Directorate introduced improved chicken varieties and native chickens, with an aim to improve the economic and living standards of tribal farmers under the Scheduled Tribe Component (formerly Tribal Sub Plan) Program. A total of 2520 *Vanaraja* day-old chicks and 5,000 kg chick feed was provided to the mother unit at ITDA, Utnoor for rearing birds up to six weeks. Grownup birds were distributed by ITDA to the tribal farmers of Adilabad district, Telangana. A total of 150 night shelters were distributed to benefit the tribal farmers.

Other activities

During the year, a total of 30 research papers, 3 review papers, 2 popular articles and 2 brochures/leaflets were published by the scientists of the institute. In addition, 6 research abstracts were presented in different conferences. Other priority programmes such as *Mera Gaon Mera Gaurav* and *Swacch Bharath* were implemented. The Institute Management Committee, Research Advisory Committee and Institute Research Committee continuously monitored and suggested the measures required for improvement in research, administration and financial management of the Institute.

At the Directorate, the budget utilized during the period was Rs. 2374.36 lakhs and at AICRP and Poultry Seed Project centers, Rs. 713.24 and Rs. 535.49 lakhs, respectively were utilized. A total revenue of Rs. 533.42 lakhs (DPR-233.96, AICRP-166.67 and PSP-132.79 lakhs Rs.) was generated during the year 2020.

1 Introduction

History

The ICAR-Directorate of Poultry Research (formerly Project Directorate on Poultry) was established on 1st March 1988 at Hyderabad, Andhra Pradesh under the aegis of Indian Council of Agricultural Research. The Institute originated from All India Coordinated Research Project (AICRP) on Poultry Breeding, an all India Net Work project launched by the Indian Council of Agricultural Research during IV five-year plan with the objective of augmenting commercial poultry production and achieving self-sufficiency in the country. In the beginning, the coordinating unit of AICRP was located at the Poultry Research Division, Indian Veterinary Research Institute, Izatnagar till 1979, which later functioned from Central Avian Research Institute, Izatnagar till its elevation to the Directorate status in 1988. The institute was elevated from the position of Project Directorate to Directorate on 18th September 2013. Further elevation to "Indian Institute of Poultry Research" (as recommended by QRT) is under active consideration with Council. The Regional Station, Bhubaneswar was transferred from CARI to DPR during July 2020. Accordingly, the total scientific strength of DPR has increased to 33.

The primary research focus at the Institute has been towards the application of quantitative genetic principles to enhance productivity of various chicken germplasm with special emphasis to meet the needs of rural and tribal people of the country. To support the core research programme, research on nutrition, health, physiology and molecular genetics has been made an integral component. In addition, several externally funded projects were also carried out at the Directorate to achieve the Institute's primary goals and objectives.

The AICRP on Poultry Breeding was started during IV plan and has made significant contribution in the development of poultry sector in India over the period of time. Seven promising varieties of chicken were released for commercial exploitation for the benefit of the intensive poultry farming. Rural component of the project was added during XI plan with two centres and further strengthened in XII plan period by adding 4 more centres to carryout research in rural poultry farming. The AICRP on poultry breeding was completely re-oriented towards the rural poultry from 2014- 15 with all the 12 centres to cater to the needs of the rural/tribal farmers across the country. The primary objective of the AICRP centre is to develop location specific rural chicken varieties utilizing the local native germplasm. The constant efforts of the scientists led to the development of 5 location specific varieties, viz. *Pratapdhan* (MPUAT, Udaipur), *Kamrupa* (AAU, Guwahati), *Jharsim* (BAU, Ranchi), *Narmadanidhi* (MPUAT, Jabalpur) and *Himsamridhi* (CSKHPKVV, Palampur). During XI plan, the activities of the Directorate were further expanded by introduction of the Poultry Seed Project with six centres located in different states to increase the availability of rural chicken germplasm for rearing in remote areas of the nation. The Poultry Seed Project was further strengthened by addition of five new centres from 2014-15 and another centre from 2017-18, thus totalling to 12. The Directorate, besides coordinating the ICAR network projects, is carrying out research in core areas of Poultry Science and supplying rural chicken germplasm to meet the demand in rural and tribal areas.

At this Directorate, three promising chicken varieties for rural poultry farming were evolved i.e., *Vanaraja*, a dual-purpose bird, *Gramapriya*,

predominantly a layer, and *Srinidhi*, a dual-purpose bird meant for free-range and backyard farming. Recently, a new variety *Vanashree* (PD-4) has been developed from Aseel and is being popularised as a high producing improved native bird. These chicken varieties have become extremely popular and are being reared in every part of the country. Several user agencies in the country are involved in dissemination of the varieties covering the southern, northern, eastern and north-eastern states including Jammu and Kashmir, Lakshadweep, and Andaman and Nicobar Islands. The Directorate also developed two crosses viz. *Krishibro*, a multi-coloured broiler and *Krishilayer*, a high yielding egg producing bird for commercial purposes. Further research in this direction is underway for developing new crosses that could be tailor-made for better adaptability under diversified regions in rural and tribal backyard conditions.

Active research is being pursued to prepare package of practices for providing optimum nutrition, management and health coverage to the pure lines as well as crosses developed by the Directorate for intensive and backyard systems of rearing. Research in nutrition at this Directorate resulted in development of technologies that have been adopted by the commercial and rural farmers to reduce cost of production. Besides nutritional knowhow, the Directorate is also familiar among poultry farming community for its services in disease diagnosis, seromonitoring and health care. The nutritional and health care solutions are being offered to the stake holders of poultry farming including network programmes and contract research programmes being operated by the Directorate. The studies on advanced molecular genetic tools like RNAi (gene silencing), SNP typing, microsatellite analysis, DNA marker-based selection, etc. have also been undertaken in evaluating and augmenting the productivity of various chicken germplasm maintained at this Directorate. The Directorate thus is actively engaged in augmenting the productivity of chicken by undertaking research in different aspects of Poultry Science to cater to the needs of the country.

Vision

- To enhance productivity of chicken for household nutritional security, income and employment generation.

Mission

- To develop and propagate improved varieties of chicken for sustainable production under intensive and extensive systems.

Mandate

- Basic and applied research to enhance productivity of poultry.
- Development of new germplasm for rural poultry husbandry.
- Capacity building.

Budget (2020)

Rs. lakhs

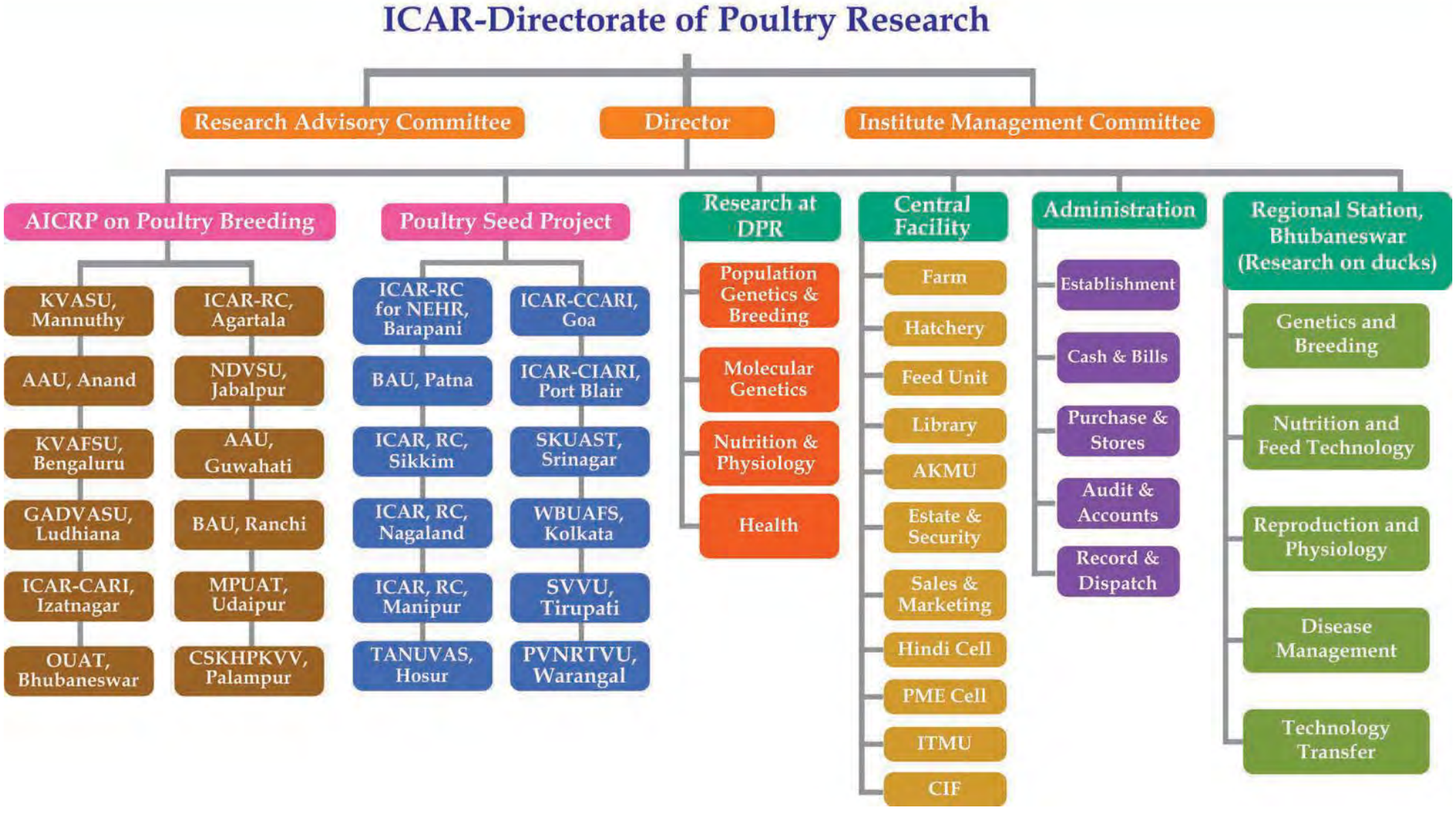
Scheme	Budget	Utilization	Receipts
DPR	2374.49	2374.36	233.96
AICRP	713.24	713.24	166.67
PSP	535.49	535.49	132.79

The Budget allocation is as per the financial year. However, the above figures are calculated proportionately from the allocations for the year 2019-20 and 2020-21.

Staff Position (as on December 31, 2020)

	Headquarters, Hyderabad		Regional Station, Bhubaneswar		Total	
Cadre	Sanctioned	In position	Sanctioned	In position	Sanctioned	In position
RMP	01	-	-	-	01	-
Scientists	23	22	10	08	33	30
Technical	16	13	02	04	18	17
Administrative	14	10	02	01	16	11
Skilled support	15	12	05	02	20	14
Total	69	57	19	15	88	70

Organogram


ICAR-Directorate of Poultry Research
Research Advisory Committee
Director
Institute Management Committee
AICRP on Poultry Breeding
KVASU, Mannuthy
AAU, Anand
KVAFSU, Bengaluru
GADVASU, Ludhiana
ICAR-CARI, Izatnagar
OUAT, Bhubaneswar
ICAR-RC, Agartala
NDVSU, Jabalpur
AAU, Guwahati
BAU, Ranchi
MPUAT, Udaipur
CSKHPKVV, Palampur
Poultry Seed Project
ICAR-RC for NEHR, Barapani
BAU, Patna
ICAR, RC, Sikkim
ICAR, RC, Nagaland
ICAR, RC, Manipur
TANUVAS, Hosur
ICAR-CCARI, Goa
ICAR-CIARI, Port Blair
SKUAST, Srinagar
WBUAFS, Kolkata
SVVU, Tirupati
PVNRTVU, Warangal
Research at DPR
Population Genetics & Breeding
Molecular Genetics
Nutrition & Physiology
Health
Central Facility
Farm
Hatchery
Feed Unit
Library
AKMU
Estate & Security
Sales & Marketing
Hindi Cell
PME Cell
ITMU
CIF
Administration
Establishment
Cash & Bills
Purchase & Stores
Audit & Accounts
Record & Dispatch
Regional Station, Bhubaneswar (Research on ducks)
Genetics and Breeding
Nutrition and Feed Technology
Reproduction and Physiology
Disease Management
Technology Transfer

2 Research Achievements

Genetics and Breeding

Development of germplasm for backyard / free range farming for rural and tribal areas

Male lines

PD-1 line (*Vanaraja* Male Line)

PD-1 line was evaluated for growth and production traits up to 40 weeks of age in S-14 generation during the reporting period.

Juvenile performance (S-14)

The six-week shank length and body weight decreased compared to last generation. The heritability of 6-week body weight and shank length was 0.31 and 0.23, respectively. The heritability estimates for body weight and shank length were moderate to high (Table 1). The body weight and shank length were positively correlated with high degree of association (0.88). The genetic and phenotypic response in 6-week shank length (SL6) was 2.53 and 1.05 mm, respectively per generation over the last 11 generations (Fig 1).

Table 1. Juvenile traits at different weeks in PD-1 (S-14)

Age		Mean±S.E.	Heritability
Body weight (g)			
	04 wks	345.9±0.04	0.25±0.05
	06 wks	705.6±0.07	0.31±0.06
Shank length (mm)			
	04 wks	57.78 ±0.002	0.22±.0.06
	06 wks	78.83±0.003	0.23±0.05

Production performance (S-14)

The ASM was 192.0±0.05 days, which increased from previous generation. The part period egg production at 40 weeks of age was 39.96± 0.05 eggs, which was reduced from last generation. The egg weight at 40 weeks was 58.55±0.01 g. The heritability estimates of production traits were low to medium from sire and dam components variance. The least squares mean for body weight of hens at 20 and 40 weeks were 2019±0.86 and 2871±0.91 g, respectively.

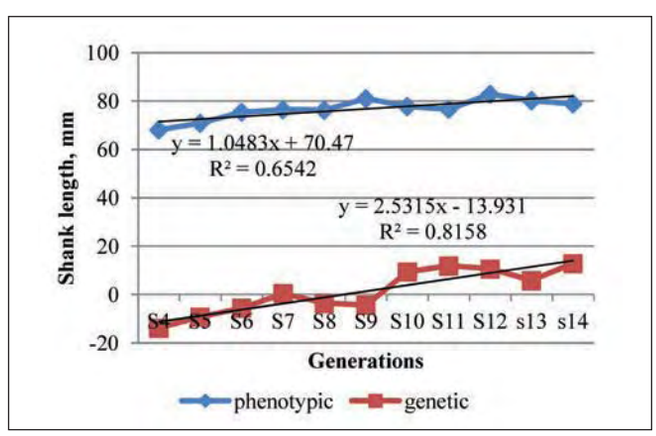


Fig 1. Short term response for 6-week shank length in PD-1

A pair of PD-1 birds

PD-6 (*Gramapriya* Male Line)

The PD-6 line is being used as male parent line of *Gramapriya* variety. The selection criterion is higher shank length at 6 weeks age. The S-10 generation was reproduced utilizing 44 sires and 250 dams selected based on shank length at 6 weeks of age and a total of 2053 chicks were produced. The fertility was 83.59% and hatchability on total and fertile eggs set was 77.58 and 92.80%, respectively. Total number of chicks produced were 3516. Among the juvenile traits, the body weight at day old, 2, 4 and 6 weeks of age and shank length at 4 and 6 weeks of age are presented in Table 2. The mortality up to 6 weeks of age was 7.51%. The heritability for body weight and shank length were moderate to high. The shank length and body weight at 6 weeks of age were positively and highly correlated. The shank length decreased by 0.89 mm as the body weight reduced at 6 weeks of age compared to previous generation.

A pair of PD-6 birds

Female lines

PD-2 (female parent line of *Vanaraja*) and PD-3 (female parent line of and *Srinidhi*) lines along with rural and Dahlem Red control were evaluated for growth and production performance.

PD-2 line

PD-2 line is developed from coloured random bred control population. This line is being used as female parent for production of *Vanaraja* chicks. The selection criteria is egg mass to 52 weeks. The production traits were recorded from 40-52 weeks of age in S-16 generation during the current period. The body weight, egg weight, egg production and egg mass up to 52 weeks of age were 2728±0.44g, 55.75±0.004g, 138.6±0.02eggs and 7898±2.01 g, respectively. The 52 weeks egg mass showed improvement of 451 g over previous generation.

The S-17 generation was reproduced utilizing 50 sires and 250 dams selected based on part period

A pair of PD-2 birds

Table 2. Least square means of Juvenile traits in PD-6 (GML) line (S-10)

Traits		Mean±S.E.	Heritability		
			Sire	Dam	Sire+Dam
Body weight (g)					
	2 wks	164.0±0.02	0.25±0.06	0.10±0.08	0.17±0.04
	4 wks	486.9±0.05	0.32±0.07	0.21±0.09	0.26±0.05
	6 wks	799.9±0.09	0.29±0.05	0.35±0.08	0.31±0.04
Shank length (mm)					
	4 wks	68.76±0.001	0.22±0.01	0.21±0.09	022±0.04
	6 wks	86.51±0.003	0.29±0.07	0.09±0.04	0.17±0.04

Table 3. Least square means of juvenile traits in PD-2 line (S-17) and rural control (RC)

Traits		PD-2	RC	Heritability		
				Sire	Dam	Sire+Dam
Body weight (g)						
	Day old	37.0±0.01	36.8	0.15±0.07	-	-
	2 wks	132.7±0.02	144.9	0.24±0.03	0.41±0.08	0.32±0.03
	4 wks	358.3±0.04	343.7	0.34±0.06	0.37±0.07	0.35±0.04
	6 wks	694.7±4.04	710.7	0.29±0.05	0.35±0.08	0.31±0.04
Shank length (mm)						
	4 wks	58.18±0.001	57.54	0.37±0.06	0.29±0.07	0.35±0.04
	6wks	76.42±0.002	77.07	0.27±0.05	0.20±0.07	0.23±0.03

egg mass up to 52 weeks of age utilizing Osborne Index. The fertility was 81.44%and hatchability on total and fertile eggs set was 73.28% and 89.95%, respectively. Total number chicks produced were 3516. Among the juvenile traits, the body weight at day old, 2, 4 and 6 weeks of age and shank length at 4 and 6 weeks of age are presented in Table 3. The mortality up to 6 weeks of age was 8.01 and 13.64% in PD-2 and rural control populations, respectively. The body weight and shank length at 6 weeks of age increased compared to previous generation.

PD-3 line

The PD-3 line is being improved for higher 40-week egg mass. The line was evaluated for production traits during S-8 generation (Table 4). The part period egg production and egg mass up to 40 weeks of age increased considerably from the previous generation. The heritability estimates for production traits were low to high from sire and dam components of variance.

Regeneration of PD-3 line (S-9)

The S-9 generation of PD-3 line was regenerated using 50 sires and 250 dams in a pedigreed mating. A total of 4870 chicks were produced. The fertility was 87.44% and hatchability on fertile and total eggs set was 91.25 and 80.0%, respectively.

The body weight at 2, 4 and 6 weeks of age was 88.98±0.32, 202.79±0.90 and 341.03±1.65 g, respectively in S-9 generation. The body weight improved from the last generation. The shank length at 4- and 6-weeks age was 46.99±0.09 and 58.11±0.13 mm, respectively. The heritability estimates were moderate to high for body weight and shank length.

Table 4. Production performance of PD-3 line (S-8)

Traits		Means		Heritability		
		PD-3	DRC*	Sire	Dam	Sire+Dam
ASM	(days)	158.1±0.02	174.6	0.39±0.14	0.11±0.13	0.25±0.09
Body weight (g)	20 wks	1413± 0.21	1245	0.43 ±0.16	0.41 ±0.16	0.42±0.12
	40 wks	1771± 0.41	1554			
Egg weight (g)	24 wks	46.79±0.005	43.20	0.33±0.15	0.49±0.17	0.41±0.14
	28 wks	51.23±0.006	50.22	0.55±0.18	0.39±0.15	0.47±0.11
	32 wks	53.41±0.005	51.91	0.70±0.20	0.31±0.14	0.51±0.14
	36 wks	54.10±0.005	52.40	0.61±0.19	0.32±0.15	0.47±0.14
	40 wks	54.64±0.006	52.90	0.56±0.17	0.04±0.13	0.30±0.12
Egg prodn. (Nos.)	40 wks	93.65±0.03	81.08	0.06 ±0.09	0.25 ±0.16	0.15±0.09
Egg mass (g)	40 wks	4968±1.84	4289	0.09±0.09	0.22±0.16	0.16±0.09

*DRC - Dahlem Red Control

Estimation of breeding value and maternal components in PD-3 line

Variance and covariance components of growth and production traits were analysed employing REML animal model to assess the population for direct additive genetic, maternal effects and to estimate the accurate estimated breeding value (EBV), genetic parameters, genetic trends and rate of inbreeding (ΔF) utilizing seven generations data in *Dahlem Red* (PD-3) chicken. The generation and hatch had significant (P≤0.01) effect on the body weight at 0 day (BW0), 2 (BW2), 4 (BW4) and 6 weeks (BW6) and shank length at six weeks of age (SL6). The average least squares mean (LSM) for BW6 and SL6 was 273.93±0.62 g and 53.97±0.05 mm, respectively. All the production traits were significantly (P≤0.01) influenced by generation and hatch. The average LSM for age at sexual maturity (ASM), egg production up to 40 weeks (EP40) and egg mass up to 40 weeks (EM40) were 168.82±0.25 d, 72.60±0.41 eggs and 4.21±0.07 kg, respectively. Model 5 with additive direct, maternal genetic, maternal permanent environmental and residual variance components was the best for BW0, BW2

A pair of PD-3 birds

and BW4 based on the AIC values obtained in WOMBAT. Model 4 was the best model for BW6, SL6, ASM, EP40 and EM40 with additive direct, maternal permanent environmental and residual variance components. Maternal effects were higher at an early age, decreased with age, and remained present until 20 weeks of age. The heritability (h^2) estimates were low to moderate in magnitude for all the growth traits ranging from 0.02±0.03 to 0.19±0.03. The maternal heritability was high at hatching (0.35±0.06), it gradually decreased until the end of the 4th week (0.02±0.01) and it ceased afterwards. The heritabilities of EP40 (0.11±0.03) and EM40 (0.12±0.04) were low. The direct additive genetic correlations (r_a) between BW2, BW4, BW6 and SL6 were high and positive (P≤0.05). The additive genetic and maternal permanent environmental correlation between EP40 and EM40 were high and positive (P≤ 0.05).

Breeding value and genetic gain

The average EBV for BW6 and SL6, the important juvenile traits, was 17.65 g and 1.33 mm at the S-7 after seven generations of selection. The genetic trend of BW6 and SL6 was significant (P < 0.05) and increased linearly over the generations. The EBV of EM40 (0.48 kg) at the end of seventh generation was significant (P≤0.05) and increased linearly as a response to selection in PD-3 line. The average genetic and phenotypic response was 0.08 and 0.11 kg per generation for EM40, the primary trait of selection (Fig 2, 3). ASM decreased significantly with an increment of one day in each generation. The breeding value of EP40 showed an increasing trend with a genetic gain of 1.87 eggs per generation. The EW28 and EW40 increased linearly.

Inbreeding

The inbreeding is almost negligible in the population. The average inbreeding coefficient of the population was 0.019 and the average ΔF was 0.007 over the last seven generations of selection. The inbreeding coefficient of the population increased gradually from 0.00 to 0.04 in the 7th generation. The trend of inbreeding and rate of inbreeding is presented in Fig 4.

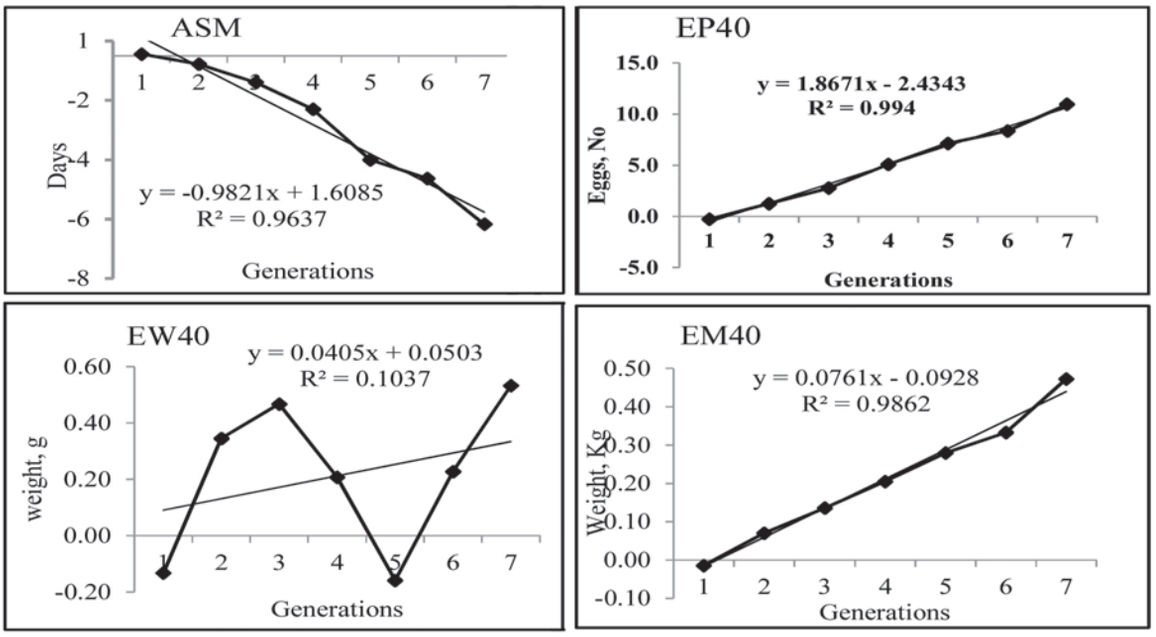


Fig 2. Trend of breeding value for important economic traits over generations. ASM: Age at sexual maturity, EP40: 40 weeks egg production, EM40: Egg mass up to 40 weeks, EW40: 40th week egg weight.

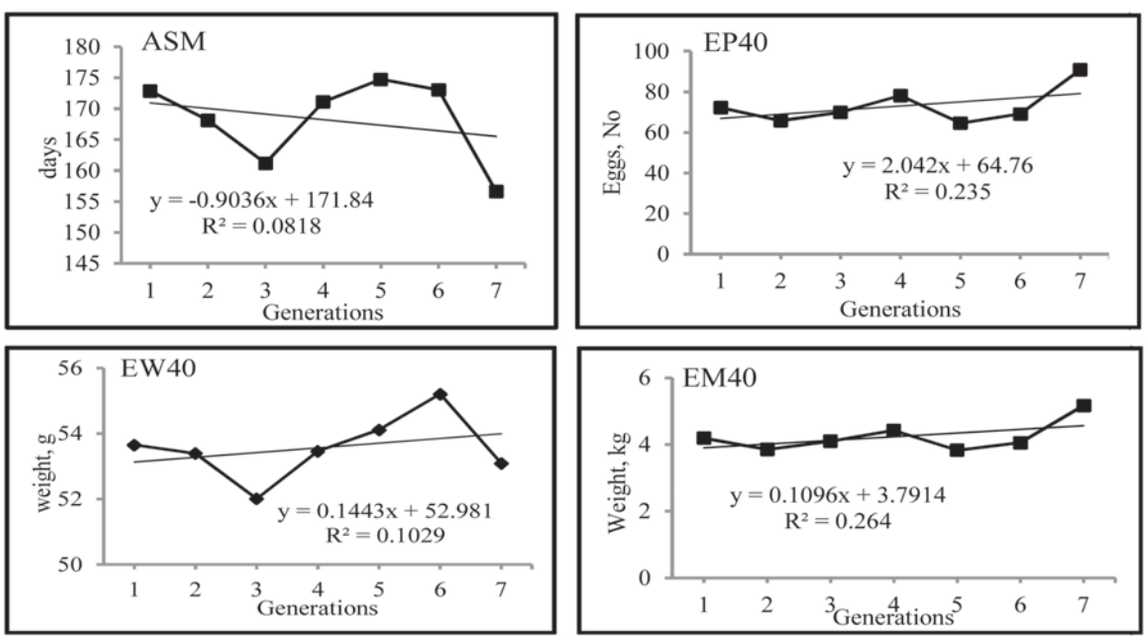


Fig 3. Phenotypic trend of important economic traits over generations. ASM: Age at sexual maturity, EP40: 40 weeks egg production, EM40: Egg mass up to 40 weeks, EW40: 40th week egg weight.

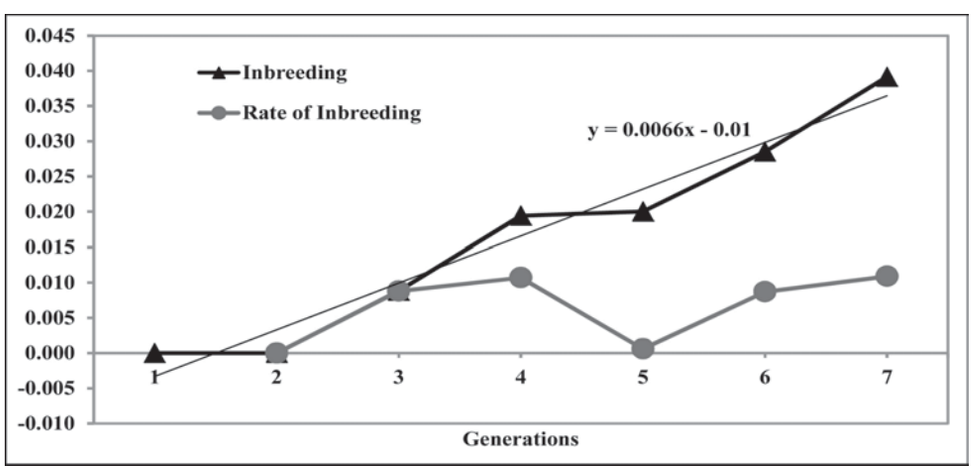


Fig 4. Status of inbreeding over the generations

Native germplasm

Vanashree

Vanashree, evolved from Aseel (PD-4), is being improved for body weight at 8 weeks of age through individual selection in males and also for egg production up to 40 weeks of age through independent culling level of selection in females. In S-11 generation, a total of 1148 good chicks were hatched in two hatches by mating 50 sires with 150 dams in 1:3 ratio. The fertility was 86.36% while hatchability was 85.87 and 74.16%, respectively on fertile and total eggs set. Selection differential and intensity of selection for 8 weeks body weight was 36.5g and 0.41σ, respectively, while those for 40 weeks egg production were 2.23 eggs and 0.11σ. Effective population size and rate of inbreeding were 145.0 and 0.0034, respectively as 50 sires and 132 dams contributed progenies to the S-11 generation.

Growth traits: The body weight at 12 weeks of age was 1029±6.97 and 872.6±10.1g, respectively in first and second hatch. The average body weights and shank length recorded sex wise up to 40 weeks of age are given in Table 5. There was increase in body weight of male (128 and 93 g) birds at 20 and 40 weeks of age as compared to previous generation. In females body weight at 40 weeks increased by 45 g as compared to the previous generation. Also, there was increase in shank length recorded at 20 and 40 weeks of age in male (2.2 and 0.4 mm) *Vanashree* birds. Liveability observed during 0-8 and 9-20 weeks of age was 88.94 and 92.85%, respectively. Liveability of males and females during 21-40 weeks of age was 99.02 and 97.83%, respectively.

A pair of *Vanashree* birds

Table 5. Growth traits in adult male and females of *Vanashree* (S-11)

Trait		Males	Females
Body weight (g)			
	20 wks	2114±11.7	1537±7.7
	40 wks	3256±23.9	2247±17.5
Shank length (mm)			
	20 wks	133.5±0.38	107.1 ± 0.23
	40 wks	136.3±0.40	107.7± 0.26

Production traits: Production traits of *Vanashree* (S-11 generation) are presented in Table 6. There was considerable increase in egg weights recorded at 28 (1.28), 32 (2.34), 36 (2.43) and 40 (2.95g) weeks of age as compared to previous generation.

Table 6. Production traits of *Vanashree* hens (S-11)

Traits		Mean±S.E.
ASM (d)		168.3±0.75
Age at 50% production (d)		169
Age at peak production (d)		213 (73.7%)
Egg production (Nos.), 40 wks		
	Survivors'	68.23±1.40
	HHEP	70.09
	HDEP	70.50
Egg weight (g)		
	28 wks	45.18±0.25
	32 wks	48.45±0.21
	36 wks	50.42±0.21
	40 wks	52.18±0.25

HHEP: Hen housed egg production, HDEP: Hen day egg production, figure in parenthesis is production percentage.

Ghagus

Ghagus, an indigenous chicken breed has been selected for higher body weight at 8 weeks of age. The production performance of S-2 generation evaluated for up to 40 weeks of age is presented in Table 7. There was an improvement of 10.84 eggs in survivors' egg production, 8.61 eggs in hen housed egg production and 11.71 eggs in hen day egg production. There was no significant change in egg weights recorded at different ages up to the age of 40 weeks. After regeneration, the Ghagus breed was further evaluated for production traits

up to 72 weeks of age. Hen housed, hen day and survivors egg production recorded up to 72 weeks of age were 117.8±3.13, 122.9 and 118.8±3.19 eggs, respectively. The egg weight and body weight at 72 weeks of age were 52.65±0.39 g and 2288±54.5 g, respectively.

Table 7. Production traits of Ghagus breed (S-2)

Traits		Mean±S.E.
ASM (d)		161.5 ± 1.01
Age at 50% production (d)		162
Age at peak production (d)		175 (58.3%)
Egg production (Nos.), 40 wks		
	Survivors'	45.77±1.59
	HHEP	43.48±1.49
	HDEP	45.63
Egg mass (g)	40 wks	2127±73.7
Egg weight (g)		
	28 wks	43.55±0.30
	32 wks	45.92±0.38
	40 wks	46.46±0.42

HHEP: Hen housed egg production, HDEP: Hen day egg production, figure in parenthesis is production percentage.

S-3 generation: A total of 875 good chicks of Ghagus were hatched in S-3 generation in two hatches with the fertility of 85.26% and better hatchability of 94.1 and 80.23% on fertile eggs and total eggs set, respectively. There was improvement in hatchability in this generation compared to previous generation. Growth performance evaluation of S-3 generation birds was completed up to 20 weeks of age during the reporting period. Growth traits recorded on pooled sex up to 8 weeks of age are presented in Table 8. There was improvement of 87.6 g in 8 weeks body weight and 3.59 mm in 8 weeks shank length when compared to previous generation. Higher estimates of heritability of juvenile growth traits of Ghagus on sire component basis were observed in S-3 generation Body weight of male and female birds at 20 weeks of age was 2245±27.1 and 1603±11.1 g, respectively. Shank length of male and female birds at 20 weeks of age was 127.2±0.63 and 103.7±0.53 mm, respectively. There was an improvement of 125 and 89 g in 20 week's body weight of males and females, respectively in this generation.

A pair of Ghagus birds

Table 8. Juvenile growth traits of Ghagus breed on pooled sex (S-3)

Traits		Mean±S.E.	h^2 (Sire)
Body weight (g)			
	0 day	35.66±0.33	-
	4 wks	182.2±1.54	0.39±0.15
	8 wks	559.3±4.40	0.21±0.11
Shank length (mm)			
	8 wks	73.68±0.28	0.13±0.11

Nicobari

Nicobari, an important indigenous breed of chicken is being evaluated and conserved at the Institute pure line farm. Pedigreed random bred population of Nicobari is being maintained from G-7 generation onwards. The G-7 generation was evaluated for growth and production traits up to 40 weeks of age. Body weight and shank length of male and females recorded at 20 and 40 weeks of age are presented in Table 9.

There was an improvement of 153 and 94 g in 20 weeks body weight of male and female birds respectively. Similarly, there was improvement of 1.6 and 1.58 mm in 20 weeks shank length of male and female birds, respectively.

Table 9. Growth performance of Nicobari birds (G- 7)

Traits		Males	Females
Body weight, (g)			
	20 wks	1737±21.1	1210±12.4
	40 wks	2252±33.7	1596±22.3
Shank length (mm)			
	20 wks	106.2±1.02	87.12±0.63
	40 wks	107.4±1.34	87.20±0.77

Production traits: Production traits of Nicobari recorded during G-7 generation are presented in Table 10. There was slight improvement in HDEP in this generation but no significant change in Survivors' and HHEP. Egg mass up to 40 weeks of age is also on higher side recorded for the first time in this breed. Slight increase in egg weights recorded at 28, 32, 36 and 40 weeks of age was observed in this generation (Table 10). Liveability was higher in male (98.89%) as compared to females (91.74%) Nicobari birds during 21-40 weeks of age.

Table 10. Production performance of Nicobari birds (G-7)

Traits		Mean± S.E.
ASM (d)		173.3±1.33
Egg production (Nos.)	40 wks	
	Survivors'	72.01 ± 1.74
	HHEP	70.27 ± 1.79
	HDEP	74.70
	Egg mass, g	3456±83.32
Egg weight (g)		
	28 wks	42.60±0.33
	32 wks	44.48±0.27
	36 wks	44.76±0.38
	40 wks	47.99±0.36

HHEP: Hen housed egg production, HDEP: Hen day egg production

A pair of Nicobari birds

Feeding trial: The Nicobari hens were evaluated for feed intake, feed efficiency, feed conversion ratio and production performance during 24 to 40 weeks. Highest hen housed egg production and egg mass was observed during 37 to 40 weeks of age. The feed efficiency (egg mass/feed) recorded was 0.36 and feed conversion ratio was (feed/egg mass) 2.8 per kg of egg mass. The trend of average daily feed intake from 24 to 40 weeks of indicated that average daily feed intake started increasing from 24 weeks (55.3) onwards and reached first peak at about 30 weeks of age (87 g) followed by a plateau and again reached the highest peak at about 39 weeks of age (90.7 g).

G-8 generation: The G-8 generation of Nicobari was produced in a single hatch with a total of 765 good chicks by mating 50 sires with 150 dams in a pedigree set up with 1:3 ratio. The fertility was 87.1%, while hatchability on fertile and total eggs set was 86.41 and 75.28%, respectively. Growth performance of Nicobari breed was evaluated on pooled sex up to 8 weeks of age (Table 11). Heritability estimates of juvenile growth traits were moderate to high in Nicobari breed.

Table 11. Growth performance of Nicobari birds on pooled sex (G-8)

Traits		Mean ±S.E	$h^2_{(Sire)}$
Body weight (g)			
	0 day	34.83±0.13	-
	4 wks	163.2±1.55	0.33±0.14
	8 wks	408.0±4.08	0.27±0.13
Shank length (mm)			
	8 wks	60.90±0.34	0.58±0.19

Aseel

The population was regenerated in G-7 generation. A total of 1199 chicks were produced in three hatches. The fertility was 82.73 % and hatchability was 88.22 and 72.98%, respectively on FES and TES. The fertility and hatchability increased significantly during this generation. Aseel breed was evaluated up to 40 weeks of age for growth and production traits in G-7 generation. The body weight of Aseel hens at 20 and 40 weeks of age was 1322 and 1942 g, respectively. The body weight of Aseel cock at 40 weeks was 3246 g. The egg weight was 45.06 g at 40 weeks of age. The part period egg production up to 40 weeks of age was 22.0 eggs. The EP40 improved by 4 eggs compared to the previous generation (18.0 eggs).

Adult Aseel male

Kadaknath

G-1 generation of Kadaknath, an indigenous chicken, breed was regenerated by pedigreed random matting. A total of 50 sires and 150 dams were mated. About 1,966 eggs were set and 1,623 good chicks were produced in 3 hatches. Fertility was 91.71%. Hatchability on total egg set and fertile egg set was 83.11 and 90.63 %, receptively. Improved fertility and hatchability parameters were observed compared to the previous generation.

The overall mean of body weight at 0 day, 4 weeks and 8 weeks of age were 29.51, 124.4 and 403.7 g, respectively. The heritability estimates (Sire+Dam) of body weight recorded at 4, 8 and 16 weeks were 0.47±0.08, 0.40±0.08 and 0.43±0.10, respectively. There was an improvement in 8 weeks body weight over the previous generation (376.3 g). Average body weight of males and females at 16 weeks of age were 1,097 and 846.3 g, respectively. Liveability was 91.0% during 0 to 8 weeks of age and 91.61% % during growing (9-20 weeks) period.

A total of 481 adult female were housed for performance evaluation. Body weight at 20 weeks of age was 1,569 g in male and 1,111 g in female. There is an improvement in body weight at 20 weeks in female compared to the previous generation (1,065 g). ASM was 176.2 days and reduced by one day compared to the previous generation. Egg weight at 28 weeks and 40 weeks were 40.61 and 45.78g, respectively which showed an improvement. Egg production up to 40 weeks of age was 76.27 eggs. Body weight of male and female birds at 40 weeks was 2,173 and 1,485 g, respectively. Livability was 94.78% during laying period (21-40 weeks).

Kadaknath male and female birds

Field evaluation of Aseel crosses for broiler purpose

A total of 10 farmers (1 from Kothur, 3 from Gudur, 2 from Bhavoji Thanda, 2 from Narsapur and 2 from Warangal) were provided with Aseel crosses involving Aseel X PD-1 or GML (PD-6). Each farmer was provided with 100 chicks making a total of 1000 chicks and 10 farmers. Two farmers were provided each with 100 chicks of Aseel x PB-2 cross for evaluation. Farmers were advised to rear chicks under intensive system with full feeding using commercial broiler feed. The results of field performance are presented in Tables 12 and 13.

Table 12. Performance of Aseel X PD-1/PD-6 cross for broiler purpose under intensive system

Traits		Farm (ICAR-DPR)		Field (Farmers)	
		Mean±SE	N	Mean±SE	N
Body weight (g)					
	0 day	39.33±0.30	100		1000
	4 wks	279.4±11.1	92	416.8±5.4	957
	5 wks	411.5±16.7	91	-	
	6 wks	579.6±24.1	91	717.7±9.6	948
	8 wks	930.5±35.5	90	1041±11.5	946
	12 wks	1716±64.1	87	1661±18.6	937
Shank length (mm)					
	4 wks	55.66±0.66	92	63.87±0.40	957
	5 wks	63.28±0.74	91	-	
	6 wks	73.05±0.82	91	95.65±0.60	948
	8 wks	91.55±0.96	90	113.8±0.67	946
	12 wks	124.6±1.42	87	130.8±0.73	937
Mortality (%)					
	0-6 wks	9.0		5.2	
	7-12 wks	4.3		1.0	

Table 13. Performance of Aseel X PB-2 cross for broiler under intensive system

Traits		Farm (ICAR-DPR)		Field (Farmers)	
		Mean±SE	N	Mean±SE	N
Body weight (g)					
	0 day	38.68±0.97	30		
	4 wks	324.1±24.4	30	393.1±5.11	188
	5 wks	491.9±33.7	30	604.0±10.7	188
	6 wks	704.8±52.1	30	1018±31.90	186
	8 wks	1716±91.5	30	1416±20.2	183
	12 wks	2106±133.4	30	2249±36.3	179
Shank length (mm)					
	4 wks	57.47±1.36		-	
	5 wks	65.33±1.77		-	
	6 wks	73.05±2.13		-	
	8 wks	91.55±2.08		-	
	12 wks	122.6±3.02		-	
Mortality (%)					
	0-6 wks		-	7.0	
	7-12 wks		-	4.8	

Janapriya

Janapriya, a promising dual-purpose chicken variety developed by crossing PD-1 with PD-4 was evaluated under farm conditions. The results of the evaluation are presented in Tables 14 and 15.

Table 14. Growth Performance of *Janapriya* under farm conditions

Trait		Male		Female		Pooled	
		Mean±SE	N	Mean±SE	N	Mean±SE	N
Body weight (g)							
	Day old	34.01±0.33	106	33.55±0.39	76	33.82±0.25	182
	1 wks	60.8±0.74	104	61.5±0.78	78	61.13±0.54	182
	2 wks	120.2±1.9	100	124.5±1.8	78	122.1±1.3	178
	3 wks	204.9±3.5	101	211.1±2.9	77	207.6±2.4	178
	4 wks	303.8±5.6	101	309.1±4.6	78	306.1±3.7	179
	6 wks	578±10.1	100	545±7.8	78	564±6.7	178
	8 wks	956±13.8	98	855±9.9	78	911±9.6	176
	10 wks	1342±18.0	98	1152±13.0	77	1258±13.6	175
	12 wks	1642±21.8	96	1367±15.4	76	1525±17.6	172
Shank length (mm)							
	4 wks	56.02±1.42	101	59.32±0.45	78	57.41±0.85	179
	6 wks	73.80±1.98	100	76.13±0.52	78	74.78±1.17	178
	8 wks	85.84±2.59	98	88.77±0.48	78	87.07±1.51	176
	10 wks	101.4±3.06	98	100.8±1.41	77	101.1±1.86	175
	12 wks	107.6±3.61	96	104.6±1.99	76	106.4±2.25	172

Table 15. Production performance of *Janapriya*

Trait		Mean±SE
ASM (d)		154.6±1.33
Body weight (g)		
	20 wks	2111±18.1
	40 wks	2709±38.4
	52 wks	2875±49.0
	64 wks	2901±46.3
	72 wks	3014±49.0
Egg weight (g)		
	40 wks	54.65±0.44
	52 wks	56.70±0.46
	64 wks	60.31±0.30
	72 wks	60.49±0.41
Egg production (Nos.)		
	40 wks	71.02±3.14
	52 wks	121.4±3.49
	64 wks	154.7±4.29
	72 wks	176.4±3.56

N : 60

Vanaraja and *Gramapriya*

The performance of *Vanaraja* and *Gramapriya* was assessed with the performance in earlier part of development (Table 16). The body weight at 14 weeks of age in *Vanaraja* and *Gramapriya* cocks was 2187±30.15 and 1650±36.46 g respectively. The ASM was reduced compared to earlier period of their development. The egg production in both *Vanaraja* and *Gramapriya* improved over the years. The annual egg production was 189 eggs in *Vanaraja* and 240 eggs in *Gramapriya*. The published data from literature from farm and backyard suggest that there is increase in egg production potential of both *Vanaraja* and *Gramapriya* birds.

Table 16. Growth and production performance of *Vanaraja* and *Gramapriya* under farm conditions (Intensive system)

Trait		*Vanaraja*		*Gramapriya*	
		Mean±SE	N	Mean±SE	N
Body weight (g)					
	4 wks	337.3±4.11	239	217.3±2.29	452
	6 wks	667.1±6.51	235	432.9±4.04	444
	20 wks	1859±17.95	72	1687±14.54	66
	40 wks	2843±30.75	72	2411±36.93	66
	52 wks	2988±33.25	72	2520±38.21	66
	64 wks	3125±45.89	72	2633±40.06	66
	72 wks	3134±47.24	72	2731±41.10	66
Shank length (mm)					
	4 wks	59.08±0.35	239	50.02±0.25	452
	6 wks	78.06±0.40	235	66.31±0.29	444
Production traits					
ASM (d)		149.0±1.63	72	146.4±1.30	66
Egg weight (g)					
	28 wks	51.11±0.34	72	48.91±0.39	66
	40 wks	55.60±0.37	72	55.93±0.41	66
	52 wks	57.14±0.32	72	56.65±0.48	66
	64 wks	58.68±0.39	72	57.13±0.52	66
	72 wks	59.09±0.40	72	59.91±0.52	66
Egg production (Nos.)					
	40 wks	87.76±2.20	72	107.1±1.94	66
	52 wks	131.5±3.49	72	161.0±2.68	66
	64 wks	163.6±4.64	72	203.3±3.42	66
	72 wks	188.7±5.39	72	239.6±3.64	66

Coloured broiler populations for intensive and semi intensive broiler farming

Genetic improvement of synthetic coloured broiler male line (PB-1)

A total of 1563 good chicks of PB-1 line in S-29 generation were hatched and juvenile performance was evaluated. Fertility was 89.27%. Hatchability on total eggs set and fertile eggs set basis was 84.85 and 95.04 %, respectively. Higher fertility and hatchability were recorded in the present generation as compared to previous generation. Body weight at 4, 5, 6 weeks of age was 582, 918 and 1162 g, respectively. Shank length at 5 weeks was 78.83 mm. Improvement in growth performance observed compared to previous generation.

Introduction of germplasm from Bengaluru centre (S-0)

To increase the variability and improve the juvenile growth traits of PB-1 line, a total of 2,321 settable eggs were obtained from Bengaluru centre of AICRP on Poultry Breeding in 4 batches and a total of 1,467 good chicks were hatched in S-0 generation. Overall fertility was 74.58%. Hatchability on total eggs set and fertile eggs set basis was 65.62 and 87.98 %, respectively.

Juvenile performance of PB-1 (Bangalore, S-0) was evaluated and average body weights at 4, 5, 6 weeks of age and shank length at 5 weeks of age were 743, 1,102, 1,404g and 84.30 mm, respectively. The ASM, 20 weeks body weight, 40 weeks body weight, 32 weeks egg weight, 40 weeks egg weight and 40 weeks egg production, respectively were 171.72 days, 2613 g, 3106 g, 56.70 g, 60.91 g and 59.82 eggs.

PB-1 grower chickens

Regeneration of PB-1 (S-1)

The mating plan was prepared and 50 sires and 207 dams from S-0 germplasm of Bengaluru centre were selected based on higher body weight at 5 weeks of age and egg production up to 40 weeks. Average body weight at five weeks of age in selected sires and dams was 1,247 and 988.4 g, respectively. A total of 1733 good chicks were obtained in 5 hatches. Fertility was 82.50%. Hatchability on total egg set and fertile eggs set was 73.81 and 89.47%, respectively. Average body weight at day old was 42.09±0.10 (1733). Performance recording of juvenile traits is in progress.

Pedigreed random bred broiler control

The pedigreed random bred broiler control population was evaluated for production traits up to 40 weeks of age in G-18 generation. The ASM, 20 weeks body weight, 40 weeks body weight, 32 weeks egg weight, 40 weeks egg weight and 40 weeks egg production, respectively were 182.0±0.66 days, 2197±18.72 g, 2882±22.88 g, 51.96±0.26g, 56.87±0.32 g and 46.81±1.49 eggs. As compared to last generation, production traits were more or less similar and they are almost stable.

The mating plan was prepared and G-19 generation of the control broiler line was generated with 50 sires and 250 dams, which were selected randomly. A total of 1207 good chicks were obtained in 2 hatches. Fertility was 88.81%. Hatchability on total egg set and fertile eggs set was 79.74 and 89.79 %, respectively. As compared to last generation there is improvement in fertility. Average body weight at day old was 40.12±0.11g (1203). Performance recording of juvenile traits is in progress.

Genetic improvement of synthetic coloured broiler female line (PB-2)

Performance of PB-2 (S-0, Bengaluru germplasm)

During the period under report, the PB-2 line was evaluated for juvenile and production traits in S-0 generation. Average body weight at day old, 2, 4 and 5 weeks of age were 43.99, 264.2, 670.3

and 951.3 g, respectively while shank length and breast angle at 5 weeks were 80.20 mm and 80.70° in S-0 Bengaluru germplasm. Average body weight at five weeks of age in male and female were 1233.5 and 924.4 g, respectively. Body weight at day old and 5 weeks of age was 40.21 and 920.3 g, respectively in S-29 generation.

About 450 PB-2 female birds and 80 males were housed to evaluate the production performance. The average ASM was 184.5 days and increased compared to the last generation. There is a decline in egg production in Bengaluru germplasm compared to last generation. Egg weights at different ages were higher than the last generation (Table 17).

Maintenance of naked neck *(Na)* and Dwarf *(Dw)* genelines

S-17 generation of Naked Neck and Dwarf gene lines were evaluated for performance traits. ASM was maintained in *Dw* line and increased in the *Na* line over the previous generation. The egg production up to 40 weeks in *Dw* line was 78.28±1.94 and improved over the previous generation. There was reduction in egg production in *Na* line compared to last generation (Table 18).

PB-2 grower chickens

Table 17. Production parameters in PB-2 line (S-0)

Trait		Mean±SE
ASM (days)		184.53±1.43
Egg Production (Nos.)		
	32 wks	-
	40 wks	50.60±1.15
Egg weight (g)		
	28 wks	52.52±0.40
	32 wks	57.18±0.37
	36 wks	60.38±0.41
	40 wks	61.27±0.34
Body weight (g)		
	20 wks	2472±16.1
	40 wks	3139±18.7

Table 18. The production traits of the *Na* and *Dw* gene lines (S-17)

Trait		Naked Neck	Dwarf
ASM (d)		197.58±2.43	154.39±1.60
Body weight 20 wks (g)			
	Male	2362±22.5	2120±22.8
	Female	2102±14.4	2068±17.9
Egg weight (g)			
	28 wks	52.28±0.45	48.83±0.47
	32 wks	56.66±0.42	52.07±0.52
	36 wks	58.49±0.36	54.25±0.49
	40 wks	59.76±0.37	53.86±0.47
Egg Production (Nos.)			
	32 wks	22.29±1.25	45.06±1.29
	40 wks	51.91±1.76	78.29±1.94

Genetic evaluation of elite layer germplasm

Under the layer project, three lines viz; IWH, IWI and IWK are under selection for higher egg numbers up to 64 weeks of age, whereas IWD, IWF and Layer Control (LC) are under random breeding programme.

During reporting period, regeneration, fertility and hatchability parameters, production traits up to 40 wks were recorded and analysed. Regeneration of the six-layer lines (S-15 of IWK and LC, S-7 of IWH and IWI, G-2 of IWD and IWF) was completed. Three crosses: Kadaknath x IWH, IWF x IWH and IWH x IWF were produced. The fertility and hatchability results of each line and crosses are given in Table 19. The fitness traits slightly reduced in all these lines over the previous generations. The growth

traits were recorded in all the lines and crosses up to 40 weeks (Table 20). The 16-week body weight increased in IWH, IWI and IWD lines while it decreased in IWK and layer control compared to their respective previous generations. The 20-week body weight increased in the IWD, IWF and layer control lines while it decreased in the IWH, IWI and IWK lines. The production traits were recorded in all the lines up to 40 weeks except for LC, IWF x IWH and IWH x IWF crosses. The ASM reduced significantly in IWH and IWD lines whereas in other lines it remained almost stable with their previous generation. The EW28 increased in IWI and IWK lines while it deceased in the IWH line. The EP40 showed significant increase in the IWI and IWD lines while it decreased in IWF line compared to previous generation (Table 21).

An IWH hen

Table 19. Fertility and hatchability traits of elite layer lines and select crosses

Line	Fertility	Hatchability (%)	
	(%)	FES	TES
IWD (G-2)	74.80	91.26	68.26
IWF (G-2)	66.26	93.18	61.74
IWH (S-7)	83.80	83.71	70.15
IWI (S-7)	76.88	86.51	66.51
IWK (S-15)	84.57	84.61	71.55
LC (S-15)	80.71	95.34	76.94
IWK x IWH	90.31	88.37	79.81
IWF x IWH	85.92	83.28	71.55
IWH x IWF	82.75	76.17	63.03

Table 20. Least square means of body weights (g) in different layer lines and their select crosses

Line	0d bwt	4 wks	8 wks	16 wks	20 wks	40 wks
IWD (G-2)	-	125.0±1.29	323.8±4.71	993.4±9.2	1236±7.8	1469±11.9
IWF (G-2)	-	126.6±1.48	325.1±4.70	931.6±10.7	-	1451±12.6
IWH (S-7)	34.88±0.10	-	-	1086.17±6.4	1151±6.5	1427±9.5
IWI (S-7)	35.91±0.11	186.2±1.32	360.4±2.88	963.5±13.8	997.3±7.5	1437±8.9
IWK (S-15)	38.27±0.15	197.6±1.60	426.8±3.80	1027±14.9	1039±9.9	1509±13.9
LC (S-15)	-	-	-	1087±10.6	1188±9.6	1585±11.5
IWK x IWH	36.80±0.14	218.7±1.99	409.4±4.08	1069±17.7	1094±9.8	1524±22.6
IWF x IWH	35.81±0.23	-	513.7±10.2	1022±16.7	1216±18.5	-
IWH x IWF	37.31±0.41	-	561.4±10.9	1057±18.4	1226±22.5	-

Table 21. Least square means of production traits in layer lines and their select crosses

Line	ASM (d)	EW28 (g)	EW40 (g)	EP40 (Nos.)
IWD	147.0±0.70	46.01±0.19	51.27±0.22	115.9±0.99
IWF	148.7±0.67	45.76±0.18	51.29±0.24	111.2±0.93
IWH	139.4±0.54	47.75±0.14	52.41±0.18	119.7±1.13
IWI	150.9±0.63	49.37±0.17	52.60±0.17	110.5±0.92
IWK	153.8±0.64	50.95±0.20	55.76±0.25	94.6±1.50
LC	157.3±0.77	47.81±0.19	55.48±0.17	-
IWK x IWH	158.7±0.69	45.83±0.20	49.89±0.26	93.5±1.33
IWF x IWH	141.6±1.39	47.84±0.28	-	-
IWH x IWF	142.7±1.22	48.09±0.32	-	-

Molecular Genetics

Development of transgenic chicken for production of human interferon alpha 2b: A therapeutic for treatment of viral diseases in human (DBT)

The complete open reading frame (567bp) of human interferon alpha 2b (hINFA2b) gene was cloned in chicken ovalbumin promoter-based vector with plasmid skeleton. The human INFA2b nucleotide sequence had 26.8 and 58.8% homology with that of chicken and cattle whereas at amino acid level, the homology of human protein with its chicken and cattle counter-part was only 9.5 and 4.7%, respectively. The human INFA2b clone was expressed in chicken magnum cells and the hINFA2b protein was detected through Western blotting. In addition, the PGC mediated method of transgenesis was perfected to produce transgenic chicken. PGCs were collected from the 60h old embryos during the HH embryonic stage of 13 to 15 and were characterized by expression analysis of cell surface markers such as CXCR, VASA, SOX, BLIMP, POUV, MYC, KLF4 and NANOG. The PGCs were also characterized with alkaline phosphatase staining, PAS staining and immuno-cytochemistry with SSEA-1, SSEA-4, TRA1-60 and TRA1-81 markers. The karyotypes of PGC chromosomes were also identified revealing both macro and micro-chromosomes. PGCs were transfected with recombinant GFP-pACGFP1-C1 construct which was used as marker for donor PGCs. The transfected PGCs were transplanted to the recipient sterile embryos prepared by x-ray irradiation of day-old embryos. A total of 3 positive live transgenic chicks were developed where percentage of obtaining live positive birds were 8.3%. It is concluded that PGC based method may be used efficiently to transfer of desired gene for production of transgenic birds.

Development of gene knock out chicken by genome editing with CRISPR/Cas for augmentation of productivity in poultry (SERB)

Inhibin α is one among the most important down regulators of FSH release, which had been recognised as a chief source of follicular recruitment and development. This study was designed to knockdown the inhibin α gene, and to make it functionless, such that the FSH function could remain unaltered. The inhibin á gene was characterized by cloning and sequencing, its structure was predicted using bioinformatics tools available online and expression was analysed in layers, control broilers and native chickens aging between 36-65 weeks and their 40-Δct values were found to be 37.915±1.07, 33.91±0.93, 33.1±1.66 for native, broilers and layers respectively which contemporarily exhibited their capacity in egg production. The CRISPR/Cas9 tool was employed to create targeted mutagenesis of both the exons of the inhibin α gene, which was subsequently sequenced to study the mutation. The mutation was successfully appreciated and had generated stop codons in exon 1, thereby hampering the gene expression and in exon 2 has created a frameshift mutation resulting in the expression of faulty protein. The expression of edited group of cells of exon1 and exon 2 were also found to be 7.12% and 5.47% lower respectively on par with the control group of cells, thus validating the mutagenesis. Therefore, the study has conclusively revealed a protocol for inducing targeted mutagenesis of inhibin α gene in chicken. It may pave a new path to enhance egg production by developing gene edited chicken.

Functional genomics, epigenetics and gene silencing technology for improving productivity in poultry (National Fellow)

The cholesterol and fat content in egg has been one of the major concerns for human health. Thus, to produce low fat egg, gene silencing by RNAi has been adopted to produce knock-down chicken. In the present study, we designed and synthesized shRNA molecules for acetyl Co-A carboxylase type A (ACACA) and sterol repeat element binding protein 1 (SREBP-1) genes to analyse their effect under *in vitro* cell culture level initially and later, to use the best molecules under *in vivo* system. We have developed knock down chicken for these two genes involved in *de novo* lipid biosynthesis. The knock down birds showed 20.2 and 24.8% lower serum cholesterol and triglycerides content as compared to normal birds. The haemoglobin percent and red blood cells did not differ significantly between knock down and control group of birds. Differential count was noted in knock-down and control birds. The total WBC count did not differ significantly ($P<0.05$) between knock-down and

control group of birds. We also analysed packed cell volume (PCV), erythrocyte sedimentation rate (ESR) and mean corpuscular haemoglobin in both knock down and control birds at the age of 42 days. Of all these parameters, only ESR at 1st hour varied significantly ($P<0.05$) between control and knock-down birds. We also analysed alkaline phosphatase and ALT activity in serum. For alkaline phosphatase activity, knock down group showed 13.8% reduction as compared to control group. In case of ACACA knock down, the alkaline phosphatase was increased by 13.5% in the knock down group while in case of SREBP-1 gene knock down, 54% reduction in alkaline phosphatase activity was observed in knock down group as compared to control group. For ALT activity, knock down birds showed 38% reduction over the control birds. In case of ACACA knock down, the enzyme activity was decreased by 34.2% in the knock down group while in case of SREBP-1 gene knock down, 40.9% reduction was observed in knock down group as compared to control group.

All the knock down birds of 1st generation for both ACACA and SREBP1 genes were of female, which were used further as female parents for back crossing with control broiler birds as male parents to produce back cross progenies. Ultimately, two positive knock down chicks where shRNA constructs were detected were hatched. Of two positive chicks, one was of male and another one was of female. From the experimental results, it is concluded that through shRNA-based gene silencing, serum cholesterol content may be reduced in knock-down birds without significantly affecting different physiological parameters.

Genome wide association study in Indigenous poultry breeds/varieties (ILRI)

A total of 10 Indian native chicken breeds namely, Aseel, Ghagus, Kadaknath, Nicobari Hansli, Ankeleswar, Mewari, Punjab Brown, Tellicherry and Haringhata Black and 2 improved exotic chicken lines were included to explore SNPs present in the whole genome of these breeds to develop native chicken specific SNP chip. The whole genomes of all these breeds were sequenced at 10X coverage under Illumina platform. A total of 1.06 GB genome of the chicken breeds were covered for sequencing. A total of 7.0, 5.9, 6.8, 5.0, 4.2, 4.9 and 4.2 million SNPs were identified in Aseel, Ghagus, Hansli, Kadaknath, Nicobari, PB-1 and IWH chicken breeds, respectively of which 95205, 79152, 91942, 72645, 61295, 69710 and 60615 SNPs were present in exons of the respective breeds. Of all the exonic SNPs around 70% SNPs were of mis-sense type. Around 25 to 30% SNPs were located in the intron regions of the genes. About 0.4 to 0.7 million SNPs each were present in the 2 kb up-stream and 2 kb down-stream of the genes. After exhaustive serial filtrations, around 1,40,303 SNPs were found as most variable and informative across the breeds. The heterozygosity of the SNPs was 0.27% across the breeds where average minor allele frequency was 0.14. However, intra-breed heterozygosity varied from 0.28 to 0.31, 0.26 to 0.32, 0.30 to 0.32, 0.27 to 0.28, 0.25 to 0.28, 0.27 to 0.28 and 0.21 to 0.31 in Aseel, Ghagus, Hansli, Kadaknath, Nicobari, PB-1 and IWH breeds, respectively.

We observed nucleotide diversity within the breeds, which depicts the informativeness of the population. The nucleotide diversity in terms of π/bp and Tajima D were 0.41, 0.36, 0.44, 0.42, 0.43, 0.41 and 0.45, and 0.87, 0.09, 1.19, 1.04, 1.04, 0.79 and 1.36 in Aseel, Ghagus, Hansli, Kadaknath, Nicobari, IWH and PB-1 breeds, respectively. We also estimated SNP wise genetic differentiation in terms of Nei's GST, Htmax, Gstmax and Hedrick's GST. The breed-wise SNPs were also plotted in terms of Box plot and Violin plot. The linkage dis-equilibrium within breed was also estimated and plotted in LD plot. All the population were clustered on the basis of SNP diversity through Principal Component analysis. The Hansli, Aseel and Ghagus breeds formed one cluster while Kadaknath, PB-1 and Nicobari formed another cluster. The IWH population was distantly related from both the cluster. The proximities of the individual birds were also estimated through posterior membership, which indicated that Ghagus breed was very close to Aseel and Hansli breeds. In addition, the SNPs of different breeds were compared with the known SNPs of the reference chicken genome (Red Jungle fowl) indicating heat map of the breeds (Fig 4). We observed that the Ghagus, Hansli and IWH SNPs had the higher heat map than those with Aseel, Kadaknath, Nicobari and

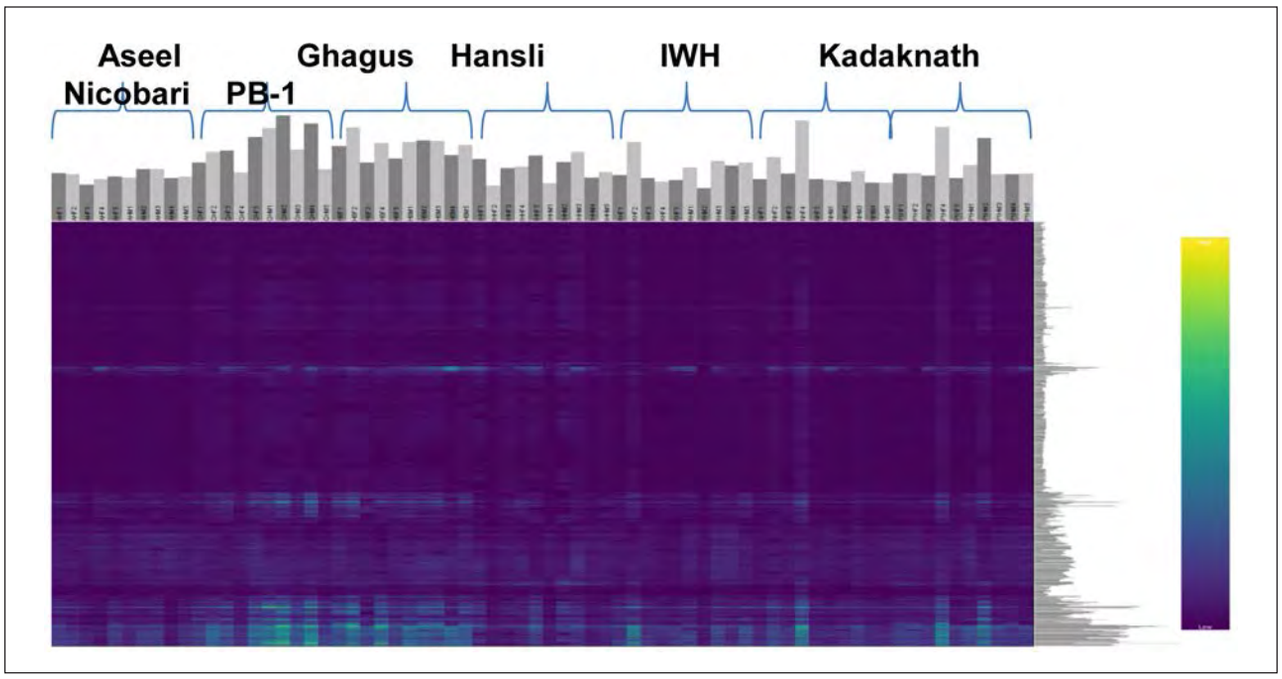


Fig 5. Heat map of SNPs of different breeds

PB-1 breeds. The phylogenetic relationship was also explored among the breeds. We observed that Aseel breed had the closest evolutionary relationship with Ghagus and PB-1 population while it was most distantly related to Nicobari breed. We also identified breed signature of the native chicken breeds encompassing unique SNPs of each breed. We validated the SNPs detected in the mitochondrial genome of all the breeds.

It is concluded that the Indian native chicken breeds are genetically diverse with respect to whole genome, which was depicted in terms of SNP diversity, genetic differentiation, PCA plot, violin plot and posterior membership. Many novel SNPs were detected in the native chicken population, which ultimately delineate the breed signature of the native chicken breeds. The cluster analysis and phylogenetic relationship revealed that the Aseel breed had the closest evolutionary relationship with Ghagus and PB-1 population while it was most distantly related to the Nicobari breed.

Generation of whole genome assembly of native Kadaknath chicken and its annotation

Kadaknath female Chicken (# 2517; Sire No 25; Dam no 9347) reared at the Institute farm was used in the study. Blood samples and different tissue samples were collected for generating genomic sequence data (duly approved by the Institute Animal Ethics committee: IAEC/DPR/20/3). High-molecular-weight DNA was isolated and quantified using Qubit dsDNA HS kit and Nanodrop for checking the sample purity, followed by analysis on femtopulse to get the accurate high molecular weight of the isolated gDNA. The HiFi library was prepared according to the Pacbio recommended protocol. The gDNA was sheared using Megaruptor3 using 20Kb settings. The sheared DNA was used further to make SMRTbell Template libraries using the SMRTbell Express Template Prep Kit 2.0 where DNA damage, End repair/A-Tailing and overhang adapter ligation were performed. The adapter ligated molecules are size selected using Bluepippin. The post library concentration was 89ng/ul in 16 ul of elution buffer. The total quantity of the library was 1.45 ug. Sequencing run is under progress

Understanding the epigenetic methylation and miRNA mediated gene regulation of transcellular calcium transport genes in avian uterus during egg calcification (SERB)

The external egg quality of IWI and IWK lines was evaluated at 40 and 64 weeks of age. The average egg shell calcium of IWI and IWK at 40 weeks of age was 34.7 and 36.3% respectively and at 64 weeks of age it was 34.7 and 36.7% respectively. The egg shell calcium content in IWI was significantly ($P<0.05$) lower compared to IWK. There was no effect of age on the egg shell

calcium content. The egg shell thickness was significantly (P<0.05) higher during both the ages in IWK in comparison to IWI. The egg shell thickness was affected by age of the birds. The shell thickness was significantly (P<0.05) lower at 64 weeks of age both the lines. The results indicate that IWK has superior egg calcification mechanism than that of IWI. However, with advancing age this calcium deposition apparatus efficiency is reduced irrespective of the lines studied. The expression of genes related to transcellular calcium transportation in the two lines at 40 and 64 weeks of age were studied through qPCR. The genes ATP1A1, ATP1B2, CA2 and CLCN2 were studied in uterus, isthmus, duodenum, kidney and liver. The expression of ATP1A1 gene was significantly higher (P<0.05) in uterus of IWK at 40 and 64 weeks as compared to IWI. There is no age effect in the expression of liver ATP1A1 gene in IWI and IWK lines. ATP1A1 gene expression was significantly (P<0.05) affected by age and line in kidney and duodenum tissues. In the uterus the ATP2B1 gene was observed to be expressed significantly higher (P<0.05) during 40 weeks of age in both the lines. In kidney at 40 weeks age there was higher expression in both the lines studied. The CA2 gene was highly expressed in the uterus compared to other tissues but there was no statistically significant effect of age or line of birds studied. In the duodenal tissue CA2 gene was expressed significantly higher at 64 weeks of age. In kidney the expression was significantly (P<0.05) affected by age and line. IWK line expressed significantly higher (P<0.05) levels in uterus at 40 weeks of age. However, at 64 weeks age IWI line expressed significantly (P<0.05) higher levels in the uterus. In uterus, kidney and liver the line or age at which samples were collected had no effect on CLCN2 gene expression. The gene expression was affected by line in the duodenal tissue.

Nutrition

Managemental and nutritional strategies to ameliorate thermal stress in poultry production (NICRA)

One experiment as conducted to find out dietary means to ameliorate the adverse effects of heat stress on chicken performance, immunity and stress variables (anti-oxidant responses) in this project.

Effect of methyl donors' supplementation on broiler chicken fed diet without supplemental methionine during summer

The non-availability and higher cost of synthetic Met often force the poultry feed manufacturers to look for alternate sources for the amino acid. Literature suggested that supplemental Met can be partially substituted with methyl donors (MD) like betaine (Bet), vitamin B12 (B12), folic acid (FA) and biotin (Bio) without negative effects on the performance of chickens. To verify this, a feeding trial was conducted on commercial broilers fed sub-optimal concentrations of methionine (Met) during tropical summer. Maize-soybean meal based broiler diets with supplemental Met (control diet - CD) and without supplemental Met (basal diet - BD) were prepared. The BD was individually supplemented with Bet (0.2%), B12 (0.1 mg), FA (4 mg) and Bio (1.5 mg/kg). Each of the six diets was fed *ad libitum* to 10 replicates of 25 chickens in each (reared in deep litter floor pens, 4'6" * 6') from 1-42 d of age.

The body weight gain (BWG) was significantly (P<0.05) reduced in broilers fed the BD having sub-optimal concentrations of Met compared to those fed the CD (Table 22). The BWG improved significantly (P<0.05) with inclusion of FA, B12 or Bet similar to those fed the CD having the recommended concentrations of Met. During the starter phase, the BWG of Bet group was similar (P<0.05) to those fed the CD and the weight gain in other MD fed groups was similar to the BD fed group. The cumulative BWG in all the MD supplemented groups showed improvement. The BWG in Biotin, B12 or Bet groups improved (P<0.05), which was on par with that of those fed the CD. The FCR was not affected (P>0.05) by the treatments during the pre-starter and finisher phases, while the FCR was higher (P<0.05) in the groups fed the low-Met BD irrespective of MD supplementation during the starter phase. Similarly, the FCR was significantly higher in BD fed group compared to the CD group during the overall experimental period (1 – 42 d). The feed efficiency did not improve with supplementation of B12 or biotin compared to those fed the BD. However, the feed efficiency improved (P<0.05) in broilers fed FA or Bet similar to those fed the CD.

The RTC yield and relative weight of abdominal fat were not affected (P>0.05) by the dietary Met level, or supplementation of MD to low-Met BD. The relative weight of breast reduced numerically (13.2%) in broilers fed the BD compared to those fed the CD. The breast weight in FA, biotin or B12 supplemented groups was similar (P<0.05) to those fed the CD. The breast meat weight in Bet supplemented groups was significantly (P<0.05) higher than those fed the BD. The serum lipid peroxidation (LP) was significantly (P<0.05) higher in broilers fed the BD compared to those fed the CD (Table 23). The LP in Biotin, B12 and Bet groups was significantly (P<0.05) reduced compared to those fed the BD. The LP in B12 or Bet groups was similar to those fed the CD, while the LP in FA group was similar to the BD group. The activity of glutathione peroxidase showed a reduction (P<0.05) in the low-Met BD fed group compared to the CD group. The enzyme activity in Biotin or B12 groups was significantly (P<0.05) higher than those fed the BD and was similar to the CD group. The anti-oxidant enzyme activity in the Bet or FA groups did not improve compared to the BD fed group.

The activity of RBC Catalase reduced significantly (P<0.05) in broilers fed the low-Met BD compared to the CD fed group. Supplementation of Biotin or Bet significantly (P<0.05) improved the activity of the anti-oxidant enzyme compared to those fed the BD. The enzyme activity in FA or B12 fed groups did not improve compared to those fed the BD. The anti-body titres against ND vaccine did not differ (P>0.05) due to the treatments employed. The lymphocyte proliferation ratio (LPR) reduced significantly (P<0.05) in groups fed the low-Met BD compared to the control group. The LPR in groups fed FA, Biotin or B12 did not differ compared to those fed the BD, whereas the LPR improved significantly in Bet supplemented groups compared to the BD fed broilers.

Feeding of diets having sub-optimal concentration of Met (BD) significantly (P<0.05) reduced the concentrations of total protein (TP) and albumin in serum compared to those fed the CD (Table 23). The concentration of TP improved significantly (P<0.05) in broilers fed the FA, Biotin or Bet supplemented diets compared to the BD fed birds. The TP in B12 supplemented group was similar to the BD fed group. Similarly, the albumin concentration in all the MD supplemented groups improved similar to those fed the CD.

Table 22. Performance of commercial broilers fed different methyl donors in diet containing no supplemental methionine

Treatment	Body weight gain (g)				Feed efficiency			
	PS	S	F	1-42d	PS	S	F	1-42d
CD	468.0^{A}	940.5^{A}	1144	2553^{A}	1.07	1.48^{B}	1.98	1.62^{B}
BD	367.8^{B}	747.3^{C}	1034	2149^{C}	1.16	1.64^{A}	2.11	1.76^{A}
FA, 4mg/kg	426.7^{A}	759.4^{BC}	1121	2355^{ABC}	1.13	1.67^{A}	1.93	1.69^{AB}
Biotin, 1.5mg/kg	417.2^{AB}	783.0^{BC}	1155	2307^{BC}	1.11	1.68^{A}	2.00	1.73^{A}
Vit. B12, 0.1mg/kg	431.9^{A}	785.9^{BC}	1140	2357^{ABC}	1.10	1.67^{A}	1.94	1.75^{A}
Betaine, 0.2%	448.5^{A}	852.0^{AB}	1105	2406^{AB}	1.12	1.64^{A}	2.09	1.69^{AB}
P	0.001	0.001	0.23	0.001	0.06	0.001	0.40	0.001
N	10	10	10	10	10	10	10	10
SEM	5.75	11.35	13.8	22.1	0.01	0.02	0.02	0.01

PS : 1-14d; S : 15-28d; F : 29-42d; CD : control diet; BD : Basal diet; FA : Folic acid; P probability; SEM standard error mean ^{ABC} means having no common super script in a column differ significantly (P<0.05)

Table 23. Serum oxidative parameters in commercial broiler fed different methyl donors in diets containing no supplemental methionine

Treatment	LP	GSHPx	RBCC	LPR	Protein	Albumin
	μM MDA/mg protein	U/mL	U/g Hb		g/dL	g/dL
CD	1.35^{C}	76.3^{AB}	586.8^{A}	0.64^{A}	2.58^{B}	0.52^{ABC}
BD	1.67^{A}	69.6^{B}	396.3^{B}	0.39^{CD}	1.74^{C}	0.28^{D}
FA, 4mg/kg	1.69^{A}	68.0^{B}	375.9^{B}	0.43^{C}	3.80^{A}	0.69^{A}
Biotin, 1.5mg/kg	1.59^{B}	79.7^{A}	529.5^{A}	0.35^{D}	3.07^{B}	0.47^{BCD}
Vit. B12, 0.1mg/kg	1.37^{C}	79.4^{A}	431.5^{B}	0.45^{BC}	1.24^{C}	0.32^{CD}
Betaine, 0.2%	1.43^{C}	67.5^{B}	539.5^{A}	0.50^{B}	2.99^{B}	0.59^{AB}
P	0.001	0.001	0.001	0.001	0.001	0.002
N	10	10	10	10	10	10
SEM	0.022	1.556	15.26	0.019	0.154	0.032

PS : 1-14d; S : 15-28d; F : 29-42d; CD : control diet; BD : Basal diet; FA : Folic acid; P probability; SEM standard error mean ; LP lipid peroxidation; GSHPx Glutathione peroxidase, RBCC RBC catalase; LPR lymphocyte proliferation ratio ^{ABCD} means having no common super script in a column differ significantly (P<0.05)

Based on the data, it can be concluded that the body weight gain and feed efficiency improved, and stress indices reduced (reduced LP and increased activity of anti-oxidant enzymes) with supplementation of some methyl donors in broiler diet having no supplemental Met. The improvement may partly be due to the improvement in protein utilization with methyl donors' supplementation as evident by increase in the concentration of total protein in the serum of broilers fed diets supplemented with MD.

Chicken or egg: Drivers of antimicrobial resistance in poultry in India (DBT)

The project aims at identification of probable routes in poultry production chain which contribute to antimicrobial resistance (AMR) in different poultry pathogens and also to find out potential alternatives for anti-biotic growth promoters in chicken diet. At ICAR-DPR, research is focussed on testing and identification of potential alternatives for anti-biotic growth promoters (AGP). Four experiments were conducted during the year with an objective of testing/screening the efficacy of different alternatives to AGPs in broilers. The protocol of all the three trials was the same. A control diet without AGP was fed for the negative control group. A positive control group with recommended dose of Virginiamycin (40 g/ tonne) was also included in each trial. Each diet was fed to 10 to 18 replicates of 5 to 6 broilers in each replicate from day 1 to 35/42d of age.

Effect of supplementing different prebiotics on broiler chicken

An experiment was conducted by supplementing AGP-free diet with three different prebiotics, i.e. Fructose oligosaccharide (FOS), Galacto oligosaccharide (GOS), Mannan oligosaccharide (MOS) and combination of all the additives at the above recommended dose of 33% of each. A diet with Virginiamycin acted as positive control (PC) and the diet without Virginiamycin acted as the negative control. Each diet was fed to 14 replicates having 5 commercial broiler (Cobb 400) male chicks housed in stainless steel battery brooders from 1 to 42 d of age. Inclusion levels of FOS, GOS and MOS were 1000, 125 and 500g/ T, respectively. The sixth diet was supplemented with all the three prebiotics at 334, 42 and 167g/ T diet, respectively.

The BWG, FI and FE at day 21 and BWG at day 42 were significantly reduced when the AGP was not included in the diet (NC) compared to the PC diet fed broilers (Table 24). Combination of FOS-GOS-MOS at 33% of each compound, improved the BWG, FI and FE at day 21.

However, at the end of the experiment, BWG in groups fed MOS and combinations of the 3 prebiotic compounds was similar to those fed the AGP supplemented diet. The FI and FE at the end of experiment were not affected.

Dietary inclusion of either AGP or various prebiotic compounds failed to elicit any response in various slaughter variables studied. The CMI response to PHA-P inoculation reduced in groups fed the diet without the AGP. Inclusion of various prebiotic compounds significantly improved the CMI response compared to those fed the NC (Fig 6).

Effects of supplementation of GOS (galacto-oligosaccharides) in broiler chicken

Galacto-oligosaccharide (GOS) is a prebiotic derived from *Saccharomyces cerevisiae* yeast cell wall, which is known to have a prebiotic role in chicken gut. An experiment was conducted on commercial broilers by incorporating graded concentrations (75, 125, 250 and 500g/Ton feed) of GOS to study the performance and immune responses. The GOS was supplemented in standard broiler diets having no supplemental antibiotic growth promoter. Each diet was fed to 15 replicates and fed *ad libitum* from day 1 to 42. Each pen had 35 commercial broiler male birds.

Table 24. Effect of supplementing different fractions of prebiotics on performance of broiler chicken

Treatment	21 d			42 d		
	BWG (g)	FI (g/b)	FI/BWG	BWG (g)	FI (g/b)	FI/BWG
PC	735.4^{a}	1041^{a}	1.42^{b}	2051^{a}	3405	1.66
NC	656.2^{c}	966.3^{b}	1.48^{a}	1918^{b}	3282	1.71
FOS	666.5^{bc}	984.7^{ab}	1.48^{a}	1918^{b}	3353	1.75
GOS	658.1^{c}	959.4^{b}	1.46^{ab}	1903^{b}	3303	1.74
MOS	688.9^{bc}	998.0^{ab}	1.45^{ab}	1980^{ab}	3390	1.72
FOS-GOS-MOS	708.1^{ab}	1001.0^{ab}	1.41^{b}	1943^{ab}	3315	1.71
SEM	6.472	8.522	0.008	16.46	26.76	0.011
N	14	14	14	14	14	14
P value	0.001	0.073	0.027	0.086	0.735	0.226

BWG body weight gain; FI feed intake; PC positive control; NC negative control; FOS Fructose oligosaccharide, GOS Galacto oligosaccharide, MOS Mannan oligosaccharide; P probability; SEM standard error of mean ^{abc} means having no common super script in a column differ significantly (P<0.05)

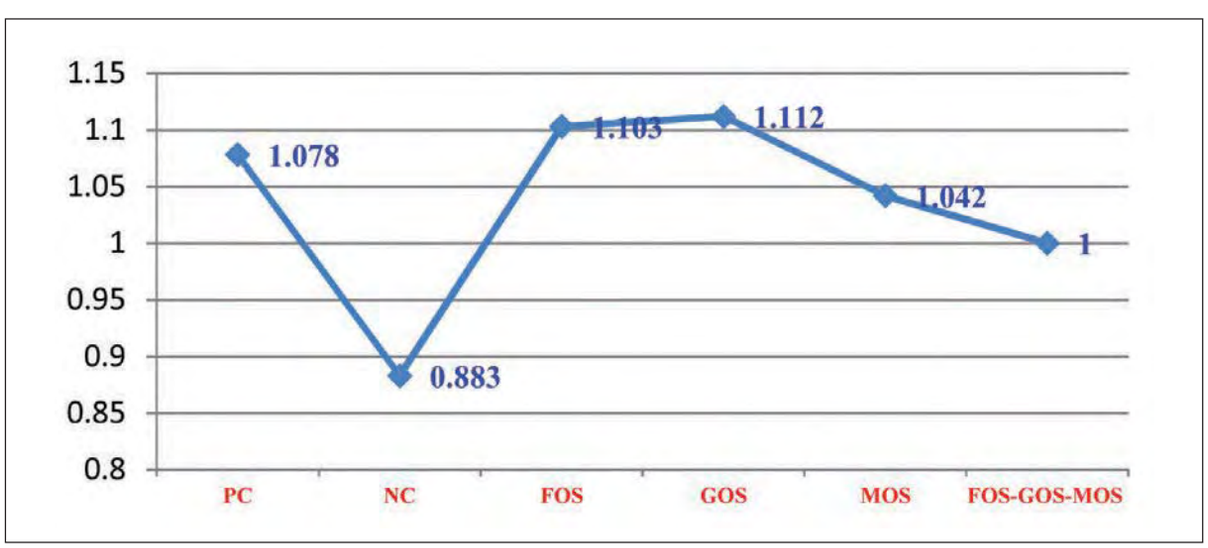


Fig 6. CMI respnse (unit value) in broiler chicks fed different prebiotic compounds

Immune response was measured at day 21 and 42 of age in terms of anti-body titre against ND and CMI response to PHA-P inoculation.

At day 21, supplementation of GOS at 250 g/Ton significantly improved the BWG compared to those fed the control diet (Table 25). At other concentrations, GOS supplementation improved the BWG which was intermediate to the CD and 250 g/T GOS fed group. Similarly at the same age, the FE was significantly improved at GOS 250 or 500 g/T inclusion. At the end of 42, the BWG and FI were not affected with GOS supplementation, while the FE was significantly improved at all concentrations of GSO supplementation and the highest FE was observed at 250 g / T inclusion.

The immune response measured as titer against ND vaccine was significantly higher in groups fed 125g/T compared to the CD fed group (Table 26). The titre at higher concentrations was intermediate between the CD and the 125 g/T fed broilers. The CMI response to PHA P in broilers fed 125 and 500 g GOS was significantly higher than those fed the CD. The CMI response at other inclusion levels was nonsignificant to the CD. The immune responses at the end of experiment (42 d of age) were not affected by the treatments employed.

Table 25. Effect of supplementation of galacto-oligosaccharide (GOS) on performance of broiler chicken

GOS (g/T)	21 d of age			42 d of age		
	BWG (g)	FI (g)	FI/BWG	BWG (g)	FI (g)	FI/BWG
Control	908.3^{B}	1147	1.263^{A}	2494	4028	1.615^{A}
75	909.8^{AB}	1146	1.260^{AB}	2503	4005	1.600^{B}
125	911.0^{AB}	1141	1.253^{ABC}	2510	4006	1.596^{B}
250	929.0^{A}	1158	1.247^{C}	2517	3989	1.585^{C}
500	923.7^{AB}	1154	1.250^{BC}	2514	4008	1.594^{B}
P Value	0.094	0.454	0.028	0.907	0.902	0.000
N	15	15	15	15	15	15
SEM	2.983	3.070	0.002	8.007	11.75	0.002

BWG body weight gain; FI feed intake; P probability; N number of replications; SEM standard error mean ^{ABC} means having no common superscript in a column differ significantly (P<0.05)

Table 26. Effect of supplementation of galacto-oligosaccharide (GOS) on humoral and cell mediated immune responses in broiler chicken

GOS (g/T)	21d			42 d		
	ND titre (log 2)	ELISA	CBH (%)	ND titre (log 2)	ELISA	CBH (%)
0	4.42^{B}	858.4	91.7^{C}	7.73	5114	88.6
75	4.35^{B}	753.4	97.8^{BC}	7.69	6058	90.1
125	4.89^{A}	969.8	102.2^{AB}	7.61	5292	92.3
250	4.61^{AB}	755.7	95.8^{BC}	7.53	5291	99.2
500	4.69^{AB}	711.8	107.9^{A}	7.65	5276	97.8
P	0.092	0.846	0.007	0.421	0.303	0.112
N	75	75	75	75	75	75
SEM	0.063	78.69	1.49	0.034	149.6	1.533

ND Newcastle disease; CBH cutaneous basophilic hypersensitivity; P probability; N number of replications; SEM standard error mean ^{ABC} means having no common superscript in a column differ significantly (P<0.05)

Effect of supplementing various strains of beneficial microbes on broiler chicken fed diets devoid of AGP

An experiment was conducted on broiler chicks to study their response when fed different probiotic strains *vis-a-vis* antibiotic growth promoter (BMD). A maize - soybean meal – meat cum bone meal based standard broiler diet was prepared to serve as the basal diet (BD). The BD was supplemented with an antibiotic growth promoter (BMD) which served as the positive control (PC) and the BD without BMD served as the negative control (NC). The BD was supplemented with direct fed microbials (DFM), *B. amyloliquifaciencs* (100g/T), *B. pumilus* (100g/T), *B. velezensis* (100g/T), combination of the above three strains (each @ 33%) and *B. coagulans & B. pumilus* (100g/T) combination.

A total of 2100, one-day old commercial male broiler chickens were divided into seven equal experimental groups with 12 replicates of 25 chicks each. The chicks were housed in deep litter floor pens (4 x 6.5 feet). The floor of each pen was covered with built up litter at 3'' thickness. The built up litter was of 7 cycles, which was used to increase the pathogen challenge to simulate the field conditions together with meat cum bone meal (4%) in the diet. The BWG and FI were not affected (P>0.05) by supplementation of either AGP or DFM strains in broiler diet (Table 27). However, the FE was significantly (P<0.05) reduced in broiler fed NC diet compared to the AGP fed broilers at all phases. At day 28, the FE in BA, BV, and BC-BP was significantly higher than the NC group. The FE in BC-BP group was similar to those fed the AGP fed group. At the end of the trial, the FE in BA and BC-BP was similar to those fed the AGP fed control group.

The cell mediated immune response to PHA-P inoculation was not affected (P>0.05) by the dietary treatments employed in the study. The antibody titres against ND vaccine were significantly (P<0.05) higher in broilers fed BA and BC-BP compared to all other treatment groups (Fig 7). The RTC yield and the relative weights of breast were not affected by replacement of BMD with different probiotic preparations or NC (Table 28). The abdominal fat in BP was higher than those fed the AGP and the weights of fat in other groups was similar and were intermediated between these groups. Similarly, the relative weight of liver in BA and BP was higher than the AGP fed control group and the weight of liver in other groups was similar. The relative weight of gizzard in BC-BP was significantly heavier than either AGP of NC groups.

Table 27. Effect of supplementing various strains of DFM on performance of broiler chicken fed diets devoid of AGP

Dose	1-28 days			1-42 days		
	BWG (g)	FI (g)	FI/BWG	BWG (g)	FI (g)	FI/BWG
AGP	1216	1769	1.455^{D}	2696	4457	1.654^{B}
NC	1165	1729	1.484^{A}	2623	4399	1.677^{A}
BA	1186	1745	1.471^{BC}	2681	4437	1.655^{B}
BP	1174	1735	1.479^{AB}	2642	4402	1.666^{AB}
BV	1190	1749	1.469^{BC}	2637	4397	1.668^{AB}
BA-BP-BV	1175	1735	1.477^{AB}	2652	4411	1.664^{AB}
BC-BP	1209	1767	1.462^{CD}	2653	4404	1.660^{B}
P Value	0.251	0.821	0.001	0.272	0.867	0.049
N	12	12	12	12	12	12
SEM	6.245	8.486	0.002	8.54	13.20	0.002

DFM direct fed microbes; BWG body weight gain; FI feed intake; BMD chemical growth promoter; BA B. amyloliquifaciencs; BP B. pumilus; BV B. velezensis; BC B. coagulans; P probability; N number of replicates; SEM standard error of mean ^{ABCD} means having common superscripts in a column do not differ significantly (P,0.05)

Table 28. Effect of supplementing various strains of DFM on slaughter variables (g/1000 g live weight) in broiler chicken fed diets devoid of AGP

Treat	RTC	Breast	Abd.fat	Liver	Gizzard
AGP	761.5	246.3	12.4^{B}	18.1^{C}	14.7^{BC}
NC	766.1	245.9	14.4^{AB}	18.9^{BC}	14.3^{C}
BA	764.4	250.3	12.6^{B}	20.2^{AB}	15.6^{ABC}
BP	766.7	245.5	15.2^{A}	20.9^{A}	16.3^{AB}
BV	773.8	250.4	14.3^{AB}	19.5^{ABC}	15.9^{ABC}
BA-BP-BV	760.3	243.6	13.6^{AB}	18.7^{BC}	15.5^{ABC}
BC-BP	767.9	234.2	12.7^{B}	19.5^{ABC}	16.6^{A}
P value	0.50	0.15	0.05	0.03	0.08
N	12	12	12	12	12
SEM	1.78	1.66	0.28	0.24	0.23

DFM direct fed microbes; RTC ready to cook yield; BMD chemical growth promoter; BA B. amyloliquifaciencs; BP B. pumilus; BV B. velezensis; BC B. coagulans; P probability; N number of replicates; SEM standard error of mean ^{ABC} means having common superscripts in a column do not differ significantly (P,0.05)

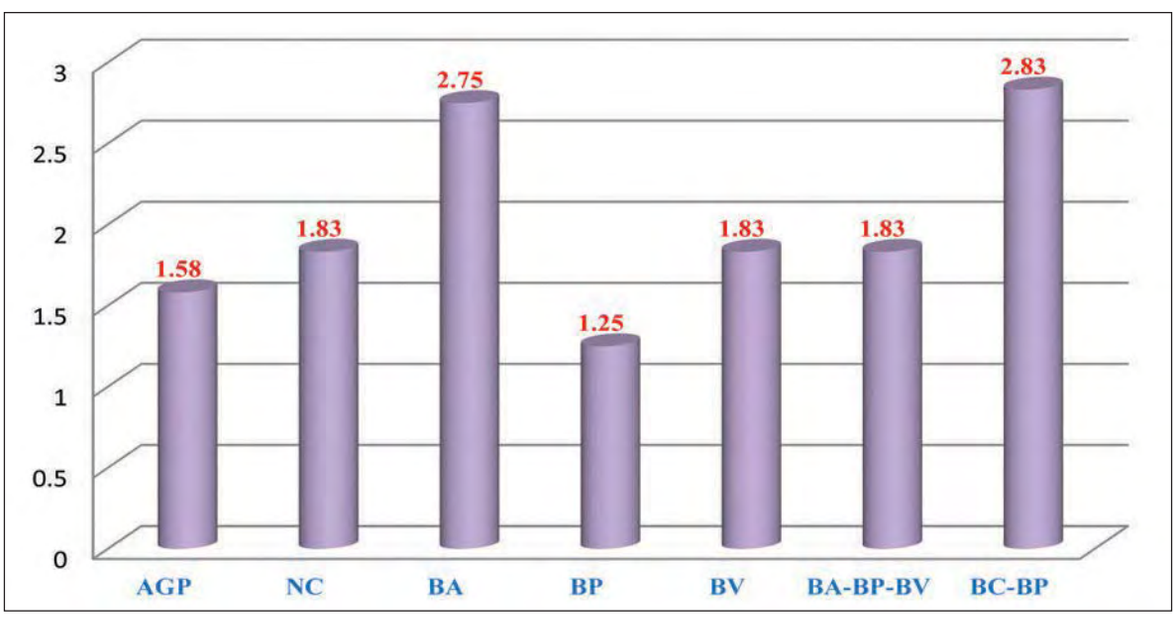


Fig 7. Antibody titre (log 10) against ND vaccine in broilers fed different DFM

Effect of supplementing bacteriophage in water on broilers

An experiment was conducted with commercial broilers chicks to compare the efficacy of including a bacteriophage product, which consists of a cocktail of four selected lytic bacteriophages which target *Salmonella*. The bacteriophage was supplemented in water at the rate of 0.02ml/b on alternate days from day 1 to 42. Broiler chicks were randomly assigned to 200 replicates with 25 birds in each and these replicates were in turn allocated to 4 dietary treatments in a completely randomized design. The 4 dietary treatments were 1. antibiotic growth promoter in feed (PC), 2. No AGP in feed (NC), 3. bacteriophage in water and AGP in feed and 4. bacteriophage in water without AGP in feed. All the groups were fed with maize – soybean diets containing 4% meat cum bone meal. The floor of each pen was covered with built up litter at 3'' thickness.

The interaction between AGP and bacteriophage supplementation did not influence (P>0.05) the performance variables from 1-21 or 1-42d of age (Table 29). Similarly, supplementation of AGP did not influence BWG, FI and FE in broilers. However, supplementation of bacteriophage significantly (P<0.05) improved the BWG, FI and FE compared to the control.

The interaction between AGP and bacteriophage supplementation did not influence the slaughter variables and intestinal lesion score (Table 29). AGP significantly increased the relative weight of spleen but no other carcass traits. Bacteriophage suplementation significantly increased the relative weights of RTC yield, breast weight, and spleen while the relative weight of liver reduced with the bacteriophage compared to the un-supplemented groups.

Table 29. Performance of broiler chicken supplemented with AGP (in feed) and/or bacteriophage (BP) (in water)

BP	AGP	21d			42d		
		BWG (g)	FI (g)	FCR	BWG (g)	FI (g)	FCR
No	Yes	833.8	1078	1.293	2696	4374	1.623
No	No	834.6	1080	1.294	2700	4375	1.621
Yes	Yes	852.3	1096	1.286	2750	4383	1.594
Yes	No	846.7	1090	1.287	2754	4390	1.595
SEM		2.293	2.75	0.0011	7.380	8.598	0.0026
	Yes	843.1	1087	1.290	2723	4378	1.609
	No	840.7	1085	1.291	2727	4382	1.608
No		834.2^{B}	1079^{B}	1.294^{A}	2698^{B}	4374	1.622^{A}
Yes		849.5^{A}	1093^{A}	1.287^{B}	2752^{A}	4386	1.595^{B}
SEM		3.168	3.849	0.0015	10.15	12.23	0.0033
P value							
BP		0.001	0.011	0.002	0.001	0.493	0.001
AGP		0.593	0.697	0.654	0.760	0.808	0.833
BP*AGP		0.482	0.481	0.899	0.990	0.876	0.800

BWG body weight gain; FI feed intake, FCR feed conversion ratio; SEM standard error mean; P probability ^{AB} means having common superscripts in a sub-column differ significantly (P<0.05)

Table 30. Slaughter variables (g/1000 g pre-slaughter live weight) in broiler chicken (at day 43) supplemented with AGP with and without bacteriophage (BP)

BP	AGP	RTC	Breast	Abd.fat	Liver	Spleen	Int. Score
No	Yes	702.1	265.7	11.9	18.1	1.24	1.28
No	No	704.3	267.9	11.3	17.7	1.15	1.12
Yes	Yes	715.1	275.0	10.9	16.9	1.35	1.16
Yes	No	712.4	273.9	10.9	16.3	1.25	1.16
SEM		2.267	1.53	0.24	0.24	0.03	0.03
	Yes	708.6	270.4	11.4	17.5	1.30^{X}	1.22
	No	708.3	270.9	11.1	17.0	1.20^{Y}	1.14
No		703.2^{B}	266.8^{B}	11.6	17.9^{A}	1.20^{B}	1.20
Yes		713.7^{A}	274.5^{A}	10.9	16.6^{B}	1.30^{A}	1.16
SEM		3.18	2.14	0.34	0.33	0.04	0.04
P value							
BP		0.02	0.01	0.13	0.006	0.04	0.50
AGP		0.96	0.87	0.54	0.29	0.05	0.18
BP*AGP		0.59	0.58	0.60	0.69	0.92	0.18

$^{AB/XY}$ means having common superscripts in a sub-column differ significantly (P<0.05) # 1.Normal; 2.Thick membrane; 3.Slight hemorrhages; 4. Moderate hemorrhages

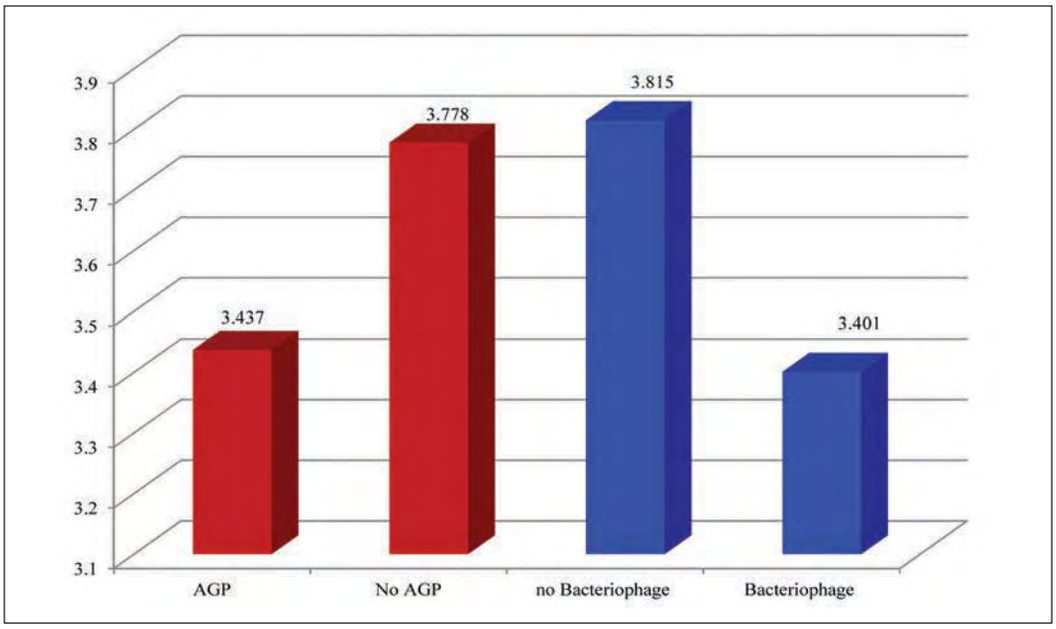


Fig 8. Salmonella (log 10) count in broiler fed AGP or Bacteriophage

Salmonella colony count was estimated in broilers exposed to AGP on day one with or without bacteriophage supplementation in drinking water (Fig 8). The interaction between the two main factors did not influence the caecal Salmonella count. However, the Salmonella count reduced significantly with either AGP or bacteriophage in drinking water. Thus, bacteriophage supplementation in drinking water on alternate days @ 0.02ml/bird significantly improved the performance (body weight gain and feed efficiency) and ready to cook yield and breast meat yield in broilers and the improvement could partly be due to the reduction in salmonella count in the chicken gut.

Evaluation of prevalence of antimicrobial resistance genes in chicken

Gut samples (96) from broiler chickens were collected and analysed for different antimicrobial resistance genes by conventional as well as real time PCR. The results of conventional PCR analysis have been presented in (Fig 9). AMR genes for beta lactamase (bla TEM and CTX M) and fluoroquinolone (qnrA, qnrB,qnrc, qnrD and qnrS) resistance were detected.

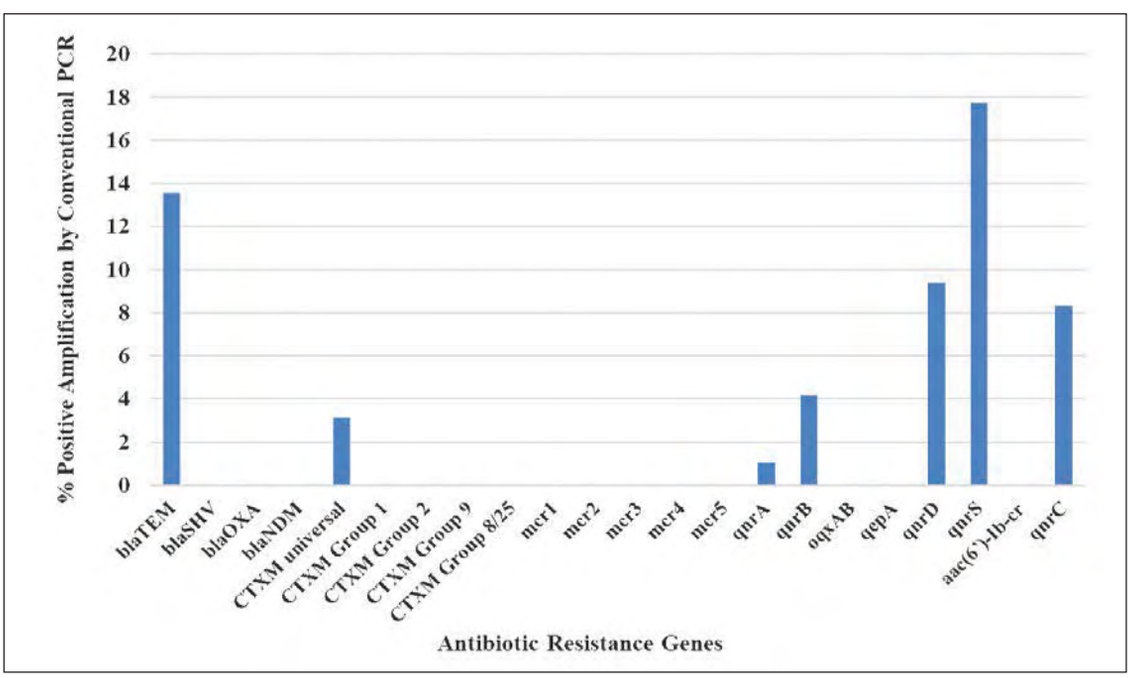
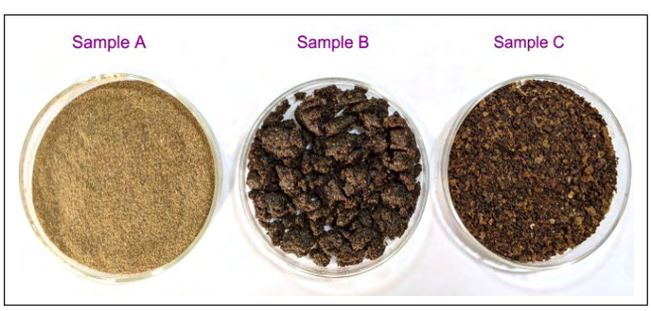


Fig 9. Conventional PCR analysis

Evaluation of Insect larva meal as a novel protein source in chicken diet

Black soldier fly (BSF) (*Hermetia illucens*), an environmentally friendly and highly efficient converter of bio-waste into valuable protein and fat-rich animal feed offers a great eco-friendly and practically feasible strategy for supporting the growing poultry production in the country. Attempts have been initiated for exploring the feeding value of BSF larval meal in poultry diet. Three samples of larvae-based meal were procured from different production sources in the states of Maharashtra, Gujarat and Karnataka. The samples were analysed for moisture, crude protein and crude fat content.

Dried BSF larvae



BSF larvae meal from different sources

The samples were found to be rich in protein and fat. The crude protein ranged from 49.8 to 59.6% among the samples, while the crude fat was 22.1 to 38.4% indicating great variation in the nutrient composition of the larva meal sourced from different sources (Table 31). In addition, the amino acid and fatty acid profile of the meal was also analysed. The larva meal samples were rich in various amino acids (Fig 10), some of which were higher in concentration than in soybean meal (by 68% in lysine, 249% in methionine, 50% in threonine and 78% in valine), whereas the concentration of tryptophan was lower in insect meal in comparison to soybean meal. The fatty acid profile of insect meal indicated higher concentration of lauric acid (62% in sample B), whereas the unsaturated fatty acids were also in considerable concentration in sample C (oleic and linoleic acids) (Fig. 11). A feeding experiment was initiated to evaluate the sample B for its feeding value in commercial broiler chicken. The BSF larva meal (sample B) was included in the diet at 0, 2.5 and 5.0% levels on *iso-caloric* and *iso-nitrogenous* basis. The evaluation of response of broiler chicken is currently underway.

Table 31. Composition of Black Soldier Fly larval meal from 3 different sources

%	Sample A	Sample B	Sample C
Moisture	15.6	4.2	4.4
Crude protein	49.8	59.6	50.2
Crude fat	35.2	22.1	38.4

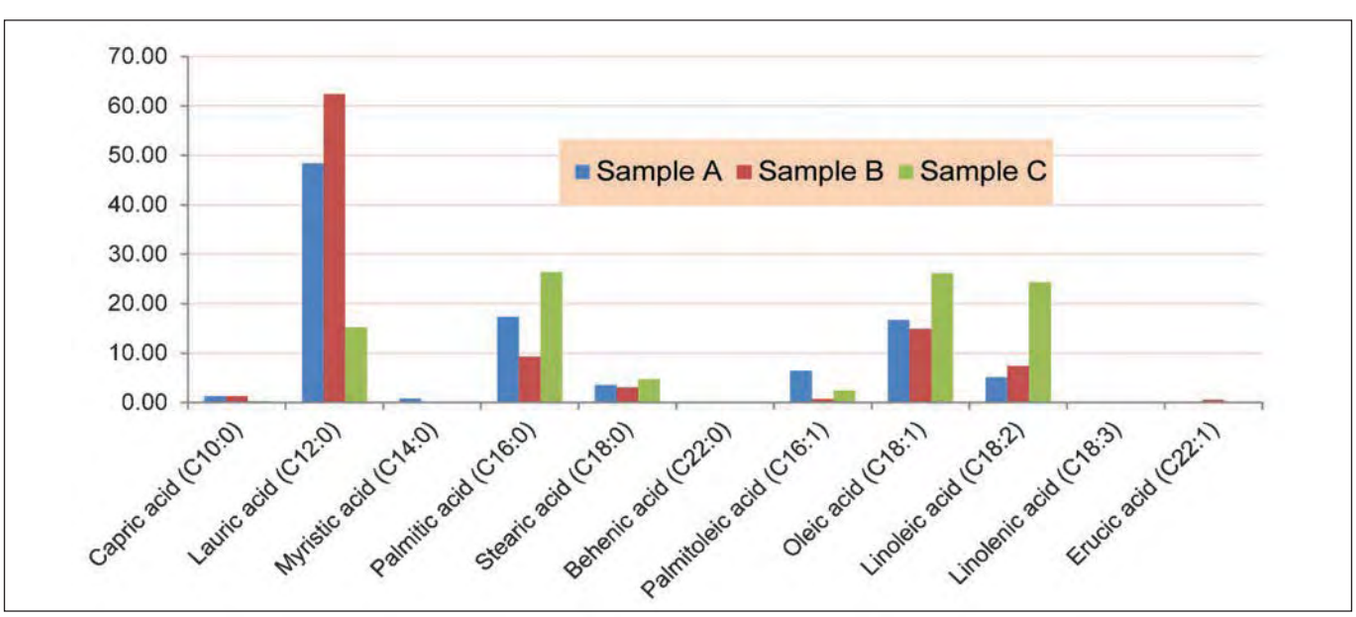


Fig 10. Fatty acid profile of BSF larvae meal from 3 different sources

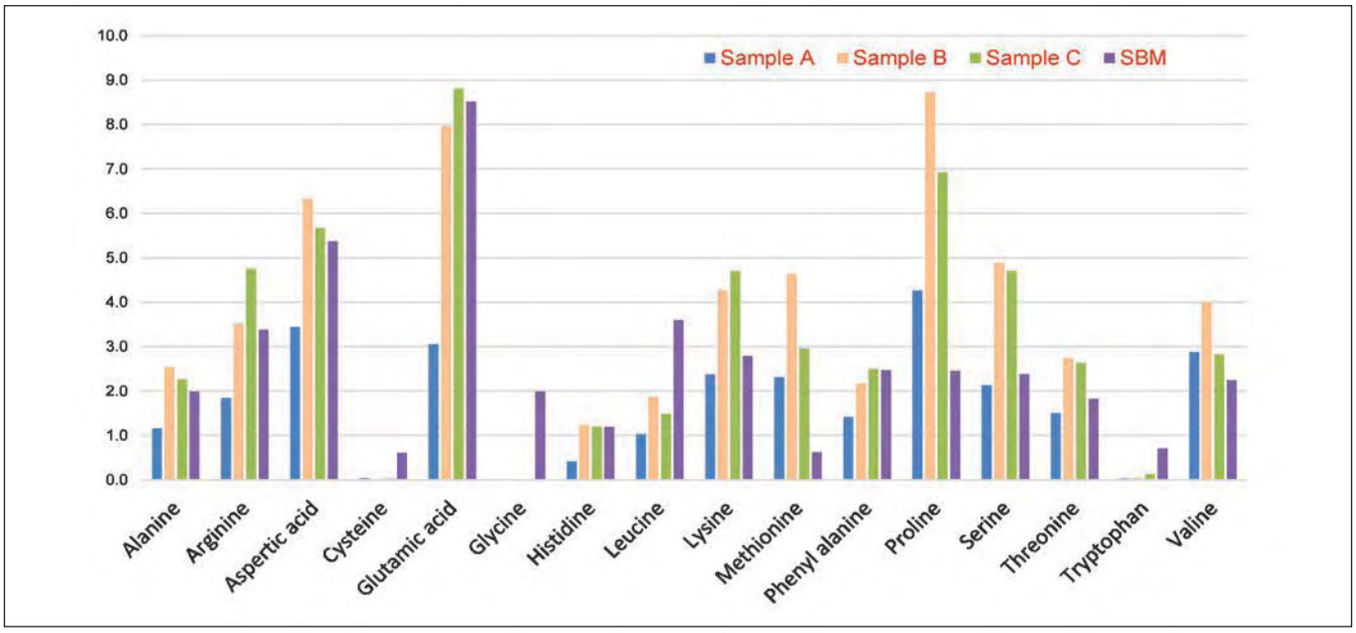
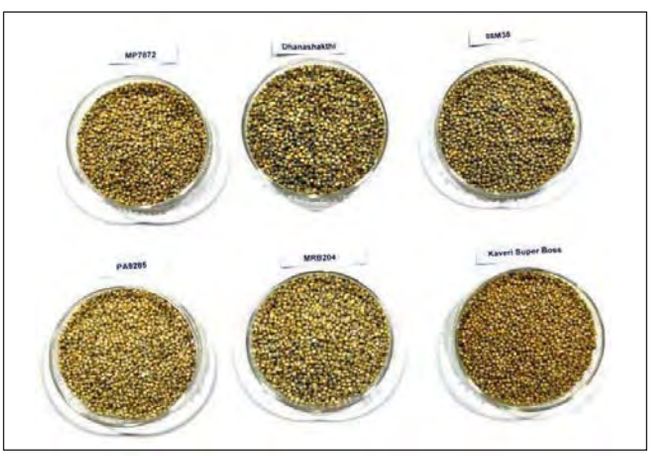


Fig 11. Amino acid profile of BSF larvae meal from 3 different sources vis-à-vis soyabean meal

b) Evaluation of bajra cultivars (in collaboration with ICRISAT, Patancheru)

The nutrient profile and feeding value of different cultivars of bajra (pearl millet) (*Pennisetum typhoides*) were evaluated. A total of five samples of bajra cultivars developed at ICRISAT, Patancheru were analysed for nutrient and amino acid profile. The crude protein content ranged between 7.02 and 10.13%. In comparison to maize (9.82%), one cultivar (DS) had higher CP content (10.13%), whereas all the other cultivars had lower CP (7.02 to 9.26%). The amino acid profile indicated higher concentration of lysine, methionine, methionine+cysteine and threonine in bajra cultivars in comparison to maize (Fig 12). On the other hand, the concentration of leucine, histidine and phenylalanine was higher in maize than in bajra.

A feeding experiment was conducted using 4 of these bajra cultivars totally replacing maize in commercial broiler diet on *isocaloric* and *iso-nitrogenous* basis. A total of 225 day-old commercial broiler chickens were divided at random into 5 treatment groups with 9 replicates of 5 chicks each and housed in 3-tiered SS battery brooders. Each of the groups was fed *ad libitum* one of the diets containing maize or one of the bajra cultivars (Kaveri super boss, 86M38, MP7872 or PA9285) from 0 to 42 days of age. The



Different bajra cultivars

response of broilers was assessed in terms of performance, nutrient digestibility, serum biochemical profile, immune response and slaughter variables.

The body weight, feed intake and feed conversion efficiency were not affected by replacing maize with the different bajra cultivars. Instead, the group fed bajra cultivar PA9285 showed better feed conversion efficiency than maize (Table 32). The other variables, serum concentration of protein and cholesterol, dry matter digestibility and cellular immune response (PHA-P) were not affected (Table 33). However, the abdominal fat content was higher in bajra fed groups (the highest with the cultivar MP7872).

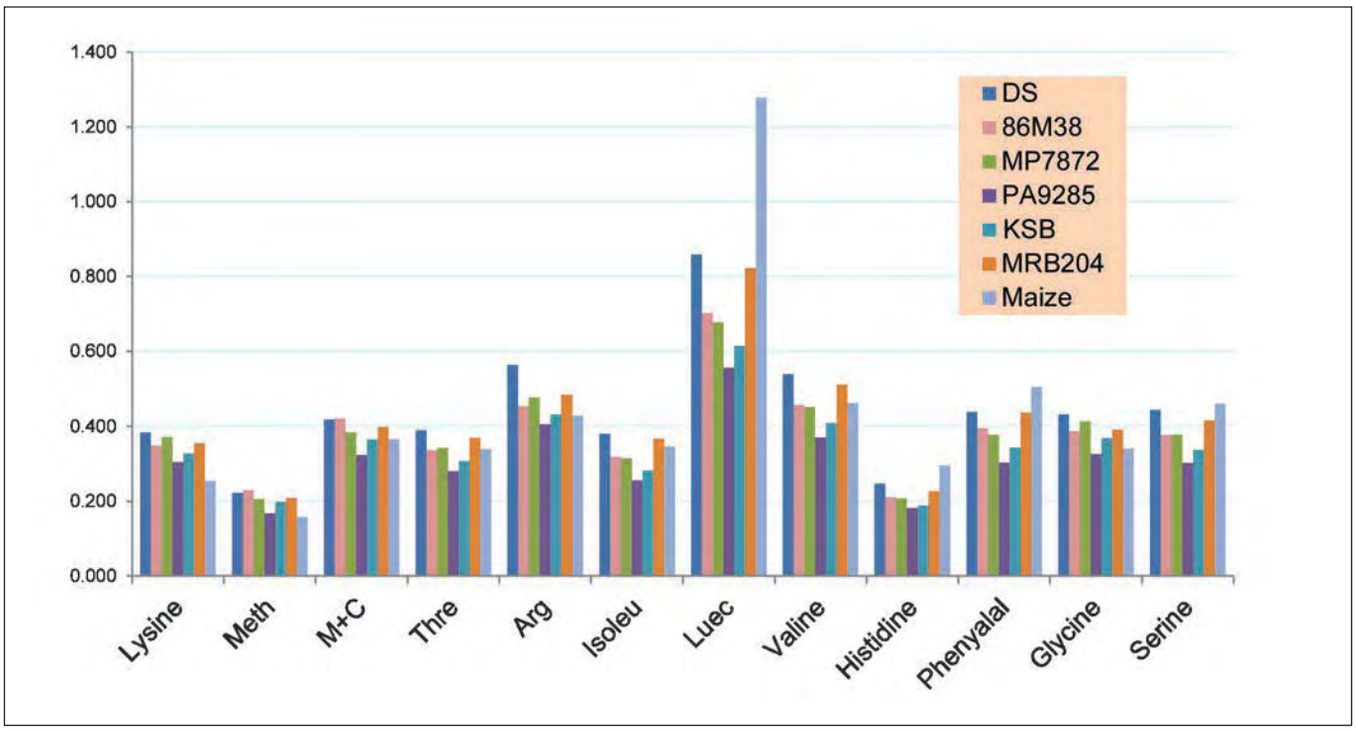


Fig 12. Amino acid concentration in different bajra cultivars

Table 32. Effect of bajra cultivars on performance of broiler chicken

Bajra cultivars	Body wt (g)		Feed (g/b)		FCR	
	3 wks	6 wks	0-3 wks	0-6 wks	0-3 wks	0-6 wks
Maize Control	875	2633	1105	4217	1.26	1.60[a]
Bajra – KS	871	2576	1193	4158	1.37	1.62[a]
Bajra – 86M38	890	2822	1165	4467	1.31	1.58[a]
Bajra – MP7872	846	2701	1112	4262	1.31	1.58[a]
Bajra – PA9285	867	2711	1117	4091	1.29	1.51[b]
P	*0.45*	*0.18*	*0.18*	*0.20*	*0.15*	*0.001*
SEM	*7.40*	*32.65*	*13.58*	*52.28*	*0.01*	*0.01*
N	*9*	*9*	*9*	*9*	*9*	*9*

Table 33. Effect of bajra cultivars on serum biochemical profile, immune response, dry matter digestibility and slaughter variables in broiler chicken

Bajra cultivar	Serum protein (mg%)	Serum cholesterol (mg%)	PHA-P response	DM digestibility (%)	RTC (g/kg)	Breast wt. (g/kg)	Abd.fat (g/kg)	Giblets (g/kg)
Maize Control	3.7	70.2	1.08	80.9	786	248	16.1[c]	38.9
Bajra – KS	4.5	79.7	1.04	81.5	772	244	21.4[b]	38.6
Bajra – 86M38	5.3	95.7	1.06	82.1	774	236	23.0[b]	39.6
Bajra – MP7872	5.5	76.2	1.12	81.6	775	234	27.1[a]	38.7
Bajra – PA9285	4.9	73.5	1.07	80.9	772	244	21.3[b]	37.9
P	*0.44*	*0.23*	*0.99*	*0.97*	*0.75*	*0.25*	*0.001*	*0.94*
SEM	*0.32*	*3.78*	*0.05*	*0.56*	*3.67*	*2.40*	*0.79*	*0.60*
N	*9*	*9*	*6*	*4*	*9*	*9*	*9*	*9*

Development of a composite feed additive using promising organic acids and plant bioactive compounds for improving gut health and productivity in chicken

During the period, characterization of differential abundance, alpha and beta diversity, identification of core microbiome and breed or line specific biomarker microbes in the gut of three indigenous chicken breeds (Nicobari, Ghagus and Aseel) and a commercial broiler line (Vencobb 400) were carried out. The amplicon sequencing results emphasizes more similarity of the microbiota within the gut lumen of indigenous breeds as compared to the commercial broiler strain. Linear discriminant analysis effect size (LEfSe) revealed 82 breed or line specific phylotyper operational taxonomic unit level biomarkers after removal of singleton and doubleton sequences. Fig 13 presents breed or line specific biomarkers identified using LEfSe algorithm. The study also indicates that, among native breeds, there is more similarity of the gut microbiome of the island breed (Nicobari) with that of the coastal breed (Ghagus), as compared to the mainland breed (Aseel).

The study indicates the existence of breed or line specific core microbial as well as across-breed or line core microbiome in chickens, and the occurrence of beneficial and potentially opportunistic pathogenic microbes as part of the core microbiome. A deeper understanding of host-microbiome interactions, as emanated from the current study, is expected to support the development of strategies, including the development of breed specific feed additives and probiotics for enhanced productivity from inconventional or low value diets, to prevent colonization by pathogenic or zoonotic organisms, and to develop an alternative to antibiotic growth promoters.

Further, during the period, feeding trials were conducted to evaluate different feed additives for improving gut health and productivity. Some of the additives showed significant improvement in delayed type hypersensitivity (cell mediated immune response) along with significant increase in gene expression of intestinal immunity related genes.

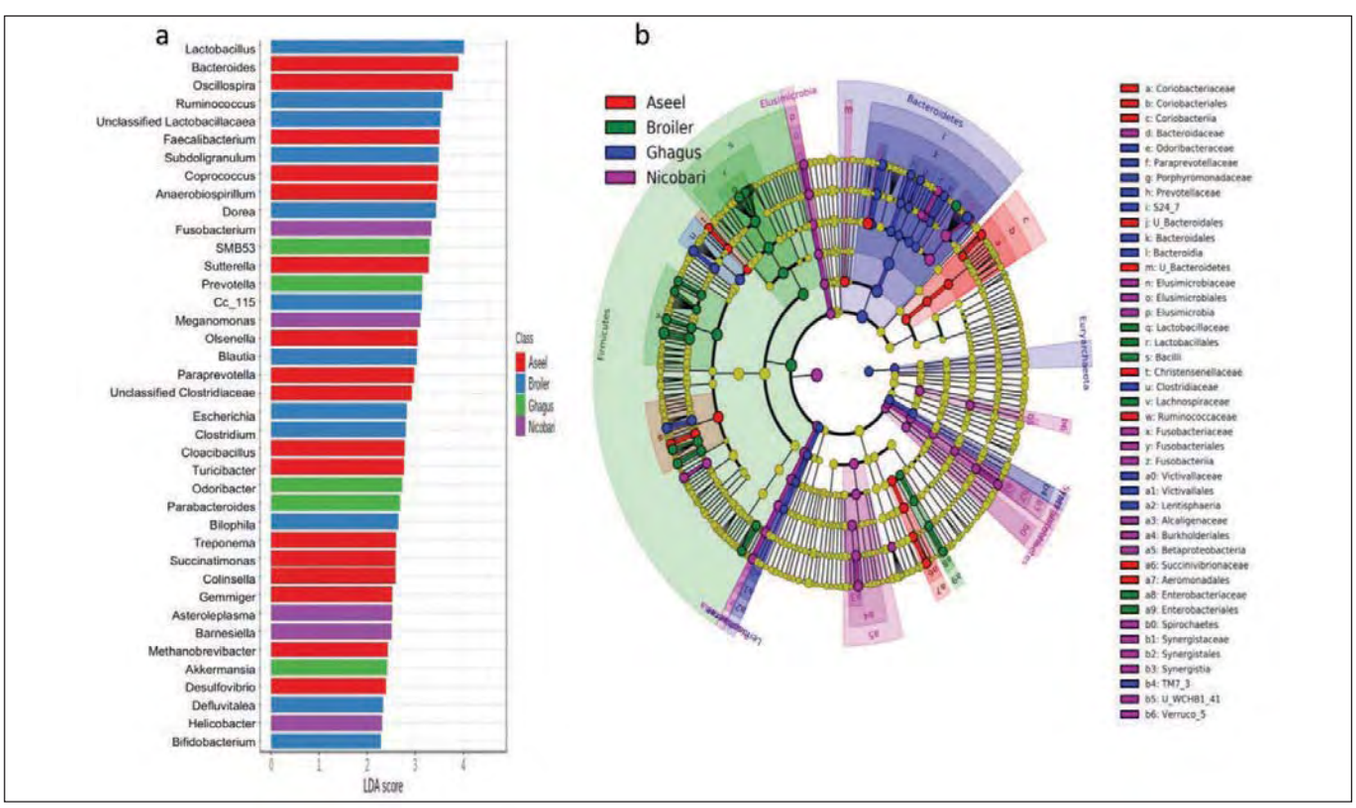


Fig 13. Chicken breed or line-specific biomarkers. (a) Genus level biomarkers identified using linear discriminant analysis effect size (LEfSe) analysis using the Kruskal–Wallis test ($p < 0.05$) with linear discriminant analysis (LDA) score > 2.0. (b) Cladogram representation of differentially abundant microbiota at the different taxonomic levels. The taxonomic levels of the phylum are labeled, while the order to the genus is abbreviated (only labels of top 43 clades are shown here), with the colors indicating breed/line with the highest abundance. The cladogram has been dual rooted to denote domain archaea and bacteria.

Production of designer eggs enriched with critical trace minerals relevant to human nutrition

Effect of supplementation of iron absorption or retention enhancers on production of iron enriched designer eggs during summer

From the previous experiments, it was observed that the iron content in eggs can be increased significantly by dietary inorganic or organic iron supplementation, but after a certain level, there was no further increase. Therefore, the potential to further increase the iron content of eggs was investigated through other approaches by using either iron absorption or retention enhancers. Vitamin C is known to increase absorption of iron from GI tract and the mechanism regulating iron intake in hen egg may involve the amount of the phosphoprotein, phosvitin, to which iron is bound in egg yolk. Since phosvitin contains about half if its amino acid residue as serine, methyl group donors may help in increasing the serine content thereby increase the retention of egg iron.

To explore the hypothesis, a study was conducted in White Leghorn layers of 25 wks of age to evaluate the effect of supplementation of ascorbic acid and methionine on egg iron contents and layer performance during summer season. A total of 270 layers were randomly divided into 9 experimental groups with 6 replicates of 5 birds each. One group was control and the other groups were supplemented with inorganic Fe 250 ppm or organic Fe 150 ppm. Experimental groups were T1 -control, T2 – Inorganic Fe 250ppm, T3 - Inorganic Fe 250ppm+ Vit C 0.3g/kg diet, T4 - Inorganic Fe 250ppm+ methionine 2.5g/kg diet, T5 - Inorganic Fe 250ppm+ Vit C 0.3g/kg diet+ methionine 2.5g/kg diet, T6 –organic Fe 150ppm, T7- organic Fe 150ppm + Vit C 0.3g/kg diet, T8 - organic Fe 150ppm + methionine 2.5g/kg diet, T9 - organic Fe 150ppm + + Vit C 0.3g/kg diet+ methionine 2.5g/kg diet. Vitamin C supplemented groups showed significant improvement in layer performance, egg weight and Haugh unit score. Compared to control, egg iron content significantly improved in all the experimental groups. However, the addition of vitamin C or methionine only marginally improved the egg iron contents over and above the egg iron content of iron supplemented groups.

Production of zinc enriched designer eggs by supplementation of zinc in the diet of layer chicken

Zinc is an essential and critical trace element in human nutrition for normal physiological functions and immunity. Production of Zn enriched egg may provide additional option to enhance Zn status of consumers. A study was conducted to increase the Zn content of egg through supplementation of organic and inorganic Zn in the diet of layers. A total of 270 layers were randomly divided into 9 experimental groups of 30 each (6 replicates with 5 birds per replicate) and supplemented with graded levels of inorganic (40, 80, 120 and 160 ppm) or organic (40, 80, 120 and 160 ppm) Zn. The Zn content of eggs increased by 20.7 to 28.9 % by supplementing inorganic Zn (40 to 160 ppm) and 27.1 to 31.0 % (40 to 160 ppm) by organic Zn (Fig 14). Feed intake and egg production were comparable among the groups. Organic Zn supplementation also significantly ($P<0.05$) improved total protein, albumen, globulin and albumen /globulin ratio. Zinc enrichment did not affect egg quality traits of stored eggs.

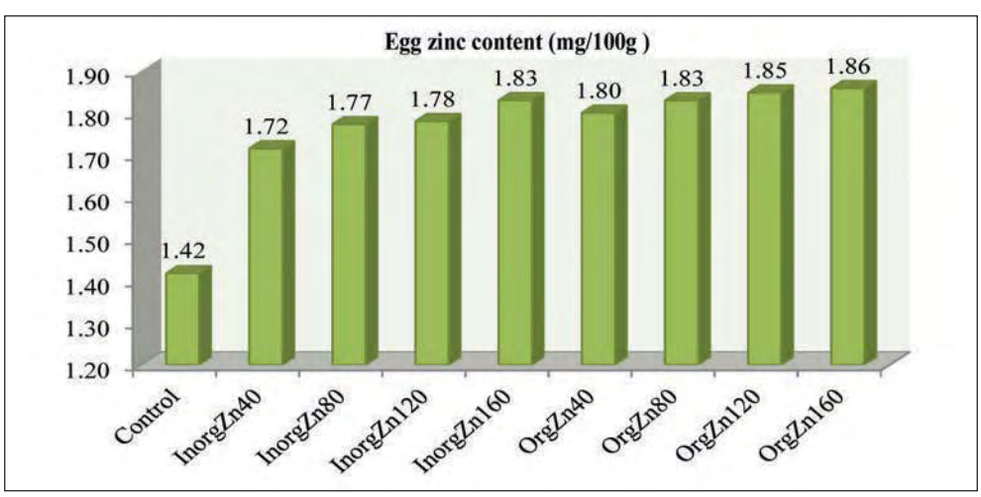


Fig 14. Effect of supplementation of inorganic and organic zinc on zinc content of egg

Biosynthesis of different nano mineral particles using plant extracts and evaluation of their potential as feed supplement in poultry

Biosynthesis and characterization of zinc oxide nanoparticles

Since there is concern in use of nano minerals prepared using chemical or physical methods for use in biomedical applications and animal feeding, attempts have been made to biosynthesize nano minerals using plant extracts in collaboration with NIANP, Bangalore and use it for feeding to poultry. After screening several plants, zinc oxide (ZnO) nano particles could be synthesized using moringa and neem leaf extract in the lab. In brief, plant extracts of moringa or neem leaves were prepared and these extracts were used to reduce zinc nitrate and the obtained product was dried overnight and calcined at 450 °C to obtain the ZnO nano particles. Since phytochemicals present in neem and moringa leaf extract acted as both reducing and capping (stabilizing) agents, no separate chemical was used for stabilizing these nano particles.

The prepared ZnO NPs were characterized using various techniques such as UV–Vis absorption spectroscopy, Particle size analyser, X-ray diffraction (XRD), and Transmission electron microscopy (TEM). The absorption peak of different green synthesized zinc oxide nano particles were around 330-380 nm. The average particle size of the biosynthesized nano zinc oxide particles were 10.84 nm and 8.27 nm, respectively. The structural analysis using XRD showed the noticeable peaks at 32°, 34°, 36°, 47°, 56°, 63°, 68°, 69°, 73° and 77°. The diffraction peaks indicated that the biosynthesized nano zinc oxide has crystalline structure. The TEM analysis also showed that most of the particles are in the range of 10-100 nm.

Effect of feeding bio-fortified maize based diets on performance in broiler and layer chickens

Effect of feeding diets with QPM (Shaktiman) with or without lysine supplementation on Vanaraja chickens

The study was conducted to determine the effect of feeding Quality protein maize (QPM) (Shaktiman) and normal maize-based diets with or without synthetic lysine supplementation on performance of *Vanaraja* chickens. For the purpose, day old chicks (n=288) were randomly divided into four dietary groups each having 12 replicates with six birds. Four diets were formulated to contain normal maize control (NMC, Diet 1); normal maize positive control (NMPC, Diet 2); QPM negative control (QPMNC, Diet 3) and QPM positive control (QPMPC, Diet 4). The body weight gain (BWG) did not differ ($P>0.05$) up to 6th week of age among different dietary groups (Table 34). However, final BWG was significantly ($P<0.05$) higher in groups fed Diets 1, 2 and 4 compared to those fed Diet 3. Similarly, better FCR ($P<0.01$) was recorded among the groups fed Diets I, II and IV compared to those fed Diet III.

Table 34. Effect of feeding diets with QPM (Shaktiman) with or without lysine supplementation on performance in *Vanaraja* chickens

Diets	2 Weeks		4 weeks		6 Weeks	8 weeks		
	BWG	FCR	BWG	FCR	BWG	FCR	BWG	FCR
NMC	149.7	1.66^{b}	450.7	1.90^{b}	838.7	2.10^{b}	1198^{a}	2.34^{b}
NMPC	143.9	1.66^{b}	448.1	1.84^{b}	832.7	2.08^{b}	1132^{a}	2.36^{b}
QPMNC	144.1	1.79^{a}	424.7	2.04^{a}	801.1	2.20^{a}	1023^{b}	2.52^{a}
QPMPC	140.5	1.69^{b}	440.5	1.85^{b}	790.0	2.13^{ab}	1138^{a}	2.44^{ab}
N	12	12	12	12	12	12	12	12
SEM	1.534	0.011	4.578	0.017	8.949	0.017	18.1	0.024
P value	0.209	0.001	0.182	0.001	0.150	0.031	0.03	0.027

FCR, feed conversion ratio (feed intake/BWG); NMC, Normal maize control; NMPC, Normal maize positive control; QPMNC, QPM negative control; QPMPC, QPM positive control

Table 35. Effect of feeding diet containing linseed oil on feed intake and egg production in layer chicken during 33-36 weeks

Treatment	33 Weeks		34 Weeks		35 Weeks		36 Weeks	
	EP	FI/b/d	EP	FI/b/d	EP	FI/b/d	EP	FI/b/d
Control	89.6	100.8^{b}	86.6	104.9	92.3^{a}	107.1^{b}	90.0^{a}	110.1^{b}
LSO	88.9	106.0^{a}	88.8	107.9	86.3^{b}	117.1^{a}	81.6^{b}	116.2^{a}
SEM	1.27	1.38	1.11	1.61	1.32	1.99	1.75	1.69
N	16	16	16	16	16	16	16	16
P Value	0.78	0.05	0.34	0.36	0.02	0.01	0.01	0.07

LSO, Linseed Oil; EP, egg production; FI, feed intake

Table 36. Effect of feeding diet containing linseed oil on feed intake and egg production in layer chicken during 37- 40 weeks

Treatment	37 Weeks		38 Weeks		39 Weeks		40 Weeks	
	EP	FI/b/d	EP	FI/b/d	EP	FI/b/d	EP	FI/b/d
Control	90.5^{a}	106.0	87.0	105.1^{b}	87.0	100.5^{b}	87.9	104.5^{b}
LSO	84.8^{b}	111.1	90.7	112.8^{a}	89.6	112.7^{a}	87.9	113.4^{a}
SEM	1.71	1.70	1.55	1.79	1.58	2.565	1.288	1.756
N	16	16	16	16	16	16	16	16
P Value	0.10	0.13	0.23	0.03	0.41	0.02	0.99	0.01

LSO, Linseed Oil; EP, egg production; FI, feed intake

Dietary enrichment of chicken eggs with Omega-3 fatty acids

The study was conducted to determine the performance and egg quality parameters in laying chickens by feeding the diets with or without linseed oil supplementation (6%). Linseed oil was determined for fatty acid composition (saturated and unsaturated) using Gas chromatograph through FID detector. Linseed oil contained saturated fatty acids i.e., Palmitic acid (6.15%) and Stearic acid (5.58%), and unsaturated i.e., Oleic acid (21.14%), Linoleic (14.27%) and Linoleic acid (52.85%). The linseed oil was used for feeding to laying chicken (IWF; 16 replicates and 5 birds in each) to record the performance parameters and egg quality parameters. Insignificant difference was observed for egg production and feed intake during 33-34 weeks of age, except feed intake, which was significantly ($P<0.05$) higher in groups fed 6% linseed oil supplemented diet compared to those fed the control diet (Table 35). Lower egg production and higher feed intake were observed among the groups fed linseed oil supplemented diet compared to control diet. Similar trend was also recorded during 37-40 weeks of age (Table 36). The egg weight was higher in groups fed control diet (55.4g) compared to those fed diets supplemented with linseed oil (49.1g). However, the other egg quality parameters (egg density, Haugh Unit and shell quality) did not differ among the groups. The total fat, extracted from the eggs, is being processed for estimating the fat for fatty acid composition.

Physiology

Comparative studies on different factors influencing egg production in chickens

A total of 50 Nos. each of 24-weeks old *Vanaraja* and Aseel breeder hens were randomly divided into two equal groups consisting of 25 birds in each. Each group had 5 replicates with five birds in each. They were reared till 28 weeks of age. The control group (CG) was offered standard layer feed and the treatment group (SG) received supplement, yeast-enriched selenium (Se) (0.15g/kg feed for *Vanaraja* birds and 0.09 g/kg feed for Aseel) in addition to standard layer feed. All the groups were fed 110 g feed/bird/day. The experiment was conducted for early laying period only. Effect of supplementation of Se was observed on concentration of amino acids in plasma and magnum tissue. Gene expression studies were conducted for amino acid transporters, Melatonin and Ghrelin receptors in

jejunum and magnum tissue of both the breeder hens. The amino acids were quantified by LC-MS.

Supplementation of Se increased concentration of plasma amino acids in *Vanaraja* birds when compared to the control group (CG) of birds. The concentration (mg/dl) of plasma amino acids serine, proline, valine, threonine, arginine, glutamate, lysine, glutamic acid, methionine, histidine, arginine, tyrosine and tryptophan were more in SG group (Fig 15). Whereas in Aseel hens in SG, the concentration of the amino acids in plasma was similar to that of the CG. On the other hand, supplementation of Se (SG) increased the concentration (ng/mg) of amino acids alanine, proline, valine, methionine, phenylalanine and tyrosine, whereas the concentration of serine aspargin, aspartate, glutamate, histidine and tyrosine decreased in magnum tissue of reproductive tract of *Vanaraja* birds (Fig 16). In Aseel, Se supplementation decreased the concentration of serine, aspargine, aspartate, glutamate, histidine and tyrosine in the magnum tissue. When comparison was made between the CGs of *Vanaraja* and Aseel, the concentration of lysine, histidine, tryptophan, aspargine and glutamic acid was more in the magnum tissue of the former group of birds, whereas methionine, phenyl alanine, tyrosine, serine, proline, valine, threonine, aspartate and glutamate were more in Aseel birds in the magnum tissue (Fig 16). With respect to the concentration of plasma amino acids, lysine, methionine, glutamic acid, histidine, phenyl alanine, arginine, tyrosine, tryptophan, glutamic acid, aspartate, aspargine, threonine, valine, proline, serine and alanine were more in the plasma of Aseel hens (Fig 15).

In Aseel birds, supplementation increased the fold expression of LAT2, CAT and BAT in the magnum tissue only but supplementation of Se did not cause significant difference in the expression fold of amino acid transporters of jejunum, except for BAT between the CG and SG groups (Fig 17). The concentration of plasma amino acids in SG of *Vanaraja* birds was more when compared to the CG, but the fold change expression of the amino acid transporter CAT increased and LAT4 decreased significantly in the jejunum, whereas in the magnum tissue, the transporters LAT2, and CAT increased significantly (Fig 18).

The relative gene expression of ghrelin and melatonin receptors (GHSR, METR) was significantly less in the jejunum of SG of *Vanaraja* birds, whereas in Aseel (SG), METR was upregulated (Fig 17 & 18). In the magnum tissue, expression of both the receptors was less in Aseel birds, whereas in *Vanaraja*, only METR was expressed less and GHSR was upregulated in SG when compared to CG. The difference was significant at $P<0.05$.

Supplementation of Se had differential effect on the expression of amino acid transporters in jejunum and magnum when compared between *Vanaraja* and Aseel breeder hens. When the expression of amino acid transporter and hormone receptor genes were compared between the CG groups of breeder hens, the expression was higher ($P<0.01$) in both jejunum and magnum tissues of *Vanaraja* birds (Fig 19). The work on differential expression of miRNAs and their effect on different pathways is in progress.

The processed reads (Table 37) were used with *Gallus gallus domesticus* reference genome (GCF_000002315.3_Gallus_gallus-4.0_genomic.fna) and chromosomal coordinates of Gallus gallus microRNAs in mirBase (gga.gff3) was carried out to predict novel and known miRNA using the miRDeep2 (Table 38).

The Target predictions for novel miRNA were performed using Miranda and the number of unique mRNA targeted by differentially expressed miRNA are as follows.

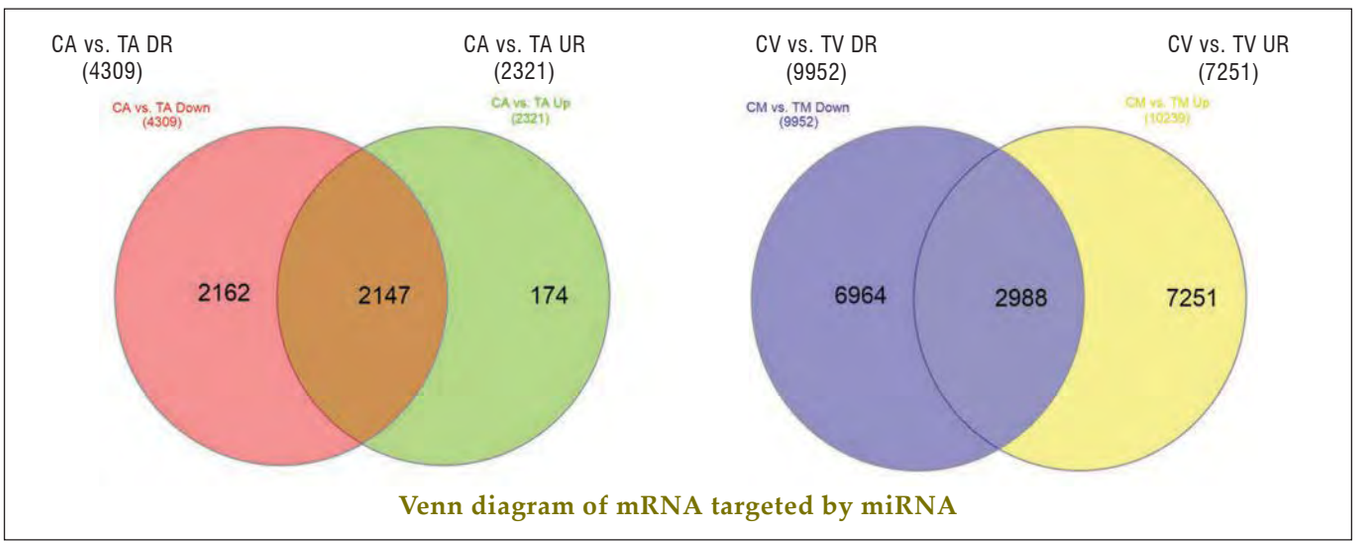
Table 37. Basic statistics of raw and processed sequences

	Raw reads			Processed reads		
Sample	Total Read	Read Length	%GC	Total Read	Read Length	%GC
CA	21461766	51	49	18096333	20-51	45
TA	37341142	51	48	34693681	20-51	42
CV	27579627	51	49	18505760	20-51	42
TV	41261475	51	52	19190702	20-51	52

The quality of raw reads sequenced was checked by using FASTQC and processed using TrimGalore (v: 0.5.0) and Cutadapt, CA, TA- Control and Treatment groups of Aseel, CV, TV- Control and Treatment groups of Vanaraja

Table 38. Predicted novel and known miRNA

Sample	Known miRNA	Novel miRNA
CA	531	50
TA	569	80
CV	566	78
TV	349	16



Venn diagram of mRNA targeted by miRNA

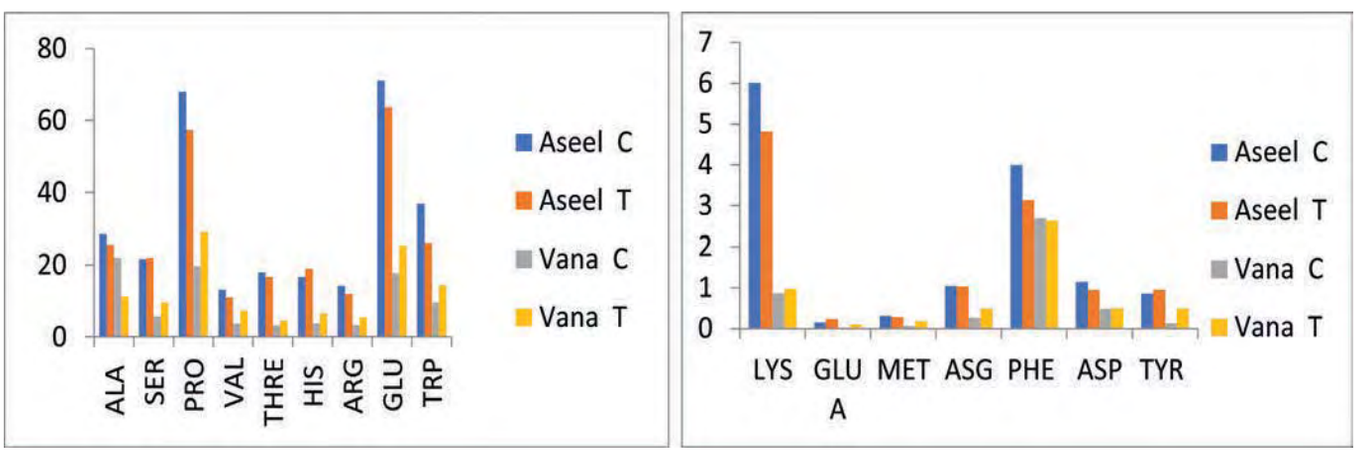


Fig 15. Concentration (mg/dl) of plasma amino acids in Aseel and *Vanaraja* breeder hens at 26 weeks of age. C-Control, T-Treatment; Yeast enriched Se supplementation @ 0.15g/kg and 0.09g/kg of feed to *Vanaraja* and Aseel hens respectively.

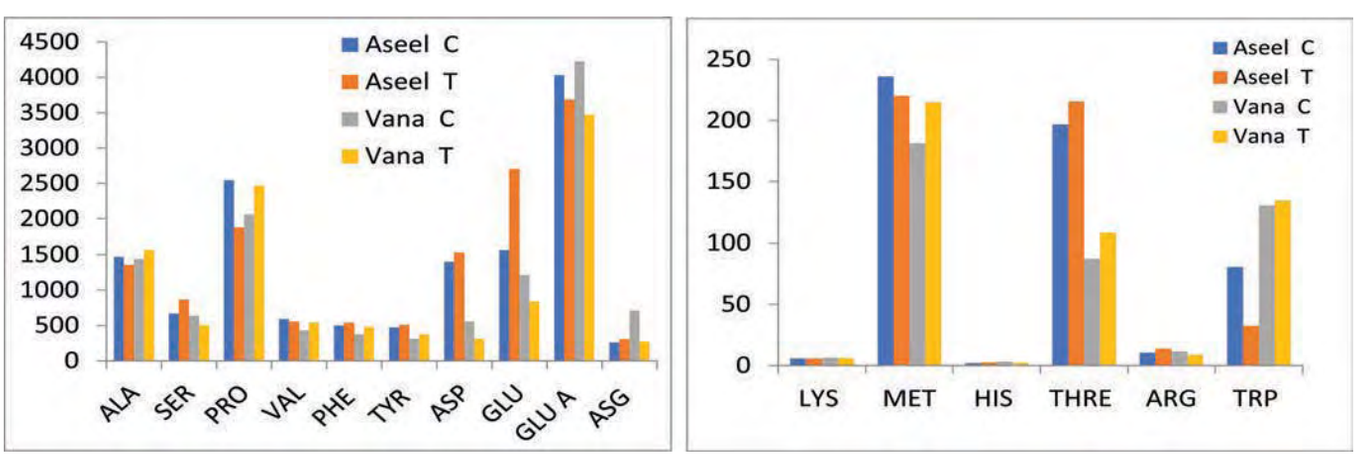


Fig 16. Concentration (ng/mg) of amino acids in magnum tissue of Aseel and *Vanaraja* breeder hens. C-Control T-Treatment, Supplementation of Yeast enriched Se @ 0.15g/kg and 0.09g/kg to *Vanaraja* and Aseel hens respectively.

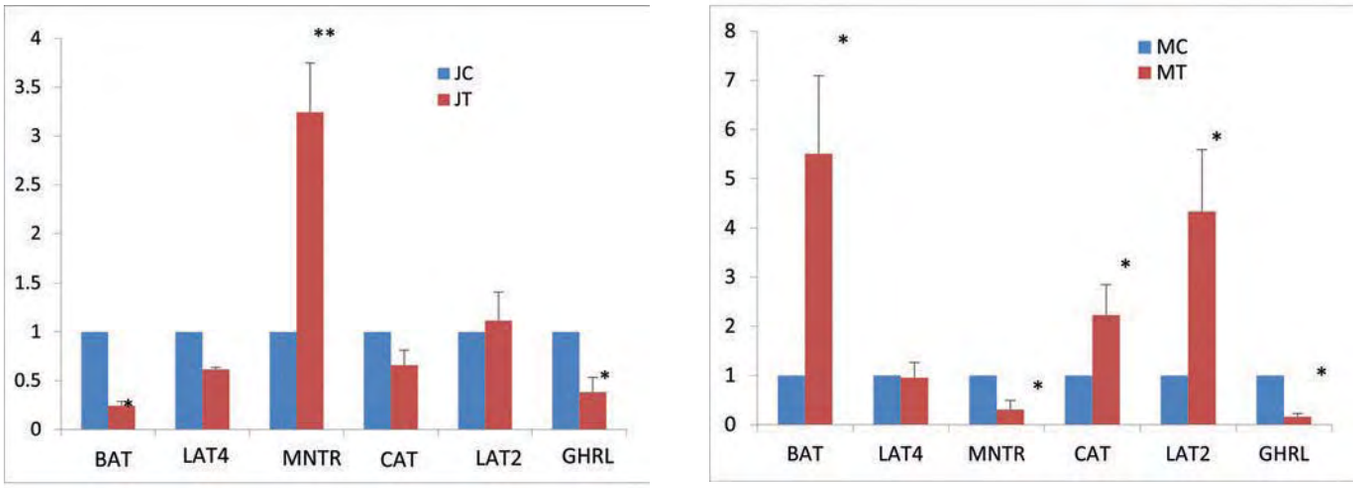


Fig 17. Relative fold change in the expression of amino acid transporters and hormone receptors in Jejunum and Magnum tissue of Aseel Birds. C- Control, T- Treatment, Treatment with yeast selenium @0.09g/kg, J- Jejunum, M-Magnum; Age of the birds - 26 weeks of age, *P<0.05, **P<0.01.

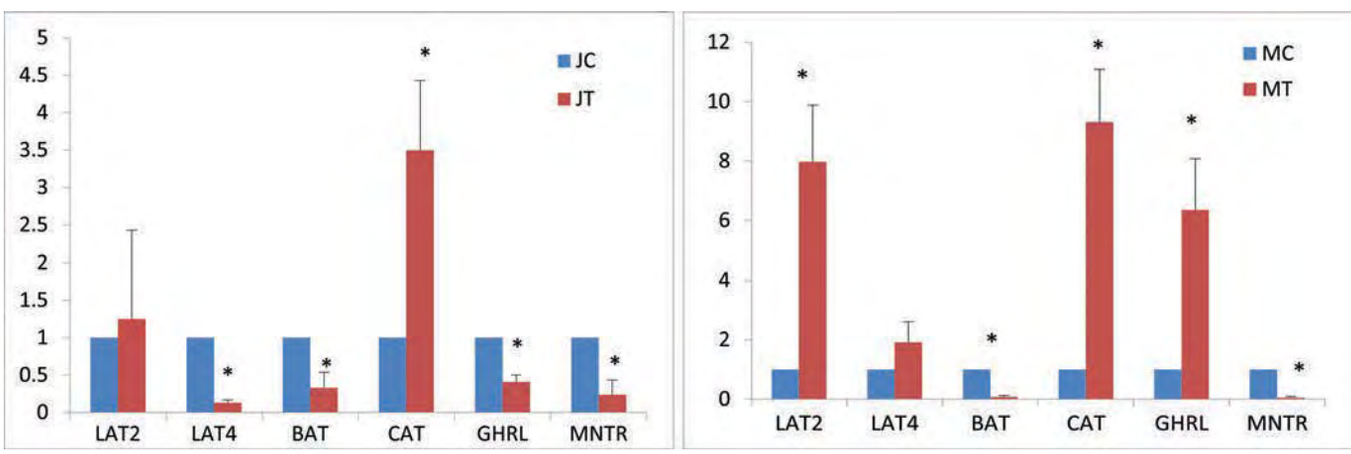


Fig 18. Relative fold change in the expression of amino acid transporters and hormone receptors in Jejunum and Magnum tissue of *Vanaraja* Birds. C- Control, T- Treatment, Treatment with yeast Se @ 0.15g/kg, J- Jejunum, M-Magnum; Age of the birds - 26 weeks of age, *P<0.05, **P<0.01.

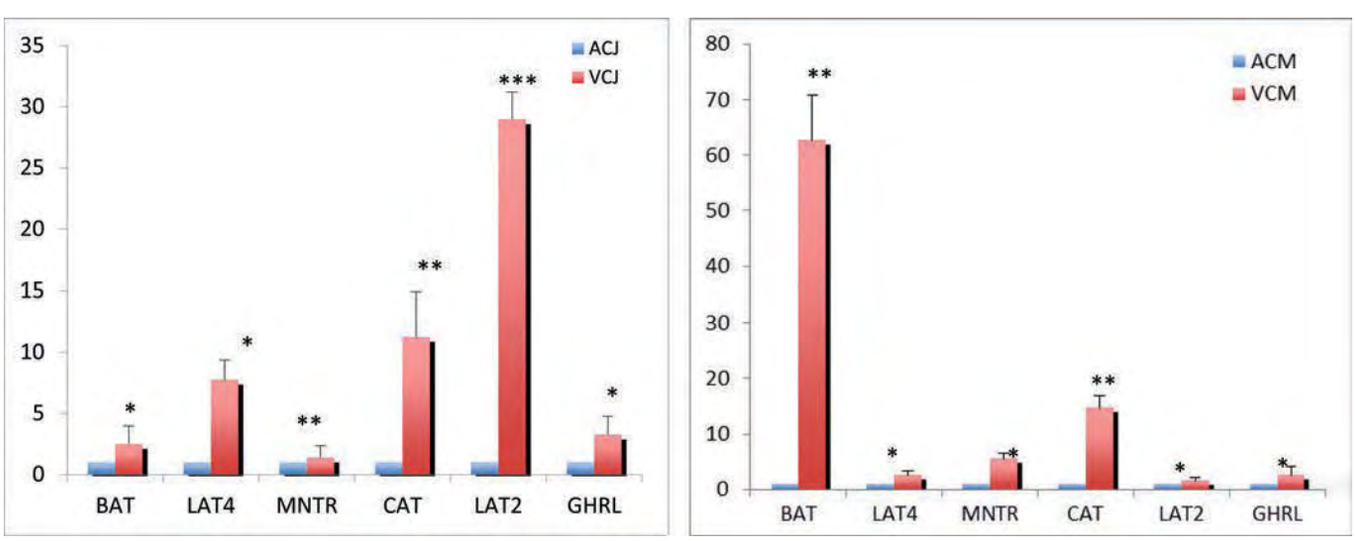


Fig 19. Comparison of Relative fold change in the expression of amino acid transporters and hormone receptors in Jejunum and Magnum tissue of control groups of *Vanaraja* and Aseel breeder hens. C- Control, T- Treatment, J- Jejunum, M-Magnum; Age of the birds - 26 weeks of age, *P<0.05, **P<0.01, ***P<0.001, Actin served as housekeeping gene.

Effect of dietary organic zinc supplementation in hen diet on fertility from IWH line cryopreserved semen

Dietary organic zinc supplementation to diet of hen has been reported to improve fertility. A study was conducted to evaluate the effect of organic zinc supplementation in hens on fertility after insemination with cryopreserved semen. IWH line of White Leghorn rooster (39 weeks age) semen was cryopreserved using 4% dimethylsulfoxide (DMSO) in 0.5ml French straws by exposing to liquid nitrogen vapours. The semen straws were stored in liquid nitrogen for minimum of a week and thawed at 5°C for 100 sec. Post-thaw semen samples were analyzed for sperm motility, live sperm, abnormal sperm, acrosome intact sperm and fertility. White Leghorn (IWH) hens were divided into 5 groups with 30 birds in each group. Each group was further divided into six replicates containing five birds in each replicate. The control group was fed basal diet while other groups were fed with basal diet supplemented with 40, 60, 120 and 160 mg/kg organic zinc (zinc proteinate). After two weeks of feeding the hens were inseminated using thawed semen (200 million sperm/0.1 ml). Basal group hens were inseminated with fresh or cryopreserved semen and served as control groups. Sperm motility, live sperm, and acrosome intact sperm parameters were significantly ($P < 0.05$) lower in thawed semen samples. Fertility from cryopreserved semen was 4.93% and was significantly ($P < 0.05$) lower than fertility from fresh semen. Fertility in 40, 60, 120 and 160 mg/kg organic zinc supplemented hens was 6.95, 5.01, 0, 0.625% respectively, that was similar to that of cryopreserved semen inseminated into basal diet group hens. In conclusion, insemination with 4% DMSO cryopreserved IWH semen gave a fertility of around 5% and organic zinc supplementation in hens does not improve fertility from cryopreserved semen.

Effect of dietary iron and vitamin C supplementation in hen on fertility from IWH line cryopreserved semen

A study was conducted to evaluate the effect of iron and vitamin C supplementation in hens on fertility from cryopreserved semen. IWH line of White Leghorn rooster (39 weeks age) semen was cryopreserved using 4% dimethylsulfoxide (DMSO) in 0.5ml French straws by exposing to liquid nitrogen vapours. The semen straws were stored in liquid nitrogen for a minimum of week duration and thawed at 5°C for 100 sec. Post-thaw semen samples were analyzed for sperm motility, live sperm, abnormal sperm, acrosome intact sperm and fertility. White Leghorn (IWH) hens were divided into 3 groups; basal diet, basal diet + inorganic iron (250 ppm) and vitamin C (0.3g/kg), and basal diet + organic iron (150 ppm) and vitamin C (0.3g/kg). After two weeks of feeding, the hens were inseminated using thawed semen (200 million sperm/0.1 ml) during hot climatic conditions. Basal group hens were inseminated with fresh or cryopreserved semen and served as control groups. Sperm motility, live sperm and acrosome intact sperm parameters were significantly ($P<0.05$) lower in thawed semen samples. The fertility from cryopreserved semen was 16.1% and was significantly ($P < 0.05$) lower than that of fresh semen. Fertility in inorganic iron supplemented hens was 4.96% and in organic iron supplemented hens was 3.16%. The fertility results from supplemented groups were similar to that of cryopreserved semen inseminated into basal diet group hens. In conclusion, iron and vitamin C supplementation in hens during hot climatic conditions did not improve fertility from cryopreserved semen.

Cryopreservation of CB and PB-2 semen

Semen cryopreservation protocols for two broiler breeder lines, PB-2 and control broiler (CB), were evaluated in separate experiments. Semen of PB-2 broiler breeder line was cryopreserved with 8% Ethylene Glycol (EG) or 6% dimethylformamide (DMF) in Beltsville Poultry Semen Extender (BPSE). In another experiment semen from CB population was cryopreserved with 8% EG, 8.2% dextran 10 kDa + 9% dimethylacetamide (DMA) or 8.2% dextran 20 kDa + 9% dimethylacetamide (DMA) in Sasaki diluent (SD). Semen was cryopreserved in 0.5 ml plastic straw and thawed either at 5°C for 100 sec or 37°C for 30 sec as per the experimental protocol. Semen was assessed for motility, live sperm, abnormal sperm and acrosome intact sperm. Post-thaw semen was inseminated, eggs were collected and incubated for obtaining fertility data. The cryopreserved samples had significantly ($P<0.05$) lower sperm motility, live sperm and acrosome intact sperm in both the breeder lines. The fertility obtained

in PB-2 line with 8% EG and 6% DMF was 30.19 and 46.58% respectively. The fertility in CB using 8% EG, 8.2% dextran 10 kDa + 9% DMA and 8.2% dextran 20 kDa + 9% DMA were 3.14, 0 and 2.34% respectively. The fertility from cryopreserved semen was significantly (P<0.05) lower in CB line. In conclusion, permeable cryoprotectants (8% EG or 6% DMF) produced acceptable fertility during PB-2 semen cryopreservation. The permeable cryoprotectant 8% EG or dextran in combination with DMA gave very low fertility in CB line.

Effect of betaine and tempol supplementation during cryopreservation of PD-1 semen

An experiment was conducted to evaluate addition of betaine and tempol during PD-1 chicken semen cryopreservation on post-thaw semen parameters and fertility. Adult PD-1 line (40 weeks age) semen was cryopreserved using 4% dimethyl sulfoxide (DMSO) in Sasaki diluent (SD). In the semen cryomixture, betaine (0.2 and 0.4 mM) or tempol (1 and 5 mM) was added at final concentrations. The semen with additives were filled in 0.5 ml French straws and exposed to liquid nitrogen vapours for 30 min and then stored in liquid nitrogen. The semen straws were thawed at 5°C for 100 sec and semen evaluated for sperm motility, live, abnormal and acrosome intact sperm. Lipid peroxidation in the seminal plasma was evaluated. Fertilizing potential of the cryopreserved sperm was evaluated by inseminating in the PD-1 line hens. The post-thaw sperm parameters were significantly (P<0.05) lower in the cryopreserved groups. The lipid peroxidation was significantly (P<0.05) higher in cryopreserved groups. The fertility in all the cryopreserved semen inseminated groups was significantly (P<0.05) lower. The fertility from un-supplemented semen group was 16.33% compared to fresh semen inseminated group (91.6%). In conclusion, addition of betaine and tempol to cryopreservation mixture did not improve the post-thaw semen parameters or fertility in PD-1 chicken.

Sustainable Poultry Waste Management through composting

Poultry litter compost and vermicompost by mixing dry leaves (Wealth from Waste): One of the major issues the poultry industry is currently facing is the accumulation of large amount of wastes, especially manure and litter, generated by intensive production, which is causing major environmental problem. The problem could be resolved by converting poultry litter (Waste) into vermicompost (Wealth).

Compost preparation with C/N ratio of 35:1: The compost preparation started with C/N ratio of 35:1 by mixing poultry litter with dry leaves having relative humidity 48%, pH 5.2 and temperature 36.2°C. About 13 Kg of litter was mixed with 46 Kg of dry leaves. The humidity was maintained at around 50%. The temperature kept changing due to the growth of the microbes inside the pile. The compost was ready on 57th day. The relative humidity was 50%, pH was 5.0 and temperature was 30.2°C on 57th day.

Compost with C/N ratio of 35:1

***Compost preparation with C/N ratio of 25:1*:** The compost preparation started with C/N ratio of 25:1 by mixing litter with dry leaves as supplement having relative humidity 47%, pH 5.3 and temperature was 36°C. About 40 Kg of litter was taken and mixed with 40 Kg of dry leaves. The final product, compost, was ready on 57th day. The relative humidity was 50%, pH was 5.0 and temperature was 30.2°C on the final day.

Compost with C/N ratio of 25:1

Vermicompost preparation with poultry litter and dry leaves:

Vermicompost was prepared with two compost samples having 35:1 and 25:1 C/N ratios.

***Vermicompost having C/N ratio of 35:1*:** Vermicompost was prepared with the poultry litter compost. The poultry litter has nitrogen toxicity where the earthworms will not survive. As a first step the nitrogen toxicity was neutralized by making compost. After making compost, the same was subjected to form the vermicompost by introducing earthworms which multiplied and converted the waste into useful product. The vermicompost was ready within 80 days and at the end good number of earthworms were left behind.

Vermicompost having C/N ratio of 25:1: In this group the nitrogen toxicity of the poultry litter was neutralized by making 25:1 C/N ratio compost and afterwards, the same was subjected to form the vermicompost. Earthworms were introduced into the compost and the vermicompost was ready within 80 days.

Poultry litter compost by mixing saw chips/dust

Intensive poultry production results in generation of large quantity of poultry litter. The poultry litter generated, could be successfully converted into compost by mixing with saw chips/dust in proper ratio of carbon to nitrogen (C/N ratio) content present in the litter as well as in saw chips/dust.

***Compost preparation with C/N ratio of 35:1*:** The compost was prepared having C/N ratio of 35:1 by mixing poultry litter with saw chips/dust having relative humidity 50%, pH 5.0 and temperature 34°C. Fifteen kilograms of litter was mixed with 48 kg of saw chips/dust. The humidity was maintained at around 50%. The temperature changed due to the growth of the microbes inside the pile. The compost was ready on 70th day. The relative humidity was 45%, pH was 5.5 and temperature was 27°C on 70th day.

Vermicompost with C/N ratio of 35:1

Vermicompost with C/N ratio of 25:1

Saw chips

Compost with C/N ratio of 35:1

***Compost preparation with C/N ratio of 30:1*:** A compost was prepared having C/N ratio of 30:1 by mixing litter with saw chips/dust as supplement having relative humidity 50%, pH 5.0 and temperature was 34°C. Eighteen kilograms of litter was taken and mixed with 42 kg of saw chips/dust. The final compost product, was ready on 70th day. The relative humidity was 44%, pH was 5.5 and temperature was 27°C on the final day.

***Compost preparation with C/N ratio of 25:1*:** A compost was prepared having C/N ratio of 25:1 by mixing litter with saw chips/dust as supplement having relative humidity 50%, pH 5.0 and temperature was 25°C. Twenty-five kilograms of litter was taken and mixed with 36 kg of saw chips/dust. The final product, compost, was ready on 70th day. The relative humidity was 45%, pH was 5.5 and temperature was 27°C on the final day.

Poultry rearing with moringa and other feed base - an Integrated Farming System

Major concerns in poultry industry is the feed cost due to high prices of protein and energy sources and development of antibiotic resistant pathogens due to unwise and excessive use of antibiotics. To overcome these problems, we need to look for cheap and safe alternative sources of protein and energy. *Moringa oliefera* leaves have many qualities like it is a good source of protein and energy. It has got antimicrobial property and antioxidant effects. The composition of earthworm and Moringa leaves were analysed. It was found that composition of earthworm constitutes moisture content of 79.86%, dry matter 20.14%, protein 48.10% and fat 8.09% and the composition of dry Moringa leaf powder includes protein 18.48% and fat 6.13%. A night shelter for the birds for conducting the trial was constructed and 610 birds were housed.

Saw chips

Compost with C/N ratio of 30:1

Saw chips

Compost with C/N ratio of 25:1

Model Project and Demonstration Unit for Backyard Poultry, Livestock, Vermifarming and Moringa Integration under Rashtriya Krishi Vikas Yojana (RKVY)

Integrated farming helps in lowering the cost of production. The leaves of *Moringa oleifera*, a widely grown plant in India, are good source of protein. In the institute's farm, *Moringa* plants were grown in an area of 19,450 square feet. A total of 600 birds of *Gramapriya* and cross of White Leghorn and Kadaknath were housed in night shelter having an area of 1245 square feet, which was constructed within the *Moringa* plantation. About 150 birds of *Gramapriya* were raised on dried *Moringa* leaf powder and poultry feed (70g) as well as supplementary diets like earthworms and kitchen wastes. The average weight of *Gramapriya* birds at the age of 20 weeks was 1361g, which increased to 1515g by 24 wks. The egg production at 24 and 26 weeks of age was 42% and 53%, respectively.

The number of birds has been increased to 610 in the Moringa field. *Gramapriya* as well as White Leghorn – Kadaknath cross have been housed in night shelter inside the Moringa field. The birds are let loose in the Moringa field for free ranging on fallen Moringa leaves, insects and earthworms in the open field.

Night shelter for birds

Gramapriya birds in Moringa field

Moringa field

Hens foraging in Moringa field

Night shelter for hens

Hens feeding on dry Moringa leaves powder

Health

Disease diagnosis, vaccination and sero-monitoring in pure line chickens

Major causes of mortality were due to coccidiosis, chronic respiratory disease, hemorrhagic tracheitis, Colibacillosis, Marek's disease, lameness and Lymphoid leukosis, heat stress. A total of 3153 birds which include PB2 (132), PB1 (513), IWD (230), IWH (451), IWF (220), PD4 (394), Kadaknath (338), PD2 (517), Naked neck (189) and Dwarf (169) were screened for ALV infection by p27 antigen ELISA. The overall positivity of ALV carriers was 15.6% (492/3153). Kadaknath was having highest percentage of ALV shedders. Typical cases of myeloid leukosis were observed in Kadaknath, Dahlem Red, Ghagus.

Multiplex PCR technology for simultaneous and differential detection of oncogenic/tumor viral diseases of chicken

Avian oncogenic or tumor diseases are common in poultry industry causing significant economic loss. These include three major viral diseases Marek's disease (MD), avian leukosis (AL) and Reticuloendotheliosis (RE). Apart from causing economic loss due to mortality; production loss, loss of pedigree birds and carcass condemnation also significant due to these infections. Co-infections of two or more viruses are quite common. These co-infections are difficult to distinguish by clinical presentation and gross pathology, necessitating specific laboratory differential diagnosis. Marek's disease is well controlled by use of vaccines and strict bio-security measures. However, frequent outbreaks were reported from vaccinated flocks due to vaccination failure, evolving new pathotypes etc. At present no commercial vaccine is available for protection against ALV and REV infection. The only method adapted is to identify and cull the virus carriers in breeder flocks. Hence, there is a need for quick and high throughput laboratory technique for this purpose. Multiplex PCR is rapid and precise method for simultaneous detection and differentiation of viruses in multiple co-infections. This multiplex PCR technique is developed, optimized and validated with field clinical samples for rapid and simultaneous detection and differential diagnosis of MD, ALV and REV infections. Target genes selected: *pp*38 gene for MDV, 5 prime end region of *polymerase* gene for ALV, *LTR* gene for REV, and β *actin* for internal control were selected for designing the primers to increase the specificity and efficiency. The PCR was carried out in single tube reaction carrying all four primer sets with template. The optimum primer concentration of each set was optimized by checker board method. The following PCR products were amplified in multiplex PCR (Fig 20). Marek's disease (206bp), ALV (429bp) and REV (128bp). Internal control primer was included to check the presence of DNA (89bp).

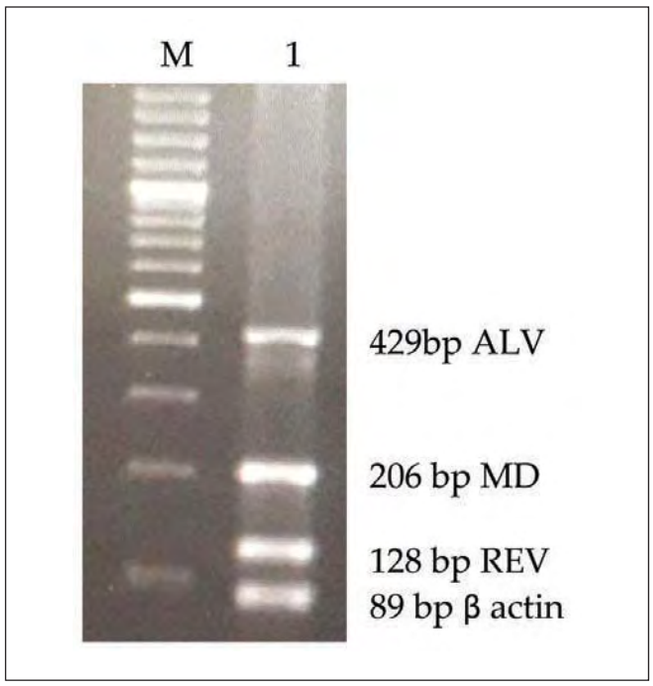


Fig 20. Gel electrophoresis of multiplex PCR for ALV, MD and REV

M: 100 bp ladder lane, 1: positive control showing ALV, MD and REV specific PCR products

Exploring medicinal plants as alternatives to antibiotic growth promoters (AGPs) in broiler production

Functional diversity of caecal microbiome of Krishibro broilers

Caecal samples were collected from 2 groups of *Krishibro* broiler chicken viz., a) basal diet alone (Without AGP), b) basal diet with AGP (With AGP). Five caecal samples for each group were taken, homogenized and pooled and subjected for shotgun sequencing using Illumina Hiseq. The caecal microbial diversity of *Krishibro* broiler chicken supplemented with and without

antibiotic growth promoters revealed functional categories of carbohydrates, clustering based subsystems and protein metabolism as the predominant categories with >10% abundance. Further functional analysis to the sub-categorical level showed central carbohydrate metabolism as the predominant category in both the groups, followed by One-carbon metabolism in AGP supplemented groups (Fig 21) and Di- and Oligo Saccharides without AGP supplemented group (Fig 22). Figures 23 and 24 depict the charts of the carbohydrates functional category with and without AGP supplementation. Table 39 depicts the top 10 functional abundances involved in carbohydrates metabolism of both the groups.

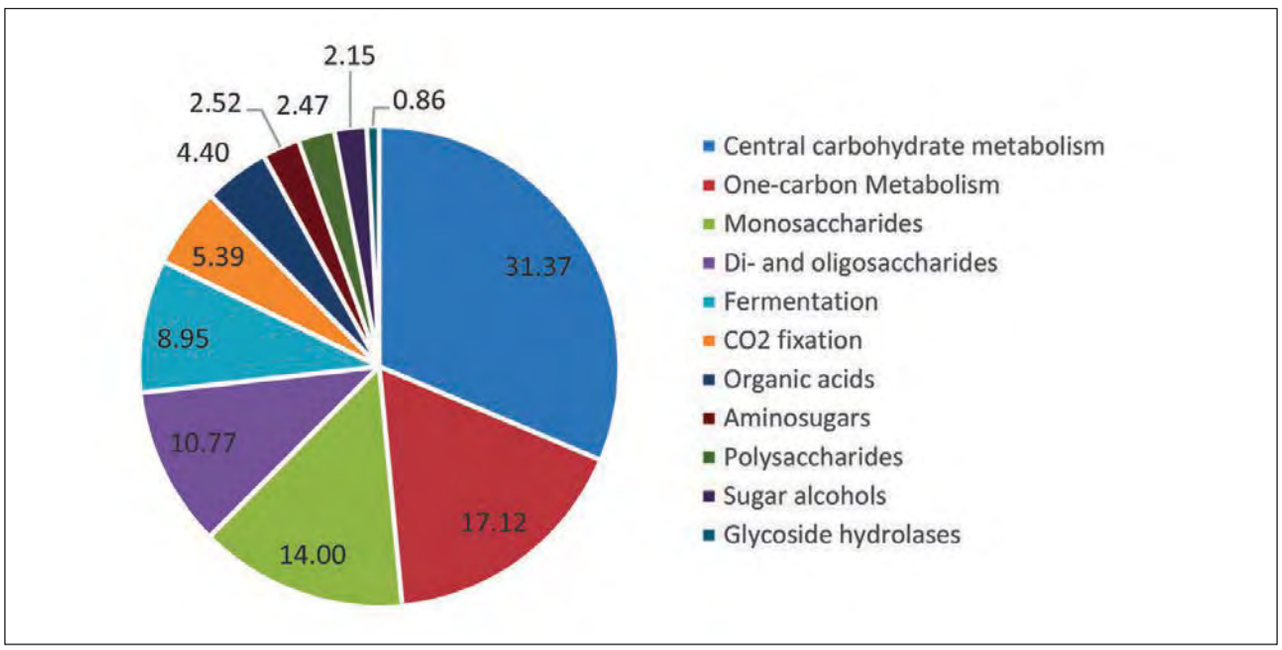


Fig 21. Sub-categories of Carbohydrates of *Krishibro* broilers supplemented AGP's

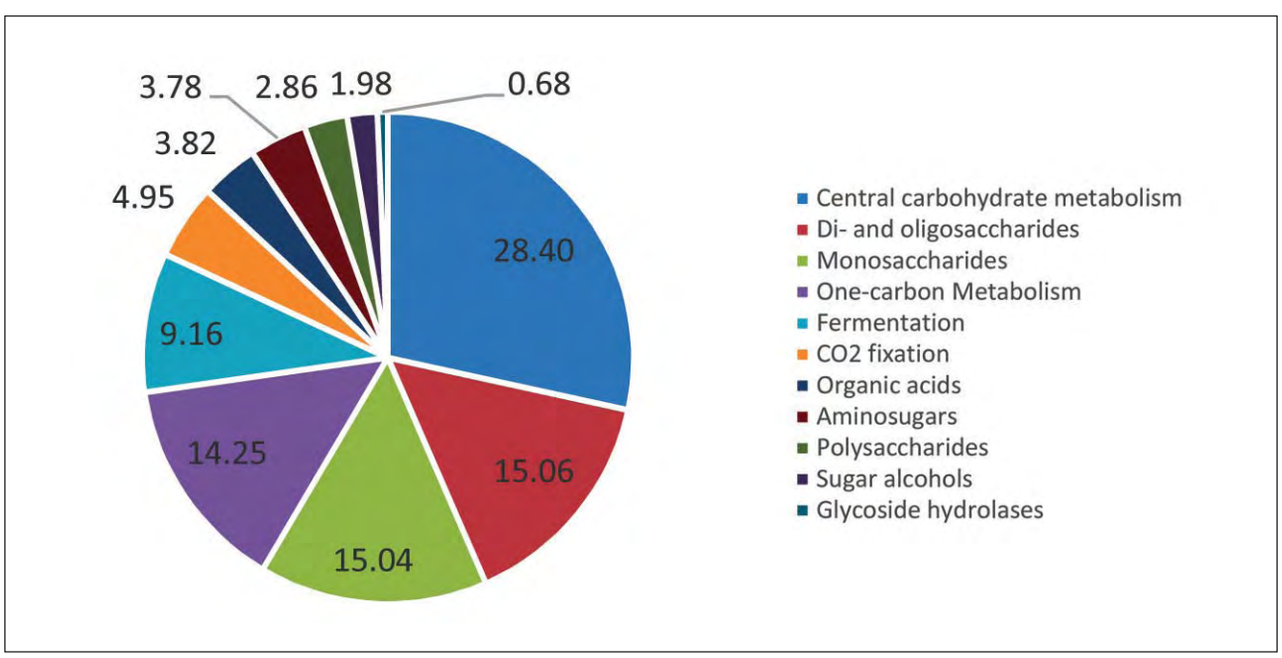


Fig 22. Sub-categories of Carbohydrates of *Krishibro* broilers without AGP Supplementation

Table 39. Percent abundances of top 10 functionalities associated with Carbohydrates functional category

Function (Carbohydrates Category)	% Abundance
Without AGP Group	
Decarboxylase	3.75
Enolase (EC 4.2.1.11)	3.43
Acetaldehyde dehydrogenase (EC 1.2.1.10)	3.31
Methylmalonyl-CoA mutase (EC 5.4.99.2)	3.19
NAD-dependent glyceraldehyde-3-phosphate dehydrogenase (EC 1.2.1.12)	2.89
6-phosphofructokinase (EC 2.7.1.11)	2.78
Pyruvate-flavodoxin oxidoreductase (EC 1.2.7.-)	2.76
Pyruvate,phosphate dikinase (EC 2.7.9.1)	2.75
Beta-hexosaminidase (EC 3.2.1.52)	2.69
UDP-glucose 4-epimerase (EC 5.1.3.2)	2.33
With AGP Group	
Decarboxylase	4.41
Methylmalonyl-CoA mutase (EC 5.4.99.2)	3.87
Enolase (EC 4.2.1.11)	3.70
Pyruvate-flavodoxin oxidoreductase (EC 1.2.7.-)	3.54
Acetaldehyde dehydrogenase (EC 1.2.1.10)	3.16
NAD-dependent glyceraldehyde-3-phosphate dehydrogenase (EC 1.2.1.12)	3.04
6-phosphofructokinase (EC 2.7.1.11)	3.04
Phosphoglycerate kinase (EC 2.7.2.3)	2.84
Pyruvate formate-lyase (EC 2.3.1.54)	2.60
Pyruvate, phosphate dikinase (EC 2.7.9.1)	2.50

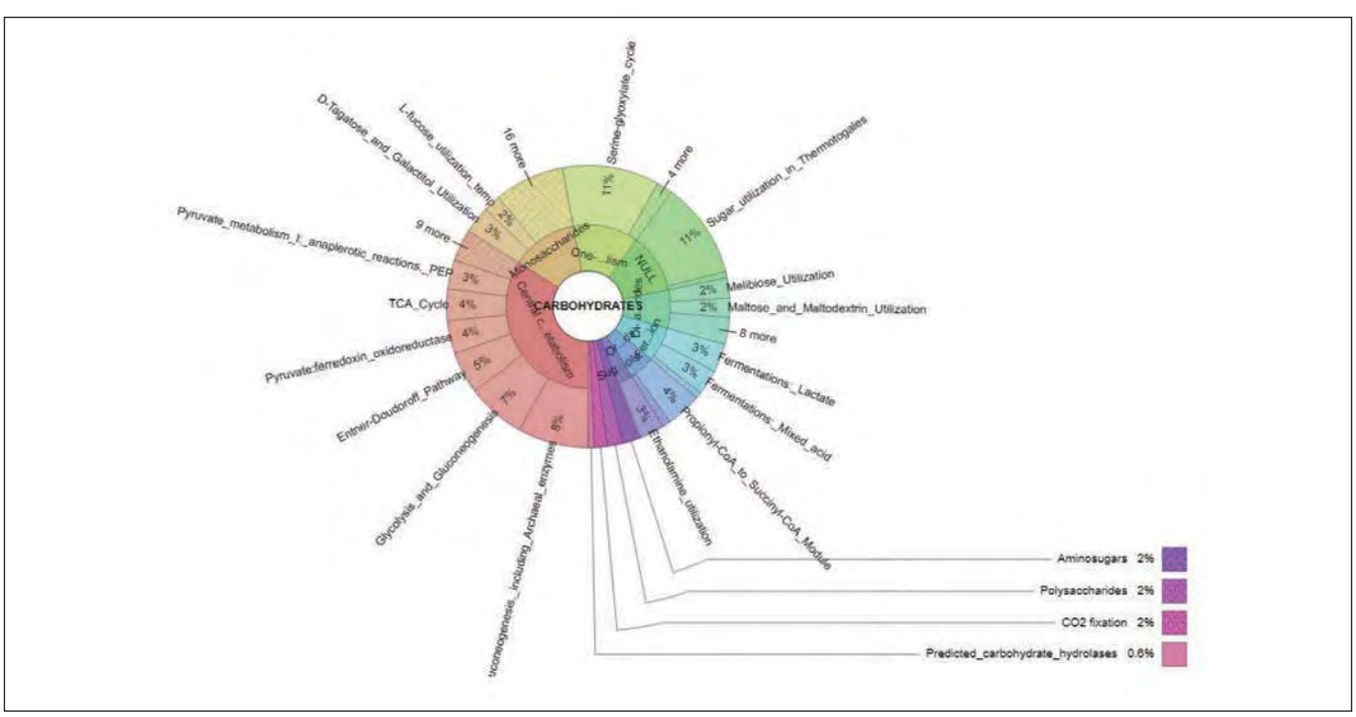


Fig 23. Percent abundance of sub-categories of genes associated with carbohydrates functional category with AGP supplementation

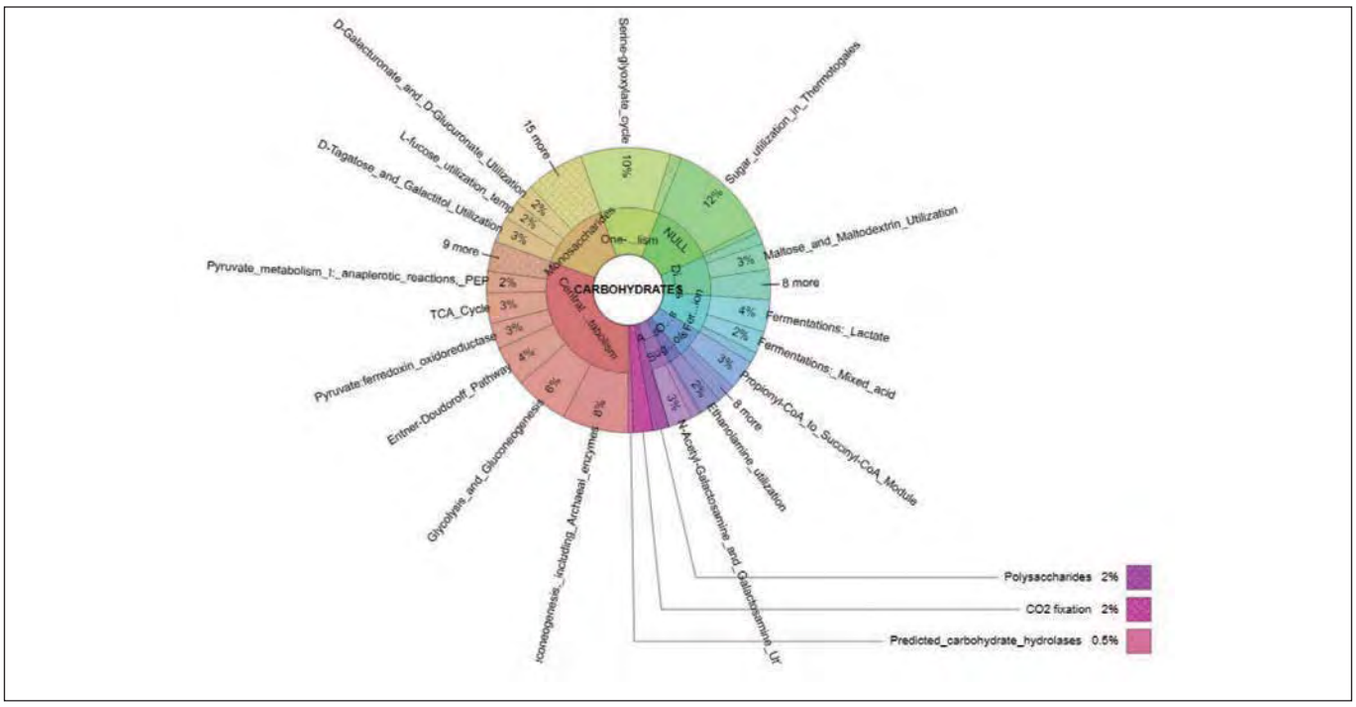


Fig 24. Percent abundance of sub-categories of genes associated with carbohydrates functional category without AGP supplementation.

Extension

Assessment of ICAR-DPR germplasms in the field condition and their impact on food security and livelihood

During the year interview schedule has been finalized to assess, the impact of technology on livelihood and food security. Due to COVID-19 pandemic there was great impact on poultry sector and it was big concern for food security and livelihood for millions of poultry farmers and other stakeholders. Large poultry farmers in India saw a 13% reduction in flock strength whereas small poultry farmers found 49% reduction. There was decrease in net income of 44.8% at small farms, while bigger farms lost up to Rs. 72/kg live weight during early phases of lockdown. The backyard poultry chicken sale price (per kg) was declined from 1.5 to 15.2 %, whereas price of eggs reduced by 44 to 50% in different parts of the country during the lockdown period due to COVID 19 pandemic. The flock size reduced from 3 - 27.2% and the degree impact was dependent on farm size and location. During the lockdown period, 26.9% families left consumption of chicken meat and 20.8% families left eating eggs due to panic of COVID 19, non-availability due to supply chain disruption and restrictions of containment zones. The chicken consumption significantly reduced during the COVID lockdown period from 2.5 kg to 1.9 kg per week per family. There was significant decrease in consumption of chicken by 26.9% and eggs by 28% in families who continued to take chicken and eggs during lockdown period. During the period, 21.1% butchers closed their shops due to low demand, COVID-19 panic and poor supply chain. Limited availability of birds led to increased sale price by 29.9%, but the quantity of sale decreased considerably. Maximum and significant increment of chicken price was observed in rural (49.2%) followed by peri-urban areas (43.5%). The butcher's earnings were significantly reduced by 55.6% affecting the family income.

3 Technologies Assessed and Transferred

Transfer of Technology

Transfer of technology Unit of the Directorate is engaged in propagation of technologies developed at the institute to different stakeholders of poultry and other allied sectors. The propagation of the improved rural chicken varieties across the country is the main objective of the section. The institute popularized the technologies through participation in exhibitions, Kisan melas, farmer's days, etc across the country. The scientists delivered TV talks on various aspects of poultry farming. Brochures, pamphlets, bulletins on different chicken varieties are prepared for distribution to the farmers during different Kisan melas, exhibitions, etc. The details of the activities are as follows.

Germplasm Supply

A total of 2,98,584 improved rural chicken germplasm was distributed to the farmers and other stake holders across the country during 2020. Out of this 20,602 are parents, which are further used for multiplication at different PSP centres and other Govt agencies. In addition, a total of 6,40,999 and 4,19,477 germplasms were supplied from the centres of AICRP and PSP, respectively.

Participation in Exhibitions/Melas

AGRI TECH SOUTH- AGRIVISION exhibition at PJTSAU, Hyderabad

ICAR-DPR participated in CII Agri Tech South-Agrivision exhibition at PJTSAU, Hyderabad on 22-24th February 2020. About 3 thousand stakeholders including farmers, entrepreneurs, students, officials of line departments were visited the stall and showed enthusiasm in knowing the technologies developed by the institute for rural poultry production. Many Extension publications were distributed among them to create more impact of Directorate among stakeholders.

Pusa Krishi Vigyan Mela at IARI, New Delhi

The institute participated in Pusa Krishi Vigyan Mela during 1-3rd March 2020 at IARI, New Delhi. The Directorate stall attracted the attention of about 10 thousand farmers, students, entrepreneurs, technocrats and scientists of different parts of the country. Many dignitaries including Director General (DG) of ICAR, Deputy Director Generals (DDGS) of Extension and Animal Sciences, Secretary, ICAR and other officers of Council had seen our technologies. Literature on different poultry varieties and scientific practices were distributed among stakeholders.

Events Organized

Exhibition on National Science Day

The Directorate organized an exhibition at the premises on 28 March, 2020 on the occasion of National Science Day to create awareness about poultry technologies and practices among common people especially school children. About 400 school children from various local schools visited the exhibition. They were explained about science behind poultry development in the country by the scientists.

Mahila Kisan Divas

Mahila Kisan Divas was organized on 15th October 2020 at the Directorate. Women farmers of many villages actively participated in the

event and they were explained about the advantages of rearing *Vanaraja, Gramapriya* and *Srininidhi* and other improved varieties over desi birds. They were also explained about how rural poultry helps in fetching supplementary income and combats malnutrition in rural areas.

Table 1. Germplasm supplied in 2020

S. No.	Particulars	Number
A. Hatching Eggs		
	Vanaraja	33,130
	Gramapriya	28,889
	Srinidhi	6,091
	Aseel	587
	Ghagus	490
	Kadaknath	6,015
	Krishibro	91
	Layer	80
	Layer Control	840
	Embryonated eggs	2,805
	Total	**79,018**
B. Day Old Chicks		
	Vanaraja	88,509
	Gramapriya	47,692
	Srinidhi	21,004
	Krishibro	14,032
	Aseel	4,096
	Vanashree (PD-4)	3,809
	Ghagus	2,270
	Kadaknath	14,854
	Layer	8
	Total	**1,96,274**
C. Parents		
	Krishibro	830
	Vanaraja	10,472
	Gramapriya	7,739
	Srinidhi	1,561
	Total	**20,602**
D. Grownup birds supplied in TSP, SCSP and at DPR		**2,690**
	Net Total (A+B+C+D)	**2,98,584**
E. AICRP on Poultry Breeding		**6,40,999**
F. Poultry Seed Project		**4,19,477**
	Grand total (DPR+AICRP+PSP)	**13,59,060**

Skill Development / Capacity Building in Poultry production

The Directorate organized an Agriculture Skill Council of India (ASCI), Ministry of Skill Development and Entrepreneurship, Government of India sponsored Training Programme on "Small Poultry Farmer" during 06 January to 04 February 2020. A total of 20 persons from four different states of the country attended the programme. The trainees were exposed to various aspects of poultry production and the training was majorly through hands on experience on setting up brooding facility, vaccination, debeaking, preparation of feed premix, artificial insemination, vermicomposting, and hatchery operations. The participants were also explained about different records to be kept in a poultry farm. The economics and marketing of poultry produce were explained in detail with real life examples. An exposure visit to NRC on Meat, Hyderabad was arranged for imparting knowledge on clean meat production. Dr. R.N. Chatterjee, Director gave away the training certificates to the participants and wished them to become successful entrepreneurs.

Dr. R.N. Chatterjee distributing certificate to trainee

Webinars Organized

National Webinar on Entrepreneurial Opportunities in Rural Poultry was organized during 03-05th November, 2020.

About 561 applicants from 200 districts of 29 States/UTI registered for the webinar. The topics covered were entrepreneurial opportunities in rural poultry and related sectors, and to apprise youth about employment and income generation opportunity. Rural youth, Professionals, Poultry farmers, staff of line departments and faculty members participated in the event.

MGMG Program

Under the Mera Gaon Mera Gaurav programme, five multidisciplinary teams of scientists have adopted 16 villages to carry out the various activities under the programme. Due to pandemic, not much activities were carried out during the reporting period. However, the scientists of each team were in regular contact with the persons of adopted villages and given advisories about the health and feeding management of backyard chicken. Further, two awareness camps (Baoiji Thanda, Balanagar Mondal, Mahabubnar Dist and Goffuranar, Kothur Mondal) were conducted to create awareness in rearing backyard chicken, especially during the nursery phase.

Technical Advisories

Technical advisories were provided to farmers, filed veterinarians from all parts of the country on both intensive and rural/backyard poultry farming in the areas of health care, management and nutrition. In spite of corona pandemic, 323 delegates and poultry farmers visited ICAR -DPR during the current year from different parts of the country. The technology developed by the institute especially the improved chicken varieties like *Vanaraja, Gramapriya, Krishibro, Srinidhi* and native birds like Aseel, Ghagus and Kadaknath attracted the poultry farmers. They were explained scientific poultry management practices.

Development Action Plan for Scheduled Castes (DAPSC)

ICAR-DPR implemented the Development Action Plan for SC (DAPSC) work in Telangana, Bihar and Madhya Pradesh during the year. Under the plan, four on field training programs were organized and 188 farmer families were trained on different aspects of backyard poultry farming. Eight input distribution plans were also organized in Telangana, Bihar and Madhya Pradesh states to start "Backyard Poultry Farming" to improve livelihoods and nutritional security of SC families. Each SC farmer family was provided with 12-20 birds, 12-20 kg feed, night shelter, feeders, drinkers, and some essential medicines as initial inputs to start poultry farming.

A total of 3311 grown up birds, 3000 kg feed, 249 Temporary night shelters, 188 feeders, 188 drinkers, pamphlets on back yard chicken farming and 188 packets of medicine and vitamins were distributed to 339 SC beneficiaries in three states (Telangana, Bihar and Madhya Pradesh) to start backyard poultry farming. The Directorate has also signed an MOU with ICAR-Central Institute for Subtropical Horticulture, Lucknow on 17th November 2020 for augmenting back yard poultry production for sustainable livelihood security and economic development of SC farmers of West Bengal under DAPSC programme.

Training cum Input distribution programme in Patna district, Bihar on 11-02-2020 under DAPSC

The Directorate in collaboration with Poultry Seed Project- Patna centre of Bihar Animal Science University (BASU), Patna organized Training cum input distribution programme on "Backyard Poultry Farming" and distributed inputs to sixty (60) SC beneficiaries to start backyard poultry farming at Chhatana village in Patna District of Bihar under Scheduled Caste Sub Plan (SCSP) on 11th February 2020.

A total of 60 SC farmers mostly women from four villages (Chhatana, Mangalichak, Mahuli and Suitha) were benefitted. These beneficiaries undergone one day off campus training on "Backyard Poultry Rearing" at Chhatana conducted by Dr. S. K. Bhanja, Dr. Vijay Kumar (DRP, Hyderabad) and Dr Pankaj Kumar (PSP, Patna). They also interacted with the beneficiaries and appraised the potential benefits of backyard farming with *Vanaraja* poultry to the farmers. Each beneficiary was provided with 20 chicks, 20kg feed, one feeder, one waterer and a training kit. Dr. R. N. Chatterjee, Director, ICAR-DPR, Hyderabad, Dr. Ravindra Kumar, Director (Research), BASU Patna and Dr. J. K. Prasad, Dean, Bihar Veterinary College, Patna participated in the programme and motivated the farmers to adopt poultry farming as supplementary source of income, source of nutrition security as well as employment.

Input distribution and training program at Patna

Input distribution to SC farmers under DAPSC

Date	Beneficiaries	Inputs distributed
16-01-2020	76 Farmer families from Chinchalpet village, Vikarabad District	76 Temporary night Shelters, Pamphlets on back yard chicken farming
11-02-2020	60 Farmer families from Chatana, Mangalichak, Mahuli and Suitha villages, Patna district Bihar	1200 chicks, 1200 kg feed, 60 feeders, 60 drinkers, 60 training bags, 60 packets of medicine and vitamins, Pamphlets on back yard chicken farming
15-02-2020	35 Farmer families from Shambunipet village, Warangal district	35 Temporary night Shelters, Pamphlets on back yard chicken farming
16-02-2020	30 Farmer families from Satna, Madhya Pradesh	600 chicks, 600kg feed, 30 feeders, 30 drinkers, 30 training bags, 30 packets of medicine and vitamins, Pamphlets on back yard chicken farming
19-02-2020	40 Farmer families from Thimmampet Village, Jangaon district	40 Temporary night Shelters, Pamphlets on back yard chicken farming
30-09-2020	50 SC Farmer families from Kottapalle Mandal, old Adilabad District, Telangana	791 grown up birds, 600 kg feed, 50 poultry feeders, 50 drinkers, 50 packets of medicine and vitamins, and Pamphlets on back yard chicken farming.
23-11-2020	48 SC Farmer families from Kottapalle Mandal, old Adilabad District, Telangana	720 grown up birds, 48 Temporary night Shelters, 600 kg feed, 48 feeders, 48 drinkers and 48 packets of medicine and vitamins and Pamphlets on back yard chicken farming.
23-11-2020	50 SC Farmer families from Kottapalle Mandal, old Adilabad District, Telangana	50 Temporary night shelters, Pamphlets on back yard chicken farming

On-field training programmes organized under DAPSC on "Backyard poultry rearing"

Training location	Trainees	Date
Chatana village in Patna district, Bihar	60 SC farmers from Chatana, Mangalichak, Mahuli and Suitha villages, Patna district, Bihar	11-02-2020
Krishi vigyan Kendra, Satna, Madhya Pradesh	30 SC farmers from Satna Taluk, Madhya Pradesh	16-02-2020
Kottapalle Mandal, old Adilabad District, Telangana	50 SC farmers from Kottapalle Village, old Adilabad District, Telangana	30-09-2020
Kottapalle Mandal, old Adilabad District, Telangana	48 SC farmers from Kottapalle Village, old Adilabad District, Telangana	23-11-2020
A total of 188 SC farmers attended the training programmes		

Scheduled Tribe Component (Tribal Sub Plan)

The Directorate introduced rural/ backyard chicken farming with improved varieties and native chickens, with an aim to improve the economic and living standards of tribal farmers under the Scheduled Tribe Component (formerly Tribal Sub Plan) Program. A mother unit facility was established at ITDA, Utnoor, Telangana to grow the chicks during nursery phase. During January to June, 2020 period, a total of 2520 *Vanaraja* day-old chicks and 5,000 kg chick feed was provided to the mother unit for rearing up to six weeks of age. Grownup birds were distributed by ITDA to the tribal farmers of Adilabad district, Telangana.

Distribution of birds, night shelters and inputs to tribal farmers

The Directorate under Tribal Sub Plan programme introduced rural/ backyard chicken farming in rural and tribal areas with an aim to improve the living standards of tribal farmers during post COVID-19 Unlock period. The input distribution program was organized at Mankapur (Narnoor Mandal) and Birsaipet-Kolamguda (Utnoor Mandal) villages of

Input distribution at Mankapur and Birsaipet-Kolamguda villages

Adilabad District on 29th August, 2020. A total of 100 tribal beneficiaries were provided with grownup birds (*Vanaraja* and Kadaknath), night shelters, feed and poultry equipments. A total of 600 birds, 100 numbers night shelters, 900 kg feed, 60 feeders and 60 waterers were distributed. Wearing masks, maintaining social distancing and SOP of COVID-19 as per Unlock guidance was followed. Benefits of backyard farming system were explained to the tribal farmers. Tribal women provided the feedback and impact on the improved germplasm, distributed one year ago. Scientists/Officers form ICAR, DPR and about 100 tribal farmers were present during the programme. For proper safeguarding of birds during night, night shelters were provided to all the beneficiaries.

Distribution of birds and night shelters to tribal farmers during post-COVID unlock period

ICAR-DPR under Scheduled Tribe Component (STC/TSP) Programme introduced rural/ backyard chicken farming intending to improve the nutritional and socio-economic status of tribal farmers during post-COVID-19 unlock period. The input distribution program was organized at Surpanchguda-Dehgaon (Bazarhathnoor Mandal) village of Adilabad District on 16th December, 2020. A total of 50 tribal families of Surpanchguda-Dehgaon, Bosra, Yapalguda, Jalluguda, Renguda, Madaguda, Gerjam, Rampoor villages were provided with grownup birds (*Vanaraja, Gramapriya* and Ghagus), night shelters, feed and poultry equipment. A total of 434 birds, 50 numbers night shelters, 750 kg feed, 50 feeders and 50 waterers were distributed. Wearing masks, maintaining social distancing and SOP as per unlock guidance was followed. Benefits of backyard chicken rearing were explained to the tribal farmers. Tribal farmers of Utnoor Mandal provided the feedback and impact of improved germplasm, distributed earlier. Dr. U. Rajkumar, Pr. Scientist & Nodal Officer (STC), Dr. L.Leslie Leo Prince, Pr. Scientist, Dr. B. Prakash, Sr. Scientist, Dr. Vijayakumar, Sr. Scientist and Mr. A.V.G.K. Murthy, AO coordinated the programme. About 125 tribal farmers were present during the programme.

Input distribution program at Surpanchguda-Dehgaon village

Genbank Submissions

1. Haunshi,S., Devara,D., Ramasamy,K., Ullengala,R. and Chatterjee,R.N. 2020. Gallus gallus isolate Ghagus G19 microsatellite LEI0258 sequence. Accession No. MT291846.
2. Haunshi,S., Devara,D., Ramasamy,K., Ullengala,R. and Chatterjee,R.N. 2020. Gallus gallus isolate Ghagus G24 microsatellite LEI0258 sequence. Accession No. MT291847.
3. Haunshi,S., Devara,D., Ramasamy,K., Ullengala,R. and Chatterjee,R.N. 2020. Gallus gallus isolate Ghagus G53 microsatellite LEI0258 sequence. Accession No. MT291848.
4. Haunshi,S., Devara,D., Ramasamy,K., Ullengala,R. and Chatterjee,R.N. 2020. Gallus gallus isolate Ghagus G92 microsatellite LEI0258 sequence. Accession No. MT291849.
5. Haunshi,S., Devara,D., Ramasamy,K., Ullengala,R. and Chatterjee,R.N. 2020. Gallus gallus isolate Ghagus G108 microsatellite LEI0258 sequence. Accession No. MT291850.
6. Haunshi,S., Devara,D., Ramasamy,K., Ullengala,R. and Chatterjee,R.N. 2020. Gallus gallus isolate Ghagus G4 microsatellite LEI0258 sequence. Accession No. MT291851.

   Haunshi,S., Devara,D., Ramasamy,K., Ullengala,R. and Chatterjee,R.N. 2020. Gallus gallus isolate Nicobari N10 microsatellite LEI0258 sequence. Accession No. MT291852.
7. Haunshi,S., Devara,D., Ramasamy,K., Ullengala,R. and Chatterjee,R.N. 2020. Gallus gallus isolate Nicobari N22 microsatellite LEI0258 sequence. Accession No. MT291853.
8. Haunshi,S., Devara,D., Ramasamy,K., Ullengala,R. and Chatterjee,R.N. 2020. Gallus gallus isolate Nicobari N28 microsatellite LEI0258 sequence. Accession No. MT291854.
9. Haunshi,S., Devara,D., Ramasamy,K., Ullengala,R. and Chatterjee,R.N. 2020. Gallus gallus isolate Nicobari N37 microsatellite LEI0258 sequence. Accession No. MT291855.
10. Haunshi,S., Devara,D., Ramasamy,K., Ullengala,R. and Chatterjee,R.N. 2020. Gallus gallus isolate N53 microsatellite LEI0258 sequence. Accession No. MT291856.
11. Haunshi,S., Devara,D., Ramasamy,K., Ullengala,R. and Chatterjee,R.N. 2020. Gallus gallus isolate Nicobari N88 microsatellite LEI0258 sequence. Accession No. MT291857.
12. Haunshi,S., Devara,D., Ramasamy,K., Ullengala,R. and Chatterjee,R.N. 2020. Gallus gallus isolate White Leghorn W2 microsatellite LEI0258 sequence. Accession No. MT291858.
13. Haunshi,S., Devara,D., Ramasamy,K., Ullengala,R. and Chatterjee,R.N. 2020. Gallus gallus isolate White Leghorn W3 microsatellite LEI0258 sequence. Accession No. MT291859.
14. Haunshi,S., Devara,D., Ramasamy,K., Ullengala,R. and Chatterjee,R.N. 2020. Gallus gallus isolate White Leghorn W5 microsatellite LEI0258 sequence. Accession No. MT291860.
15. Haunshi,S., Devara,D., Ramasamy,K., Ullengala,R. and Chatterjee,R.N. 2020. Gallus gallus isolate White Leghorn W10 microsatellite LEI0258 sequence. Accession No. MT291861.
16. Haunshi,S., Devara,D., Ramasamy,K., Ullengala,R. and Chatterjee,R.N. 2020. Gallus gallus isolate White Leghorn W38 microsatellite LEI0258 sequence. Accession No. MT291862.
17. Haunshi,S., Devara,D., Ramasamy,K., Ullengala,R. and Chatterjee,R.N. 2020. Gallus gallus isolate White Leghorn W80 microsatellite LEI0258 sequence. Accession No. MT291863.
18. Haunshi,S., Devara,D., Ramasamy,K., Ullengala,R. and Chatterjee,R.N. 2020. Gallus gallus isolate White Leghorn W114 microsatellite LEI0258 sequence. Accession No. MT291864.

4 Trainings and Capacity Building

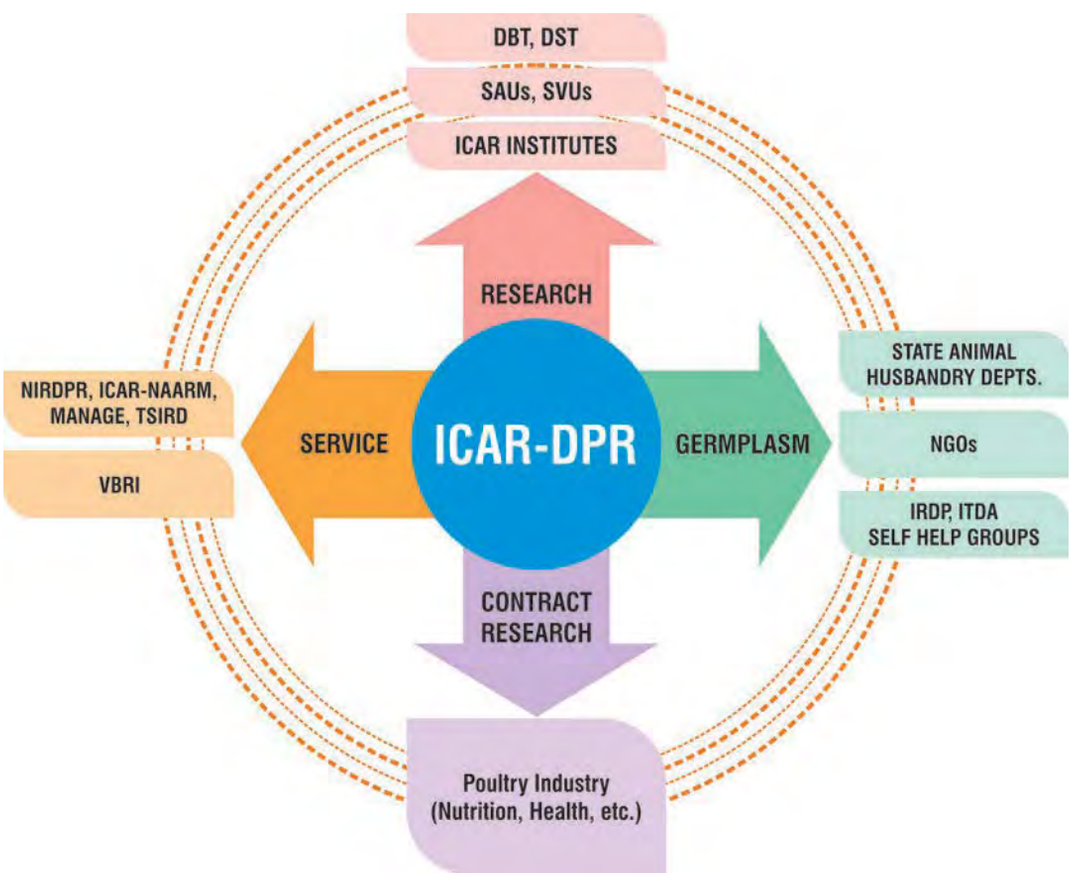
S. No.	Name of the Staff and designation	Title of the Training	Duration	Place of Training
1.	Shri R. Sudarshan Jr. Accounts Officer	Training Programme on Public Procurement	03-02-2020 to 08-02-2020	National Institute of Financial Management, Faridabad
2.	Dr. Santosh Haunshi Principal Scientist	Online training programme on “Stress Management”	07-07-2020 to 10-07-2020	ICAR-NAARM, Hyderabad
3.	Shri P. Santosh Phanikumar Technical Assistant	On-line Training Programme on “Analysis of Experimental Data using R”	05-08-2020 to 11-08-2020	ICAR-NAARM, Hyderabad
4.	Dr. N. Anand Laxmi Principal Scientist	On-line training on “Metabolomics and System Biology”	05-09-2020 to 18-09-2020	Biotecnika Info Labs Pvt.Ltd, Bengaluru.
5.	Dr. Suchitra Sena Principal Scientist	Training on Quality Management System in AMR laboratories for INFAAR	14-09-2020	FAO, India
6.	Dr. N. Anand Laxmi Principal Scientist	On-line training programme on “Climate change: Challenges and response for Women Scientists”	05-10-2020 to 09-10-2020	Lal Bahadur Shastri National Academy of Administration, Mussorie
7.	Dr. N. Anand Laxmi Principal Scientist	On-line training on Bioinformatics Methods and Tools Master-Self learning Course	05-12-2020 to 18-12-2020	Biotecnika Info Labs Pvt. Ltd, Bengaluru
8.	Dr. L.L.L. Prince Principal Scientist	On-line National Seminar on “Big data Analytics”	10-12-2020 to 11-12-2020	ICAR-NAARM, Hyderabad
9.	Dr. S. Jayakumar Senior Scientist	On line National Seminar on “Big data Analytics”	10-12-2020 to 11-12-2020	ICAR-NAARM, Hyderabad

5 Awards

- Dr. T. K. Bhattacharya, National Fellow received Dr. D.S. Balian Memorial Award-2019 of Society for Conservation of Domestic Animal Biodiversity (SOCDAB) in the year 2020.
- Dr. N. Anand Laxmi, Principal Scientist received 'Reviewer Excellence Award' from Indian Journal of Animal Research (ARCC Journals).

6 Linkages and Collaboration

The state-of-the-art infrastructure facilities available at the Directorate make it the premier institute in the country for carrying out advanced research in various branches of poultry science. The institute extended these facilities to the PG and PhD students of institutions like Indian Veterinary Research Institute, PVNR Telangana Veterinary University, Sri Venkateswara Veterinary University, PJTSAU etc. for carrying out their thesis research work. The Scientists of the Directorate guided the research work of the students as Co-chairmen/members of their Advisory Committee. Further, the library and information facilities were utilized by the faculty and students of the neighbouring Veterinary College. Several trainees/ students from sister Institutes like PVNRTVU, PJTSAU, NAARM, MANAGE, NIRDPR, TSIRD etc. visited the Directorate to have an exposure to practical aspects of poultry farming. The Directorate is in network mode having research and extension linkages with various SAUs, SVUs and ICAR institutions across the country. A DBT funded research project was underway during the period of report in collaboration with NIAB, Hyderabad and other institutions. Besides the two network research programmes (AICRP and PSP), the Directorate is actively working with various stake holders of rural and commercial poultry farming fraternity like NDDB and Animal Husbandry departments of Telangana, Andhra Pradesh, Madhya Pradesh etc.



7

Regional Station, Bhubaneswar

Research Achievements

Genetics and Breeding

Genetic up-breeding of duck production to strengthen livelihood security in NER of India by converging conventional and molecular techniques (DBT project No.BT/PR24311/NER/95/645/2017)

The indigenous (Kuzi) ducks of Odisha, hatched in S1 generation, were brooded and kept for growing after selection at high 8-week body weight. At the age of 20th week, a total of 80 males and 462 females were kept for egg production and supply of ducklings. At 20 weeks of age, 20 male ducks were sacrificed for carcass quality study. Egg quality was measured at 20, 28, 32, 36 and 40 weeks of age on 30 eggs for each period. Juvenile data were analysed for genetic parameters and mortality, if any was recorded daily. At 32 weeks of age, the birds were kept/transferred to the breeding pen (40 Nos. per breeding pen) for the production of S-2 generation of ducklings using 40 sires and 200 dams. The sires (drakes) after selection for high 8 weeks body weight were tested for the semen producing ability before releasing in the breeding pen. Hatching eggs were collected sire wise and the ducklings hatched in 40 sire family in three hatches were kept for brooding. The fertility and hatchability were poor, so number of hatches was increased. Along with S-2 generation, two crosses Kuzi (D) X Khaki Campbell (K) and Khaki Campbell (K) X Kuzi (D) ducklings were hatched, reared and the juvenile data were recorded.

The body weights recorded at 40 weeks of age in male and female birds were 1671±32 and 1592±11 g, respectively. Corresponding body weights at 52 weeks of age were 1793±41 and 1518±7 g. Heritability estimates for juvenile body weight were high in magnitude and for conformation traits, they were moderate to high in magnitude (Table 1). Genetic correlations between different juvenile traits were positive and moderate to high in magnitude. The rate of inbreeding in S-1 generation was 0.0039. More than 100 g weight increase in body weight at 8 weeks of age was recorded in S-1 generation compared to S-0 generation. Growing period body weight varied in different hatches and at 20 weeks of age, both male and female birds were below 2 kg body weight (Table 2). Carcass quality traits measured at 20 weeks of age in male ducks (Table 3) revealed that eviscerated carcass was 69.36% of

Table 1. LSMs for body weights and heritability estimates (Half sib) in Kuzi ducks

Traits		Mean±SE (1718 Nos.)	Heritability
Body weight (g)			
	Day old	37.31±0.005	0.81±0.16
	2 wks	233.53±0.08	0.34±0.08
	4 wks	673.33±0.10	0.42±0.10
	6 wks	1003±1.01	0.68±0.14
	8 wks	1281±1.21 (1130 g S0 Gen)	0.55±0.13
Conformation traits at 8 wks			
Shank length (mm)		64.44±0.009	0.14±0.05
Keel length (mm)		117.98±0.01	0.27±0.07
Bill length (mm)		61.51±0.006	0.41±0.10

live weight. Meat bone ratio of breast (3.5:1) was better than leg (2.6:1) at 20 weeks of age in male Kuzi ducks (n=20). Results of egg quality traits measured at different ages indicate that the egg quality was good at different ages (Table 4). The egg weights of ducks were above 60 g as recorded at different weeks of age. The average egg production of three hatches up to 40 weeks of age was 110.79 numbers. Egg production recorded up to 60 weeks was 182 numbers. Mortality up to 8 weeks of age was 7.13% and there after the mortality was less. Plumage colour, shank colour and bill colours are presented in Figures 1, 2 and 3. Eye colour was dark in 93.94% and yellow in 6.06% of ducks. Body carriage of the Kuzi ducks is slightly upright.

Table 2. Body weight of Kuzi ducks during growing period (S-1 gen.)

Body weight (g)	Male	Female
12 wks	1666±15 (193)	1492±10 (467)
16 wks	1760±17 (193)	1566±8 (467)
20 wks	1818±18 (193)	1628±9 (467)

Figures in parenthesis indicate number of observations

Table 3. Carcass quality of Kuzi drakes at 20 weeks (S-1 gen.) (N=20)

Parameters	Weight (g)	Proportion of live weight (%)
Live weight	1591±37	
Live weight just before slaughtering	1540±31	
Weight after bleeding	1458.5±31	
Blood		5.36±0.49
Weight after defeathering	1364.3±33	
Feathers		6.19±0.58
Head	84.9±1.83	
Shanks+feet	41.4±1.22	
Eviscerated carcass	1070.4±27.69	69.36±0.57
Heart	11.6±0.34	0.75±0.02
Liver	25.2±0.97	1.63±0.05
Gizzard	42.3±1.65	2.74±0.09
Testis	30.55±2.74	1.99±0.18
Total edible part		76.48±0.60

Cut-up parts	Weight (g)	% of eviscerated carcass weight
Leg	186.1±5.54	17.45±0.44
Breast	266.0±9.92	24.78±0.44
Wing	143.2±5.35	13.39±0.37
Neck	127.5±4.03	11.95±0.32
Back	348.0±12.97	32.40±0.54
Breast meat	162.1±4.52	15.19±0.32
Breast bone	48.6±2.73	4.55±0.22
Breast skin	48.3±3.33	4.44±0.21
Leg meat	106.0±3.96	9.98±0.39
Leg bone	40.6±1.22	3.82±0.12
Leg skin	37.7±2.45	3.49±0.19

Table 4. Egg quality traits in Kuzi ducks (S-1 gen.)

Age (n=30)

Parameters	20 wks	28 wks	32 wks	36 wks	40 wks
Egg wt. (g)	64.40±0.58	67.13±0.61	66.07±0.99	67.61±0.97	68.19±0.73
Shape index	75.14±0.58	74.14±0.63	72.93±0.69	74.43±0.59	74.26±0.50
Albumen index	0.17±0.003	0.17±0.004	0.15±0.005	0.16±0.003	0.15±0.005
Yolk index	0.45±0.004	0.45±0.006	0.43±0.007	0.44±0.005	0.45±0.006
Yolk colour	2.24±0.11	2.86±0.16	2.83±0.16	2.43±0.09	1.60±0.11
Albumen %	60.31±0.99	60.88±0.37	60.66±0.54	60.59±0.43	60.73±0.43
Yolk %	29.22±0.93	28.79±0.34	29.03±0.51	29.34±0.36	29.15±0.25
Shell %	10.47±0.13	10.33±0.09	10.32±0.13	10.08±0.12	10.13±0.24
Shell thickness (mm)	0.34±0.007	0.38±0.005	0.35±0.005	0.39±0.001	0.38±0.004
Haugh unit	97.10±0.75	99.16±0.51	95.74±1.14	96.79±0.46	94.05±1.51
Meat spot %	0	0	0	0	0
Blood spot %	0	0	0	0	6.66

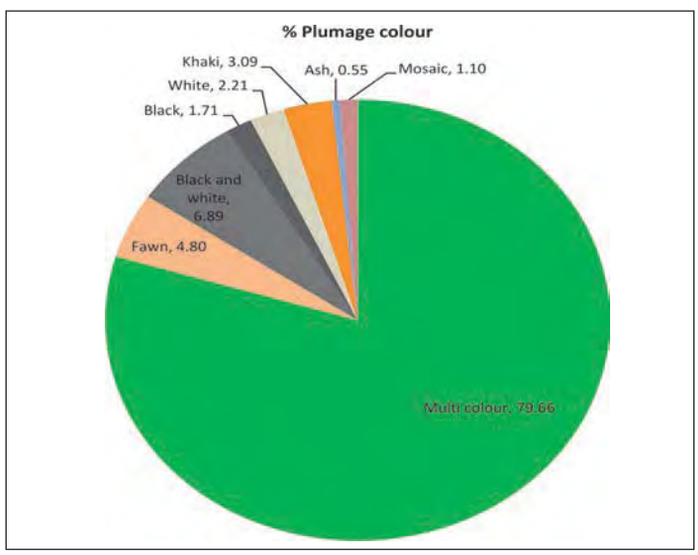


Fig 1. Plumage colour % of Kuzi ducks (S1 gen.)

Fig 2. Shank colour (%) of Kuzi ducks
(Light pink: 68.63, brown:21.28, black:5.73, orange:1.38, yellow: 1.10, slate grey: 0.72, black+pink:0.72 and spotted:0.44)

Fig 3. Bill colour (%) of Kuzi ducks
(brown: 42.28, pink to white 37.65, black:10.31, spotted: 7.61, slate grey:0.77, black+brown:0.55, black+pink:0.33)

Farm based S&T Interventions for Socio-economic Development in the Aspirational District of Nabarangpur, Odisha (RKVY PROJECT No. OR/RKVY-AMEC/2019/892) (September, 2019 to March, 2021)

This is a multidimensional S&T initiative of Govt. of Odisha in partnership with national R&D agencies under RKVY. The project is an effort by various R&D institutions from national agencies like CSIR, ICAR, ICMR, DBT located in and outside Odisha to leverage technological innovation to meet specific requirements based on local resources and needs in Nabarangpur district of Odisha. During the period, data were collected from different farmers' field and one training programme was imparted on backyard duck farming (Table 5) and ducklings were distributed to 51 farmers of Papadahandi and Nabarangpur block (Table 6). The works done during the year 2020 are summarized below.

Table 5. Trainings organised under the project

Date	Venue	Topic	No of farmers attended
21st January, 2020	On field visit and demonstration at Kosagumuda	Backyard duck	12
22nd January, 2020	Papadahandi	Backyard duck farming	74
23rd January, 2020	On field visit and demonstration at Umerkote (Kursi)	Backyard chicken	21

Table 6. Performance of ducks and chicken (*Vanaraja*) provided to the farmers in the field

Parameters	Kosagumuda	Papadahandi and Nabarangpur	Umerkote (Kursi village): *Vanaraja*
Date of supply27-11-2019	05-02-2020	27-11-2019	
No of beneficiaries	50	51	50
Category of farmers	Different category	Different category	All ST
No of ducklings/farmer	24	20	-
No of chicks/farmer	-	-	20
Body wt. 4 wks (g)	423±8 (295)	370±7 (850)	244±2 (809)
Body wt. 8 wks (g)	1132±10 (199)	920±10 (800)	976±6 (722)
No of units data collected at 4 wks (Data collected from total no of farmers taking one farmer as one unit)	28	51	49
No of units data collected at 8 wks (Data collected from total no of farmers taking one farmer as one unit)	20	43	46
Start of laying (wks)	20-25	20-24	20-22
Body wt. (kg) range at 24 wks			
Males	1.5 to 2.0	1.5 to 2.0	2.5 to 3.00
Females	1.4 to 1.8	1.4 to 1.8	1.6 to 2.8
Adult body wt. (kg)			
Males	1.5 to 2.0	1.5 to 2.0	4.0 to 5.0
Females	1.4 to 1.8	1.4 to 1.8	3.0 to 3.5

Table 7. Income and impact of backyard poultry (in respect to livelihood and nutritional security)

Parameters	Kosagumuda	Papadahandi	Nabarangpur	Umerkote Kursi
Type of farming	Backyard duck	Backyard duck	Backyard duck	Backyard chicken
Eggs produced in some units up to 6 months (Nos.)	30 to 300	0 to 30	0 to 30	15 to 200
Eggs used for	Own consumption and hatching of ducklings	Own consumption and hatching of ducklings	Own consumption	Mostly own consumption and hatching of chicks
Birds used for own consumption in unit (0-4)	0-1	0-1	0-2	0 to 4
Taste of egg and meat	Good to very good	Good to very good	Good to very good	Excellent to good
Birds sale price (Rs.)	500 / piece	500 / piece	500 / piece	250 to 350 / kg
Investment by farmers if any (Rs)	0	0	0	0 to 1000
Net Profit per unit* (Rs.) where birds survived	2500 to 6400	2000 to 6000	1000 to 2000	1750 to 12000
Income used for	Mostly not sold those sold are used for grocery	Birds not sold	Birds not sold	House hold expenditure, purchase of seed, medicine, repayment of loan etc.

* Assumed sale price if sold all live birds in one go (taking in to consideration of own consumption, mortality) Sale price (Rs): Chicken-@250 /Kg, Duck-500/duck, Duck eggs sold at @ 10 per egg, Chicken eggs sold at @ 7 per egg

Some observations from the project activities

Backyard chicken **(Table 7)**

- People were happy with the growth performance of the birds as they grew much faster compared to the indigenous chicken.
- Plumage colour of the birds was well accepted by the farmers.
- Vaccination for different diseases was required.
- The farmers sold the birds at the age of 18 to 20 weeks of age when the average body weight of birds was more than 2 kg.
- The birds started laying at 20 weeks of age in some farmers' field.
- The farmers sold the birds at the rate of Rs. 700/- to Rs. 750/- per bird.
- Taking in to consideration of input cost of Rs. 150/- per bird up to 18 weeks of age, one could earn Rs. 550 to Rs. 650/- per bird.
- From a unit of 20 birds, if at least 10 birds were surviving, then one could earn net profit of Rs. 5500/- to Rs. 6500/- in 5 months.
- They used the birds for own consumption, which could improve their nutritional status.
- The consumption of chicken and egg by the beneficiary indicates to fulfill some nutritional security in respect to protein.

Backyard duck **(Table 7)**

- Introduced Khaki Campbell first time in Nabarangpur district for duck production in the district both for egg and meat purpose.
- The growth performance of the ducklings was better than the chicken during juvenile phase.
- Except for brooding problems and mortality during brooding, the performance of the surviving ducklings was very encouraging.

- Ducks started laying at 20 to 22 weeks of age and the egg size was better than the chicken.
- Farmers were happy with the birds and few farmers were using the eggs for hatching of ducklings.
- The eggs were sold @ Rs. 6/- to Rs. 10/- per egg and the extra males were sold @ Rs. 300 to Rs. 500/- depending upon the size of the ducks.
- The farmers were happy with the scavenging behavior of the ducks and their growth.

It is observed that in a farmer's field, if all the ducklings survived and taking in to consideration of 50% males one could earn approximately Rs. 2000 to 4000 in 5 months period from sale of male ducks and the females for egg production.

Training at Papadahandi

Field visit Kosagumuda on 21-1-2020

Field visit on 23-1-2020 to Kursi

Inputs distribution to the farmers at Papadahandi

Nutrition

Nutrient requirement of White Pekin ducks

In order to determine the ideal level of metabolizable energy (ME) required for white Pekin ducks during 0-6 weeks, an experiment was planned with three levels of energy viz. 2700, 2900 and 3100 kcal of ME/kg diet.

For this study, a total of 216 Nos. day old ducklings were divided into three experimental groups with six replicates of 12 ducklings each. Three iso-nitrogenous diets were formulated with 2700, 2900 and 3100 kcal ME/ kg. Daily feed intake and weekly body weights were recorded up to 6th week of age. One digestion trial was conducted at the end of 6th week.

The result of the experiment indicated that similar growth rate was observed in three treatment groups without any significant differences among the groups (Fig 3).

The feed intake was significantly ($p<0.05$) lower in ME-2900 group than ME-2700 group at the end of 6 weeks. However, the difference was not significant than ME-3100 group. The FCR at the end of 3rd week was almost similar without any significant differences among the groups. But at 6th weeks of age, significantly lower FCR was observed in ME-2900 group than ME-2700 and ME-3100 groups (Table 8).

Blood samples were collected from the ducks at 6th week of age to study various parameters like total protein, albumin, urea, creatinine, calcium, phosphorus, total cholesterol and triglyceride levels in serum. No significant differences among the groups were observed.

At the end of 6th week, six ducks from each group were sacrificed to study the carcass characteristics. No significant differences among the groups were observed with respect to blood, feathers, head, offal, giblet and eviscerated weight percentage. Similarly, when the cut-up parts were expressed as percentage of eviscerated weight, no significant differences among the groups were observed in leg, neck, breast and wing percentages. The eviscerated weight as percentage of live weight was 68.47±0.93, 66.32±0.32 and 67.99±0.83 in ME-2700, ME-2900 and ME-3100 -groups, respectively. From the experiment it was concluded that the diet containing 2900 kcal ME per kg was optimum for growth of White Pekin ducks during starter period (0-6 weeks).

Table 8. Body weight gain, feed intake and FCR in different treatment groups

Particulars	3rd week			6th week		
	Body wt. gain (g)	Feed intake (g)	FCR	Body wt. gain (g)	Feed intake (g)	FCR
ME-2700	645.3±23.8^{a}	1465±19.5	2.26±0.07	2041±18.3	6229±65.9^{a}	3.05±0.13^{a}
ME-2900	605.8±24.7^{a}	1300±20.9	2.16±0.09	1983±19.6	5299±75.9^{b}	2.67±0.05^{b}
ME-3100	535.9±21.1^{b}	1276±17.5	2.38±0.04	1946±17.5	5879±41.1^{ab}	3.02±0.08^{a}

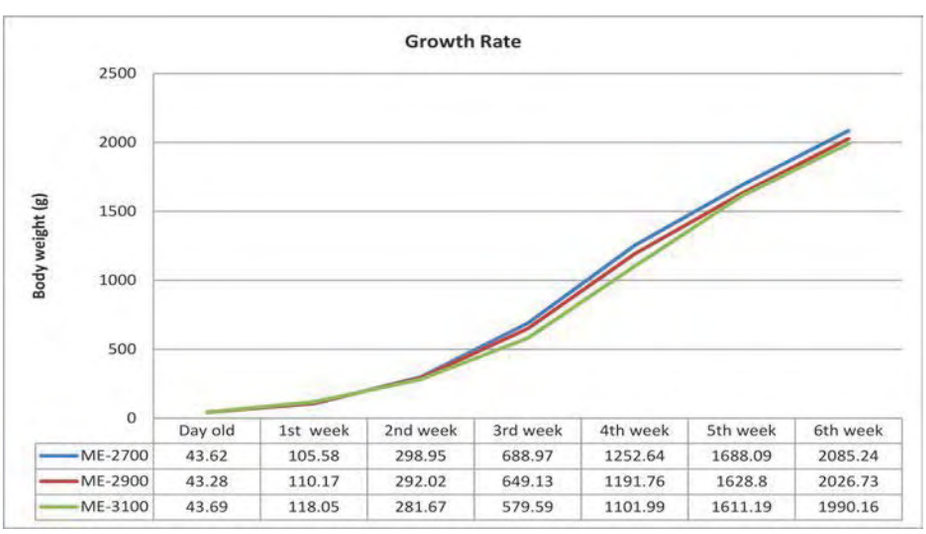


Fig 3. Growth rates of ducks in different treatment groups.

Evaluation of broken rice or tuber crops based feed mixture supplement in White Pekin ducks in semi-intensive rearing system

Effect of feeding graded levels of broken rice on nutrients metabolisability in White Pekin ducks during second year of laying

A study was conducted to find out the effect of feeding graded levels of broken rice replacing wheat on various nutrient metabolisability in White Pekin ducks during second year of laying. White pekin ducks (Nos. 75) in second year of laying (82 weeks) were divided into five groups with three replicates in each group and each replicate had five ducks. Five experimental diets without broken rice (BR-0) and with BR replacing 25 (BR-25), 50 (BR-50), 75 (BR-75) and 100 (BR-100) percent of wheat were prepared. The above diets were offered randomly to the above groups, as per the suggested practical levels of nutrient requirements for a period of 73 days. The ducks were reared on deep litter and fed the respective diets *ad lib.* during the experimental period following standard management practices and availability of clean drinking water. At the end of the feeding trial, a metabolism trial of 4-d collection period was conducted by keeping the birds in individual cages. All the diets were iso-nitrogenous (18.33-18.37% CP) and iso-caloric (2614-2661, ME, kcal/kg). There was significant ($P<0.05$) difference in DM and OM metabolisability among the groups; being highest in BR-75 (78.87 and 79.59) and lowest in BR-25 (76.17 and 76.54); however the values of all the treatment groups (76.17-78.87 and 79.59-76.54) were similar to the control (76.36 and 76.45). There was no difference ($P>0.05$) in the metabolisability of CP (67.40-70.09) among the groups. The metabolisability of EE was higher ($P<0.05$) in BR-75 (79.41) than the other groups (75.22-79.41), which are similar. The CF metabolisability (59.57-62.05) was similar among the groups. There was no difference ($P>0.05$) in the nitrogen balance (g/d) i.e. nitrogen intake (5.56-6.25, g/d); nitrogen outgo (1.74-1.87, g/d); nitrogen balance (3.76-4.38, g/d); among the groups. The nitrogen balance as percentage of nitrogen intake (67.40-70.09) was also similar among the groups. It is concluded that wheat can be completely replaced by broken rice in the diets of White Pekin ducks during second year of laying without affecting the metabolisability of various nutrients.

Effect of replacing fish meal by soybean meal on the performance of Khaki Campbell laying ducks

A study was conducted to find out the effect of replacing fish meal by soybean meal on the performance of Khaki Campbell (KC) laying ducks. Khaki Campbell laying ducks (Nos. 72) of 35 weeks were divided into three groups with three replicates in each group and each replicate had 8 KC laying ducks. Three experimental diets with fish meal (Control, T_1), without fish meal (replacing fish meal completely by Soybean meal) (T_2) and T_2+addition of Lysine and Methionine 50 % more than control diet (T_3) were prepared. The diets were offered randomly to the experimental groups for a period of 97 days. During the experiment, the ducks were kept on deep litter system using rice husk as the litter material and fed the respective diets *ad lib.* Standard management practices were followed during the entire experimental period. The ducks had access to clean drinking water all the times. Results indicated that ducks fed the control diet with fish meal (T_1) produced significantly ($P<0.05$) higher number of eggs (5.58 dozens) compared to T_2 (without fish meal) (3.77 dozen) and T_3 (3.39 dozen). Feed intake decreased significantly ($P<0.05$) when fish meal was replaced by soybean meal with or without addition of extra amino acids i.e. lysine and methionine. KC laying ducks fed diets with fish meal (T_1) had significantly ($P<0.05$) better FCR compared to T_2 and T_3 groups. It is concluded that replacement of fish meal by soybean meal adversely affected egg production, feed intake and FCR in Khaki Campbell laying ducks.

Duck rearing management practices in farm condition for optimum productivity under changing climatic condition

Floor space requirement of ducks (Khaki Campbell) during brooding period (0 to 2 weeks of age)

A total of 1042 day old Khaki Campbell (KC) ducklings were randomly divided into five (05) groups and reared separately in one duck house with different floor space provisions i.e. 250 (Gr 1), 275 (Gr 2), 300 (Gr 3), 325 (Gr 4) and 350 (Gr 5) sq. cm per duckling (Table 9). Standard management practices were followed for brooding of ducklings with rice husk as litter material and required number of electric bulbs for maintaining the inside temperature of brooding chamber. Soaked (*ad lib*) duck mash (CP: 20% and ME: 2900 kcal/g) and sufficient

clean drinking water was offered during the brooding period. Precautions were taken for optimum hygiene and sanitation during the experiment period. Growth (body wt), mortality rate and feed consumption were recorded to study the effect of floor space provision on performance of birds.

It was observed that ducklings brooded with more floor space provision comparatively consumed more feed. Accordingly, body weight at 2 weeks of age was significantly ($p< 0.05$) higher for the group provided with maximum space. Again, mortality rate up to 2 weeks of age was the highest (33.19%) with the group maintained at lowest 250 sq. cm/duckling) floor space provision.

Thus, it is recommended to provide 350 sq cm floor space per duckling (KC) during brooding period (0-2 weeks) for optimum growth and least mortality.

Floor space requirement of ducks (Khaki Campbell) after brooding period (3 to 5 weeks of age)

A total of 840 number of 2 weeks old Khaki Campbell (KC) growing ducklings were randomly divided into five groups and reared separately in a duck house with different floor space provisions i.e. 400 (Gr 1), 425 (Gr 2), 450 (Gr 3), 575 (Gr 4) and 500 (Gr 5) sq. cm per duckling (Table 10). Standard management practices, soaked (ad lib) duck mash (CP: 20% and ME: 2900 kcal/kg) and sufficient clean drinking water were provided. Body weight, mortality rate and feed consumption were recorded to study the effect of floor space provision on performance of growing birds.

Brooding of ducklings under experiment

The body weight of growing ducks was significantly ($p<0.05$) higher in group 4 (475 sq cm/duck) by 3rd and 4th week of age. However, the 5th week body weight of ducks was highest in group 5 (500 sq cm/bird) which did not differ significantly from other groups. Feed intake was the highest in group 5 during 3-5th week and mortality was minimal for all the groups during the experimental period. Thus, at-least 475 sq. cm floor space per growing KC duck was recommended during 3-5 weeks of age under intensive management practice for over-all performance.

Table 9. Growth performance of ducklings maintained under various floor space allowances

Age	Body weight of birds under different experimental Groups				
	1 (250 sq cm) n=247	2 (275 sq cm) n=224	3 (300 sq cm) n=205	4 (325 sq cm) n=190	5 (350 sq cm) n=176
0 day	36.87±0.47	37.37±0.48	36.08±0.43	36.52±0.40	37.93±0.45
1st week	67.27±1.35^{b}	69.33±1.37^{ab}	72.77±1.59^{a}	67.43±1.52^{b}	70.20±1.98^{ab}
2nd week	142.9±5.82^{b}	155.7±4.10 ^{b}	151.1±4.85 ^{b}	153.8±5.45 ^{b}	170.8±5.93^{a}

Values having dissimilar superscripts differ significantly ($p<0.05$)

Table 10. Growth performance of growing ducklings (3-5 weeks) maintained under different floor space

Age	Body weight of birds in different experimental Groups				
	1 (400 sq cm) n=188	2 (425 sq cm) n=177	3 (450 sq cm) n=167	4 (475 sq cm) n=158	5 (500 sq cm) n=150
3 wks	289.1±10.4^{b}	286.1±7.9^{b}	281.5±12.6^{b}	328.6±10.8^{a}	309.2±10.3^{ab}
4 wks	374.5±16.7 ^{c}	391.5±12.3 ^{c}	396.7±15.3^{bc}	439.8±14.4^{a}	436.1±14.1^{ab}
5 wks	593.9±18.5	628.5±18.6	610.8±16.8	611.1±14.8	632.1±18.1

Values having dissimilar superscripts differ significantly ($p<0.05$)

Health

Arsenic toxicity and its amelioration with some herbs in ducks

A study was conducted to investigate the effect of ginger root powder in arsenic induced sub-chronic toxicity on body weight, haematological, biochemical and oxidative parameters along with gross and histopathological changes in grower White Pekin ducks. Eight weeks old ducks were selected for sub-chronic arsenic toxicity in ducks. 90 grower ducks were divided into 5 groups. Each group had 3 replicates containing 6 grower ducks in each replicate. Group I (control) was given arsenic free water and Group II was administered Sodium Arsenite (30 ppm arsenic) and Group III, Group IV & Group V were given Arsenic @ 30 ppm in water along with ginger @ 250 mg, 500 mg and 1 g per kg of feed respectively. Administration of arsenic over a period of 90 days has caused certain changes in the arsenic treated birds at 30 ppm, which included decreased food intake and body weight, depression and dullness, watery diarrhoea, pale comb, discoloration of beak, excessive scaling of the legs, ruffled feathers, which were very significant. The above signs were also observed in all the ginger treated groups, except in birds with supplementation of 1g ginger /kg of feed, where symptoms were in milder form.

There was significant reduction in mean body, absolute and relative organ weights with 30 ppm arsenic and with supplementation of 1g ginger / kg of feed, there was significant increase in mean body, relative and absolute organ weights. Macrocytic hypochromic anaemia was evident indicating adverse effects of arsenic at 30 ppm on mean levels of Hb, PCV, TEC, TLC and these effects were partially ameliorated with supplementation of 1 g ginger /kg of feed. There was significant increase in levels of ALT, AST, ALP, creatinine and uric acid indicating liver and kidney dysfunction with 30 ppm arsenic whereas with supplementation of 1 g ginger/kg of feed these effects were ameliorated significantly. The increase in levels of LPO, superoxide level and marked reduction in levels of reduced glutathione in various tissues like liver, kidney and spleen indicate the oxidative stress induced with arsenic 30ppm and with supplementation of 0.5 g & 1 g ginger/kg of feed the levels were reversed oxidative changes significantly. Grossly pale, reticulated and congested kidneys, pale and slightly enlarged liver, enlarged in 30ppm arsenic. Histopathologically, kidneys showed tubular epithelial degeneration and necrosis with interstitial congestion, increased Bowman's space and atrophy of glomerulus while, liver exhibited vacuolar degeneration and necrosis of hepatocytes with marked congestion and perivascular infiltration of inflammatory cells, with depletion of lymphocytes in spleenic pulp in 30 ppm arsenic treated birds whereas, the pathological lesions were partially ameliorated with 1 g ginger /kg of feed. Thus, it can be concluded that ginger @1 g/Kg of feed can work as adjunct therapy during chronic arsenic toxicity.

In the second trial, effect of garlic powder was observed in arsenic induced sub-chronic toxicity on body weight, haematological, biochemical and oxidative parameters along with gross and histopathological changes in grower White Pekin ducks. Eight weeks old ducks were selected for sub-chronic arsenic toxicity in ducks. Ninety grower ducks were divided into 5 groups. Each group had 3 replicates containing 6 grower ducks in each replicate. Group I (control) was given arsenic free water and Group II was administered Sodium Arsenite (30 ppm arsenic) and Group III, Group IV & Group V were given Arsenic @ 30 ppm in water along with ginger @ 0.5 g, 1 g and 2 g per kg of feed respectively. Trial was completed and samples were collected and processed. Data is under process for statistical analysis.

Surveillance and monitoring of duck diseases and their biosecurity measures

Total number of birds reared were 3623 birds/ month out of that 830 White Pekin / Month, 1596 Khaki Campbell / month, 1068 desi/ month and Muscovy 129/ month were reared. A total of 780 ducks were reported to be died during the period. The average mortality of duck revealed to be approx. 1.76%. Month wise highest mortality was in December, 2020 (163, 4.39%) and minimum mortality was observed in January, 2020 (9, 0.18%). The main cause of mortality was septicaemia (228, 29.23%), followed by hepatitis

(204, 26.15%), omphalitis (91, 11.67%), inanition (62, 7.95%), gout (48, 6.15%), egg bound (30, 3.85%), Aspergillosis (14, 1.79%), egg peritonitis (5, 0.64%), ascitis (5, 0.64%), nephritis (4, 0.51%), cannibalism (4, 0.51%) and drowning (4, 0.51%). Age wise highest mortality was found in adults (529) followed by ducklings (223) and least in growers (28). Breed wise highest mortality was revealed in Khaki Campbell (360), White Pekin (280) followed by Desi – Pati (109), and Muscovy Moti (31), respectively. Proper health care and prophylactic measures (Vaccination and preventive therapy) was provided to different breeds of duck.

Surveillance and monitoring of common diseases in ducks of Odisha (RKVY)

A total of 76 samples (cloacal swab, tracheal swab, tissue samples for histopathology and virus isolation in 10% NBF and virus transport media, respectively) were collected from Cuttack, Keonjhar and Bhadrak for detection of duck cholera and duck plague (DP). During the period, a total of 12 outbreaks of duck plaguein coastal districts of Odisha were attended. Out of a total of 350 ducks at risk, 250 (73.80%) were affected clinically and 150 died. Highest mortality was recorded in duckling (76.5%) followed by grower (44.3%) and adult ducks (36.2%), respectively.

In molecular investigation, out of total 50 samples, 20 post mortem samples and 5 clinical samples were positive for duck plague virus specific nucleic acid. Highest numbers of tissue samples that were positive for PCR were liver and spleen followed by kidney, heart and intestine. In biochemical study, the ALT and AST activities in serum and tissues were significantly higher in DP affected ducks in comparison to the healthy ducks. This increase in the activity of ALT and AST might be due to the hepatic damage. The virus was successfully isolated in 9-11 days old duck embryos from the field samples. The infected CAM and the embryos showed extensive haemorrhages throughout the body. As a prophylactic measure, live attenuated duck plague vaccine was given to the affected flocks. In vaccinated group, morbidity and mortality percentage of ducks was found to be reduced. As therapeutic management, doxycycline and neomycin were given to check secondary bacterial infections,which were found to be fruitful.

The detection and identification of the causative agent from affected ducks was done first by culture analysis. They were differentiated using biochemical tests, which werefound to be negative for indole production and voges-proskauer, but positive for enzyme activity like methyl red, catalase, oxidase and glucose fermentation. The isolates were also confirmed by molecular assays like 16S rRNA based PCR and *Riemerella anatipestifer* specific PCR, which would help for rapid confirmation of the disease at the time of an outbreak and out of 25 samples, 6 were found positive by this method. Analysis of the electrophoresed gel revealed that there was presence of 665 bp fragment in both of the isolates and thus confirmed as *Riemerella anatipestifer.* The antibiogram pattern was determined to advocate the choice of drugs for the purpose of treatment. The isolated organism was sensitive to Ciprofloxacin, Norfloxacin, Gentamycin, Chloramphenicol and Polymyxin-B, moderately sensitive to Doxycycline and resistant to penicillin G, Metronidazole, Sulphadiazine, Methicillin, Ampicillin, Cefuroxime, and Erythromycin.

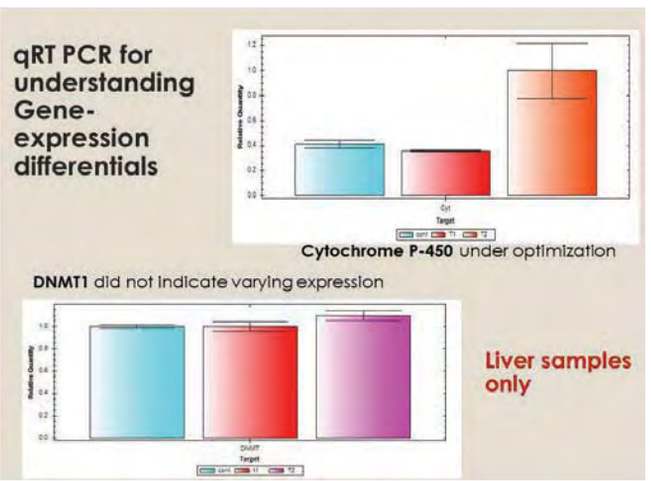
Aflatoxin-tolerant duck production through genetic and epigenetic approaches (NASF)

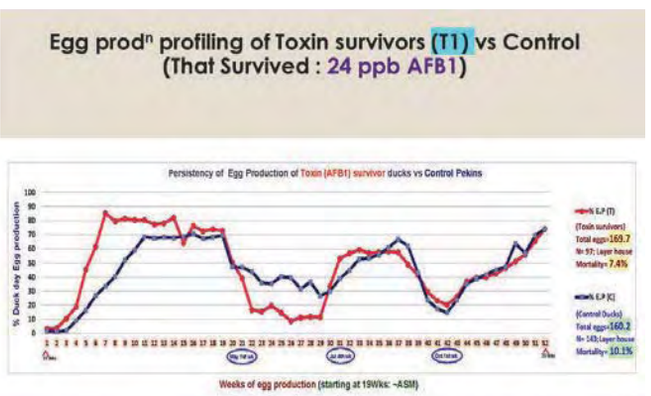
The approved NASF Project sanctioned with 4 centres, i.e. CARI-RC, Bhubaneswar as the lead center; OUAT, Bhubaneswar; AAU, Guwahati & CAU, Aizawl as collaborating Centers, adopted 3 duck-breeds (Pekin, Khaki & Pati) aiming to render them tolerant to Aflatoxin-B1 (AFB1), through brief dietary-AFB1-exposures for epigenetic-sensitization'. The challenge-survivors were raised every generation and were bred for next generation, starting with G0; then onto G1 and G2 and so on. As the 1st generation's results characterized the Pekin's tolerance to be around 50ppb AFB1 (0- 6 wks ages) as threshold of morbidity and 150ppb as a threshold of mortality, there emerged 2 experimental groups of survivors, post AFB1-challenge which were raised @ 24 and @ 150ppb AFB1 levels. These survivor ducks were raised through, to adulthood who were evaluated for their hen-day egg production during 2020. The 1st group of AFB1 survivor (24ppb AFB1) registered

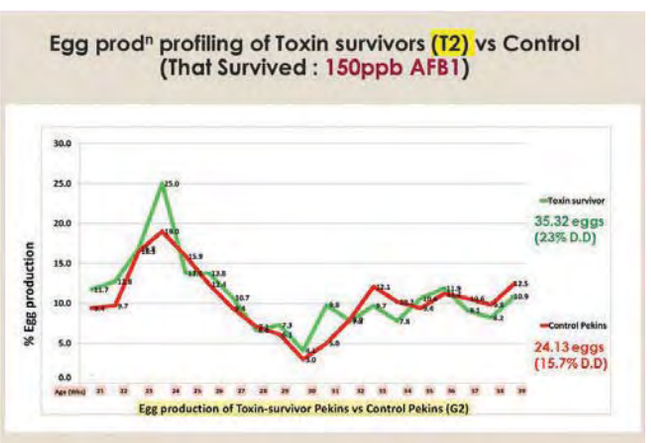
significantly-higher annual egg production (↑5.9%) vs the controls, while scoring numerically less layer-house mortality (↓2.7%) than the control. Similarly, the 2nd group of survivors (150ppb AFB1)also registered a numerically higher % hen-day egg production (?8.0%) compared to the control, till 40 weeks of egg production. The Khaki ducks under trial at the Aizawl (Mizoram) center, during this year, too gave similar findings with AFB1-sensitization @ 50ppb, with evidence of better egg production (% egg production) in G1 *vs* the respective controls.

During this year, using the Pekin ducklings (raised from G1 survivor ducks), a study was taken up to freshly determine the threshold of AFB1-tolerance from 3 experimental groups (E1 and E2 *vs* control) in respect of AFB1 induced-morbidity. This was done using 2 supplementary doses of aflatoxin-B1 in diet, i.e. 200ppb *vs* 400ppb *vs* 0 ppb for ducklings for duration of 0 to 6 weeks of age. Results revealed that the E1 succumbing @ 45% mortality & and E2 @ 85% mortality, until the 6th week of age, while the Control group showed no mortality at all, for the period. The growth depressions were distinctly visible in the manner: (E2<E1<Control). With respect to molecular studies, a quantitative gene-expression assay (qRT PCR) was conducted in these ducklings, to measure differential expression of 2 major candidate genes, using liver as the target organ of affliction, i.e. differential expression DNA-Methyl Transferase assay between AFB1-exposed *vs* the control ducks. Methylation assessment (being an epigenetic feature as well) was done through qRT-PCR of cDNA, for DNMT series of genes. As the result, the DNMT3 expressed at kidney and DNMT at liver, showed significant-upregulation in E2 *vs* Control, indicating possible methylation in host, thereby warranting further studies (eg. bi-sulphite sequencing etc.) to confirm methylation. Results from the Indigenous ducks, bred at our collaborative center showed that breed-variations between pekin (>24ppb) and native Patis (>48ppb), with distinct difference in AFB1-at threshold of morbidity actually existed, which manifested in slower rate of growth and clinical sicknesses.

With respect to ameliorating AFB1-contaminations (~150ppb) of feed of Pekins, it was proven that supplementation of *Curcuma longa* (turmeric @ 10-20g/kg) and tulsi (*Ocimum sanctum* @ 0.5 to 1.0%) in diets was indeed helpful to some extent to minimize the growth depression and clinical sicknesses, as correlated from heamatology counts and histopathological data. In summary, analyzing the data from all three breeds of ducks, it was concluded that perinatal aflatoxin-sensitization of duck aided in raising aflatoxin-tolerant duck seed-stocks for improved field-performances.







Linkage and collaboration

Diversified rice-based farming system for livelihood improvement of small and marginal farmers: (*Lead centre: ICAR-NRRI, Cuttack*).

Studies on rearing ducks (Khaki Campbell & Kuzi variety) in Rice-Fish-Duck Integrated model for enhanced farm productivity and economic return

In the integrated model experimentation farm of ICAR-NRRI, Cuttack, two breeds of ducks (Khaki Campbell & Kuzi) were introduced. Initially the rice field was prepared where the peripheral area (10 feet from the bund) was made 6 inches deeper than other part. Implantation of rice saplings were done after due preparation of land. Simultaneously, day old ducklings (60 Nos. KC and 60 Nos. Kuzi) were brooded for 30 days with boiled rice as starter feed. After that the growing ducklings were allowed to enter rice field. Fish fingerlings (2000 Nos.) of 6 inches size (Rohu and Katla) were introduced to the same field. The rice along with fish and ducks are maintained in one field for 3-4 months when application of pesticide and chemical fertilizer were strictly prevented. Under one eco-system the three crops grow with mutual benefits. Droppings of ducks not only enrich the soil but enhance growth of plankton which was consumed by fishes. Ducks also help in bio-control of insects and weeds in the rice field. They consume snails, molluscs, earthworms and many weeds and attain optimum growth. Performances of two varieties of ducks were recorded and found that Kuzi ducks gained higher body weight in comparison to KC ducks. No significant difference was observed with respect to attaining sexual maturity in both the varieties. Experiment is continuing till the harvest of rice. Kuzi ducks recorded body weight of 0.91 to 1.34 kg at 12 weeks and 1.28 to 1.72 kg at 20 weeks.

Increasing productivity and sustaining the rice-based production system through Farmer FIRST approach.

Four villages (Biswanathpur, Satyabhamapur, Laxminarayanpur and Ganeswarpur) of Cuttack district were adopted from the inception of the project. During 2020, new farmers (40 for backyard poultry and 20 for duck farming) were added to the previously adopted farmers. The new farmers were briefed about backyard poultry and duck farming through leaflets, telephone and near-by farmers. A total of 800-day-old chicks (*Vanaraja* and Kadaknath from CPDO, Bhubaneswar) and 400 Nos. day old ducklings (KC and Kuzi) were supplied along with initial chick mash, electric bulb and essential medicines. Mortality during brooding was found to be less (< 5 percent) in both chicks and ducklings. Farmers were guided from time to time regarding vaccination and other management practices. It was observed that economic return from sale of Kadaknath bird for meat purpose was the highest in comparison to other varieties as there was much demand for the live bird in the local market.

Rice-Fish-Duck integrated Model: ICAR-NRRI Cuttack



Brooding of *Vanaraja* chicks; Lasota vaccination; *Vanaraja* birds

Khaki Campbell in village pond (Satyabhamapur village)

Khaki Campbell in pre-laying stage (Laximinarayanpur village)

Extension

During the year due to COVID 19 pandemic, many farmers who were interested in duck farming could not visit the Station. However, more than 50 farmers contacted telephonically or via e-mail to enquire different aspects of duck farming including, housing, management, profit, marketing, feed, suitable ducklings for egg and meat, availability of ducklings, integrated farming, disease, vaccination as well institutional financial support given, if any. More than 20 farmers mostly from Odisha have visited the Station personally to know about duck farming. They were apprised about different aspects of duck farming. Most of the farmers were interested for the Khaki Campbell ducklings as it lays more eggs. Few farmers' fields were visited to demonstrate the onsite activities of duck farming.

In the year, one skill training programme was imparted on 14th December, 2020 to 16 rural youth on duck rearing and management, organized by KVK, ICAR-NRRI, Cuttack. They were trained in different aspects of duck farming. The Station In-Charge and the SMS of KVK Cuttack were also present during the training.

Participants of Skill training programme

A farmer with ducks

Technologies assessed and transferred

National workshop on entrepreneurship development through duck farming

The National Workshop on entrepreneurship development through duck farming was held on 22nd July, 2020 on the Zoom online webinar platform and was live streamed on YouTube. The workshop was organised by the National Cooperative Development Corporation in partnership with the Ministry of Rural Development, Government of India, Indian Council of Agricultural Research, DARE, MoA & FW and Government of Bihar, Government of Goa, Government of Kerala and Government of Manipur. A total of 442 participants joined the workshop directly through Zoom. They included Secretaries ARD, RD, Directors ARD of almost all the states of the country, scientists, professionals, NGOs associated with poultry and duck production, Hotel management of Oberoi and The Ashok Hotel, New Delhi, many entrepreneurs and progressive farmers. Besides direct participation, many people have joined through YouTube live.

The details of duck farming status in India, opportunities, developing entrepreneurship were presented and few measures were suggested to boost up duck farming in the country as an alternative to poultry / chicken for better egg production, not only to meet the huge requirement towards nutritional security of our people, but to contribute significantly to national GDP. The DDG (AS) and ADG (AP&B) also addressed the participants on this occasion.

Trainings imparted

Farmers were imparted training about duck health management in a workshop on "Integration of duck farming with fish farming" held on 17th November 2020 at Dasbidyadharpur, Satyabadi, Puri organized by Siddha Development Research and Consultancy Pvt. Ltd. (Entrepreneur Development project, Puri).

Participants in the training program

Lectures delivered in the training programs conducted by other organizations (by Dr. S.C. Giri)

S. No.	Date	Venue/Organizer	No of farmers	Remarks
1.	7th January 2020	CTCRI, RS, Bhubaneswar	35	Progressive farmers from Kendrapada dist (ATMA)
2.	9th January 2020	Dean Extension Education, OUAT, Bhubaneswar	~ 50	Review meeting of Farmers FIRST project with interaction with progressive farmers
3.	28th February 2020	ICAR-NRRI, Cuttack	~200	National Workshop on doubling farmers income
4.	5th March 2020	ICAR-NRRI, Cuttack	38	Integrated agriculture practice to progressive farmers of Jagatsinghpur dist, Odisha
5.	11th March 2020	ICAR-NRRI, Cuttack	22	Integrated agriculture practice to progressive farmers of Brahmagiri block, Puri

Seminars, Conferences and Workshops attended

S. No.	Particulars of Conference	Official(s)	Schedule	Venue/Organizer
1.	National Virtual Workshop on Entrepreneurship Development through Duck Farming: Organized by National Cooperative Development Corporation (NCDC) In partnership with Ministry of Rural Development, Govt of India, Indian Council for Agricultural Research, DARE, Govt of India, Government of Bihar, Government of Goa, Government of Kerala and Government of Manipur.	Dr. S.C. Giri Dr. S.K. Sahoo Dr. M.K. Padhi	22 July 2020	NCDC, New Delhi
2.	Annual conference of Indian society of Veterinary Pharmacology and Toxicology as virtual conference (e conference) & International webinar on Receptor Dynamics and Cell Signalling and national e conference of Indian society of Veterinary Pharmacology and Toxicology on Translational Approaches in Herbal Drug Development.	Dr. D. Kumar	4-5 October 2020	CVSc & AH, DUVASU, Mathura.
3.	Online Webinar on 'Egg: A natural immunity booster' on the occasion of celebrating world Egg Day 2020' organized by ICAR-DPR, Hyderabad on virtual mode.	All Scientists of Regional Station, Bhubaneswar	9 October 2020	ICAR-DPR, Hyderabad
4.	Workshop on Integration of duck and fish farming.	Dr. C.K. Beura Dr. S.K. Mishra Dr. D. Kumar	17 November 2020	Siddha Development Research and Consultancy Pvt. Ltd, Dasbidyadharpur, Satyabadi, Puri.

Awards

Dr. B. K. Swain received Reviewer Excellence Award as reviewer of Agricultural Science Digest (ARCC Journal).

Publications

Majhi, R.K., Kumar, A., Giri, S.C. and Goswami, C. 2020. Differential expression and localization of TRPV channels in the mature sperm of *Anas platyrhynchos*. *Reproduction in Domestic Animals*, 00:1–10. *https://doi.org/10.1111/rda.13822*. http://krishi.icar.gov.in/jspui/handle/123456789/57202

Naik, P.K., Swain, B.K., Sahoo, S.K., Kumar, D. and Mishra, S.K. 2020. Effect of graded levels broken rice on egg quality of White Pekin ducks during second year of laying. *Indian Journal of Animal Nutrition*, 37(2): 191-194. http://krishi.icar.gov.in/jspui/handle/123456789/50604

Naik, P.K., Swain, B.K., Sahoo, S.K., Kumar, D. and Mishra, S.K. 2020. Effect of graded levels broken rice on blood biochemical profile of White Pekin ducks during second year of laying. *Indian Journal of Animal Nutrition*, 37(3): 288-291. http://krishi.icar.gov.in/jspui/handle/123456789/51130

Elmorsy, M.A., Jena, G.R., Panda, S.K., Kundo, A.K., Kumar, D., Mishra, S.K., et al., 2020. Isolation, identification, and clinical impact of coccidiosis in Japanese quail farms in and around Bhubaneswar, Odisha, India. *Journal of Entomology and Zoology Studies*, 8(6): 302-307. http://krishi.icar.gov.in/jspui/handle/123456789/51132

Behera, H.K., Jena, G.R., Kumar, D., Mishra, S.K., Das, D.P., Samal, L. and Dalai, N. 2020. Ameliorative effect of Vitamin C on hematobiochemical and oxidative parameters in Ducks during summer. *International Journal of Livestock Research*, 10 (11): 140-148. http://krishi.icar.gov.in/jspui/handle/123456789/51133

Research Projects in operation during 2020

S.No.	Project Title	PI & Co-PIs	Duration
A. Institute Funded Projects			
1.	Nutrient requirements of White Pekin ducks	Dr. S.K. Sahoo (PI) Dr. B.K. Swain Dr. P.K. Naik	2020-23
2.	Evaluation of broken rice or tuber crops based feed mixture supplement in White Pekin ducks in semi-intensive rearing system	Dr. P.K. Naik (PI) Dr. B.K. Swain Dr. S.K. Sahoo Dr. S.K. Mishra Dr. D. Kumar	2018-23
3.	Duck rearing management practices in farm condition for optimum productivity under changing climatic condition	Dr. S.C. Giri (PI) Dr. M.K. Padhi Dr. S.K. Sahoo Dr. K.V.H. Sastry (up to Feb. 2020) Dr. R.K.S. Bias (up to July 2020)	2020-23
4.	Arsenic toxicity and its amelioration with some herbs in ducks	Dr. D. Kumar (PI) Dr. P.K. Naik Dr. S.K. Mishra Dr. B.K. Swain	2018-21
5.	Service project: Surveillance and monitoring of duck diseases and their biosecurity measures	Dr. D. Kumar (PI)	July 2009 To March 2020
B. Externally Funded Projects			
1.	Genetic up-breeding of duck production to strengthen livelihood security in NER of India by converging conventional and molecular techniques (DBT)	Dr. M.K. Padhi (PI) Dr. R.K.S. Bais (up to July 2020) Dr. S.K. Sahoo Dr. K.V.H. Sastry (up to Feb. 2020) Dr S.C. Giri Dr. V.K. Saxena (up to Feb. 2020)	2018-21
2.	Farm based S&T interventions for socio-economic development in the aspirational district of Nabarangpur, Odisha (RKVY)	Dr. M.K. Padhi (PI) Dr. R.K.S. Bais (up to July 2020) Dr. K.V.H Sastry (up to Feb. 2020) Dr. S.K. Sahoo Dr. S.C Giri	2019-21
3.	Surveillance and monitoring of common diseases in ducks of Odisha (RKVY)	Dr. D. Kumar (PI) Dr. P.K. Naik Dr. S.K. Mishra Dr. B.K. Swain	2017-21
4.	Aflatoxin-tolerant duck production through genetic and epigenetic approaches (NASF)	Dr. S.K. Mishra (PI) Dr. P.K. Naik Dr. B.K. Swain Dr. D. Kumar	2017-20

C. Inter-institutional Projects		
1.	Diversified rice based farming system for livelihood improvement of small and marginal farmers: (Lead centre: ICAR-NRRI, Cuttack)	Dr A. Poonam-PI (ICAR-NRRI, Cuttack) Dr. S.C. Giri
2.	Increasing productivity and sustaining the rice based production system through Farmer FIRST approach. (Externally Funded Project: Lead centre: ICAR-NRRI, Cuttack)	Dr. Sumanta Kumar Mishra-PI (ICAR-NRRI, Cuttack) Dr. S.C. Giri

Other Relevant Information

Independence Day and Republic Day Celebrations

The Regional Station, Bhubaneswar celebrated Republic day on 26th January 2020 and Independence Day on 15th August 2020. The Station In-charge/s Dr. R.K.S. Bais hoisted the National Flag on Republic Day and Dr. C.K. Beura hoisted the National Flag on Independence Day.

Celebration of Hindi Saptah

The regional station celebrated "Hindi Saptah" from 14.09.2020 to 20.09.2020. During this period, the staff of the Regional Station participated in different literary competitions. The prizes were distributed to the winners / runners for different competitions.

In-Charge, Regional Station, Dr. C.K. Beura addressing the staff on Independence Day

Prize distribution to the winner of Hindi Essay Competition

8 All India Coordinated Research Project on Poultry Breeding

The year 2020 saw AICRP on Poultry Breeding completing its 50 years of research successfully, thus, marking the Golden Jubilee year of launch of AICRP on Poultry Breeding. The AICRP is being operated at twelve centres viz. KVASU, Mannuthy; AAU, Anand; KVAFSU, Bengaluru; GADVASU, Ludhiana; OUAT, Bhubaneswar; CARI, Izatnagar; ICAR RC for NEH Region, Agartala; NDVSU, Jabalpur; AAU, Guwahati; BAU, Ranchi; MPUAT, Udaipur and CSKHPKVV, Palampur. The main objectives of the project are development of location specific chicken varieties; conservation, improvement, characterization and application of local native, elite layer and broiler germplasm and development of package of practices for village poultry and entrepreneurships in rural, tribal and backyard areas. In addition, KVASU, Mannuthy and AAU, Anand centres are to maintain two elite layer germplasm (IWN and IWP). KVAFSU, Bengaluru, GADVASU, Ludhiana, OUAT, Bhubaneswar and ICAR-CARI, Izatnagar are to maintain four elite broiler germplasm (PB-1, PB-2, CSML and CSFL).

Pedigreed random bred control populations (control layer and control broiler) were maintained at the Directorate Samples of hatching eggs from these populations were sent to different centres of AICRP on Poultry Breeding to measure the genetic progress. During the year, a total of 6,40,999 chicken germplasm was distributed to the farmers from different centres. An amount of Rs. 166.67 lakhs revenue (Table 1) was generated through distribution and propagation of the improved chicken germplasm.

The AICRP on Poultry Breeding, Mannuthy centre during the calendar year 2020 has evaluated the S-5 generation of native chicken germplasm up to 40 weeks of age. Egg production of native chicken germplasm up to 40 weeks of age was 78.96 eggs with an average egg weight of 43.91 g. Egg production and egg weight remained the same as compared to the previous generation. Pedigree selection based on Osborne Index was carried out in native population (S-5) and 250 females and 50 males were selected for producing next generation. The centre distributed a total of 1,28,339 number of germplasms to 520 beneficiaries and generated revenue of Rs. 14.69 lakhs.

The AAU, Anand centre evaluated native chicken i.e. "*Ankleshwar*" and White Leghorn strains (IWN, IWP, IWD and IWK) during the year 2020. The egg production up to 40 weeks of age was 76.38 eggs in S-2 generation of "*Ankleshwar*" chicken, which was higher as compared to S-1 (71.06) generation. Egg production up to 72 weeks of age was 307.24 and 317.50 eggs in IWN and IWP strains (S-1), respectively. Egg production up to 64 weeks of age was 226.47 and 218.14 eggs in IWD and IWK strains (S-8 Gen.), respectively. The centre has supplied a total of 62,794 chicken germplasm to 1104 farmers during the year 2020. The centre has generated revenue of Rs. 24.87 lakhs.

Bengaluru centre evaluated S-11 generation of PB-1 and S-25 generation of PB-2 lines. Raja II (the commercial strain with 2.00 kg body weight at 7th week and 2.0 FCR) chicks were distributed

to the farmers. The centre has supplied 1,45,023 chicken germplasm to the farmers during the calendar year 2020 with a total revenue of Rs 49.32 lakhs. A total of 301 farmers benefitted during the period.

GADVASU, Ludhiana centre evaluated PB-1 and PB-2 lines and native chickens. The body weight at 5, 20, 40 weeks of age was 1150, 1065 and 799 g in PB-1, PB-2 and HBC, respectively. The FCR at 5 weeks for PB-1, PB-2, and HBC was 1.98, 1.96 and 2.00, respectively. The average egg production up to 36 weeks for PB-1, PB-2, and HBC was 59, 60 and 58 numbers, respectively. The body weight in Punjab Brown, native birds at 4, 8, 16, 20, 40 weeks of age was 480, 696, 1423, 1984, 2683 g, respectively. The average egg production up to 36 weeks for Punjab Brown native chickens was 66 eggs. A total of 77,295 germplasms were supplied during the reporting period to 295 farmers. The revenue generation was Rs. 19.79 lakhs.

Bhubaneswar centre maintained *Hansli*, CSML, CSFL and their crosses during the year. All the flocks were liquidated due to the outbreak of Avian Influenza. During the year, 190 birds, were distributed to the farmers.

ICAR-CARI, Izatnagar centre evaluated the local native chicken, CSML and CSFL. Development and improvement of dual-purpose backyard cross was continued. Egg production was recorded from 36 to 68 weeks of age. The average egg production up to 40, 48, 60 and 68 weeks was 29.23±2.64, 68.09±4.79, 122.18±4.61 and 153.92±6.57 eggs, respectively. The ASM was 150 days. The average five-week body weight of CSFL and CSML was 1012±11.03 and 1198±4.07 g, respectively. The germplasm supply was 21,322 with revenue of Rs. 4.42 lakhs. A total of 26 farmers were benefited,

Udaipur centre evaluated *Mewari*, RIR, CSFL and *Pratapdhan* populations during the year. The germplasm supply during the period was 38,877 and centre has generated revenue of Rs. 7.64 lakhs during the period. A total of 311 farmers were benefited during the year.

Jabalpur centre evaluated Kadaknath, Jabalpur colour and *Narmadanidhi* populations during the year. JBC females matured at 151 days and produced 161 eggs up to 52 weeks of age. The hens of Kadaknath population matured at 166 days and produced 93.7 eggs. *Narmadanidhi* birds produced 170 eggs up to 72 weeks in field conditions with an average egg weight of 45.0 g. During the year, a total 12,454 germplasm was distributed to 195 farmers with a revenue generation of Rs. 5.79 lakhs.

Guwahati centre evaluated native, Dahlem Red, PB-2 and BN populations up to 52 weeks of age and *Daothigir* breed up to 40 weeks of age. The 5-week body weight was 150.3 g in indigenous, 1181 g in PB-2 and 410.3 g in Dahlem Red. In native population, the egg weight and egg production up to 52 weeks was 40.80 g and 68.60 eggs, respectively. In Dahlem Red egg production improved by 0.7 eggs. In *Kamrupa*, the age at sexual maturity was 150.4 days in the farm and 171.2 days in the field. The hen housed egg production up to 40 and 52 weeks of age was 49.90 and 91.30 eggs in the farm and corresponding values in the field were 44.30 and 74.80 eggs, respectively. For *Daothigir* the age at sexual maturity was 208.3 days. The hen housed egg production up to 40 weeks of age was 18.1 eggs. The centre supplied a total of 42,487 numbers germplasm to 266 farmers with a revenue receipt of Rs. 5.31 lakhs during the year.

Palampur centre evaluated native germplasm, Dahlem Red and *Himsamridhi* during the year. The HDEP up to 40 weeks and 52 weeks was 45.95 and 80.16 eggs, respectively in native chicken. The 40 weeks-HDEP was 63.97 eggs in Dahlem Red breed. The HDEP up to 40 and 52 weeks was 53.61 and 92.35 eggs, respectively in *Himasamridhi*. A total of 53,679 germplasm was distributed to the 466 farmers of Himachal hill region. An amount of Rs. 15.71 lakhs revenue was generated during the year.

Ranchi centre evaluated native chicken, *Dahlem Red*, PB-2 and *Jharsim* populations. The HDEP of native chickens was 91.51 (G-7) at 72 weeks of age. The body weight at day old and 4 weeks of age was 28.08±0.12 and 166.33±0.87 g in native chickens. The body weight and egg production in native chickens showed improvement compared to previous evaluation. Centre supplied 21,995 *Jharsim* chicks among 125

farmers, NGOs, KVKs and other agencies. The revenue receipt was Rs. 6.14 lakhs.

Tripura centre evaluated Tripura Black, *Dahlem Red*, broiler dam line and their crosses during the year. The 40 week-egg production of BND cross (E4) was 53.77 and 42.95 eggs under farm and field conditions, respectively. The body weight at 8, 20 and 40 weeks of age was 515.8, 1605 and 1964g at farm and 435.2, 1532 and 1772 g, respectively at farmers' field. During the period, a total of 36,544 chicks were supplied to 516 farmers of Tripura with a revenue receipt of Rs. 12.95 Lakhs.

Table 1. Germplasm distribution, farmers benefited and revenue generation during 2020

Centre	Germplasm (Nos.)	Farmers (Nos.)	Revenue (Rs. in Lakhs)
KVASU, Mannuthy	1,28,339	520	14.69
AAU, Anand	62,794	1,104	24.87
KVAFSU, Bengaluru	1,45,023	301	49.32
GADVASU, Ludhiana	77,295	295	19.79
OUAT, Bhubaneswar	190	2	0.04
ICAR-CARI, Izatnagar	21,322	26	4.42
MPUAT, Udaipur	38,877	311	7.64
NDVSU, Jabalpur	12,454	195	5.79
AAU, Guwahati	42,487	266	5.31
CSKHPKVV, Palampur	53,679	466	15.71
BAU, Ranchi	21,995	125	6.14
ICAR-RC, Agartala	36,544	516	12.95
Total	**6,40,999**	**4,127**	**166.67**

9 Poultry Seed Project

The Poultry Seed Project was evolved with an objective to increase the availability of rural chicken germplasm in remote areas of our country. In this endeavour, the Indian Council of Agricultural Research has initiated "Poultry Seed Project" during the XI Five-year Plan with six centres, three in the northeast region and three in different state veterinary/agricultural universities. The project has been strengthened during the XII plan by adding five more centres to cater to needs of the farmers in their respective regions. At present the project is being operated at 12 centres across the country. The main objective of this project is local production of improved chicken germplasm (fertile eggs, day old chicks and grownup chicks) and supply to various stake holders in the remote areas to target production enhancement of egg and meat for augmenting rural poultry production, socio-economic condition of the target groups and linking small scale poultry producers with organized market.

The PSP centres are located at Bihar Animal Sciences University, Patna; ICAR Research complex for NEH region, Nagaland Regional Centre, Jharnapani; ICAR –National Organic Farming Research Institute, Gangtok; ICAR Research complex for NEH region, Manipur Regional Centre, Imphal; Tamil Nadu Veterinary and Animal Sciences University, Hosur, ICAR-Central Coastal Agricultural Research Institute, Panaji; ICAR-Central Island Agricultural Research Institute, Port Blair; Sher-e-Kashmir University of Agricultural Sciences and Technology, Srinagar, PVNR Telanagna Veterinary University, Warangal; Sri Venkateswara Veterinary University, Tirupati, ICAR Research Complex for NEH Region, Umiam and West Bengal University of Animal and Fishery Sciences, Kolkata.

The Directorate as a coordinating unit, supplies parent chicks, co-ordinates and monitors the activities of different centres to enable them to achieve the set targets for each centre. The target set for supplying chicks for mainland and north-east centres during the year 2020 were between 0.3 and 1.0 lakhs chicks per annum and to collect feedback on the performance of the germplasm under backyard farm conditions. A total of 4,19,477 improved chicken varieties have been distributed in their respective regions/states with a revenue receipt of Rs. 132.79 lakhs during the year (Table 1).

Patna centre reared three batches of *Vanaraja* and one batch of *Gramapriya* parents. A total of 55, 953 *Vanaraja* chicken germplasm was distributed to the farmers in Bihar during the year 2020 with an amount of Rs. 16.19 lakhs revenue.

One batch each of *Vanaraja* and *Srinidhi* were in position at present in Jharnapani centre. A total of 52,528 improved chicken germplasm was distributed to farmers of Nagaland and neighbouring states during the year. A total of Rs. 21.01 lakhs revenue was generated.

Two batches of *Vanaraja* parents was reared at ICAR-NOFRI, Gangtok, Sikkim. A total of 76,208 improved chicken germplasm of *Vanaraja* was distributed to 2090 farmers covering 280 village habitats in Sikkim with an amount of Rs. 30.7 lakhs revenue.

Three batches of *Vanaraja, Gramapriya* and *Srinidhi* parents were reared at Manipur Centre during the year. A total 24,367 improved chicken germplasm was distributed to the farmers in Manipur. The Centre has generated Rs. 13.57 lakhs of revenue during the year.

A total of 78,049 improved rural chicken (*Vanaraja* and *Gramapriya*) germplasm was distributed to 884 farmers in Tamil Nadu by Hosur Centre during the reporting period. The Centre has generated total revenue of Rs. 17.87 lakhs during the year.

One batch each of *Vanaraja* and *Krishibro* parents were reared at Goa during the year. A total of 41,696 improved chicken germplasm was distributed to 1342 farmers in Goa with revenue generation of Rs. 4.76 lakhs.

One batch of *Vanaraja* parents was reared under deep litter system at Port Blair. A total of 2,283 improved chicken germplasm were distributed to farmers in Andaman & Nicobar Islands with revenue of Rs. 83774/- during the year.

Two batches of *Vanaraja* parents were reared at ICAR RC for NEH Region, Umiam, Meghalaya. A total of 13,414 improved chicken germplasm was distributed to the farmers in Meghalaya with an amount of Rs. 9.52 lakhs of revenue during the year 2020.

Two batches of *Vanaraja* parents were maintained at SVVU, Tirupati, Andhra Pradesh. A total of 26,083 chicks were supplied to the farmers and generated Rs.3.62 lakhs as revenue by sale of chicks and eggs during the period.

Three batches of parents of *Gramapriya* and two batches of *Vanashree* were reared at PVNRTVU, Warangal, Telangana during the reporting period. A total of 32,769 improved rural chicken (*Gramapriya* and *Vanashree*) germplasm was distributed to the farmers. The centre has generated total revenue of Rs. 8.67 lakhs during the year.

Srinagar centre reared one batch of *Vanaraja* parents during the year. A total of 16,127 chicks were distributed to 1210 farmers. An amount of Rs. 6.05 lakhs revenue was realized during year.

Table 1. Centre wise distribution of germplasm under Poultry Seed Project

Sl.No.	Centre	Germplasm (Nos.)	Revenue (Rs. in lakhs)
1	BASU, Patna	55,953	16.19
2	ICAR-RC, Jharnapani	52,528	21.01
3	ICAR-NOFRI, Gangtok	76,208	30.7
4	ICAR-RC, Imphal	24,367	13.57
5	TANUVAS, Hosur	78,049	17.87
6	ICAR-CCARI, Goa	41,696	4.76
7	ICAR-CIARI, Port Blair	2,283	0.83
8	SKUAST, Srinagar	16,127	6.05
9	ICAR-RC for NEHR, Umiam	13,414	9.52
10	PVNRTVU, Warangal	32,769	8.67
11	SVVU, Tirupati	26,083	3.62
12	WBUAFS, Kolkata	-	-
	Total	**4,19,477**	**132.79**

10 Publications

Research papers

Dushyanth, K., Shukla, R., Chatterjee, R.N. and Bhattacharya, T.K. 2020. Expression and polymorphism of Follistatin (*FST*) gene and its association with growth traits in native and exotic chicken. *Animal Biotechnology*, doi: 10.1080/10495398.2020.1838917. http://krishi.icar.gov.in/jspui/handle/123456789/46339

Ganapathy, K., Ball, C., Baylis, M., Tirumurugaan, K.G., Suwetha, K.R., Gowthaman, V., Senthilvel, K., Gopal Murthy, K., Kannaki, R., Pankaj, D. and Chhabra, R. 2020. QX-like infectious bronchitis virus reported in India. *Veterinary Record*, 186 (2): 2-70.http://krishi.icar.gov.in/jspui/handle/123456789/46311

Guru Vishnu, P., Bhattacharya, T.K., Divya, D., Rajendra Prasad, A. and Govardhan Sagar, N. 2020. Establishment of primary chicken embryo myoblast cell culture, antigenic epitopes prediction and production of anti activin receptor type IIB polyclonal antibody in chicken. *Animal Biotechnology*, doi: 10.1080/10495398.2020.1870483. Published on 21st January 2021

Haunshi, S., Divvya, D., Kannaki, T.R., Rajkumar, U. and Chatterjee, R.N. 2020. Genetic diversity at major histocompatibility complex and its effect on production and immune traits in indigenous chicken breeds of India. *Archives Animal Breeding*, 63:173–182.http://krishi.icar.gov.in/jspui/handle/123456789/38070

Krishnegowda, D.N., Mariappan, A.K., Dhama, K., Singh, K.P., Singh, B.R., Saminathan, M., Ramalingam, R., Singh, V., Reddy, M.R. 2020. Pathobiology of different chicken organs in septicemic deaths. *Indian Journal of Veterinary Pathology*, 44(2):91-100. http://krishi.icar.gov.in/jspui/handle/123456789/46535.

Kumar, V., Rajkumar, U., Niranjan, M. and Rama Rao, S.V. 2020. Impact of COVID-19 pandemic on chicken meat and egg consumption patterns in rural and urban areas. *Indian Journal of Poultry Science*, 55(2):147-150. DOI: 10.5958/0974-8180.2020.00030.6. http://krishi.icar.gov.in/jspui/handle/123456789/45319

Kumar, V., Rajkumar, U., Niranjan, M. and Rama Rao, S.V. 2020. Impact of COVID-19 pandemic on retail chicken shop owners (Butchers) and their livelihoods. *International Journal of Livestock Research*, 10(11):39-43. http://krishi.icar.gov.in/jspui/handle/123456789/45318

Naga Raja Kumari, K., Kalyani, P., Rama Rao S.V. and Rajkumar, U. 2020. Concentration of digestible threonine in diet on production performance and intestinal morphometry of WL layers. *Indian Journal of Animal Research*, 55:167-173 http://krishi.icar.gov.in/jspui/handle/123456789/46919

Paul, S.S., Venkata, H.G.R.V., Raju, M.V.L.N., Rama Rao, S.V., Nori, S., Suryanarayan, S., Kumar, V., Perveen, Z. and Prasad, C.S. Dietary supplementation of extracts of red sea weed (*Kappaphycus alvarezii*) improves growth, intestinal morphology, expression of intestinal genes and immune responses in broiler chickens. *Journal of the Science of Food and Agriculture*. DOI: 10.1002/jsfa.10708. http://krishi.icar.gov.in/jspui/handle/123456789/39451

Paul, S.S., Chatterjee, R.N., Raju, M.V.L.N., Prakash, B., Rama Rao, S.V., Yadav S.P. and Kannan, A. 2021. Gut microbial composition differs extensively among Indian native chicken breeds originated in different geographical locations and a commercial broiler line, but breed-specific, as well as across-breed core microbiomes, are found. *Microorganisms*, 9(2):391. http://krishi.icar.gov.in/jspui/handle/123456789/45374

Paul, S.S., Chatterjee, R.N., Rama Rao, S.V., Raju, M.V.L.N., Kannan, A. and Prakash, B. 2020. Connection of gut microbiome, gut health and productivity in chicken. *Indian Journal of Animal Health.* 59(2)-Special Issue:62-74. http://krishi.icar.gov.in/jspui/handle/123456789/45373

Pradeep, M., Reddy, M.R. and Kannaki, T.R. 2020. Molecular identification and characterization of chicken parvovirus from Indian chicken and association with runting and stunting syndrome. *Indian journal of Animal Research*, 54(12):1517-1524. http://krishi.icar.gov.in/jspui/handle/123456789/46309

Prince, L.L.L., Rajaravindra, K.S., Rajkumar, U., Reddy, B.L.N., Paswan, C., Haunshi, S. and Chatterjee, R.N. 2020. Genetic analysis of growth and egg production traits in synthetic coloured broiler female line using animal model. *Tropical Animal Health and Production*, 52:3153–3163. https://doi.org/10.1007/s11250-020-02340-4, http://krishi.icar.gov.in/jspui/handle/123456789/38069

Rajasekhar, K.V., Prakash, B., Vijaya Lakshmi, K., Rama Rao, S.V. and Raju, M.V.L.N. 2020. Effect of feeding diet with alternate protein sources and quality protein maize on performance and nutrient utilization in broiler chickens. *Tropical Animal Health and Production*, 52:2297–2302. DOI 10.1007/s11250-020-02251-4. http://krishi.icar.gov.in/jspui/handle/123456789/46312

Rajkmuar, U, Prince, L.L.L., Haunshi, S., Paswan, C. and Reddy, B.L.N. 2020. Evaluation of *Vanaraja* female line chicken for growth, production, carcass and egg quality traits. *Indian Journal of Animal Sciences*, 90(4):603-609. http://krishi.icar.gov.in/jspui/handle/123456789/46247

Rajkmuar, U., Niranjan, M., Prince, L.L.L., Paswan, C., Haunshi, S. and Reddy, B.L.N. 2020. Genetic evaluation of growth and production performance and short term selection response for egg mass in *Gramapriya* female line chicken. *Indian Journal of Animal Sciences*, 90(3):401-406. http://krishi.icar.gov.in/jspui/handle/123456789/46246.

Rajkumar, S., Reddy, M.R. and Somvanshi, R. 2020. Molecular typing of Indian *Mycoplasma synoviae* isolates. *Indian Journal of Animal Research*. DOI: 10.18805/IJAR.B-4153. http://krishi.icar.gov.in/jspui/handle/123456789/46537

Rajkumar, U, Prince, L.L.L., Haunshi, S., Paswan, C. and Chatterjee, R.N. 2020. Estimation of breeding value, genetic parameters and maternal effects of economic traits in rural male parent line chicken using pedigree relationships in an animal model. *Journal of Animal Breeding and Genetics*, DOI: 10.1111/jbg.12531. http://krishi.icar.gov.in/jspui/handle/123456789/46250

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11 Research Projects in Operation

S. No.	Project Title	PI	Co-PIs	Project Duration
A. Institute Funded Research Projects				
1.	Genetic improvement of rural parent lines and development of promising chicken varieties suitable for free range poultry farming (Project No. ANSCDPRSIL202000200072)	Dr. U. Rajkumar	Dr. M. Niranjan Dr. S. Haunshi Dr. L.L.L. Prince Dr. M.R. Reddy Dr. Vijay Kumar Dr. B. Prakash	2020-25
2.	Improvement and Evaluation of PD-2 and PD-6 lines for Rural Poultry Production (Project No. ANSCDPRSIL202000300073)	Dr. M. Niranjan	Dr. U. Rajkumar Dr. K.S. Rajaravindra Dr. T.R. Kannaki	2020-25
3.	Genetic improvement and evaluation of native chicken breeds (Project No. ANSCDPRSIL202000400074)	Dr. S. Haunshi	Dr. U. Rajkumar Dr. L.L.L. Prince Dr. T.R. Kannaki Dr. Suresh Devatkal (ICAR-NRCM)	2020-25
4.	Improvement and maintenance of elite layer germplasm (Project No. ANSCDPRSIL202000500075)	Dr. K.S. Rajaravindra	Dr. R.N. Chatherjee Dr. T.K. Bhattacharya Dr. M. Niranjan Dr. U. Rajkumar Dr. S. Haunshi Dr. L.L.L. Prince	2020-25
5.	Genetic improvement of synthetic coloured broiler male line (PB-1) and maintenance of Broiler Control population (Project No. ANSCDPRSIL202000600076)	Dr. L. Leslie Leo Prince	Dr. K.S. Rajaravindra Dr. T.K. Bhattacharya Dr. U. Rajkumar Dr. B.L.N. Reddy Dr. M. Niranjan	2020-25
6.	Genetic improvement of the coloured broiler female line (PB-2) (Project No. -ANSCDPRSIL201900100068)	Dr. B.L.N. Reddy	Dr. U. Rajkumar Dr. L.L.L. Prince	2019-24
7.	Generation of whole genome assembly of native Kadaknath chicken and its annotation (Project No. ANSCDPRSIL202000100071)	Dr. S.P. Yadav	Dr. S.S. Paul Dr. R.N. Chatterjee Dr. T.K. Bhattacharya Dr. S. Jayakumar	2020-21

S. No.	Project Title	PI	Co-PIs	Project Duration
8.	Precision feeding of Atulya to exploit its comprehensive genetic potential (Project No. ANSCDPRSIL202100100084)	Dr. S.V. Rama Rao	Dr. M.V.L.N. Raju Dr. S.S. Paul Dr. A. Kannan Dr. B. Prakash	2021-24
9.	Evaluation of Insect larva meal as a novel protein source in chicken diet (Project No. ANSCDPRSIL202000700077)	Dr. M.V.L.N. Raju	Dr. S.V. Rama Rao Dr. S.S. Paul Dr. B. Prakash Dr. A. Kannan Dr. M. Shanmugam Dr. M.R.Reddy	2020-23
10.	Biosynthesis of different nano mineral particles using plant extracts and evaluation of their potential as feed supplement in poultry (Project No. ANSCDPRSIL202000800078)	Dr. A. Kannan	Dr. S.S. Paul Dr. M. Shanmugam Dr. D. Rajendran (NIANP) Dr. M. Muthkumar(NRCM) Dr. R. Venkateshwarlu (IIMR)	2020-23
11.	Empowering tribal farmer through backyard poultry farming in NEH region (Project No. ANSCDPRSIL202000900079)	Dr. B. Prakash	Dr. U. Rajkumar	2020-22
12.	Dietary enrichment of chicken eggs with Omega-3 fatty acids (Project No. ANSCDPRSIL202001000080)	Dr. B. Prakash	Dr. S.V. Rama Rao Dr. M.V.L.N. Raju	2020-22
13.	Disease Monitoring, Surveillance and Control in Chicken Populations of DPR (Project No. ANSCDPRSIL202001100081)	Dr. M.R. Reddy	Dr. D. Suchitra Sena Dr. T.R. Kannaki Dr. S.K. Bhanja	2020-23
14.	Exploring medicinal plants as alternative to antibiotic growth promoters (AGP) in broiler production (Project No. – ANSCDPRSIL201500700056)	Dr. D. Suchitra Sena	Dr. B. Prakash	2016-21
15.	Understanding the disease tolerance/ resistance in Indian native chicken breeds to Newcastle disease and novel control strategies (Project No. ANSCDPRSIL201900300070)	Dr. T.R. Kannaki	Dr. M.R. Reddy Dr. S. Haunshi Dr. S.P. Yadav	2019-22
16.	Comparative studies on different factors influencing egg production in chicken (Project No. – ANSCDPRSIL201900200069)	Dr. N.Anand Laxmi	Dr. R.K. Mahapatra Dr. M. Shanmugam	2019-22
17.	Sustainable poultry waste management through composting (Project No. ANSCDPRSIL201700100063)	Dr. R.K. Mahapatra	Dr. N. Anand Laxmi Dr. M. Shanmugam Dr. S.K. Bhanja Dr. B. Prakash Dr. P.K. Pankaj (CRIDA) Dr. Md. Osman (CRIDA)	2017-22
18.	Poultry rearing with moringa and other feed base - an Integrated Farming System (Project No. ANSCDPRSIL202001200082)	Dr. R.K. Mahapatra	Dr. S.K. Bhanja Dr. B. Prakash Dr. M.R. Reddy	2020-24

S. No.	Project Title	PI	Co-PIs	Project Duration
19.	Evaluation and standardization of protocol for cryopreserving semen of DPR pure line (Project No. – ANSCDPRSIL201800100067)	Dr. M. Shanmugam	Dr. R.K. Mahapatra	2018-21
20.	Assessment of ICAR-DPR germplasms in the field condition and their impact on food security and livelihood (Project No. ANSCDPRSIL202001300083)	Dr. Vijay Kumar	Dr. S.K. Bhanja Dr. M. Niranjan Dr. S.V. Rama Rao	2020-24
B. Externally Funded Research Projects				
1.	Functional genomics, epigenetics and gene silencing technology for improving productivity in poultry (National Fellow)	Dr. T.K. Bhattacharya		2016-21
2.	Development of transgenic chicken for production of human interferon alpha 2b: A therapeutic for treatment of viral diseases in human (DBT)	Dr. T.K. Bhattacharya	Dr. R.N. Chatterjee	2018-21
3.	Chicken or egg: Drivers of antimicrobial resistance in poultry in India (DBT)	Dr. S.V. Rama Rao	Dr. S.S. Paul	2018-21
4.	Understanding the epigenetic methylation and miRNA mediated gene regulation of transcellular calcium transport genes in avian uterus during egg calcification (SERB)	Dr. Chandan Paswan (Upto April 2020) Dr. M. Shanmugam (From Dec. 2020)	Dr. R. N. Chatterjee Dr. M. Shanmugam	2018-21
5.	Development of Gene Knock out Chicken by Genome Editing with CRISPR/Cas for augmentation of productivity in poultry (SERB)	Dr. T.K. Bhattacharya		2019-22
6.	Genome wide association study in Indigenous poultry breeds (ILRI)	Dr. T.K. Bhattacharya	Dr. R.N. Chatterjee Dr. S.P. Yadav Dr. L.L.L. Prince	2019-22
7.	Model Project and Demonstration Unit for Backyard Poultry, Livestock Vermifarming and Moringa Integration (DAHD)	Dr. R.K. Mahapatra	Dr. S.K. Bhanja Dr. B. Prakash	2020-23
8.	Network project on INFAAR (Indian Network of Fisheries and Animal Antimicrobial Resistance) (Network)	Dr. D. Suchitra Sena	Dr. S.K. Bhanja Dr. M.R. Reddy Dr. T.R. Kannaki	2020-24
9.	Effect of dietary supplementation of biofortified maize (QPM) on productive performance in broilers chickens (ICAR Network project)	Dr. B. Prakash	Dr. S.V. Rama Rao Dr. M.V.L.N. Raju	2015-22
C. Contract Research Projects				
1.	Evaluation of Shea olein & Lecithinated bypass fat in broiler chicken diet (M/s 3F Industries, Hyderabad)	Dr. M.V.L.N. Raju		2019-20 (11 months)
2.	Evaluation of sea plant extracts as alternative to antibiotic growth promoters in broilers chickens (M/s Sea6 Energy Private Ltd., Bengaluru)	Dr. S.S. Paul		2020-21 (12 months)

S. No.	Project Title	PI	Co-PIs	Project Duration
List of projects completed during 2020				
A. Institute Funded Projects				
1.	Development and improvement of male lines for production of backyard chicken varieties for free range farming (Project No. - ANSCDPRSIL201500100050)	Dr. U. Rajkumar	Dr. Santosh Haunshi Dr. L.L.L. Prince Dr. C. Paswan	2015-20
2.	Improvement and evaluation of female lines for backyard/ free range farming (Project No. - ANSCDPRSIL201500200051)	Dr. U. Rajkumar	Dr. L.L.L. Prince Dr. S.P. Yadav Dr. C. Paswan	2015-20
3.	Genetic characterization and conservation of indigenous chicken germplasm (Project No. - ANSCDPRSIL201500300052)	Dr. Santosh Haunshi	Dr. U. Rajkumar	2015-20
4.	Genetic evaluation of elite layer germplasm (Project No. - ANSCDPRSIL201500400053)	Dr. C. Paswan	Dr. R.N. Chatterjee Dr. T.K. Bhattacharya	2015-20
5.	Maintenance of coloured broiler populations for intensive and semi intensive broiler farming (Project No. - ANSCDPRSIL201500500054)	Dr. B.L.N. Reddy	Dr. L. Leslie Leo Prince	2015-20
6.	Utilization of distillery by-products in poultry diet: the nutritional implications and strategies for improving the nutritional value (Project No. - ANSCDPRSIL201700100062)	Dr. M.V.L.N. Raju	Dr. S.V. Rama Rao Dr. B. Prakash Dr. S.S. Paul Dr. A. Kannan	2017-20
7.	Development of a composite feed additive using promising organic acids and plant bioactive compounds for improving gut health and productivity in chicken (Project No. ANSCDPRSIL201700300065)	Dr. S.S. Paul	Dr. M.V.L.N. Raju Dr. B. Prakash Dr. S.V. Rama Rao Dr. S.P. Yadav	2017-20
8.	Disease diagnosis, Vaccination & Sero-monitoring in pureline chickens (Project No. ANSCDPRSIL201700200064)	Dr. T.R. Kannaki	Dr. S.K. Bhanja	2017-20
B. Externally Funded ResearchProjects				
1.	Adaptation and mitigation strategies inpoultry to thermal stress through nutritional and environmental manipulation (NICRA)	Dr. S.V. Rama Rao	Dr. M.V.L.N. Raju Dr. U. Rajkumar Dr. B. Prakash Dr. T.R. Kannaki	2017-20

12 Consultancy, Contract Research and Commercialization of Technologies

Institute Technology Management Unit (ITMU)

Institute Technology Management Unit at ICAR-DPR is managed by the Institute Technology Management Committee (ITMC). ITMC is the highest body which takes important decisions for the intellectual property management at DPR viz., filing of patents, approval of the technology for commercialization, pricing of the technologies ready for commercialization etc. ITMC is chaired by the Director of the Institute.

ITMC Meeting Conducted

ITMC meeting was held on 23rd July, 2020 to examine patent applications for their novelty and commercial applicability, to review two Trademarks applications of chicken varieties "*Srinidhi*" and "*Vanashree*" and evaluation of technologies developed at this Directorate for commercialization.

Technologies Approved for Commercialization

Two technologies developed at this Directorate having commercial value and practical application in poultry industry were approved and submitted to Agrinnovative India Limited, New Delhi, for commercialization to reach the end users and benefit them. Details of the technologies are given in the following (Table 1).

Contract Research

The facilities of the Directorate were extended for the benefit of poultry industry through the contract research mode of ICAR. Two projects were in operation during the year. One project was on "Evaluation of sea plant extracts as alternative to antibiotic growth promoters in broilers chickens" for M/s Sea6 Energy Private Ltd., Bengaluru for 12 months from September 2020 (Rs. 15.81 lakhs). The other project was on "Evaluation of Shea Olein & Lecithinated Bypass fat in broiler chicken diet" for M/s 3F Industries, Hyderabad for 11 months from August 2019 (Rs. 9.16 lakhs).

Collaborative program with ICAR-CISH under DAPSC

With the aim of human resource development of the Schedules Castes and promotion of free range and backyard poultry farming utilizing the potential of *Vanaraja*, *Gramapriya*, *Srinidhi*, Aseel, Kadaknath etc. in the rural areas, ICAR-DPR entered in agreement with ICAR-CISH from November 2020 to March 2022 with objective of collaborative capacity building programmes on "Value Chain on Backyard Poultry" under Developmental Action Plan for Schedules Caste (DAPSC) for women empowerment at adopted SC villages of Malda district, West Bengal.

Patent filed

One patent application for the technology invented at ICAR-DPR was filed with the Indian Patent office during the period under report (Table 2).

Table 1. Technologies approved for commercialization

S.No.	Technologies developed	Inventors
1.	Paper dip assay kit for detection of myostatin or any other protein	Dr. T.K. Bhattacharya
2.	Concanavalin A (Con-A) EIISA Kit for Newcastle disease virus Sero-monitoring in chicken	Dr. T.R. Kannaki

Request for Examination of Patents

The details of requests for examination of patents received during the year 2020 is given in Table 3.

Trademarks

Two trademarks of ICAR-DPR viz. KRISHIBRO® and KRISHILAYER® were renewed for a period of 10 years with effect from 24th March 2020 (Table 4).

Table 2. Details of patents filed for the technologies

S.No	Title of patent	Date of filing	Application number	Inventor
1.	Methods for production of chicken having low cholesterol content in serum and eggs	29 December, 2020	TEMP/E-1/63512/ 2020-CHE	Dr. T.K. Bhattacharya

Table 3. List of requests received for examination of patents during 2020

S. No	Name of innovation	Date of filing	Application no.	FER/Hearing notice issued on	FER submitted/ Hearing attended on
1.	A simple method of detection of protein(s) by using a paper-dip assay kit	25 July, 2018	TEMP/E-1/30619/ 2018-CHE	FER issued on 7 July 2020	FER submitted on 7 January 2021
2.	Primers and method for detection of haplotypes on promoter of a gene and its use in poultry	27 March, 2013	1365/CHE/2013	Hearing notice issued on 23 July 2020	Hearing attended on 24 August, 2020
3.	Primers and method for detection of haplotypes on promoter of a gene and its use in poultry	27 March, 2013	1365/CHE/2013	Received refusal order under section 15 on 27 October 2020	Review appeal with revised claims filed on 27 November 2020

Table 4. Details of trademarks renewed during the year

S. No	Trademarks	Date of filing Application	Application Number	Date of grant	Renewal date
1.	KRISHIBRO®	24 March, 2010	1941583Class: 29/31	28 March 2012	21st March 2020
2.	KRISHILAYER®	24 March, 2010	1941584Class:29/31	1 June 2015	21st March 2020

13 Committees

Research Advisory Committee

The meeting of Research Advisory Committee of the Directorate was held on 18th and 19th February, 2020 under the Chairmanship of Prof. B.B. Mallick, Ex Vice Chancellor, West Bengal University of Animal and Fisheries Sciences, Kolkata and former Director, Indian Veterinary

Prof. B.B. Mallick chairing the RAC meeting

Research Institute, Izatnagar. The meeting was attended by the RAC members, viz. Dr. B.S. Prakash, former ADG (AN&P), ICAR; Dr. Arjava Sharma, former Director, NBAGR, Karnal; Dr. J.R. Rao, former HOD, IVRI, Izatnagar; Dr. R.S. Gandhi, ADG (AP&B), ICAR; Dr. R.N. Chatterjee, Director, ICAR-DPR and Dr. M.V.L.N. Raju, Member Secretary. Dr. R.N. Chatterjee, Director, ICAR-DPR presented an overview of research progress during the year 2019. He informed about the achievements with regard to functional genomics, production of low-cholesterol eggs, alternate feed ingredients etc. Dr. M.V.L.N. Raju, Member Secretary presented the action taken report for the recommendations of the previous RAC meeting. Subsequently, the gist of research progress in various projects undertaken in Genetics & Breeding, Nutrition, Physiology and Health was presented and reviewed.

RAC meeting in progress

The Chairman and Members expressed satisfaction about the overall achievements. In addition, a programme for enhancing germplasm supply involving research elements was discussed and the tentative road map was prepared.

IAEC Meeting

XXV Institutional Animal Ethics Committee Meeting was conducted virtually on 20th June 2020 through Google Meet online. CPCSEA nominees, Dr. Ramavat Ravindar Naik, Technical Officer, National Centre for Laboratory Animal Sciences (NCLAS), Dr. Uma Mahesh Yelisetti and Dr Krishna Kumar, Biological E Ltd. were present in the meeting.

Institute Management Committee

The 41st Institute Management Committee meeting was held at this Directorate on 20th March, 2020.

Institute Research Committee Meeting

The Annual IRC meeting was held on 5th to 6th June and 25th July, 2020 at the Directorate. The meetings were chaired by Dr. R.N. Chatterjee, Director and Dr. T.K. Bhattacharya acted as the Member Secretary. The Principal Investigators presented the achievements of their respective projects. The Chairman, IRC suggested measures for overcoming the difficulties in achieving desired targets.

14 Seminars, Conferences, Workshops

Participation of Scientists in Seminars, Conferences, Workshops etc.

S. No.	Particulars of Conference/ Seminar/Workshop	Official(s)	Schedule	Venue/Organised by
1.	Workshop on 'Understanding the emergence of variant infectious bronchitis virus in chickens in UK and India: shared control strategies'	Dr. T.R. Kannaki, Sr. Scientist	6-7 February 2020	Namakkal, Tamil Nadu
2.	XXXII Annual Convention (IAVMICON2020)	Dr. Suchitra sena, Pr. Scientist	6-7 February 2020	IVRI, Izatnagar
3.	National Symposium on Enhancement of farmers, income through management of animal genetic resources and XVII annual convention of society of conservation of domestic animal biodiversity (SOCDAB)	Dr.T.K. Bhattacharya, National Fellow Dr. Santosh Haunshi, Pr. Scientist Dr. L.L.L. Prince, Pr. Scientist	10-11 February 2020	College of Veterinary and Animal Husbandry, Mhow, MP
4.	International Webinar Series 2020- Emerging trends in Extension & Social Sciences Research	Dr. Vijay Kumar, Sr. Scientist	10-16 June 2020	College of Fisheries, C.A.U., Imphal ICAR-NAARM, Hyderabad and ICAR-CTCRI, Kerala.
5.	Webinar on Critical elements for safe and efficient feed production	Dr. M.V.L.N. Raju, Pr. Scientist	26 June 2020	Trow Nutrition, India
6.	Webinar on Natural is future	Dr. M.V.L.N. Raju, Pr. Scientist	8 July 2020	Natural Remedies Pvt. Ltd, Bengaluru
7.	Webinar on Sensitization on uploading of data and new functionalities in KRISHI Repositories	Dr. Santosh Haunshi, Pr. Scientist	15 July 2020	ICAR-IASRI, New Delhi
8.	National Webinar on Microbial Disease Occurrence/ Emergence Pattern Under Changing Climatic Conditions in Livestock and Poultry	Dr. N. Anand Laxmi, Pr. Scientist	3- 4 August 2020	Veterinary College and Research Institute, Orathanadu, Tamil Nadu

S. No.	Particulars of Conference/ Seminar/Workshop	Official(s)	Schedule	Venue/Organised by
9.	Gender and Pandemic: Challenges and Opportunities	Dr. Vijay Kumar, Sr. Scientist	10-12 August 2020	ICAR-ATARI, Bengaluru, ICAR-CPCRI Kayamkulam, ICAR-NIANP, Bengaluru, ICAR-IIHR, Bengaluru and ICAR-CIFT, Kochi
10.	Webinar on HPTLC: Technique and Applications	Dr. S.V. Rama Rao, Pr. Scientist Dr. M.V.L.N. Raju Pr. Scientist	24 August 2020	Anchrom Enterprises (I) Pvt. Ltd., Mumbai. And College of Veterinary Science, Hyderabad
11.	Webinar on How to control poultry gut inflammation with feed additives	Dr. M.V.L.N. Raju, Pr. Scientist	4 September 2020	Watt Global Media, Illinois, USA
12.	Online International Workshop on Regulatory Approaches for Animal Biotechnology	Dr. S.P. Yadav, Pr. Scientist	8-9 September 23-24 September 7-8 October 2020	ISAAA
13.	Webinar on Could local sourcing help control feed ingredients' microbial quality ?	Dr. M.V.L.N. Raju, Pr. Scientist	16 September 2020	Watt Global Media, Illinois, USA
14.	Virtual Workshop on Recent Advances in feed Evaluation for Poultry	Dr. S.V. Rama Rao, Pr. Scientist Dr. M.V.L.N. Raju, Pr. Scientist Dr. S. S. Paul, Pr. Scientist	23-30 September 2020	Massey University, New Zealand and US Soybean Export Council
15.	International webinar on Veterinary and Livestock	Dr. N. Anand Laxmi, Pr. Scientist Dr. D. Suchitra Sena, Pr. Scientist	23-25 September 2020	-
16.	Workshop-cum-training programme on "Intellectual Property Rights in Agricultural Research and Education in India"	Dr. M.R. Reddy Pr. Scientist	12-28 September 2020	NAHEP and IP&TM Unit of ICAR Headquarters, New Delhi.
17.	Online International Conference on Climate Change, Environment and Sustainable Development 2020	Dr. R. K. Mahapatra, Pr. Scientist Dr. S.P. Yadav, Pr. Scientist	2-3 October 2020	International Multidisciplinary Research Foundation
18.	Egg: A natural immunity booster	All the Scientists of the Directorate	9 October 2020	ICAR-DPR, Hyderabad
19.	National webinar on Entrepreneurial opportunities in Rural Poultry	All the Scientists of the Directorate	3-5 November 2020	ICAR-DPR, Hyderabad
20.	4th Interactive Session for IBSCs registered on IBKP portal	Dr. S.P. Yadav, Pr. Scientist	05 November 2020	DBT, New Delhi

S. No.	Particulars of Conference/ Seminar/Workshop	Official(s)	Schedule	Venue/Organised by
21.	J-Gate@CeRA Online Regional Ambassador and Users Orientation Program - Southern region	Dr. S.P. Yadav, Pr. Scientist Shri J. Srinivas Rao, A.C.T.O.	09 November 2020	DKMA-ICAR
22.	Knowledge Day Webinar	Dr. S.V. Rama Rao, Pr. Scientist Dr. M.V.L.N. Raju, Pr. Scientist Dr. N. Anand Laxmi, Pr. Scientist	25 November 2020	IPEMA, Hyderabad
23.	Webinar on "The promise of livestock genomics"	Dr. S. Jayakumar, Sr. Scientist	26 November 2020	ICAR-NBAGR, Karnal
24.	International Webinar on Defeating Biotic Stressors to Safeguard Poultry Production, Health and Food Safety	Dr. L.L.L. Prince, Pr. Scientist Dr. S.P. Yadav, Pr. Scientist Dr. A. Kannan, Pr. Scientist Dr. M. Shanmugam, Sr. Scientist	27-28 November 2020	TANUVAS, Chennai
25.	Online National Seminar on "Big data Analytics"	Dr. L.L.L. Prince, Pr. Scientist Dr. S. Jayakumar, Sr. Scientist	10-11 December 2020	ICAR- NAARM, Hyderabad

15

Distinguished Visitors

- Dr. B.N. Tripathi, DDG (Animal Sciences), ICAR, New Delhi
- Prof. B.B. Mallick, Chairman, RAC & Former VC, WBUAFS, Kolkata
- Dr. R.S. Gandhi, ADG (AP&B), ICAR, New Delhi
- Dr. B.S. Prakash, Former ADG (ANP) & Member, RAC
- Dr. Arjava Sharma, Former Director, NBAGR, Karnal & Member, RAC
- Dr. J.R. Rao, Former HOD, IVRI, Izatnagar & Member, RAC
- Dr. Sudhakar Reddy, Former Registrar, SVVU, Tirupati
- Shri Rajendra Pawar, Chairman, Agricultural Development Trust (ADT), Baramati

Dr. B.N. Tripathi, DDG (AS) visiting DPR

16 Personnel

Headquarters, Hyderabad

Research & Management Position

1. **Dr. R.N. Chatterjee,** Director (Acting)

Scientific

1. **Dr. S.V. Rama Rao,** Pr. Scientist
2. **Dr. M.V.L.N. Raju,** Pr. Scientist
3. **Dr. B.L.N. Reddy,** Pr. Scientist
4. **Dr. N. Anand Laxmi,** Pr. Scientist
5. **Dr. Shyam Sundar Paul,** Pr. Scientist
6. **Dr. M.R. Reddy,** Pr. Scientist
7. **Dr. M. Niranjan,** Pr. Scientist
8. **Dr. U. Rajkumar,** Pr. Scientist
9. **Dr. R.K. Mahapatra,** Pr. Scientist
10. **Dr. D. Suchitra Sena,** Pr. Scientist
11. **Dr. Santosh Haunshi,** Pr. Scientist
12. **Dr. L. Leslie Leo Prince,** Pr. Scientist
13. **Dr. S.P. Yadav,** Pr. Scientist
14. **Dr. A. Kannan,** Pr. Scientist
15. **Dr. B. Prakash,** Sr. Scientist
16. **Dr. M. Shanmugam,** Sr. Scientist
17. **Dr. T.R. Kannaki,** Sr. Scientist
18. **Dr. K.S. Rajaravindra,** Sr. Scientist
19. **Dr. S. Jayakumar,** Sr. Scientist
20. **Dr. Chandan Paswan,** Sr. Scientist,
21. **Dr. Vijay Kumar,** Sr. Scientist

National Fellow

1. **Dr. T.K. Bhattacharya,** National Fellow

Technical

1. **Dr. S.K. Bhanja,** C.T.O. (Farm Manager)
2. **Sri V.V. Rao,** A.C.T.O.
3. **Smt. Minakshi Dange,** A.C.T.O.
4. **Sri D. Pratap,** A.C.T.O.
5. **Sri J. Srinivas Rao,** A.C.T.O.
6. **Sri A. Ravi Kumar,** Tech. Officer
7. **Sri G. Rajeshwar Goud,** Tech. Officer
8. **Sri Md. Maqbul,** Tech. Officer (Driver)
9. **Sri M. Pantulu,** Sr. Tech. Asst. (Driver)
10. **Sri G. Madhukar,** Sr.Tech. Asst.(T-4)
11. **Sri Md. Yousufuddin,** Sr. Tech. Asst.(Driver)
12. **Sri P. Santosh Phani Kumar,** Tech. Asst.
13. **Sri D. Ashok Kumar,** Technician (T-1)

Administration

1. **Sri A.V.G.K. Murthy,** A.O.
2. **Smt. R.T. Nirmala Veronica,** A.A.O.
3. **Sri R. Sudarshan,** A.F. & A.O.
4. **Smt. O. Suneeta,** P.S.
5. **Smt. T.R. Vijaya Lakshmi,** Assistant
6. **Smt. M. Kamala,** Assistant
7. **Sri Rajesh Parashar,** U.D.C.
8. **Sri L.V.B. Prasad,** U.D.C.
9. **Miss N. Siva Dharani,** L.D.C.
10. **Sri R. Ganesh,** L.D.C.

Skilled Support Staff

1. **Sri Syed Mujtaba Ali**
2. **Sri N. Manyam**
3. **Sri K. Charles**
4. **Sri G. Narsimha**
5. **Sri Manzoor Ahmed**
6. **Sri D. Srinivas**
7. **Sri M. Narsing Rao**
8. **Sri V. Ravinder Reddy**
9. **Sri P. Shankaraiah**
10. **Sri K. Venkataiah**
11. **Sri D. Shiva Kumar**
12. **Smt. K. Vimala**

Promotions

- **Dr. Vijay Kumar**, Scientist has been promoted to the next higher grade of Sr. Scientist w.e.f. 15-12-2018.
- **Sri R. Sudarshan**, JAO has been promoted to AF&AO w.e.f. 01-05-2020.
- **Sri D. Ashok Kumar**, S.S.S. has been promoted to Technician (T-1) on 08-12-2020.

The following personnel have been granted 3rd and Final Financial upgradation under MACPS

1. **Smt. M. Kamala**, Assistant
2. **Smt. K. Vimala**, SSS

New Joinings

- **Dr. S. Jayakumar,** Sr. Scientist has joined on 01-10-2020 on transfer from ICAR-National Bureau of Animal Genetic Resources, Karnal, Haryana.
- **Sri G. Madhukar,** Sr. Technical Asst. has joined on 31-10-2020 on transfer from ICAR-NIASM, Baramati, Pune, Maharashtra.

Retirements

- **Sri C. Bagaiah**, AF&AO has retired on superannuation on 30-04-2020
- **Sri A. Subrahmanyam**, Tech. Officer. has retired on superannuation on 31-08-2020

Transfers

- **Smt. N.R. Dhanutha**, Sr. Tech. Asst. has been transferred to ICAR-CMFRI on 31-10-2020.

Obituary

- **Dr. Chandan Paswan,** Sr. Scientist passed away on 20th April 2020.

Regional Station, Bhubaneswar

Scientific

1. **Dr. R.K.S. Bais,** Pr. Scientist & In-Charge, Regional Station (till July, 2020)
2. **Dr. C.K. Beura,** Pr. Scientist & In-Charge, Regional Station (from July, 2020)
3. **Dr. S.K. Mishra,** Pr. Scientist
4. **Dr. M.K. Padhi,** Pr. Scientist
5. **Dr. S.K. Sahoo,** Pr. Scientist
6. **Dr. B.K. Swain,** Pr. Scientist
7. **Dr. P.K. Naik,** Pr. Scientist
8. **Dr. S.C. Giri,** Pr. Scientist
9. **Dr. D. Kumar,** Scientist

Technical

1. **Sri A.K. Nanda,** Sr. Technical Officer
2. **Sri A.K. Jha,** Technical Officer
3. **Sri S. Rakesh Jaiswara,** Sr. Technical Assistant
4. **Sri S. Pradeep Kumar,** Sr. Technician

Administration

1. **Sri. Sukul Hansada,** Assistant

Skilled support staff

1. **Sri Birendra Kumar Behera,** Skilled Supporting Staff
2. **Sri Harish Chandra Sahoo,** Skilled Supporting Staff

Transfers

- **Dr. R.K.S. Bais** transferred to ICAR-CARI Headquarters, Izatnagar in July, 2020.
- **Dr. K.V.H. Sastry** transferred to ICAR-NIANP, Bengaluru in February, 2020.

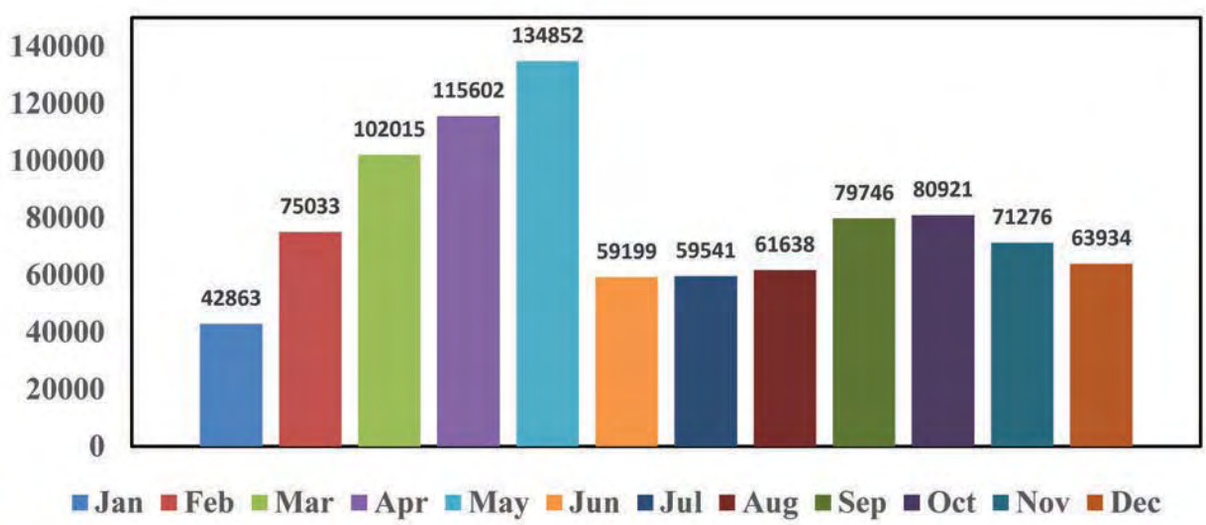
17 Other Relevant Information

Agricultural Knowledge Management Unit

NKN Connectivity: Leased line connectivity of 100 Mbps under National Knowledge Network (NKN) has been maintained with suitable firewall hardware for security. Backup connectivity with BSNL leased line is also maintained for connectivity without interruption. This high bandwidth connectivity was effectively utilized by the staff in conducting and participating in several online meetings and webinars during COVID period and new normal situation.

Institute webpage with payment gateway: Institute webpage (http://www.pdonpoultry.org) was frequently updated and had about 9.46 lakh hits during 2020 with an average of 2590 visits per day. More number of people visited the webpage during COVID lockdown period. Payment Gateway link has been maintained in DPR webpage. Online payment through State Bank Collect on "Booking or purchase of germplasm" and "Payment by DPR staff" has been provided.

Hits on DPR webpage during 2020



ICAR-DPR Mobile App: An Android mobile App in English named "ICAR DPR" is maintained which provides information about institute, chicken germplasm, AICPR on Poultry Breeding, Poultry Seed Project, germplasm availability, etc. About 1,690 users downloaded this app during 2020. Average rating given by 19 users was 4.5 out of 5.

DPR Profile film: Film on the profile of DPR "DPR Marching ahead" is available on YouTube. This film is available in English, Hindi and Telugu. YouTube Link: https://www.youtube.com/channel/UCDL2gnmjtzabrxX39waOITA. Informative and awareness videos are also available in the ICAR-DPR Poultry channel.

Information dissemination: Facebook page https://www.facebook.com/ICAR.DPR.Hyderabad and Twitter handle https://twitter.com/IcarPoultry were created for effective dissemination of information to farmers and poultry entrepreneurs.

Webpage of ICAR-DPR: http://pdonpoultry.org/

Webpage of AICRP on Poultry Breeding: https://aicrp.icar.gov.in/poultry/

Facebook Page: https://www.facebook.com/ICAR.DPR.Hyderabad

Twitter page: https://twitter.com/IcarPoultry

Android Mobile:App https://play.google.com/store/apps/details?id=com.webfarmatics.icar&hl=en

YouTube: https://www.youtube.com/channel/UCDL2gnmjtzabrxX39waOITA

Farm Unit

The ICAR-DPR experimental farm has two units viz. Pureline and Commercial Units. Pureline farm is for the scientific research related to breeding, nutrition and health experiments whereas the commercial unit serves the purpose of technology transfer by means of producing commercial hatching eggs and other allied activities.

During this period of report, one isolation unit of 465 square feet area has been constructed in the Pure Line farm area. The monthly average of livestock reared in experimental farm were 27,689 birds. In the farm, a total of 15,83,533 eggs were produced during the year, out of which 4,73,367 were hatching eggs and the remaining were table eggs.

New Campus

The 10 acre area procured from the Veterinary University (located at about 1 km distance from the existing campus) has been developed into a Germplasm Supply Unit and Research Centre on commercial germplasm. During the year 2020, a broiler shed having capacity to house 2000 chicks was constructed under a DBT sponsored project. The same was inaugurated by Dr. B.N. Tripathi, DDG (AS), ICAR, New Delhi on 1st March 2020. In addition, construction of one brooder house and another breeder house is nearing the completion. Arrangements are actively being made for provision of water and electricity supply and other miscellaneous ancillary facilities in the campus.

Experimental Hatchery

The experimental hatchery of the institute has the state of art equipment and infrastructure to carry out pedigree hatching of pure line populations as well as hatching and supply of improved germplasm developed by the Directorate to farmers, NGOs, Govt. agencies and other stakeholders. The Unit has 4 setters of 15,000 eggs capacity each and 4 hatchers of 9000 capacity each, besides the facility for fumigating the hatching eggs upon receipt from the Farm and a walk-in cold room with storage capacity of 40,000 eggs. The Incubators have been fitted with data loggers to monitor and control humidity and temperature in the setters, hatchers and in cold room 24/7. During the year 2020, a total of 76,213 hatching eggs, 1,96,274 numbers of day-old chicks, 20,602 parents and 2,690 grown up birds were sold/supplied to the farmers across the country. In addition, 2,805 embryonated eggs were supplied to different organizations for diagnosis and vaccine production.

Feed Compounding Unit

The Feed Compounding Unit served as the Central Facility for supplying feed required for the various purelines and commercial stocks of the Directorate. The unit is equipped with 2 feed plants, each of 500kg capacity/hour, besides a go-down with a capacity to store 180-200 tonnes of raw materials. The raw materials, like maize, soybean meal, DORB, shell grit, vitamins, minerals etc. were procured, their quality was checked and by using them in required proportions, balanced rations were compounded for chick, grower and adult breeding stocks of layer, broiler and rural type of birds as per the nutrient specifications. During the year, a total quantity of 983.4 MT of feed was compounded and supplied to the experimental farm. In addition, 3.65 MT of feed was supplied to the farmers and beneficiaries under the TSP and SCSP programs.

Sales and Marketing Unit

The Sales and Marketing Unit was the core unit for coordinating and undertaking various activities related to sales and marketing of hatching eggs and day-old chicks of parent stock and terminal crosses of germplasm developed by the Directorate. The birds culled in the breeding programme, dressed birds and surplus eggs for table purpose were also sold for table purpose to the consumers. The

DPR Sale counter

grownup birds of about 4-6 weeks age were supplied to the farmers for rearing purpose.

Library and Information Centre

The Directorate is having a small library with informative and resourceful reference material, which is much helpful to the readers like scientific, technical, administrative staff of the institute. Besides this, the other users from Veterinary University and poultry industry utilize the resource material available at the institute library. The library has been subscribing three foreign journals and six Indian journals/magazines and having approximately eight hundred reference books on different aspects of poultry science and livestock as well other general subject books. The Scientists of the Institute are also utilizing the services of ICAR-Cera consortia for their research work. All the DPR publications (such as annual reports, newsletters, un-priced books) were digitalized. The facilities of this library are being utilized by the institute's scientists, scholars and students and faculty of neighbouring veterinary college as well those from other parts of the country.

ICAR-DPR celebrates 33rd Foundation Day

The Directorate celebrated the 33rd Foundation Day on 1st March 2020. Dr. B. N. Tripathi, Deputy Director General (Animal Sciences), ICAR, New Delhi graced the occasion as the Chief Guest. During his speech, he lauded the contribution of ICAR-DPR in the improvement of poultry production in the country, particularly the backyard poultry production through dissemination of improved chicken varieties throughout the country. Dr. Tripathi highlighted the need for giving importance to research in the areas of precision farming, trans-disciplinary research and use of artificial intelligence for further improvement in productivity of poultry farming. On this occasion, Dr. Tripathi released a booklet entitled "Production of low cholesterol chicken: A biotech intervention" authored by Dr. T.K. Bhattacharya et al. He also distributed the prizes to winners of the games and sports competitions organized for the staff of the Institute.

Shri. P. Venugopal Reddy, Chairman, Ekalavya Foundation, Hyderabad participated in the program as the Guest of Honour. He emphasised the need for collaboration of different stake holders to realize the goal of doubling of farmers' income through interventions in animal husbandry activities, particularly in backyard poultry rearing in order to diversify and improve the source of income of the country farmers. Dr. S. Vaithiyanathan, Director, NRC on Meat, Hyderabad also graced the occasion as the Guest of Honour.

Dr. R. N. Chatterjee, Director, ICAR-DPR presided over the function and highlighted the contribution of ICAR-DPR for development of poultry sector in the country through its germplasm, technologies

Dr. B.N. Tripathi, DDG (AS) lighting the lamp and addressing the staff

Dr. B.N. Tripathi, DDG (AS) releasing the booklet and distributing the prizes

and extension activities. He also narrated the future thrust areas for which the Institute has prepared the road map to attain the target of doubling farmers' income by 2022. Earlier, Dr. S. V. Rama Rao, Principal Scientist presented the research activities of the Institute to the August gathering. Dr. M. R. Reddy, Principal Scientist, Chairman organizing committee welcomed the dignitaries.

ICAR-DPR celebrates National Science Day

The Directorate organized the National Science Day celebrations on 28th February 2020. Dr. G.R. Yugandhar, MS (General Surgery), Swamy Hospital and founder President, 'The World United' organization graced as the Chief Guest. Dr. S.V. Rama Rao, Director I/c thanked the Chief Guest for giving the staff a detailed demonstration on the mind control process to reduce stress. An exhibition to showcase the new technologies and varieties developed by the institute and information on chicken and eggs was also organized, where about 500 school children from different Schools visited the stall.

Dr. G.R. Yugandhar addressing the staff

School children at the exhibition stall

Hindi Implementation Activities

The Directorate conducted three quarterly meetings of Official Language Implementation Committee on 27-06-2020 (March & June meeting conducted jointly due to lockdown), 23-10-2020 and 18-12-2020, in which different issues were discussed for effective implementation of Hindi Language in office. The Institute conducted two Hindi workshops in virtual mode, i.e. on 19-09-2020 and 19-12-2020 for upgrading the Hindi skills of staff in their day to day routine official work.

Hindi Day celebrations

The Directorate also celebrated Hindi Fortnight celebrations during 14-28 September, 2020 and Hindi Day on 14th September, 2020. During the celebrations, different literary competitions were conducted for the staff members. Dr.R.N. Chatterjee, Director highlighted the importance of Hindi language and its vast usage throughout the country. The Director presented cash awards and certificates to all winners. All the programs conducted during this period followed COVID-19 instructions. A virtual meeting of Town Official Language Implementation Committee (TOLIC) was attended on 16-12-2020, in which suggestions and guidance noted for further effective Hindi implementation at Institute.

Republic Day and Independence Day

The Directorate celebrated the Republic Day on 26th January 2020 and the Independence Day on 15th August 2020. Dr. R.N. Chatterjee, Director hoisted the National Flag and addressed the staff of the institute and their families.

Rooftop Solar System Installation

In relation to utilization of renewable solar energy at the institute, Grid-connected 50 KW Rooftop Solar panels were installed on the terrace of the Admn-Lab building and commissioned.

International Yoga Day Celebrated

The staff members actively celebrated International Yoga Day on 21st June 2020 by participating in the Yoga session at their homes due to COVID restrictions and shared their pictures. The message on the importance of Yoga was given wide publicity by posting on the website of the Directorate and in the notice boards for the information of the staff.

Swachhta Pakwada Celebrations

A Swacchta Pakwada was organised at the Directorate during16-31 December 2020 honouring the principles and preachings of the Father of the nation Mahatma Gandhi regarding cleanliness. In this connection, several activities were organised. The programme started with the delivering of Swacchta pledge and tree plantation drive at the directorate. The staff of the institute was involved in cleanliness drive within and outside the campus.

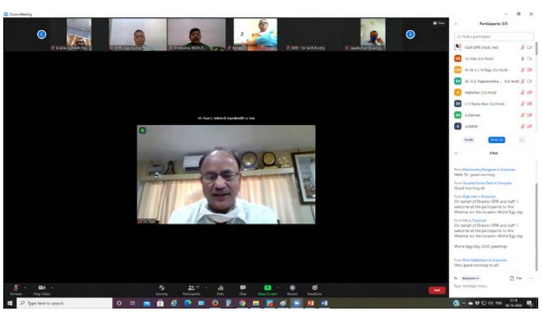
Dr. R.N.Chatterjee, Director planting a sapling

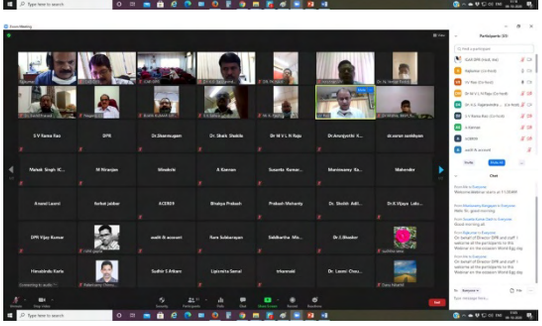
Swacchta Pakwada celebrations

An e-office implementation drive and weeding of old and obsolete records was also carried out at the Directorate. The procedure for vermicomposting was demonstrated to the staff for proper utilization of kitchen and garden waste. The staff visited the MGMG adopted village at Khandu Thanda, Balanagar Mandal, Mehboob Nagar district and Kismatpur village in Ranga Reddy district and conducted cleanliness drive. The importance of segregation of waste into biodegradable and non-biodegradeable was explained to the public. Kisan Diwas was also celebrated on 23.12.2020 at the Directorate by inviting farmers from nearby villages. The farmers were briefed about the COVID-19 safety measures, Swachh Bharat initiatives and schemes and technologies developed by this Directorate for the farmers. Competitions were conducted for the staff regarding Swachh Bharat programmes and the winners were honoured. The staff also participated in the cleanliness drive in a tourist spot located at Himayat Sagar. A Swachhta Rally was also undertaken at Rajendra Nagar displaying placards on cleanliness. An expert lecture was delivered by the Chief Guest Dr. R. Ramesh, Head, Center for Rural Infrastructure, NIRD & PR, Rajendra Nagar, Hyderabad on sanitation and well-being.

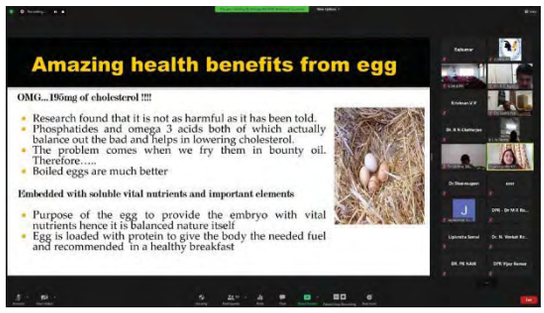
ICAR-DPR celebrated "WORLD EGG DAY 2020"

ICAR-DPR, Hyderabad organised a webinar on the occasion of the "World Egg Day 2020" with the theme "Egg: A natural immunity booster" on 9th October, 2020. In his opening remarks, Dr. R.N. Chatterjee, Director appreciated the team for organising the webinar at this compelling time. He said egg is the cheapest source of balanced food which is affordable by all sections of the people and which can improve the health of children, pregnant women and elderly people. He said that more and more public awareness should be created to educate about the good qualities of egg consumption and also eradicate the misconceptions and myths regarding the eggs. Mr. V.V. Krishnan, Chief Technical Officer of SKM Egg Products Export (India) Ltd, Tamil Nadu delivered a talk on "Residue-free egg production". He elaborated on the various regulatory mechanisms followed in the country in producing residue-free egg products for





local and export market. He also spoke on different possible residues in egg production, their source and ways and means to address these issues in the production line. Dr. Arunjyothi, Scientist (Home Science), KVK, PVNRTVU, Telangana also delivered a talk on "Role of egg in human nutrition and health". She described the various components of egg and their role in human health. She also described the nutritive qualities of eggs and how they support the wellbeing for different age groups. Dr. P. Mahesh, Director, CPDO, Bengaluru also participated in the webinar. The webinar was attended by staff of the Directorate and its Regional Station, Bhubaneswar, AICRP-PB and PSP centres,



SVUs, field veterinarians from various state AHDs and poultry entrepreneurs from all over the country. The programme was coordinated by Dr. U. Rajkumar, Dr. L. Leslie Leo Prince and Dr. K.S. Rajaravindra.

National Webinar on "Entrepreneurial Opportunities in Rural Poultry" organized by ICAR

A National Webinar on "Entrepreneurial Opportunities in Rural Poultry" as part of a three days training programme, with an objective to apprise youth about employment and income generation opportunities in rural poultry sector was inaugurated by Dr. R.N. Chatterjee, Director, ICAR-DPR on 3rd November 2020. Dr. Chatterjee, highlighted the scope and opportunities in this sector and how to achieve the goal of doubling farmers income by 2022. He also emphasized the issue of impact of COVID 19 on income generation and employment in rural India and contribution of poultry sector to mitigate malnutrition. There were 561 applicants from 200 districts of 29 states. About 60% applicants belonged to the Southern region of India followed by Northern region (15.9%), Eastern region (13.9%), Western

Dr. R.N. Chatterjee delivering inaugural address

region (9.3%) and NE region (1.6%). Similarly, about 60% of applicants had the rural background. There was great interest among the youth about the programme because about 62% of them were below 35 years of age and about 32 % applicants were students. During this 3 days programme,

different topics such as status and scope of rural poultry in India, commercialization to promote entrepreneurship, business plan, economics and marketing opportunities and small-scale business opportunities were covered by eminent speakers. Dr. U. Rajkumar, Pr. Scientist highlighted the present scenario and future prospects of rural poultry farming and the role of ICAR-DPR in promoting the rural poultry farming in the country. More than 150 persons virtually participated in the inaugural session of webinar through Zoom meeting and Facebook live streaming.

International Women's Day

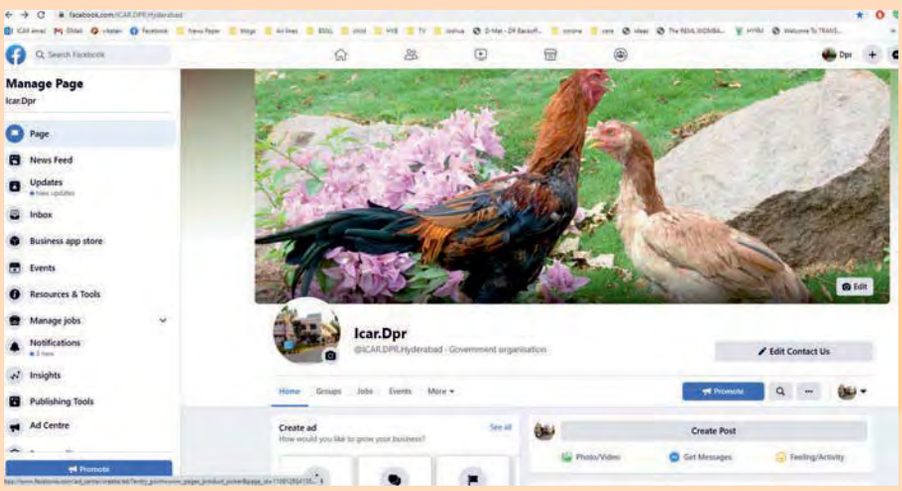
ICAR- DPR celebrated the International Women's Day on 7th March 2020. A meeting was organized in which Director I/c, Dr. B.L.N. Reddy and AO, Mr. A.V.G.K. Murthy, interacted with the lady staff members in the committee hall of administration building. Director I/c gave brief summary of women's contributions in different fields. Women employees of the institute discussed issues related to welfare, grievances etc. On this occasion, another meeting was organized at the Cherish Orphanage, Kismatpur, Rajendranagar, Hyderabad, where children were made aware of the effects of malnutrition and described the nutritive value of the eggs and fruits for health by ladies of the institute. Eggs and fruits were distributed to the children.

Director i/c with women staff

NOTES

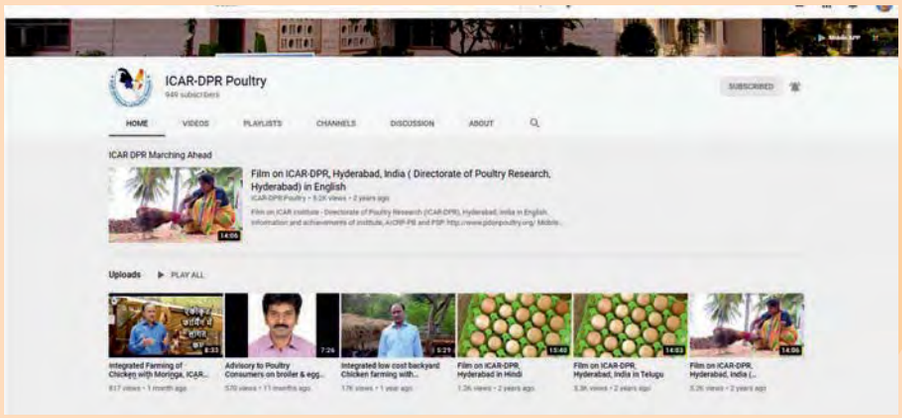
DPR

DPR-App



Face Book

Twitter



YouTube

भाकृअनुप - कुक्कुट अनुसंधान निदेशालय
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