Annual Report
2017-18

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भाकृअनुप - कुक्कुट अनुसंधान निदेशालय

ICAR-Directorate of Poultry Research

ISO 9001 - 2015

Rajendranagar, Hyderabad - 500 030 India


Annual Review Meeting of AICRP on Poultry Breeding & Poultry Seed Projects
And
Release of Location Specific Poultry Variety : Himsamridhi
Organized by:

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Two-way cross rooster in the farmer's field

Inside Front Cover
Release of *Himsamridhi* a dual purpose rural chicken variety at CSKHPKVV, Palampur

Inside Back Cover
ICAR-DPR Publications

Back Cover
Location of AICRP on Poultry Breeding and Poultry Seed Project centres

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Preface

The ICAR-Directorate of Poultry Research is a national institute under the aegis of Indian Council of Agricultural Research catering to the needs of the various stakeholders connected with poultry production in the Country. The institute is located in the poultry hub of the country and has been serving the sector for the last thirty years in promoting and supporting poultry production in the country. Sustained efforts of committed staff helped in fulfilling the mandated responsibilities of coordinating and monitoring ICAR-network projects, conducting basic and applied research in various aspects of poultry farming, and imparting capacity building in poultry science. I feel privileged to present the Annual Report for the year 2017-18.

The rural chicken varieties, i.e. *Vanaraja, Gramapriya* and *Srinidhi* developed by the Directorate have reached nook and corner of the country. The birds are performing extremely well in low input system and are able to alleviate protein hunger and malnutrition in rural and tribal areas. Rural poultry has been one of the proven technologies for improving the socio economic condition of the poor, land-less labour and tribal people. During the period, a promising two-way cross was developed and evaluated under farm, and field conditions. The performance of this new cross offers a bright scope for its propagation in the rural and tribal areas.

The AICRP on Poultry Breeding has been reoriented towards the rural poultry and all the centres are currently working on development of location specific rural chicken varieties suitable for their local conditions. The elite layer and broiler pure lines developed earlier are being maintained for improvement of economic traits and use in development of rural crosses. During the year, a dual purpose variety *Himsamridhi* was developed and released at CSKHPKVV, Palampur centre for the benefit of hilly and tribal regions of the country.

Twelve Poultry Seed Project centres spread across the country are in operation with the aim of increasing the availability of improved germplasm throughout the country. During the current plan, two new centres (SVVU, Tirupati and PVNRTVU, Warangal) have been added to cater to the needs of the farmers in Andhra Pradesh and Telangana.

Seventeen pure lines maintained at this Directorate have been constantly improved for various economic traits based on the feedback from farmers. Four native chicken breeds (Aseel, Ghagus, Nicobari and Kadaknath) are conserved at the Directorate. Kadaknath breed has been new addition during this year, which will be distributed to the farmers in due course of time. Research is under progress in poultry genomics through functional genomics, epigenetics and gene silencing technology for augmenting poultry production. The research conducted in the area of nutrition, physiology and health is aiding in developing package of practices for different pure lines and improved varieties developed by the Directorate, besides addressing the issues of the commercial poultry industry. Efforts are on to develop protocols for cryopreservation of semen at the Directorate. Further, several extramural projects funded by agencies like DST, NICRA etc. and collaborative projects with the industry under PPP mode were also undertaken by the Directorate. The research output was communicated through peer reviewed journals, magazines and electronic media.

The propagation of germplasm is being strengthened through brochures, visual media and participating in the exhibitions. I am happy to inform that the Directorate has distributed 18.70 lakhs of improved germplasm and realized an amount of 636.87 lakhs of revenue from the three components (Institute, AICRP and PSP).

I am extremely grateful to Dr. Trilochan Mohapatra, Secretary, DARE and Director General, ICAR for all the support and encouragement extended to the Directorate during the period. I am thankful to the Secretary, ICAR and Financial Adviser, ICAR for their continuous support to the Directorate.

I am thankful to Dr. J.K. Jena, DDG (AS) for his keen interest and valuable guidance in delivering the mandated responsibilities of the Directorate. I am also thankful to Dr. R.S. Gandhi, ADG (AP&B); Dr. Vineet Bhasin, Principal Scientist (AG&B) and other scientific and administrative staff of the ICAR (HQ) for extending help from time to time. The overall research progress achieved could not have been possible without the support and contribution of all the scientists at this Directorate and different centres of AICRP and Seed Project, who deserve due appreciation. I am thankful to each one of them. I also thank all other staff for supporting the scientists in their research endeavor. I also thank the editorial committee in bringing out this report in an appreciable manner.

Dated : 28.6.2018

(R.N. Chatterjee)
Director

Abbreviations

AAU	Anand Agricultural University/Assam Agricultural University
AICRP	All India Coordinated Research Project
ARS	Agriculrural Research Service
ASM	Age at Sexual Maturity
BW	Body Weight
CARI	Central Avian Research Institute
CBH	Cutaneous Basophile Hypersensitivity
CP	Crude Protien
CPCSEA	Committee for the Purpose of Control and Supervision on 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
DST	Department of Science and Technology
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
HVT	Herpes Virus of Turkey
IAEC	Institute 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
LP	Lipid Peroxidase

LPR	Lymphocyte Proliferation Ratio
MANAGE	National Institute of Agricultural Extension Management
MD	Marek's Disease
ME	Metabolizable Energy
mill	Million
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
no.	Number
NPP	Non-Phytate Phosphorus
NRC	National Research Centre
OUAT	Orissa 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
RBC	Red Blood Cell
SAU	State Agricultural University
SL	Shank Length
PVNRTVU	P.V. Narasimha Rao Telangana Veterinary University
SRBC	Sheep Red Blood Cells
SVU	State Veterinary University
SVVU	Sri Venkateswara Veterinary University
TSA	Total Sulfur-containing Amino Acids
U	Unit(s)
VBRI	Veterinary Biologicals and Research Institute
VHL	Venkateswara Hatcheries Limited
wks	Weeks

Contents

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 impart 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 2017-18 are summarized below.

Research at the Directorate

Genetics and Breeding

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

Germplasm for rural poultry farming

Two male lines, PD-1 (*Vanaraja* male line) and PD-6 (*Gramapriya* male line); two female lines, PD-2 (*Vanaraja* female line) and PD-3 (brown egg layer line) are maintained for use in developing rural chicken varieties. In PD-1 (S-11), the egg production improved by 3 and 7 eggs, respectively at 40 and 52 weeks of age from the last generation. The shank length also increased significantly from the last generation. In PD-6 (GML), the shank length increased significantly from 75 to 77 mm during this generation. The heritability estimates for body weight and shank length were moderate, while those for production traits were low to medium from sire and dam components variance. In PD-2 (S-14), the egg production upto 52 weeks of age was improved by 3 eggs and egg mass improved by 390g. In S-15 generation, body weight at 6 weeks of age was 662.4±0.02g, while the shank length was 71.5±0.002 mm. There was a marginal decrease in juvenile body weight, egg production and egg mass at 40 weeks of age in PD-3 line (S-6).

Two-way cross chicks (PD-1 x PD-4) were evaluated at institute farm and in the field. The body weight was significantly higher in farm reared birds. Broodiness was observed in about 30% of birds that had led to reduced egg production. The economics of rearing of these birds was calculated and the estimated net profit from a pair of birds was Rs. 610.

Native chicken populations

In PD-4 (improved Aseel) (S-8), selection differential and intensity of selection for 8 wks body weight were 47.1g and 0.56σ, respectively, while those for 40 wks egg production were 8.09 eggs and 0.42σ, respectively. There was an improvement of 10.9g in body weight and 0.01mm in shank length at 8 weeks of age. In the pure Aseel chickens obtained from field (G-4), the egg production up to 40 and 72 weeks of age was 17.2±0.71 and 58.1, respectively, while the corresponding egg weight was 45.3±0.88 and 52.3g, respectively. In *Ghagus* population (G-5), body weight and shank length of male birds at 40 weeks of age were 2627±34.8g and 128.5±1.45mm, respectively. Random bred *Nicobari* population has been maintained as resource population and was evaluated for production traits up to 40 weeks of age during the year.

Broiler populations

Three coloured synthetic broiler lines (PB-1, a male line; PB-2, a female line and control) have been maintained and evaluated. In PB-1 (S-26), body weight at 20 and 40 weeks decreased by 57 and 100g, respectively. Higher juvenile body weights were recorded in the S-27 generation as compared to previous generation. Pedigreed random bred broiler control population (G-16 generation) was regenerated.

In PB-2 line (S-26), ASM has decreased by two days as compared to the last generation, while the egg weight and egg production at 40 weeks remained stable. The phenotypic and genetic response to selection for the 40 week part period egg production over the last 12 generations was 0.68 and 1.28 eggs per generation, respectively. In S-27 generation, the body weight, shank length and breast angle at five weeks were 758.8±3.21g, 77.18±0.21mm and 74.78±0.18°, respectively. The phenotypic and genetic response to selection for the five week body weight over the last nine generations was 2.95 and 3.08g per generation, respectively. The naked neck and dwarf gene lines were maintained as resource populations.

Layer populations

Six layer lines (IWH, IWI, IWK, IWD, IWF and control) were maintained and evaluated. The IWK and control (S-13), IWH and IWI (S-5) and IWD and IWF (S-0) layer lines were regenerated. The egg production to 40 weeks of age in IWH, IWI, IWK and control increased by 9.78, 7.61, 7.72 and 9.63 eggs in the current generation. The egg production was higher in IWF than IWD. The egg weights at 28 and 40 weeks in six layer lines ranged from 45.66 to 48.44g and 48.36-52.15g, respectively.

Molecular Genetics

Expression of fatty acid synthase (FASN) and acetyl-CoA carboxylase A (ACACA) genes were analysed during ontogenic and post-hatch juvenile period in broiler, layer and indigenous native (*Ghagus*) chicken lines. Chicken hepatocyte culture was established and shRNA molecules were designed, synthesized and tested for silencing FASN and ACACA genes under cell culture system. A transgenic vector (DPREGG1 vector) has been prepared and used for expressing green fluorescent protein (GFP) in oviductal cells *in vitro*. The exons of Tapasin and TAP2 genes were found to be polymorphic with 21 haplogroups in Tapasin and 10 haplogroups in TAP2 gene exons. NAb titres to rabbit RBCs and specific antibody titres to Newcastle Disease virus (NDV) were determined at various ages in *Ghagus, Nicobari* and White Leghorn (WL) chickens. NAb titres at 20 weeks of age were significantly associated with survivability of birds up to 72 weeks of age in *Ghagus*. There was higher genetic variability in indigenous breeds compared to WL at MHC. Genetic polymorphism in coding sequence of MDA5, LGP2, TLR3, TLR1LA, and B-NK genes through SSCP was carried out in *Ghagus, Nicobari* and WL breeds.

Nutrition, Physiology and Health

The egg production, egg mass and feed efficiency in layers were significantly improved by enhancing dietary ME from 2400 to 2500 kcal/kg diet and by supplementing low energy diet with microbial enzymes during summer. Increased concentrations (0.65 to 0.8%) of digestible lysine improved performance of layers fed guar meal based diet (10%). In *Vanaraja* chicks, inclusion of 20% alternate feed ingredients like DDGS, rape seed meal or cotton seed meal significantly depressed performance and immune response, and increased stress responses. Feed efficiency, immune response and activity of anti-oxidant response were improved in *Vanaraja* chicks fed OxyCure, a supplement (blend of antistress agents) developed at DPR.

The nutrient profile of rice DDGS samples collected from local market varied significantly. Rice DDGS could be used upto 10% in *Vanaraja* chicks diet with beneficial effects at lower level (5%). At further higher level of 15%, rice DDGS significantly depressed performance of *Vanaraja* chicks. The nutritional status of backyard chickens of the country as studied in the states of Tripura, Himachal Pradesh, Rajasthan and Telangana indicated deficiency of energy, protein and calcium in the diet being consumed by the birds. In a field study in Telangana, supplementing 15g of feed/bird improved growth rate in *Vanaraja* chicks.

Among various Zn salts studied, Zinc sulphate was found suitable for producing organic Zn using yeast. Further, strain (*S. cerevisiae* strain 050) and inorganic Zn concentration in media (200 ppm Zinc sulphate) were optimized for the purpose. Organic Se produced at DPR improved body weight in *Vanaraja* chicks at 0.2 ppm level. Feeding nutrient specific maize cultivars (QPM and QPM + Provit A) resulted in better body weight gain and improved feed efficiency in *Vanaraja* chicks, besides improving carcass quality. Select plant bioactive compounds were evaluated, out of which some could inhibit *E. coli* at as low dose as 2 ul/30 ml medium with ability to spare *Lactobacillus*.

Cryopreservation using dimethylacetamide (DMA) and vitrification produced acceptable post thaw motility in semen of PD-1 and PD-6 lines, but fertility was very low. Chicken semen cryopreservation in French straws was standardized. Supplementing vitamin E analogue (0.2 mM) during cryopreservation of semen along with N-methylacetamide (12%) improved fertility. Other supplements like BHT, L-glycine and L-carnitine, however showed no such beneficial effect. In *Nicobari*, fertility with cryopreserved semen could not be improved by different cryoprotectants.

The lipogenic genes, steroyl Co A desaturase and fatty acyl synthase were expressed higher in liver and brain of PD-3 and *Nicobari* chickens in summer. The receptors for hormones, leptin, ghrelin and GH were down regulated and adverse effects of high ambient temperatures on plasma leptin,

histomorphology of intestine and performance of *Nicobari* chicken were reduced with fermented yeast culture supplementation in diet. Cage house litter was found rich in various nutrients of manure value.

The ALV incidence in breeding flocks was 2.4%. The immune response to virosome vaccine prepared from mesogenic Newcastle disease virus was found to induce antibody titres equivalent to currently used lentogenic live vaccine. The pathogenicity of IBV–DPR isolate was characterized and found that it was a heterologous strain having poor cross neutralization with Mass type strains. *E. coli* and *Salmonella* isolates were characterized based on morphology and biochemical parameters. *In vitro* antibiotic sensitivity test against enteropathogens *viz., E. coli* and *Salmonella* was carried out. Further, the enteropathogens were also tested for i*n vitro* antimicrobial susceptibility using certain herbal extracts. The aqueous extracts of select herbs did not show any zone of inhibition.

AICRP on Poultry Breeding

The AICRP on Poultry Breeding has been operated at twelve centres viz. KVASU, Mannuthy; AAU, Anand; KVAFSU, Bangalore; GADVASU, Ludhiana; OUAT, Bhubaneswar; CARI, Izatnagar; ICAR Research Complex for NEH Region, Agartala; MPPCVVV, Jabalpur; AAU, Guwahati; BAU, Ranchi; MPUAT, Udaipur and CSKHPKVV, Palampur. The main objectives of the project were 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 backward areas. The KVASU, Mannuthy and AAU, Anand centres are maintaining two elite layer germplasm (IWN and IWP). KVAFSU, Bangalore; GADVASU, Ludhiana; OUAT, Bhubaneswar, and CARI, Izatnagar are maintaining four elite broiler germplasm (PB-1, PB-2, CSML and CSFL).

Further, so as to cope with the exigencies, elite strains have been duplicated at different centres like IWF at Mannuthy, IWD and IWK at Anand and M-1 and M-2 at Jabalpur. Two pedigreed random bred control populations (one for layer and the other for broiler) were maintained at ICAR-DPR and supplied to centres for measuring the genetic progress. During the year, a total of 8,54,261 chicken germplasm was distributed to the farmers from different centres with a total revenue generation of Rs. 261.11 lakhs.

At Mannuthy centre, egg production of native chicken germplasm (S-2) up to 40 weeks of age was 75.96 eggs with average egg weight of 42.5g, which showed an increase of 3.88 eggs and 0.7g in egg weight than in the previous generation. Hen housed egg production up to 40 weeks of age of NDR cross was 80.87 eggs in farm and 49.73 eggs in field. Besides, the centre evaluated IWN and IWP strains up to 40 weeks of age in S-30 generation. Hen housed egg production up to 40 weeks of age decreased by 2.51 eggs in IWN (120.2), whereas it increased by 3.8 eggs in IWP (124.83) strain on phenotypic scale. The centre has supplied a total of 2,16,397 number germplasm during the year. At Anand centre, egg production up to 40 weeks of age was higher in native chicken (71.3) (S-1) as compared to RIR (68.5), while body weight and egg weight were higher in RIR. Egg production up to 40 weeks of age was higher in IWN (120.7) than IWP (110.4), which has improved over previous generation. The centre has supplied a total of 49,036 germplasm.

At Bengaluru centre, body weight of native local chicks at 8 and 20 weeks of age was 477.8 and 1110g, respectively, while the ASM was 165.5 days. The 8th week body weight of test cross (PB-1 x local native) was 886.9g in males and 768.8g in females. The average phenotypic and genetic response of body weight in PB-1 at 5 weeks over 11 generations were 14.4 and 24.4g, respectively. Corresponding values in PB-2 at 5 weeks over 12 generations were 9.25 and 17.08g, respectively. The average body weights at 6 and 7 weeks of age were 1692 and 2080g in Raja-II (PB-1xPB-2) at 47th RSPPT, Gurgaon and the feed efficiency was 1.56 at 7 weeks. A total of 2,10,086 germplasm were supplied. At Ludhiana centre, the body weight of native germplasm at 4 and 8 weeks of age was 572.1 and 737.9g, respectively. The body weight of PB-2 x native at 4 weeks was 612.0g in farm and 359.1g in field, while egg production up to 40 weeks was 77.2 eggs. Genetic response over last 11 generations for 5 week body weight was 22.09 g in PB-1 and 11.9g in PB-2. A total of 68,829 germplasm were supplied.

At CARI centre, the body weight of local native chicken germplasm at 4 and 6 weeks was 291.0 and 543.9g, respectively. The phenotypic response

of body weight in CSML and CSFL at 5 weeks per generation was 16.0 and 15.9g, respectively, while the genetic response was 14.3 and 14.2g, respectively. A total of 43,084 germplasm were supplied. At Bhubaneswar centre, native *Hansli* chicken has been registered with ICAR-NBAGR with Accession Number INDIA_CHICKEN_1500_HANSLI_12018. The body weight at 8 weeks was 556.5g in *Hansli*, whereas the egg production up to 40 weeks was 20.18 eggs. The body weight at 5 weeks in CSML X Hansli cross was 548.8g. The egg production increased in both CSFL and CSML lines. Centre has supplied 31,685 day old chicks to farmers.

At Tripura centre, the body weight at 8 weeks was 316.4, 544.2, 1044 and 550.1g in Tripura Black, Dahlem Red, Coloured broiler dam line and BN cross, respectively. During E-2 evaluation of BND cross, the 72 week egg production was 141 and 119 eggs under farm and field conditions, respectively. A total of 20,913 germplasm were supplied. At Jabalpur centre, the 6th week body weight was 397 and 827g in Kadaknath and Jabalpur colour populations, respectively (G-8). At 40 weeks of age, the egg weight was 58.7g in Jabalpur colour and 47.8g in Kadaknath, while the hen housed egg production was 88.9 eggs in JBC and 54.6 eggs in Kadaknath. Narmadanidhi birds produced 44, 85.2 and 168 eggs up to 40, 52 and 72 weeks, respectively in field conditions. A total of 51,851 germplasm were supplied.

At Guwahati centre, the 5 week body weight was 126.6g in indigenous, 1035g in PB-2 and 350.2g in Dahlem Red. In native population, the egg weight and egg production up to 52 weeks were 39.3g and 66.85 eggs, respectively. In Dahlem Red, egg production improved by 2 eggs. In Kamrupa, the hen housed egg production up to 40 and 52 weeks of age was 48.3 and 88.9 eggs in the farm and corresponding values in the field were 42.8 and 72.9 eggs. The centre supplied 28,057 germplasm to farmers. At Ranchi centre, the hen housed egg production up to 52 weeks was 52.89 eggs in native population (G-6). In BN cross (E6), hen housed egg production up to 64 weeks of age was 92.73 eggs. The hen day egg production in E6 up to 64 weeks of age was more in DBN (*Jharsim*) cross (131.4 eggs) than BND cross (87.2 eggs) during E5 evaluation under farm conditions. Centre supplied 21,235 germplasm to the farmers.

The Palampur centre released the location specific dual purpose chicken variety *Himsamridhi* suitable for backyard poultry farming in hilly areas. In native germplasm (G-5), annual hen-day egg production was 84.58 eggs. In Dahlem Red (G-4), the 72 weeks hen-day egg production was 175.0 eggs. *Himsamridhi* birds recorded hen housed egg production of 58.9, 90.9 and 154.0 eggs up to 40, 52 and 72 weeks of age showing improvement of 5.42 eggs over previous year. At farmers' level, the 52 weeks HHEP and HDEP of *Himsamridhi* birds were 81.6 and 97.0 eggs, respectively. The centre supplied 29,617 chicks of Himsamridhi, Native and other crosses to farmers.

At Udaipur centre, the juvenile body weight in *Mewari* breed at 8 weeks marginally reduced during G-7 generation. However, 20 weeks and 40 weeks body weight increased by 109 g and 196 g. The hen housed egg production up to 52 weeks of age decreased by 1.62 eggs, while hen day egg production increased by 2.27 eggs. In *Pratapdhan*, hen day egg production up to 40 and 72 weeks of age decreased by 13 and 3.39 eggs in the E-6 evaluation. Body weight of *Pratapdhan* at 8 weeks of age has increased by 316g. A total of 83,471 germplasm was supplied.

Poultry Seed Project

The "Poultry Seed Project" was initiated during the XI Five Year Plan with six centres, three in the northeast region and three in different state veterinary/agricultural universities. The project was strengthened during the XII Plan by adding five more centres. In addition, one non-funding centre was also functioning. The main objective of the 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 West Bengal University of Animal and Fishery Sciences, Kolkata; Bihar Agricultural 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 and Sher-e-Kashmir University of Agricultural Sciences and Technology, Srinagar. The project was further strengthened with addition of three more centres viz., PVNR Telangana Veterinary University, Warangal; Sri Venkateswara Veterinary University, Tirupati and ICAR Research Complex for NEH Region, Umiam. Two centres viz., Chhattisgarh Kamadhenu Viswa Vidyalaya, Durg and ICAR-IVRI Regional Station, Mukteswar were discontinued from 2017-18.

The Directorate acted as the coordinating unit and supplied parent chicks. The target set for supplying chicks for mainland and north-eastern centres during the year 2017-18 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 6,31,543 improved chicken varieties were distributed in their respective regions/states during the year. A total of Rs. 176.71 lakhs revenue was generated from the Project.

Six batches of *Vanaraja* parents were reared during the year at Kolkata centre, out of which, four are in laying, one in growing and one in brooding phase. The egg production of 50% was achieved at 32 weeks, which was maintained up to 64 weeks. A total of 79,390 *Vanaraja* chicks were distributed to the farmers. Three batches of *Vanaraja* parents were reared at Patna Centre. The average age at sexual maturity was 172 days. The HDEP in *Vanaraja* at 40 weeks of age was 51.27 % with an egg weight of 51.56g. A total of 60,008 *Vanaraja* chicken germplasm was distributed. A total of 2,250 parents of *Vanaraja* and *Srinidhi* were reared in four batches at Jharnapani centre. The production of 50% was attained at 36 weeks of age in both *Vanaraja* and *Srinidhi* parents. A total of 1,36,828 improved chicken germplasm was distributed to farmers of Nagaland and neighbouring states.

Two batches of *Vanaraja* parents were reared at ICAR-NOFRI, Gangtok, Sikkim. The HDEP in *Vanaraja* was 50% (24-72 weeks). Peak production (70 %) was attained at 31-34 weeks of age. A total of 94,800 *Vanaraja* germplasm was distributed. Three batches of *Vanaraja* and *Srinidhi* parents were reared at Manipur Centre. The average HDEP was 39% (28-72 weeks) in *Vanaraja* and 46% (24-72 weeks) in *Srinidhi* parents. A total of 75,126 improved chicken germplasm was distributed. Two batches of *Vanaraja* and *Gramapriya* parents were reared at Hosur Centre. The egg production was 67% (32-78 weeks) in *Vanaraja* and 69% (28-74 weeks) in *Gramapriya*. The peak production was 80.4% (37 wks) in *Vanaraja* and 88% (28 wks) in *Gramapriya*. A total of 1,26,870 germplasm was distributed.

One batch each of *Gramapriya* and *Srinidhi* parents were reared at Goa. The egg production was not consistent. The construction of poultry houses was completed. A total of 3,749 improved chicken germplasm was distributed.

Two batches of *Vanaraja* and one batch of *Gramapriya* parents were reared at Port Blair. The highest egg production (38%) was recorded at 35-38 weeks of age. A total of 10,759 germplasm were distributed. The construction of poultry houses and hatchery was completed at SKUAST, Srinagar. Two batches of *Vanaraja* breeders were reared. The average egg production was above 60% (59-62%) from 56 weeks to 72 weeks of age. A total of 21,401 *Vanaraja* chicks were distributed to farmers. Two batches of *Vanaraja* and *Srinidhi* parents were reared at ICAR-RC for NEH Region, Umiam, Barapani. The HDEP at 36 weeks of age was 43% in *Vanaraja* and 28% in *Srinidhi* parents. A total of 22,612 germplasm was distributed. Two new centres, one at SVVU, Tirupati, Andhra Pradesh and the other at PVNRTVU, Warangal, Telangana were added from 2017-18 to popularize backyard poultry in respective regions. The two centres were launched on 1 February and 22 March 2018, respectively and rearing of parents was initiated in the existing facilities.

Technology Transferred

During the year, the Directorate participated in a number of exhibitions and farmers' fairs and propagated the technologies and varieties developed at the institute. Training programmes were organized for imparting knowledge on rural and commercial poultry production to the farmers, veterinary officers and other beneficiaries from across the country. Consultancy and contract research services were also extended to the stakeholders in the area of nutrition and health. TV and Radio media was effectively used for dispelling misconceptions about poultry products in the society. A total of 76,963 hatching eggs and 2,76,155 day-old chicks and grown-up birds of *Vanaraja*,

Gramapriya, Srinidhi, Krishibro etc. were supplied by DPR to the farmers and different organizations including Government agencies across the country. In addition, 31,098 parent chicks of different varieties were also supplied. From the AICRP and Seed Project centres, respectively, another 8,54,261 and 6,31,543 number of germplasm 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.

Other activities

During the year, a total of 38 research papers, 1 review paper, 3 books/book chapters, 2 popular articles were published by the scientists of the institute. In addition, 3 invited papers and 20 research abstracts were presented in different Conferences. Technical seminars and stakeholders meetings were organised for the benefit of poultry sector in the country. Priority programmes such as Mera Gaon Mera Gaurav and Swacch Bharath were implemented. The Research Advisory Committee, Institute Research Committee and Institute Management Committee continuously monitored and suggested improvement in research, administration and financial management of the Institute. The Quinquennial Review Team evaluated of the institute's performance during the period 2012-17.

At the Directorate, the budget utilized during the period was Rs. 1597.44 lakhs, and at AICRP and Poultry Seed Project centers Rs. 544.50 and Rs. 511.50 lakhs, respectively were utilized. A total revenue of Rs. 638.32 lakhs (DPR-200.50, AICRP-261.11 and PSP-176.71 lakh Rs) was generated during the year.

1. Introduction

History

The ICAR-Directorate of Poultry Research is a premier institution in the field of poultry science research and extension in the country. This institute 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 monitored the activities of the AICRP centres located at different State Agricultural Universities (SAUs) and ICAR Institutes. Later, it functioned from Central Avian Research Institute, Izatnagar till its elevation to the Directorate status in 1988. In addition, the activities of the Directorate were expanded by introducing new research programmes in Poultry Nutrition and Housing & Management under separate network programmes in selected SAUs, where the breeding units were already in existence. The research work in these areas continued till March 1993 after which the Nutrition along with Housing and Management activities were discontinued and only the research on breeding aspects continued. Consequently, the Directorate was entrusted the task of developing germplasm suitable for rural poultry production; maintenance and improvement of elite broiler and layer pure lines; maintenance of random bred control populations; and two gene lines (naked neck and dwarf) for augmenting productivity under tropical climate. The institute was elevated from the position of Project Directorate to Directorate on 18th September 2013.

The principal research focus at the Institute has been towards the application of quantitative genetic principles to enhance productivity of various chicken germplasm. 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. Keeping in view the present needs of poultry farming in the country and to meet the challenges ahead, the Directorate has formulated a Perspective Plan, 'Vision 2050', in which thrust areas of the research programmes were identified.

The AICRP centers made sustained efforts resulting in the release of seven promising varieties of chicken for commercial exploitation and utilization for the benefit of the farmers. The potential of these varieties has been regularly evaluated in Random Sample Poultry Performance Tests and found them suitable for intensive farming. Scientists at AICRP centres are continuously involved in developing new crosses incorporating various germplasm including indigenous stocks through two/more breed crosses. Till date, the most promising layer varieties released from AICRP centres are ILI-80 at CARI, Izatnagar; ILM-90 at KVASU, Mannuthy and ILR-90 at SVVU, Hyderabad, while the broiler varieties developed are B-77 and IBI-91 at CARI, Izatnagar; IBL-80 at GADVASU, Ludhiana and IBB-83 at KVAFSU, Bangalore. In the XII Plan, the AICRP was reoriented towards development of location specific varieties for rural poultry production. Under this activity, several new varieties like Pratapdhan, Kamrupa, Jharsim, Narmadanidhi and Himsamridhi have been released at different centres. During XI plan, the activities of the Directorate were further expanded by introduction of a new net work project, 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. In the financial year 2014-15, six new centres were added under the Poultry Seed Project. The Directorate is coordinating the activities of the Seed Project centres for rearing parent stock of improved rural poultry germplasm and supplying hatching eggs, day-old or grown-up chicks to meet the demand in rural and tribal areas.

At this Directorate, two promising chicken crosses were evolved i.e., *Vanaraja*, a dual-purpose bird and *Gramapriya*, predominantly a layer, meant for free-range and backyard farming. These two 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 northeastern states including Jammu and Kashmir, Lakshadweep, and Andaman

and Nicobar Islands. The Directorate also developed two crosses viz. *Krishibro*, a multicolored broiler and *Krishilayer*, a high yielding egg producing bird for commercial purposes. Besides these varieties, a recently released dual purpose variety *Srinidhi* is being popularized in the country. Further research in this direction is underway for developing new crosses that could be of tailor-made for better adaptability under diversified regions in rural and tribal backyard conditions.

India is a rising power in the world in every sphere right from the economy to education, science and technology to infrastructure and health care to food security. The country is basically an agrarian country where more than 70% population depends on agriculture for their livelihood. In this context, the rural backyard poultry has become one of the avenues for the landless or marginal farmers to earn their livelihood and balanced food. Thus to meet the needs of rural farmers, the Directorate has taken a lead in this direction by adopting a holistic approach to develop high performing, better adaptable and disease resistant germplasm suitable for backyard farming with low input system.

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 important 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 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 and at AICRP centres. To measure population dynamics of various chicken lines used in the AICRP programme molecular characterization has been initiated 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.

Mandate

The Directorate has been striving hard to realize its Vision of "enhancing productivity of chicken for household nutritional security, income and employment generation" and the Mission of "developing and propagating improved varieties of chicken for sustainable production under intensive and extensive systems". To achieve the goals, the following Mandate of this Directorate has been implemented precisely.

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

Organogram

The Directorate is working with different wings and sections with required infrastructure and well devised functionalities. Different committees formulated and approved by the Council are guiding the Directorate for efficient and quick functioning of the Institute with greater transparency. The organizational set up of the Institute is shown on next page.

Financial outlay

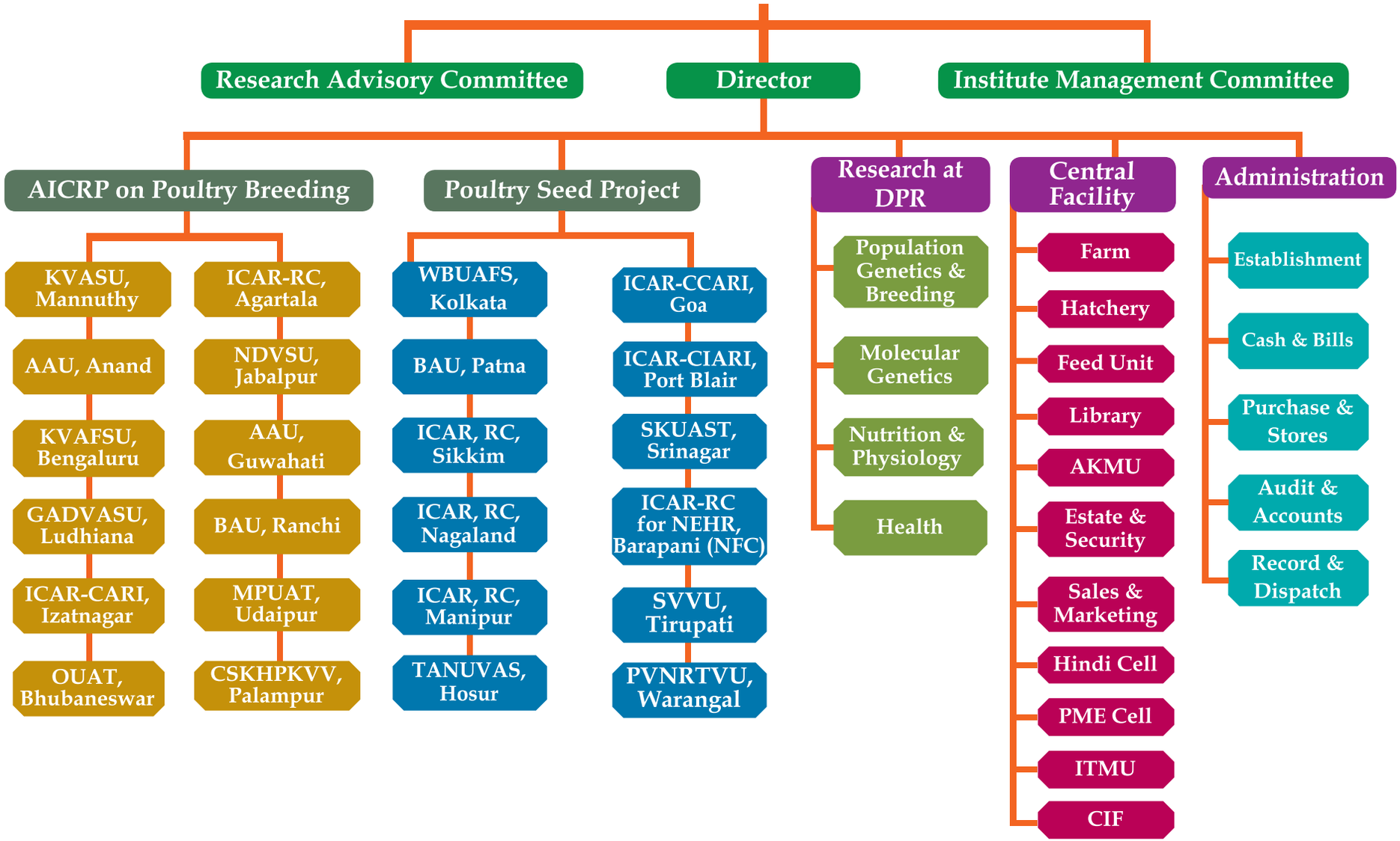
(Rs. lakhs)

Component	Budget	Expenditure	Receipts
DPR	1597.50	1597.44	200.50
AICRP	544.50	544.50	261.11
Seed Project	511.50	511.50	176.71

Staff position

Cadre	Sanctioned	Cadre in position as on March 31, 2018
RMP	01	01
Scientists	15	17
Technical	16	13
Administrative	14	9
Skilled support	15	14
TOTAL	**61**	**54**

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
WBUAFS, Kolkata
BAU, Patna
ICAR, RC, Sikkim
ICAR, RC, Nagaland
ICAR, RC, Manipur
TANUVAS, Hosur
ICAR-CCARI, Goa
ICAR-CIARI, Port Blair
SKUAST, Srinagar
ICAR-RC for NEHR, Barapani (NFC)
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

2. Research Achievements

Genetics and Breeding

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

Male lines

PD-1 line

The PD-1 population was evaluated for production traits up to 52 weeks of age during S-11 generation (Table 1). There was a marginal decrease in 20 week body weight, however, the 40 week body weight increased marginally from previous generation. The egg weights were almost similar to the S-10 generation. The part period egg production up to 52 weeks of age was 80.47±0.17 eggs. The egg production improved by 3 and 7 eggs, respectively at 40 and 52 weeks of age from the last generation. The heritability estimates for egg production were low to high from sire & dam components variance.

PD-1 chicken was regenerated in pedigreed mating with 50 sires and 250 dams in five hatches during S-12 generation. A total of 2538 chicks were produced in S-12 generation. The fertility and hatchability on FES and TES were 84.8 and 91.6 and 77.7%, respectively. Hatchability improved over the last generation. Juvenile performance in S-12 generation is given in Table 2. The shank length increased significantly from last generation. The heritability estimates for body weight and shank length were moderate. The body weight and shank length were positively correlated with high degree of positive association.

A pair of PD-1 birds

Table 2. Juvenile traits in PD-1 (S-12)

	Body weight (g)	Herita-bility	Shank length (mm)	Heritability
4 wks	405.2±0.02	0.29±0.08	62.50 ±0.002	0.23±.07
6 wks	814.6±0.03	0.26±0.07	82.85±0.002	0.25±0.09

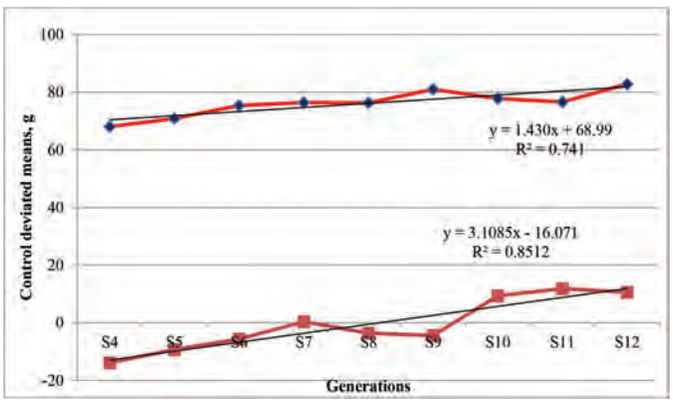


Fig. 1. Short term response for 6 week shank length in PD-1

Table 1. Production performance of PD-1 line (S-11)

Traits		Means	Heritability		
			h^2_S	h^2_D	$h^2_{(S+D)}$
ASM (days)		176.36 ±0.04	0.82±0.26	0.02 ±0.21	0.40±0.17
Body wt. (g)	20 wks	2162.2± 0.34	0.45±0.21	0.10±0.25	0.28±0.17
	40 wks	2906.6± 0.76	0.51±0.29	--	--
Shank length (mm) 20 wks		110.26±0.01	0.29±0.22	0.62 ±0.29	0.51±0.21
Egg weight (g)	28 wks	50.47±0.01	--	--	--
	32 wks	53.01± 0.01			
	36 wks	55.21±0.01			
	40 wks	55.90±0.01	0.55 ±0.26	0.16 ±0.38	0.39±0.19
Egg prodn. (no.)	40 wks	52.24± 0.05	0.25 ±0.19	0.14 ±0.25	0.18±0.11

PD-6 (Gramapriya Male Line)

The PD-6 line (GML) was evaluated for juvenile traits in S-7 generation. The shank length increased significantly from 75 mm to 77 mm during this generation. Body weight also increased from the last generation. The heritability estimates for body weight and shank length were moderate. The body weight and shank length were positively correlated with high degree of association.

A pair of PD-6 birds

Table 3. Juvenile traits in PD-6 (SL-7)

	Body weight (g)	Shank length (mm)
Day old	37.12±0.001	
2 wks	120.05±0.01	
4 wks	300.45±0.02	57.72±0.001
6 wks	612.46±0.04	77.17±0.002

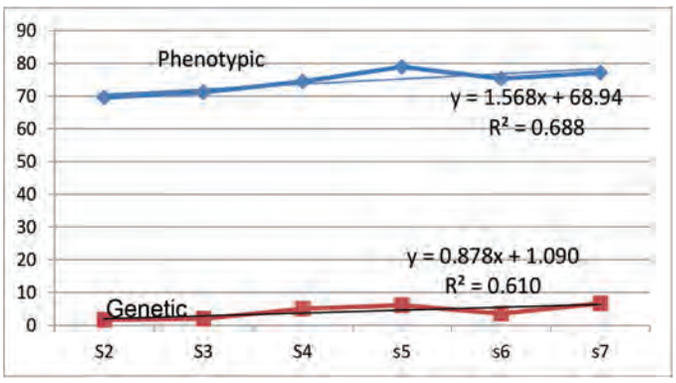


Fig. 2. Response to 6 week shank length in GML

The selected population of PD-6 was evaluated for production traits up to 40 weeks of age. The ASM was 175.7±0.04 days. The least squares means for body weight at 20 and 40 weeks were 1891.0±0.74 and 2620.0±0.89g, respectively. There was a marginal increase in body weights, which was within the standard limits of body weight at laying stage. The egg weight at 40 weeks was 55.0±0.003g. The part period egg production at 40 weeks of age was 72.91±0.04, which was almost similar to the last generation. The heritability estimates for production traits were low to medium from sire and dam components variance.

Female lines

PD-2 and PD-3 lines along with rural and Dahlem Red controls were evaluated for growth and production performance. The registration of PD-2 line was taken up and the prescribed application was submitted to NBAGR for further processing.

Table 4. Heritability estimates in PD-6 (SL-7)

Parameter	Sire (h^2S)	Dam (h^2D)	Sire+Dam (h^2S+D)
0 BW	0.30 ±0.11	0.68 ±0.11	0.49±0.10
2 BW	0.23 ±0.08	0.41 ±0.08	0.32 ±0.06
4 BW	0.19 ±0.07	0.27 ±0.07	0.23 ±0.05
6 BW	0.21±0.07	0.24 ±0.06	0.22 ±0.05
Shank length			
4 SL	0.22±0.07	0.19±0.06	0.20±0.06
6 SL	0.22±0.06	0.18±0.05	0.20±0.05

Table 5. Correlation coefficient for juvenile traits in PD-6

	0BW	2BW	4SL	4BW	6SL	6BW
0 BW	*	0.25	0.09	0.15	0.02	0.09
2 BW	0.11	*	0.73	0.80	0.50	0.60
4 SL	0.05	0.62	*	0.91	0.89	0.73
4 BW	0.04	0.61	0.87	*	0.81	0.86
6 SL	0.06	0.49	0.79	0.76	*	0.87
6 BW	0.05	0.46	0.66	0.73	0.85	*

PD-2 line

PD-2 was evaluated for production traits up to 52 weeks of age in S-14 generation. The line has been improved for higher egg mass to 52 weeks of age based on Osborne Index. The egg production up to 52 weeks of age was improved by 3 eggs compared to previous generation (Table 6). The egg mass improved by 390 g over the last generation.

PD-2 line was regenerated in pedigreed mating with 50 sires and 250 dams in four hatches during S-15 generation. A total of 3737 chicks were produced. The fertility and hatchability on FES & TES were 83.6 and 86.7 & 72.5%, respectively. The population was evaluated for juvenile traits in S-15 generation. The means for body weight at 4 and 6 weeks of age were 335.6±0.01 and 662.4±0.02 g, respectively. The shank length at 4 and 6 weeks was 54.21 ±0.001 and 71.53±0.002 mm, respectively.

A pair of PD-2 birds

The body weights increased compared to the previous generation. The heritability estimates for body weight and shank length were moderate. The body weight and shank length were positively correlated with high degree of positive association.

PD-3 line

PD-3 line was evaluated for juvenile traits during S-6 generation (Table 7). The criterion of selection was part period egg mass up to 40 weeks of age. PD-3 was regenerated with 50 sires and 200 dams in a pedigreed mating. The fertility was 81.3%, while hatchability was 70.0% on FES and 57% on TES, respectively.

The selected population of PD-3 was evaluated for production traits up to 40 weeks of age in S-6 (Table 10). There was a marginal decrease in body weights. The part period egg production and egg mass at 40 weeks of age decreased from the last generation. The heritability estimates for production traits were low to high from sire and dam components variance.

PD-3 Male and Female

Table 7. Juvenile body weights in PD-3 (S-6)

	Body weight (g)	Shank length (mm)
Day old	37.11±0.002	
2 wks	79.41±0.006	
4 wks	168.1±0.001	57.23±0.001
6 wks	320.1±0.04	61.64±0.002

Table 6. Production performance of PD-2 line (S-14)

Traits		Means	Heritability		
			h^2_S	h^2_D	$h^2_{(S+D)}$
ASM (days)		160.1±0.56	0.09±0.12	0.18±0.15	0.13±0.19
Body wt. (g)	20 wks	2016.6±8.18	0.35±0.19	0.43 ±0.20	0.39±0.14
	40 wks	2431.5±10.35	--	--	--
	52 wks	2603.8±10.65	--	--	--
Egg wt. (g)	28 wks	47.94±0.16	0.42±0.21	0.09±0.06	0.23±0.15
	40 wks	51.45±0.11	0.39±0.22	--	--
	52 wks	53.87±0.84	--	--	--
Egg prodn. (no.)	40 wks	88.5±1.24	0.07±0.09	0.14±0.18	0.1±0.13
	52 wks	126.26±1.41	0.27±0.16	0.17 ±0.23	0.22±0.12
Egg Mass (g)	52 wks	6821.1±121.5	0.07±0.16	0.43±0.25	0.18±0.15

Table 8. Heritability estimates in PD-3

Parameter	Sire (h^2S)	Dam (h^2D)	Sire+Dam (h^2S+D)
0 wk BW	0.07 ±0.11	--	--
2 wk BW	0.18 ±0.10	0.51 ±0.11	0.35 ±0.08
4 wk BW	0.25 ±0.10	0.33 ±0.08	0.29 ±0.06
6 wk BW	0.33±0.12	0.45 ±0.10	0.39 ±0.08
Shank length			
4 wk SL	0.24±0.09	0.34±0.08	0.29±0.09
6 wk SL	0.24±0.10	0.35±0.08	0.30±0.08

Table 9. Correlation coefficient for juvenile traits in PD-3

	0BW	2BW	4SL	4BW	6SL	6BW
0 wk BW	*	0.56	0.39	0.43	0.42	0.37
2 wk BW	0.16	*	0.77	0.72	0.70	0.68
4 wk SL	0.10	0.59	*	0.93	0.91	0.93
4 wk BW	0.14	0.54	0.69	*	0.92	0.99
6 wk SL	0.15	0.47	0.59	0.78	*	0.98
6 wk BW	0.15	0.46	0.55	0.76	0.80	*

PD-4 (Improved Aseel)

PD-4 variety evolved from Aseel has been improved for body weight at 8 weeks of age through individual selection. In S-8 generation, a total of 878 good chicks were hatched in two hatches by mating 50 sires with 150 dams in 1:3 ratio. Fertility (84.8%) and hatchability (83.2 and 70.7% on FES and TES) improved by 2.7, 6.0 and 7.3%, respectively as compared to previous generation. Selection differential and intensity of selection for 8 wks body weight were 47.1g and 0.56σ, respectively, while those for 40 wks egg production were 8.09 eggs and 0.42σ, respectively. Effective population size and rate of inbreeding were 144.4 and 0.0035, respectively as 50 sires and 130 dams contributed progenies to the S-8 generation. Birds in this generation were evaluated for growth and production traits up to 40 weeks of age. Means along with their heritability estimates for growth traits on pooled sex up to 8 weeks of age are presented in Table 11. There was an improvement of 10.9g in body weight and 0.01mm in shank length at 8 weeks of age. Heritability estimates of growth traits were higher in magnitude. Positive and high genetic (0.88±0.08), and phenotypic (0.85) correlations between body weight and shank length were observed at 8 weeks of age. Body weight at 20

Table 10. Production performance of PD-3 (S-6) line

Traits		Means	Heritability		
			h^2_S	h^2_D	$h^2_{(S+D)}$
ASM (days)		173.18±0.39	0.43±0.15	--	--
Body wt. (g)	20 wks	1242.6± 0.37	0.48 ±0.22	0.18 ±0.19	0.33±0.15
	40 wks	1657.7± 0.53	0.37±0.22	0.51±0.23	0.44±0.17
Egg wt. (g)	24 wks	43.78±0.007	--	--	--
	28 wks	49.05±0.009	0.55±0.22	0.09±0.05	0.32±0.16
	32 wks	50.23±0.008	0.29±0.21	--	--
	36 wks	52.56±0.009	0.47±0.22	0.25±0.20	0.36±0.17
	40 wks	54.04±0.01	0.73±0.24	--	--
Egg prodn. (no.)	40 wks	71.15±0.05	0.03 ±0.15	0.35 ±0.23	0.16±0.14
Egg mass (g)	40 wks	3838.6±2.85	0.07±0.16	0.43±0.25	0.18±0.15

weeks of age increased by 82 and 31 g, respectively in female and male birds as compared to previous generation (Table 12). Heritability estimates of body weight at 20 weeks of age in females were on higher side (0.52 ± 0.29 sire component, 0.46 ± 0.15 Animal Model). Livability during 0-8, 9-20 and 0-20 weeks of age was 89.4, 95.2 and 85.1% respectively. Livability of males and females during 21-40 weeks of age was 94.4% and 97.6%, respectively, and livability of females was higher in this generation as compared to previous generation.

Adult PD-4 cock

Adult PD-4 hen

Table 11. Least square means and estimates of heritability of growth traits of PD-4

Traits	Mean±S.E.	$h^2_{(Sire)}$	$h^2_{(Animal\ Model)}$
Body weight (g)			
0 day	33.9±0.11	0.38±0.25	
4 wks	192.7±1.29	0.37±0.15	0.38±0.08
8 wks	565.4±3.21	0.26±0.13	0.30±0.07
Shank length (mm)			
8 wks	79.12±0.19	0.19±0.12	0.25±0.007

Table 12. Means of growth traits of female and male PD-4 birds

Traits	Female	Male
Body weight (g)		
20 wks	1574±8.4	2166±15.4
40 wks	2072±14.8	3054±30.9
Shank length (mm)		
20 wks	107.80±0.24	132.1±0.56
40 wks	106.98±0.25	134.1±0.60

Survivors' egg production up to 40 weeks of age improved by 10.76 eggs, while hen housed and hen day egg production up to 40 weeks of age improved by 12.07 and 11.3 eggs, respectively as compared to previous generation. Further, age at sexual maturity reduced by 20.6 d. There was no significant change in egg weight in this generation (Table 13).

Table 13. Production traits of PD-4 (S-8)

Traits	Mean
Age at fist egg (d)	129
Age at sexual maturity (d)	159.7±0.97
Survivors' EP 40 wks (Nos.)	79.97±1.41
Hen housed EP 40 wks (Nos.)	78.64±1.52
Hen day EP 40 wks (Nos.)	79.46
Egg weight (g)	
28 wks	43.44±0.23
32 wks	45.87±0.23
36 wks	47.53±0.25
40 wks	48.93±0.29

Native germplasm

Evaluation of Aseel population

Aseel chicken was evaluated for growth and production traits up to 72 weeks of age in G-4 generation. The ASM was 198±8.45 days. The body weight at 20, 40 and 52 weeks of was 1411±18.67, 1840±21.11 and 2076±23.22 g in hens and 1947±23.85, 2246±25.14 and 3234±28.44 g in cocks, respectively. The egg production up to 40 and 52 weeks of age was 17.23±0.71, (155 birds) and 30.68±1.01 (142 birds), respectively. The corresponding egg weight at 40 and 52 weeks was 45.34±0.88 and 49.03±0.92, respectively. The body weight at 72 weeks of age was 2.50 kg in females and 3.49 kg in males, respectively. The annual egg production up to 72 weeks of age was 58.10 eggs. The egg weight at 72 weeks was 52.28 g in Aseel chicken.

Aseel rooster and hens

Aseel chicken was regenerated randomly during G-5 generation. A total of 702 good chicks were produced in four hatches in G-5 generation. The fertility and hatchability on fertile (FES) and total (TES) eggs were 86.9% and 85.4 and 74.2% respectively.

Characterization of Ghagus breed

Ghagus, an indigenous chicken breed in G-5 generation was evaluated for production traits up to 40 weeks of age. Average body weight and shank length of male birds at 40 weeks of age were 2627±34.8 g and 128.5±1.45 mm, respectively. Results of production traits of Ghagus breed recorded in G-5 generation are presented in Table 14.

Table 14. Production traits in G-5 generation in Ghagus breed

Traits	Mean ± S.E.
Hen housed EP 40 wks (Nos.)	29.61
Hen day EP 40 wks (Nos.)	31.30
Body wt. at 40 wks of age (g)	1562±22.59
S. L. at 40 wks of age (mm)	101.9±0.33
Egg weight (g)	
28 wks	41.65±0.34
32 wks	43.68±0.37
36 wks	43.76±0.56
40 wks	44.08±0.54

A pair of Ghagus chicken

A total of 910 good chicks of Ghagus were hatched in G-6 generation in two hatches. Fertility of 85.2% and hatchability of 91.2 and 77.7% respectively on fertile egg and total egg set, respectively were observed. Evaluation of G-6 generation birds was completed up to 20 weeks of age during the period. Body weight and shank length at 8 weeks of age improved by 43.1g and 4.66mm, respectively, as compared to previous generation (Table 15). Body weight of males (2020±23.87g) and females (1400±10.95g) at 20 weeks improved by 191 and 92g, respectively, while shank length of males (126.5±0.93mm) and females (102.8±0.49mm) improved by 1.1 and 1.2mm, respectively. Livability during 0-8 (89.2%), 9-20 (94.9%) and 0-20 (84.7%) weeks improved by 3.7, 4.0 and 6.9%, respectively as compared to previous generation.

Table 15. Juvenile growth traits of Ghagus breed in G-6 generation on pooled sex

Traits	Mean ± S.E.
0 day body wt (g)	31.84±0.01
4 wks body wt (g)	163.3±1.59
8 wks body wt (g)	427.1±4.31
8 wks SL (mm)	68.85±0.31

Carcass characteristics and meat quality traits studied in male Ghagus birds at 24 weeks of age are presented in Tables 16 and 17, respectively. Water holding capacity and tenderness of breast muscle (determined by MFI and shear force) were significantly higher as compared to those of thigh muscle. Colour of leg muscle (redness and yellowness) was significantly higher in thigh muscle as compared to breast muscle.

Table 16. Carcass characteristics of Ghagus male birds at 24 weeks of age

Characteristics (%)	Mean ± S.E.
Dressing (without skin)	70.2 ± 0.79
Dressing (with skin)	76.0 ± 0.61
Breast	16.3 ± 0.27
Neck	3.5 ± 0.13
Back	14.1±0.30
Legs	23.4 ± 0.39
Wings	9.1 ± 0.15
Giblets	4.41 ± 0.18
Liver	1.58±0.08
Heart	0.49±0.02
Gizzard	2.34±0.11
Testes	0.64±0.09
Spleen	0.12±0.02
Feathers	5.13±0.75
Skin	5.84±0.37

Table 17. Meat quality characteristics of Ghagus male birds at 24 weeks of age

Meat quality characteristics	Mean ± S.E.		p value
	Breast	Leg	
pH	6.1±0.04	6.2±0.05	NS
Water holding capacity (ml/100g)	32.7±3.33[a]	24.3±3.19[b]	0.05
Shear force – Raw (N)	10.5±1.35[b]	23.9±3.75[a]	0.008
Shear force – Cooked (N)	7.3±0.85	6.1±0.47	NS
Myofibrillar fragmentation index (%)	93.7±1.82[a]	87.2±2.79[b]	0.04
Moisture (%)	73.7±0.49	74.1±0.79	NS
Protein (%)	22.9±0.60	22.6±0.87	NS
Fat (%)	1.4±0.15	1.3±0.11	NS
Salt soluble proteins (g/100g)	6.9±0.29	7.0±0.09	NS
Heme Iron (ppm)	49.7 ±7.61	51.8±5.46	NS
Total meat pigments (ppm)	563.1±86.7	587.6±61.6	NS
a* (redness)	8.8±0.57[b]	16.1±1.02[a]	0.0001
b* (yellowness)	10.1±0.79[b]	12.9±0.71[a]	0.005
L* (lightness)	25.66±2.05	27.14±2.24	NS

Maintenance of Nicobari breed

Random bred Nicobari population has been maintained as resource population. G-4 generation of brown Nicobari birds was evaluated for production traits up to 40 weeks of age (Table 18). Livability of males (98.0%) during 21-40 weeks was better than that of female birds (91.1%).

Table 18. Production performance of brown Nicobari birds in G-4 generation

Traits	(Mean± S.E.)
ASM (d)	182.2±2.16
Survivors' EP 40 wks (Nos.)	66.8 ± 3.14
Hen housed EP 40 wks (Nos.)	66.88
Hen day EP 40 wks (Nos.)	67.92
Body wt. at 40 wks of age (g)	1340 ±32.4
Shank length at 40 wks of age (mm)	84.84±1.4
Egg weight (g)	
28 wks	41.79±0.67
32 wks	44.56±0.70
36 wks	44.81±0.64
40 wks	45.17±0.76

A pair of Nicobari chicken

A total of 340 good chicks of brown Nicobari were produced in a single hatch in G-5 generation by random mating using pooled semen. Overall fertility was 87.6%, while hatchability on fertile and total eggs set was 88.2 and 77.3%, respectively. Better fertility and hatchability on fertile eggs set was observed in G-5 generation. Growth performance of Nicobari breed was evaluated on pooled sex up to 8 weeks of age (Table 19).

Table 19. Growth performance of brown Nicobari birds in G-5 generation

Traits	Mean ±S.E
Body weight (g)	
0 day	32.03±0.22
4 wks	124.8±2.80
8 wks	352.1±8.66
Shank length (mm)	
8 wks	52.81±0.73

Evaluation of crosses under farm and field conditions

A total of 360 two-way cross chicks were produced and reared for 6 weeks under farm conditions. At six weeks of age, a total of 233 birds were distributed to 20 farmers in Bhavoji Thanda and remaining 110 were reared under farm conditions and evaluated for growth and production traits (Table 20).

The body weight was significantly higher in farm reared birds. The body weights reduced in both hens and cocks compared to the first field evaluation, which may be due to availability natural food base and supplementary feeding followed. The egg production reduced by seven eggs from first evaluation due to broodiness and some hens produced chicks. Broodiness was observed in about 30% of birds. The major advantage of these cross is it is self regenerative without adversely affecting the egg production, which is an added advantage for rural poultry farming.

The economic feasibility of the birds was evaluated by interacting with the farmers considering the production data up to 52 weeks of age. All the farmers expressed their satisfaction on the performance of the birds. The input costs like chick, feed, medicine and others was Rs. 100 for males up to 3 months and Rs. 180 for females up to 52 weeks of age. The average weight of cocks was 2 kg at 3 months age. After reaching the suitable weight the farmers were advised to sale the cocks. The cocks (2.0 kg) were sold at Rs. 250/kg with an earning of Rs. 500/ cock. Each hen produced 78 eggs which were either consumed by the farmers or used for reproducing the chicks. None of the farmers sold the eggs. About 70% eggs were consumed and remaining 30% was used for regeneration.

2-way cross birds in the field

Table 20. Performance of 2-way cross under farm and field conditions

	Farm	n	Field	N (233)
Body weight (g)				
4 wks	213.7±2.62	349		
6 wks	505.10±5.14	326		
14 wks- females	1485.8±10.42	90	1230.8±24.47	140
males	1826.0±22.27	20	1610.0±33.41	60
Production traits				
BW(g)				
20 wks	1832.6 ± 14.58	87	1306.5±22.27	131
40 wks	2392.3 ±18.92	84	1788± 25.17	108
ASM (days)	157.83 ±2.84	86	200 ±3.2	123
Egg Prodn. (no.)				
40 wks	71.25±1.65	84	44.21±2.12	108
52 wks	118.57±2.58	80	76.78±3.54	82
Egg Weight (g)				
40 wks	54.54±0.71	84	51.87±1.54	108
52 wks	55.98±0.77	80	54.15±1.89	82

A total of Rs. 390 was estimated income from each hen at the rate of Rs. 5 per egg. The estimated total income from a pair of birds was Rs. 890 with a net profit of Rs. 610. A farmer with flock size of 20 birds can earn a net profit of Rs. 10370/- considering 15% mortality in the free range conditions as an additional income for the family. The income will further increase if the hens are reared till 72 weeks as the egg production increases to 140-150 eggs.

Coloured broiler populations for intensive and semi intensive broiler farming

Synthetic Coloured Broiler Male Line (PB-1)

S-27 generation of PB-1 was regenerated with 70 sires and 350 dams. A total of 4670 eggs were set and 3447 chicks were generated in 3 hatches. Percent fertility was 82.5 and percent hatchability on TES and FES was 73.8 and 89.4, respectively. As compared to last generation, fertility and hatchability were improved. Higher juvenile body weights were recorded in the present generation as compared to previous generation (Table 22).

Table 21.Summary of selection records in PB-1

Particulars	Magnitude
No of sires	70
No of Dams	350
No of sires contributed	70
No of dams contributed	350
Effective number	233.33
Rate of inbreeding	0.0021
Average selection differential (5 wks BW) g	150
Intensity of selection	1.25
Expected response(g) 5 wks BW	60.20

Table 22. Performance of juvenile traits of PB-1 (S-27 generation)

Traits		Mean±S.E (S-26)	Mean±S.E (S-27)
Body weight (g)			
	4 wks	618±0.62	688.7±0.60
	5 wks	916±0.81	982.2±0.90
	6 wks	1150±0.72	1170.8±0.80
Shank length (mm)	5 wks	74.69±0.06	76.32±0.08
Breast angle (°)	5 wks	83.22±0.08	84.1±0.09

During the period, recording of adult performance traits was completed in S-26 generation (Table 23). As compared to last generation, egg weights remained almost similar. Body weight at 20 and 40 weeks decreased by 57 and 100g, respectively, whereas 40 weeks egg production increased by 2 eggs.

Table 23. Production performance of PB-1 (S-26 generation)

Trait	Mean (S-25)	Mean (S-26)
Body weight (g)		
20 wks	2518±1.20	2461±0.67
40 wks	3360±1.30	3262±0.73
ASM (days)	156.5±0.20	188±0.04
Egg weight (g)		
32 wks	54.9±0.04	53.98±0.08
40 wks	61.72±0.10	61.62±0.04
Egg prodn. (no.)		
40 wks	55.03±0.09	56.9±0.09

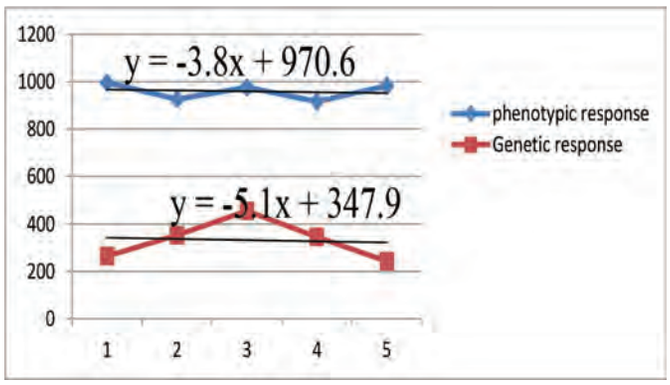


Fig. 3. Genetic and phenotypic responses of 5WK body weight in PB-1

A pair of PB-1 chicken

Pedigreed random bred broiler control population

G-16 generation of pedigreed random bred broiler control population was regenerated with 48 sires and 192 dams. A total of 2961 eggs were set and 2103 good chicks were produced. Percent fertility was 79.0, while percent hatchability on total eggs set and fertile eggs set, respectively was 71.9 and 91.1. As compared to last generation, both fertility and hatchability increased. As compared to last generation, all juvenile body weights were increased (Table 24).

Table 24. Juvenile performance of Control Broiler

Trait	Mean (G-15)	Mean (G-16)
Body weight (g)		
4 wks	381±0.50	539±0.60
5 wks	570±0.61	734±0.83
6 wks	836±0.90	951±1.20
Shank length (m.m)	66.18±0.08	70.68±0.09
Breast angle (°)	76±0.06	68.67±0.05

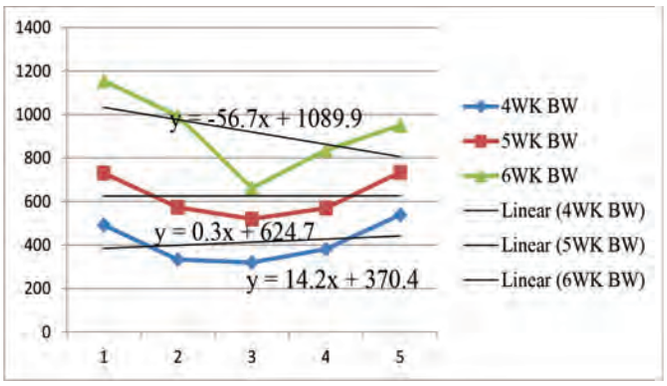


Fig. 4. Time trend of juvenile body weights in Control Broiler

Evaluation of broiler pureline and cross populations under heat stress

Three genetic groups, i.e. PB-1, PB-1X Naked neck cross and Naked neck were generated simultaneously along with the corresponding control group. They were brooded in the brood-grow pens and from 4-6 weeks, temperatures inside the pens were raised to 42^0C by using halogen lamps during the summer season. Lower juvenile body weights were recorded in groups exposed to heat stress at 4, 5 and 6 weeks of age. The difference in the body weight among the genetic groups was significant (P≤0.05). At 6 weeks of age, super oxide dismutase, lipid peroxidation, RBC catalase, alkaline phosphatase and glutathione peroxidase in serum were analysed. It was observed that SOD and ALP were significantly different (P≤0.05) among the genetic groups. However numerically higher estimates were obtained in heat stressed genetic groups as compared to the control genetic groups.

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

The PB-2 line completed evaluation of production traits for S-26 generation and juvenile traits for S-27 generation (Table 25). The average ASM has decreased by two days as compared to the last generation (180.2±0.98 days). The egg weight and egg production at 40 weeks remained stable compared to the last generation. Egg production at 52 weeks increased by 15 eggs compared to last generation (10.38±1.39). The phenotypic and genetic response to selection for the 40 week part period egg production over the last twelve generations was 0.68 and 1.28 eggs per generation, respectively (Fig. 5). The layer house mortality up to 40 weeks of age was 15.68%.

Table 25. Production traits in PB-2 (S-26 generation)

Trait		
ASM (days)		178.26±0.99
Egg Prodn. (no.)		
	32 wks	32.28±0.63
	40 wks	68.01±0.91
	52 wks	125.6±1.02
	64 wks	157.21±1.44
Egg weight (g)		
	28 wks	51.0±0.24
	32 wks	53.76±0.19
	36 wks	55.79±0.2
	40 wks	58.02±0.35
Body weight (g)		
	20 wks	2359.5±11.41
	40 wks	3004.4±14.9

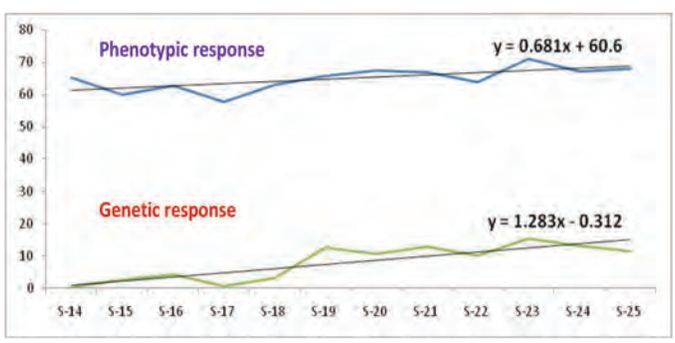


Fig. 5. Phenotypic and genetic response of 40 week egg production in PB-2 over last ten generations

PB-2 was regenerated with 60 sires and 300 dams in S-26 generation. A total of 4549 eggs were set, of which 3792 healthy chicks were obtained in three hatches. The percent fertility and hatchability on TES and FES were 91.0, 83.4 and 91.6, respectively. The fertility and hatchability improved by more than 10% when compared to the last generation.

The least square means for day old, two and four week's body weight were 38.98±0.07, 207.84±0.84 and 502.13±4.54 g, respectively. The principal selection trait i.e., body weight, shank length and breast angle at five weeks were 758.81±3.21 g, 77.18±0.21mm and 74.78±0.18^0, respectively. The five week body weight of the control broiler was 734±0.83g. There was decline in body weights at 4 and 5 weeks of age compared to previous generation, mainly due to disease incidence. The phenotypic and genetic response to selection for the five week body weight over the last nine generations was 2.95 and 3.08 grams per generation, respectively (Fig. 6). The overall mortality up to 5 weeks of age was 11.9%, which was lower than in the last generation.

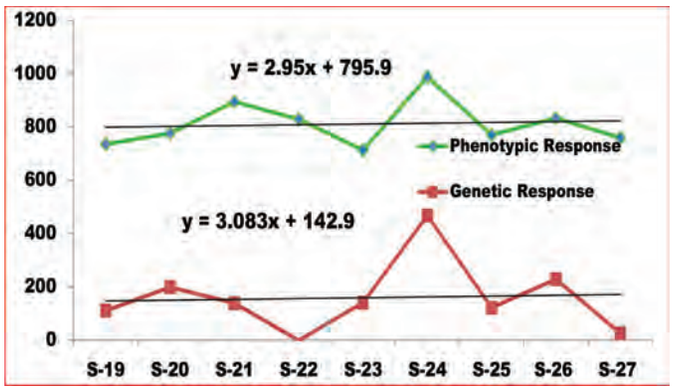


Fig. 6. Phenotypic and genetic response of 5 week body weight in PB-2 over last seven generations

The h^2 of juvenile growth traits of PB-2 was estimated by utilizing data of last three generations using univariate animal model (REML) by WOMBAT (Table 26). Genetic trend lines were plotted by average of breeding value of body weight at 5 weeks and egg production up to 4 weeks of last three generations and found positive, indicating that the selection was effective for principal traits.

A pair of PB-2 chicken

Table 26. Heritability estimates in PB-2

Trait	h^2
Body weight	
2 wks	0.18±0.04
4 wks	0.14±0.04
5 wks	0.17±0.03
Shank length	
5 wks	0.26±0.03
Breast angle	
5 wks	0.04±0.01

Maintenance of Naked neck (*Na*) and Dwarf (*Dw*) *gene lines*

The gene lines were evaluated for their juvenile growth and production traits in S-15 generation (Table 27). The gene lines were regenerated using 30 sires and 90 dams in three hatches. In naked neck (*Na*), 407 chicks were produced with 84.1% fertility, 67.3% hatchability on TES and 79.9% hatchability on FES, whereas in Dwarf (*Dw*), 396 chicks were produced with 80.1% fertility, 69.6% hatchability on TES and 86.8% hatchability on FES. The fitness traits improved in both the gene lines compared to the last generation.

The six week body weight increased by 57 and 39g in the *Na* line and *Dw* gene lines, respectively compared to the last generation.

The ASM was maintained in the *Na* line and decreased by 6 days in the *Dw* gene line over the previous generation. The body weight in both lines remained stable compared to last generation. The egg production to 32 weeks in Na line was 30.75±1.46.

Table 27. Juvenile growth traits of gene lines (S-15)

Trait	Naked Neck	Dwarf
Body weight (g)		
Day old	44.44±0.19	38.70±0.24
3 wks	295.67±2.68	230.98±2.89
6 wks	1027.83±7.23	716.34±7.47
Shank length (mm)		
6 wks	84.92±0.26	72.49±0.29
Breast angle (^{0})		
6 wks	81.33±0.24	80.99±0.25

Table 28. Production traits of gene lines (S-15 generation)

Trait	Naked Neck	Dwarf
ASM (days)	174.23±2.20	146.53±1.79
Body weight (g)		
20 wks	2711.45±26.64	2258.35±31.02
Egg weight (g)		
32 wks	55.09±0.56	49.59±0.65

Genetic evaluation of elite layer germplasm

Six lines (S-13 of IWK and LC, S-5 of IWH and IWI, S-0 of IWD and IWF) of layers were regenerated. In the current generation, the LSM for body weight at hatch (BW1) in IWH, IWI, IWK, IWD, IWF and LC were almost similar to the previous generation. The BW1 of S-0 generation of IWD and IWF was 29.88 and 31.04g, respectively. LSM for the body weights at 4 and 8 weeks ranged from 110 to 154 and 339 to 400g, respectively (Table 29). The body weights at 16 weeks in IWH increased by 16g, but there was marginal decrease in IWI, IWK and LC. The LSM for body weight in S-0 generation of IWD and IWF was 805 and 861g, respectively. The LSM for body weights at 20 and 40 weeks in these lines ranged from 1120 to 1177 and 1320-1492g, respectively. The LSM for age at sexual maturity (ASM) for IWH, IWI and IWK increased, whereas in LC, it remained static as compared to previous generation. The LSM for ASM in S-0 generation of IWD was more than IWF. The EP20 in all layer lines ranged from 4.25 to 5.65 eggs. The EP40 of IWH, IWI, IWK and LC increased by 9.78, 7.61, 7.72 and 9.63 eggs in the current generation as compared to previous generation. The EP40 was higher in IWF than IWD. The egg weights at 28 and 40 weeks in six layer lines ranged from 45.66 to 48.44 and 48.36-52.15g, respectively. The fertility and hatchability decreased across all lines as compared to previous generation, which could be due to the high ambient temperatures prevailed at the time of hatch (2).

A pair of WL birds

Table 30. Incubation records of layer lines

Line	Fertility (%)	Hatchability % (TES)	Hatchability % (FES)	Good Chicks
IWH (S-5)	54.59	48.34	58.11	1253
IWI (S-5)	67.7	42.46	63.0	1792
IWK (S-13)	73.45	46.36	63.31	1563
IWD (S-0)	71.09	47.96	67.74	765
IWF (S-0)	76.78	56.71	76.78	794
LC (S-13)	59.22	47.81	80.73	1291

Table 29. Least Square means of body weight, age at sexual maturity and egg production traits up to 40 weeks in layer lines

Trait	IWH (S-5)	IWI (S-5)	IWK (S-13)	IWD (S-0)	IWF (S-0)	LC (S-13)
Body weight (g)						
1 wk	32.47±7.15 (1286)	32.67±7.28 (1809)	34.84±3.31 (1526)	29.88±2.92 (761)	31.04±3.49 (744)	35.95±3.86 (1306)
4 wks	147.84±5.61 (1149)	124.31±41.72 (1381)	110±7.26 (1525)	126.88±30.32 (668)	133±34.94 (714)	154.47±33.16 (1188)
8 wks	399.95±90.9 (646)	365.13±84.1 (1229)	421.92±92.2 (1195)	339.33±92.8 (442)	383.45±101.5 (275)	373.85±95.6 (509)
16 wks	913.8±128.6 (474)	953.0±173.96 (665)	844.1±96.3(610)	804.6±152.7(215)	861.3±167.5 (176)	880.4±123.8 (366)
20 wks	1177.4 ±140.9 (303)	1114.1±119.9 (611)	1083.9±129.2 (595)	1125±197.0 (214)	1141.3±138.3 (181)	1182.4±132.5 (248)
40 wks	1415.6±195 (262)	1336.9±147.8 (289)	1320±142 (343)	1319.5±163 (183)	1374.1±193.8 (119)	1492.1±2.11 (140)
Egg weight (g)						
28 wks	48.44±10.40 (280)	47.10±3.13 (406)	48.01±7.05 (354)	45.99±3.8 (196)	45.66±3.48 (165)	47.64±4.16 (171)
40 wks	49.67 ±4.32 (236)	51.65±3.62 (280)	52.15±3.7 (316)	48.88±4.13 (163)	48.36±3.9 0 (110)	51.11±3.87 (133)
Egg prodn. (no.)						
20 wks	5.61 ±4.05 (166)	4.85±3.81 (213)	4.99±3.86 (184)	5.36±3.70 (44)	5.65±3.60 (48)	4.25±2.61 (128)
40 wks	124.23±14.20 (253)	123.98±14.93 (289)	111.64±18(337)	105.37±18.23 (189)	118.23±16.7 (108)	107.69±15.64 (135)
ASM (days)	140.11±9.83 (289)	143.84±9.6 (587)	147.86±13.52 (594)	148.41±11.46 (207)	144.84±10.87 (172)	150.56±10 (224)

Molecular Genetics

Functional genomics, epigenetics and gene silencing technology for improving productivity in poultry

The expression of fatty acid synthase (FASN) and acetyl-CoA carboxylase A (ACACA) genes were analysed during ontogenic and post-hatch juvenile period in broiler, layer and indigenous (Ghagus) chicken lines. The FASN expression was higher in layer chicken line over Ghagus and broiler lines. In layer line, the highest expression was observed during embryonic day 5 (ED5) and decreased thereafter. In broiler and Ghagus lines, the highest expression was detected during ED15. During post-hatch period, the highest expression was found on 42nd day of age in all the lines. The expression of ACACA gene was lower in broiler chicken than Ghagus and layer breeds during embryonic and post-hatch period. The highest expression of this gene was observed on embryonic day 5, while the lowest expression was detected on embryonic day 11. During the post-hatch period, expression of this gene was the lowest on day of hatch in all the lines. There was no significant difference of expression of ACACA gene during 14th, 28th and 42nd day of age.

Chicken hepatocyte culture was established in the lab. A total of 5 shRNA molecules were designed and synthesized for FASN and ACACA genes to silence these genes under cell culture system. The shRNA2 molecule of FASN gene had the best knock-down efficiency (97%) for FASN gene. In case of ACACA gene, the shRNA 3 and 4 molecules had the best gene silencing efficiency (90%) in primary liver cell culture. The immune response (Ir) genes particularly, interferon alpha, interferon gamma and BL-beta genes were not affected by incorporation of shRNA molecules of FASN and ACACA genes in primary liver cell culture. Thus the shRNA moleculaes for both FASN and ACACA genes had potential to silence the expression of the FASN and ACACA genes under cell culture system.

Characterization of chicken ovalbumin gene for development of transgenic cassette

The transgenic vector incorporating chicken ovalbumin gene promoter, poly A tail of ovalbumin gene and non-coding sequence of histone 2A gene has been prepared and named as DPREGG1 vector, which acted as excellent vector for expressing eukaryotic genes in chicken oviductal cells. This vector was used for expressing marker gene (Green fluorescent protein: GFP) in oviductal cells *in vitro*. The 720 bp GFP coding fragment (Primers were: GFPF: 5′-GTC GAC ATG CAC CAC CAT CAC CAT CAT ATG GTC AGC AAG GGC GCC-3′ and GFPR: 5′-GGA TCC GCT CTT GCG CTA GTG TAC TAG-3′) was cloned in the DPREGG1 vector. The oviductal cells were transfecetd with recombinant DPREGG1 vector through electroporation and was examined for expression of GFP gene in the oviductal cells. The levels of GFP expression in oviductal cells were observed in oviduactal cells. The control cells did not show any expression of GFP. The GFP protein expression was also detected in Western blot. It is concluded that DPREGG1 vector is very specific to chicken and was functionally active to express marker gene in chicken oviductal cells.

DPREGG1 vector map

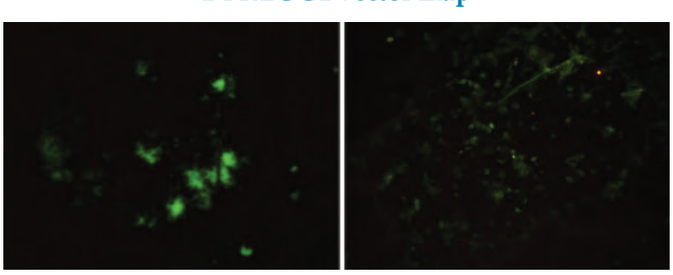


Fig. 7. GFP expression in chicken oviductal cells

Fig. 8. Western blot of GFP expressed in chicken oviductal cells transfected with recombinant GFP construct in DPREGG1 vector

Genotyping MHC class I loading complex genes for their association with immunocompetence traits

Dahlem Red had significantly higher serum creatinine levels compared to Ghagus. Triglycerides level was significantly higher in Ghagus compared to Dahlem Red. The ALT (IU/L) was significantly higher in females (32.3±1.28 IU/L) compared to males (28.7±1.15 IU/L). However, the breed effect was not significant and Brown Nicobari had the least ALT (29.29±1.46 IU/L) among the three breeds. Likewise, breed-wise as well as sex-wise, AST (IU/L) levels were similar, but ALT and AST levels were lowest in Brown Nicobari (213.1±5.45 IU/L).

PCR conditions were standardized for different exons of the Tapasin (Exons 3, 5, 6, 7 and 8) and TAP2 (Exons 1, 3, 4, 5, 6 and 7) genes. SSCP revealed that these exons of Tapasin and TAP2 gene were polymorphic and a total of 21 different haplogroups were observed in Tapasin and 10 haplogroups in TAP2 gene exons, respectively in all the three breeds of chickens. The cumulative frequency of haplogroup h1h2 was the highest (0.26) in Tapasin, while in TAP2 haplogroups h2h2 was the highest (0.47). Haplogroups h2h1 and h2h2 in Dahlem Red differed significantly in HI titre (8.65±0.35 and 7.18±0.54) and cytotoxic T cell number (3.62±0.03x 10^3/µl and 3.78±0.03 x 10^3/µl).

Genetic analysis of innate immunecompetence and survivability for identification of genetic markers in indigenous chicken breeds

Association between Natural Antibody (NAb) titres to rabbit red blood cells (RBCs) and survivability

NAb titres to rabbit RBCs and specific antibody (SpAb) titres to Newcastle Disease virus (NDV) were determined at 8, 20 and 40 weeks of age in Ghagus, Nicobari and WLH breeds of chicken. Association between NAb titres and survivability of birds between 20 and 72 weeks of age was carried out through logistic regression analysis. NAb titres to rabbit RBCs at 20 weeks of age were significantly (P<0.019) associated with survivability of birds up to 72 weeks of age in Ghagus. When data were pooled from three breeds, same but strong (P<0.002) association was evident. NAb titres to rabbit RBCs at 20 weeks of age were significantly higher in birds survived up to 72 weeks of age as compared to those died in Ghagus (P<0.03) and also when all three breeds were pooled together. The similar trend was observed in Nicobari and WLH breeds, but difference was not significant due to lower mortality observed in these breeds. However, NAb titres determined at 8 and 40 weeks of age were not associated with survivability up to 72 weeks of age when analysed within breed as well as pooled samples across breeds. The significant (P<0.013) association of antibody titre to rabbit RBCs at 20 weeks of age with survivability of birds during 40 to 72 weeks of age was also evident in pooled samples.

Genotyping with MHC linked marker revealed higher genetic variability in indigenous chicken breeds

Ghagus (119), Nicobari (125) and WLH (119) breeds were genotyped with MHC linked LEI0258 marker. Number of alleles (Na) and number of effective alleles (Ne) were highest in Ghagus followed by Nicobari and WLH breeds. Na and Ne, respectively observed were 24 and 8.2 with a range of 193 to 489 bp in Ghagus. In Nicobari, Na and Ne alleles were 17 and 3.16, respectively with a range of 191 to 572 bp. In WLH breed, Na and Ne alleles were 11 and 2.18, respectively with a range of 242 to 577bp. Altogether 44 alleles were observed in three breeds. The most frequently observed alleles were 261bp in WLH (66%), 309bp in Ghagus (28%) and 343bp in Nicobari (50%) breed. When all three breeds were pooled, 261bp was found to be the most common allele (157 times). The number of private alleles were highest in Ghagus (20) followed by Nicobari (13) and WLH (6). Surprisingly, the genetic distance (Nei) between Ghagus and Nicobari breeds (2.41) was higher as compared to Ghagus and WLH (1.25) and Nicobari and WLH (0.90). Observed heterozygosity was highest in Ghagus (0.85) followed by Nicobari (0.58) and WLH (0.49), while the expected heterozygosity was highest in Ghagus (0.88) followed by Nicobari (0.68) and WLH (0.54). Based on observed and expected genotype frequencies, Ghagus and Nicobari breeds significantly (p<0.001) deviated from Hardy Weinberg equilibrium. Overall, the study revealed higher genetic variability in indigenous breeds as compared to WLH breed at MHC which plays critical role in disease resistance, immune competence and production traits.

Association of SNPs in coding sequence of LGP2 and NAb to rabbit RBCs

Genetic polymorphism in coding sequence of MDA5, LGP2, TLR3, TLR1LA, and B-NK genes through SSCP was carried out in Ghagus (122 Nos.), Nicobari (125 Nos.) and WLH (120 Nos.) breeds. The association analysis of polymorphic markers (SNPs) with various growth, production and antibody titres revealed that polymorphic loci in exon 4 of LGP2 gene was significantly associated with the NAb titre to rabbit RBCs at 20 weeks of age, body weight and shank length at 8 weeks of age, age at sexual maturity and egg production up to 40 weeks of age.

Nutrition

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

Effect of low dietary energy with microbial enzyme on layers during summer

An experiment was conducted with WL layer chicken (60-67 weeks of age) to study the possibility of reducing the ill effects of summer by supplementing microbial enzyme to low energy diet. A standard (2500 kcal/kg) and low ME (2400 kcal/kg) diets were prepared, and the low ME diet was fed with and without supplementation of fibre degrading enzyme. Each diet was offered *ad libitum* to 15 replicates of 15 birds each in open sided poultry house. The mean maximum and minimum temperatures and humidity were 35.5 & 25.4 ^{o}C; 51.1 & 22.1%, respectively during the experimental period. Egg production, egg mass and feed efficiency were significantly improved by enhancing dietary ME from 2400 to 2500 kcal / kg diet during summer season (Table 31). Similar benefits were also observed by supplementing 2400 kcal ME diet with microbial enzymes (Fig. 9), besides improving eggs shell quality in layers reared during summer season. The results demonstrate that either enhancement of ME or supplementation of fibre degrading enzymes improve the layer chicken performance during heat stress condition.

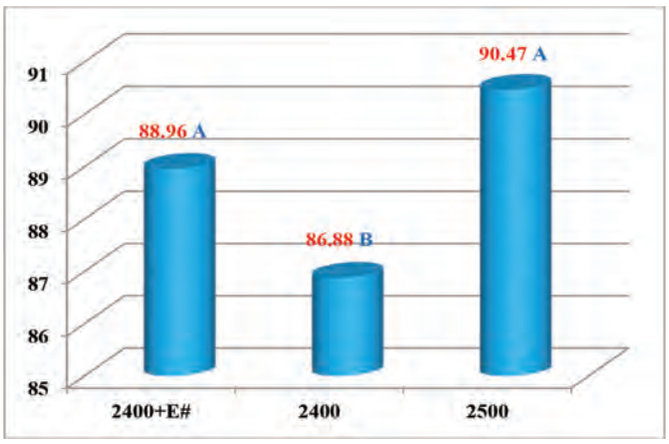


Fig. 9. Effect of enzyme supplementation to low ME diets on egg production

Effect of graded dietary levels of lysine on layers fed guar meal during summer season

Two experiments were conducted simultaneously with WL layer chicken to study the role of supplemental lysine to mitigate the effects of low digestible protein source (guar meal) during summer months. Layers were housed in 4-bird colony cages, 22 adjacent cages having a common feeder was a replicate. Each diet was fed *ad libitum* to 8 replicates for a period of 8 weeks from 33 to 40 weeks of age during April and May. The mean maximum and minimum temperature and humidity were 36.2 & 27.9 ^{0}C; 45.8 & 21.5%, respectively during the period. Increased concentrations (0.65, 0.70, 0.75 and 0.8%) of digestible lysine in soybean meal based diets, significantly reduced egg production, feed intake and feed efficiency (Table 32). But all the layer performance variables improved significantly with increase in concentrations of digestible lysine (Table

Table 31. Effect of dietary energy and microbial enzyme supplementation on performance of WL layers reared in summer

ME, kcal/kg	EP, %	FI, g/b	FCR	FI /EM	EW, g	EM, g/day
2400+E#	88.96^{a}	113.3^{ab}	127.4^{b}	2.189^{b}	58.30	51.89^{ab}
2400	86.88^{b}	113.9^{a}	131.4^{a}	2.237^{a}	58.79	51.09^{b}
2500	90.47^{a}	111.7^{b}	123.4^{c}	2.112^{c}	58.49	52.93^{a}
P value	*0.007*	*0.001*	*0.001*	*0.001*	*0.191*	*0.036*
N	*15*	*15*	*15*	*15*	*15*	*15*
SEM	*0.378*	*0.361*	*0.567*	*0.009*	*0.086*	*0.228*

EP egg production; FI feed intake; FCR feed intake / egg; EW egg weight; EM egg mass; FI/EM feed intake / unit egg mass produced
E microbial enzyme
$^{a\,b\,c}$ means having different superscripts in a column differ significantly (P<0.05)

33) in layers fed guar meal based diet (10%). Egg mass also showed a trend of reduction in SBM based diet, and improved in GM based diets with increase in lysine concentration in diet (Fig. 10). The results demonstrate that the performance of layer could be improved during summer season by increasing the levels of essential amino acids in guar meal based diets, but not when the layers fed highly digestible protein source (soybean meal).

Table 32. Effect of graded levels of limiting amino acids on layers fed maize – SBM diets during summer

Lysine %	EP %	FI g/b/d	FCR	EW g	EM g/d	FI/ EM g	Mort %
0.65	88.22[a]	87.74	99.27	54.95[ab]	48.43[ab]	1.815	2.295
0.7	88.01[a]	86.96	98.71	55.84[a]	49.09[a]	1.776	1.663
0.75	85.86[b]	85.94	99.82	53.94[b]	46.23[c]	1.859	1.641
0.8	87.01[ab]	87.06	100.1	53.97[b]	46.91[bc]	1.858	1.066
P	*0.043*	*0.965*	*0.983*	*0.083*	*0.004*	*0.685*	*0.736*
N	*8*	*8*	*8*	*8*	*8*	*8*	*8*
SEM	*1.906*	*1.190*	*1.276*	*0.310*	*0.337*	*0.027*	*0.374*

EP egg production; FI feed intake; FCR feed intake / egg; EW egg weight; EM egg mass; FI/EM feed intake / unit egg mass produced

[a b c] means having different superscripts in a column differ significantly (P<0.05)

Table 33. Effect of graded levels of limiting amino acids on performance of layers fed maize – SBM-Guar meal (10%) based diets during summer

Lysine, %	EP %	FI g/b/d	FCR	EW g	EM g/d	FI/EM g
0.65	67.71[c]	91.99	138.7[a]	53.52	36.18[c]	2.59[a]
0.7	74.04[b]	92.31	125.5[b]	52.94	39.18[b]	2.37[b]
0.75	77.28[a]	92.19	119.8[c]	53.60	41.39[a]	2.24[c]
0.8	77.20[a]	92.69	121.1[c]	53.55	41.33[a]	2.26[c]
P	*0.000*	*0.874*	*0.000*	*0.850*	*0.000*	*0.000*
N	*8*	*8*	*8*	*8*	*8*	*8*
SEM	*0.735*	*0.294*	*1.477*	*0.288*	*0.426*	*0.030*

EP egg production; FI feed intake; FCR feed intake / egg; EW egg weight; EM egg mass; FI/EM feed intake / unit egg mass produced

[a b c] means having different superscripts in a column differ significantly (P<0.05)

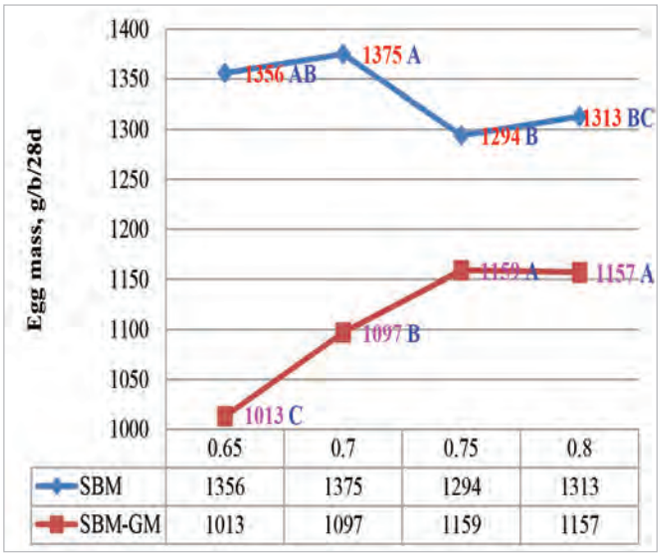


Fig. 10. Effect of concentration of Lysine on egg mass in WL layers fed maize – SBM and Guar meal (10%) based diets

Effect of alternate protein sources in diet on *Vanaraja* chicken during summer

An experiment was conducted on *Vanaraja* chicks fed diets containing 20% alternate feed ingredients like distillery dried grain with soluble (DDGS), rape seed meal (RSM) or cotton seed meal (CSM). Each diet was allotted to 15 replicates consisting of 5 *Vanaraja* birds which were housed in stainless steel battery brooders. Inclusion of the alternate protein sources at 20% in diet (1-42d of age) significantly (P<0.05) depressed body weight gain and feed efficiency compared to the soybean meal control group (Table 34). Stress responses (lipid peroxidation, super oxide dismutase, glutathione peroxidise) were significantly (P<0.05) higher and humoral immune response was significantly lower in alternate protein fed birds compared to the control group. Among the alternate protein sources, the performance and immune responses were lower in birds fed 20% RSM compared to other 2 sources of protein. The oxidative attributes (LP and GSHP) were significantly higher in groups fed CSM compared to other groups (Fig. 11). It can be concluded that incorporation of less digestible alternate protein sources in diet at higher inclusion level (20%) reduces immune response and oxidative stress, besides reducing the performance variables during heat stress condition.

Table 34. Effect of inclusion of alternate protein sources on performance and immune responses in *Vanaraja* chicken

Treatment	BWG, g	FI, g/b	FCR	CMI, %	HI, log2
SBM	789.1[a]	1717[ab]	2.177[d]	50.98	7.022[a]
DDGS	737.5[b]	1758[a]	2.385[b]	51.84	7.000[a]
RSM	660.0[c]	1614[c]	2.447[a]	47.02	6.156[b]
CSM	737.0[b]	1685[b]	2.289[c]	52.36	6.667[a]
SEM	*7.709*	*11.70*	*0.015*	*1.331*	*0.091*
N	*15*	*15*	*15*	*15*	*15*
P-Value	*0.000*	*0.000*	*0.000*	*0.482*	*0.002*

SBM soy bean meal; DDGS distillery dried grain with soluble; RSM rape seed meal; CSM cotton seed meal; BWG body weight gain; FI feed intake; FCR feed conversion ratio; CMI cell mediated immune response against PHA-P inoculation; HI haemogglutination inhibition against ND virus

[a b c] means having different superscripts in a column differ significantly (P<0.05)

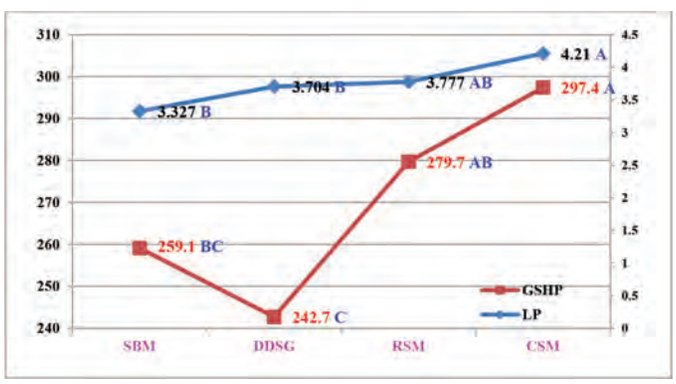


Fig. 11. Effect of inclusion of alternate protein sources on anti-oxidant variables in *Vanaraja* chicken

Effect of supplementing different variants of OxyCure on *Vanaraja* chicken in summer

Based on the results from previous trials, 5 combinations (variants) of OxyCure were identified which can mitigate / minimise the ill effects of high ambient temperature. In this current study, those five variants were re-assessed with *Vanaraja* chicken reared during summer season. A diet without OxyCure was fed as control diet. Each diet was offered *ad libitum* to 10 replicates (5 birds/replicate) from d 1 to 42d of age. The average maximum and minimum temperature and humidity were 34.5 & 22.4 ^{0}C and 58.4 & 27.1%, respectively during the experimental period. Feed efficiency was significantly improved (P>0.05) in *Vanaraja* chicks fed 3 combinations of OxyCure compared to the control diet at the end of experiment (Table 35 and Fig. 12). Activity of anti-oxidant enzyme (glutathione peroxidise) improved in all OxyCure combinations (Fig. 13), while HI response was significantly improved in 3 combinations compared to the control group. The results demonstrate the potential benefits of supplementing OxyCure in chicken diet during summer season in terms of feed efficiency and immune responses besides reducing anti-oxidant stress.

Table 35. Effect of supplementing different variants of OxyCure on *Vanaraja* chicken in summer

Treatment	BWG, g	FI, g	FCR	CMI, %	HI, log2
Control	676.7	1511	2.26[a]	45.2	6.0[b]
OxyCure 1	703.8	1540	2.19[b]	45.1	5.3[b]
OxyCure 2	674.7	1517	2.20[a]	44.9	6.2[b]
OxyCure 3	681.3	1521	2.23[ab]	41.5	8.7[a]
OxyCure 4	682.8	1504	2.20[b]	50.3	8.0[a]
OxyCure 5	709.5	1558	2.20[b]	34.6	8.4[a]
P	*0.291*	*0.674*	*0.027*	*0.189*	*0.000*
N	*10*	*10*	*10*	*10*	*10*
SEM	*5.406*	*10.13*	*0.006*	*1.753*	*0.223*

OxyCure 1, 2, 3, 4, 5, variants of OxyCure; BWG body weight gain; FI feed intake; FCR feed conversion ratio; CMI cell mediated immune response against PHA-P inoculation; HI haemaglutination inhibition against ND virus

[a b c] means having different superscripts in a column differ significantly (P<0.05)

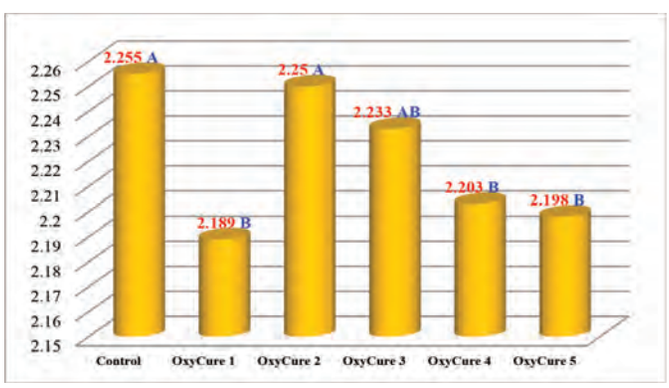


Fig. 12. Effect of supplementing OxyCure on FCR in Vanaraja birds during summer

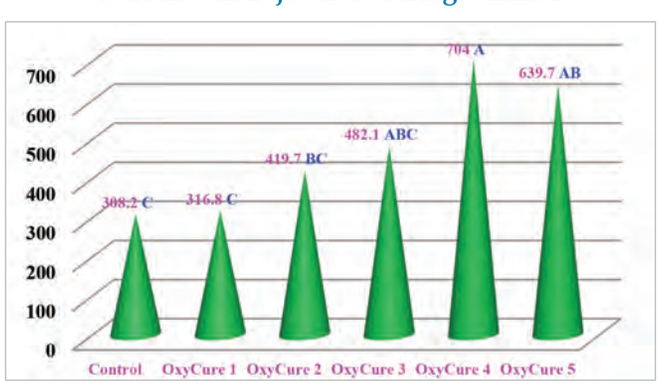
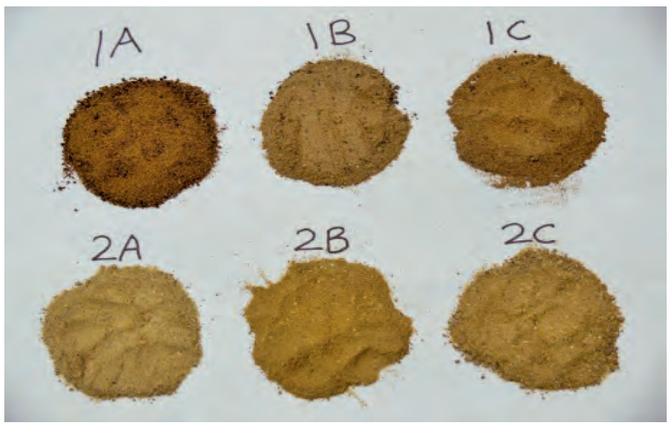


Fig. 13. Effect of supplementing OxyCure on GSHP activity in *Vanaraja* chicken

Utilization of distillery by-products in poultry diet: the nutritional implications and strategies for improving the nutritional value



Rice DDGS samples

A total of 7 samples of rice based DDGS were collected from local market. Physical examination of the rice DDGS samples revealed considerable variation in color and texture of the material. The crude protein content was found to vary between 44.68 and 62.42% among the samples, while the mean CP was 52.97±6.55%. The amino acid profile of the various DDGS samples varied significantly (Fig. 14). The average amino acid content of DDGS vs soyabean meal is given in Fig.15. The calcium and phosphorus contents varied between 2.54 to 3.88 and 0.65 to 1.39%, respectively.

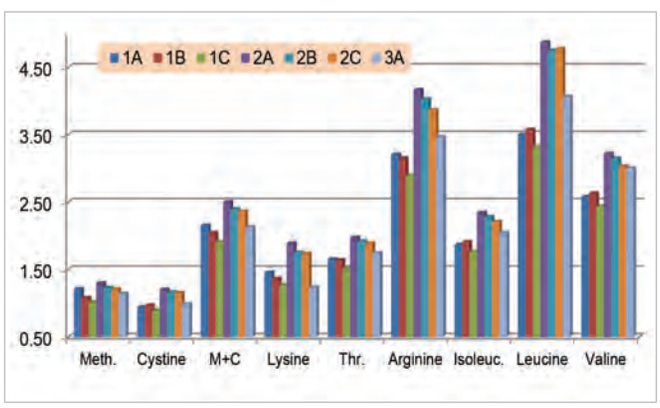


Fig. 14. Variation in Amino acid profile of DDGS samples (n=7)

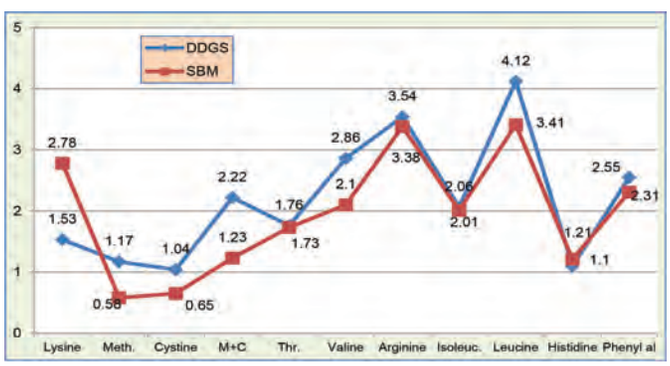


Fig. 15. Amino acid profile of rice DDGS vs soyabean meal

b) Feeding value of rice DDGS for *Vanaraja* chicks

The feeding value of 2 samples of rice DDGS, viz. high protein (57% CP) and low protein (47% CP) was evaluated in the diet of *Vanaraja* chicks during the nursery phase of 0 to 6 weeks of life. Both lots of DDGS were fed separately at 0, 5 and 10% levels in diet on *isocaloric* and *isonitrogenous* basis. Body weight remained unaffected till 4weeks of age, but at 5 weeks, the highest body weight was recorded with 5% level of both types of DDGS. At 6 weeks, the body weight was significantly ($P \leq 0.05$) higher at 5% level of both types of DDGS in comparison to control and at their higher level of 10%, the body weight, however was similar to that of control (Table 36). Feed intake was higher in all the groups fed DDGS, the difference being statistically significant ($P \leq 0.05$) at 3 weeks, while feed conversion efficiency was poor at the higher levels of DDGS. Breast meat protein content was higher in groups fed DDGS. Serum protein and cholesterol concentration, DM digestibility, carcass yields and organ weights were not affected, except for reduced weight of intestine in the groups fed DDGS.

Table 36. Effect of dietary inclusion of rice DDGS on *Vanaraja* chicks at 6 weeks of age

DDGS,% in diet	DDGS type	Body wt., g	FCR	Breast Protein %	Wt. of intestine, g/kg live wt
-	-	766.6^{b}	2.18^{ab}	81.28^{c}	64.70^{a}
5	1	817.4^{a}	2.12^{b}	83.06^{bc}	56.09^{b}
10	1	$764.^{b}$	2.21^{a}	86.36^{bc}	60.55^{ab}
5	2	791.1^{ab}	2.22^{a}	87.86^{a}	56.60^{b}
10	2	768.9^{b}	2.19^{a}	91.70^{a}	54.90^{b}
N		*10*	*10*	*9*	*10*
P		*0.04*	*0.18*	*0.001*	*0.19*
SEM		*6.55*	*0.02*	*0.93*	*1.08*

c) Evaluation of rice DDGS at higher levels in *Vanaraja* chick diet

The feeding value of rice DDGS at further higher level of 15% is currently being evaluated in *Vanaraja* chick diet. Rice DDGS procured from a local source (43% CP) was included in diet at 15% level on *isocaloric* and *isonitrogenous* basis. A total of 360 day-old *Vanaraja* chicks were divided into 60 replicate groups of 6 chicks each and housed in battery brooder cages. Chicks in 20 replicate groups are being fed the control diet, while the rest are fed the test diet containing 15% DDGS. From 2nd week onwards, the body weight significantly decreased

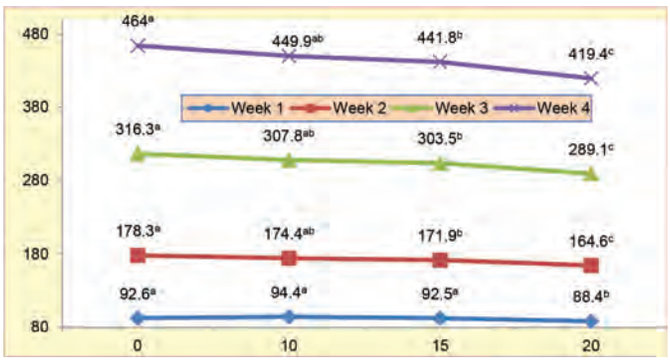


Fig. 16. Effect of rice DDGS on *Vanaraja* chicks

with ≥ 15% DDGS, whereas feed conversion efficiency decreased in all the groups fed DDGS.

Development of nutritional package of practices for backyard chicken production

To determine the nutritional status of backyard chickens of the country, four regions were selected for the study, i.e., Tripura, Himachal Pradesh, Rajasthan and Telangana. Crop and gizzard contents were collected from the scavenging birds of the regions and were subjected for estimation of energy. The samples collected from scavenging birds revealed lower energy, crude protein and calcium among growers and layers during rainy season (Table 37). However, the phosphorous levels remained comparable to those birds reared at Institute farm. The samples collected from scavenging birds during winter showed lower energy compared to those birds reared at Institute farm (Table 38). Further, the

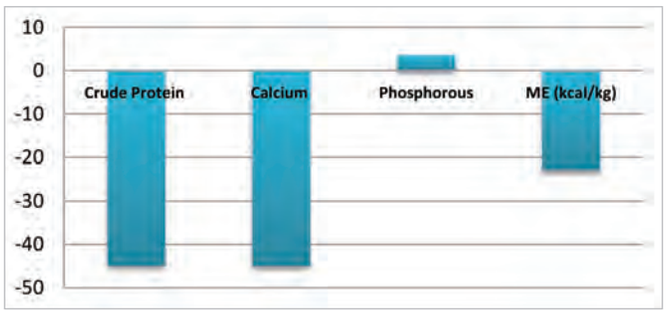


Fig. 17. Per cent excess or deficit of nutrients in adult birds

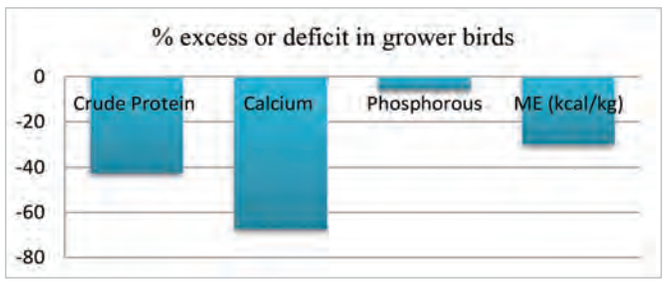


Fig. 18. Per cent excess or deficit of nutrients in grower birds

birds kept under scavenging mode were deficient of energy, protein and calcium compared to those birds kept at Institute farm. The phosphorous level in scavenging birds was comparable to those reared at the Institute farm.

The supplemental diet was computed to have energy and protein at 25% higher compared to the standard level. The levels of lysine and methionine were maintained proportionally to the protein level of the diet. *Vanaraja* birds (n=200; 8 weeks) were

Table 37. Mean chemical composition (%) of crop contents (DM basis) in grower and adult birds during rainy season

Chemical component, %	Growers		% excess or deficit	Adults		% excess or deficit
	DPR	Scavenging		DPR	Scavenging	
DM (g)	6.12	8.36	+36.60	18.97	17.89	-5.69
Crude Protein	13.20	8.56	-35.15	12.77	7.41	-41.97
Calcium	3.52	1.32	-62.5	4.86	1.10	-77.37
Phosphorous	0.12	0.10	-16	0.08	0.08	0
Energy (kcal/kg)	3423	2516	-26.5	3536	2391	-32.38

Table 38. Mean chemical composition (%) of crop contents (DM basis) in grower and adult birds during winter season

Chemical component, %	Grower		% excess or deficit	Adult		% excess or deficit
	DPR	Scavenging		DPR	Scavenging	
DM (g)	9.95	22.83	+129	15.62	27.93	+78.8
Crude Protein	15.64	8.96	-42.71	16.91	9.29	-45.06
Calcium	3.21	1.043	-67.50	3.13	1.72	-45.04
Phosphorous	0.408	0.385	-5.63	0.363	0.376	+3.58
ME (kcal/kg)	3462	2418	-30.15	3470	2675	-22.91

Table 39. Performance of *Vanaraja* birds under field condition

Week	Supplemental diet		SEM	P Vale
	+	-		
8	994	1008	*3.66*	*NS*
10	1347^{A}	1130^{B}	*22.23*	*0.01*
12	1322^{A}	1145^{B}	*24.35*	*0.01*

distributed among 20 farmers with 10 birds each in Baoji Tanda, Mahabubnagar district, Telangana. A total of 10 farmers were advised to offer 15 g/bird supplemental diet in the evening in addition to the natural scavenging and another 10 farmers were advised to maintain birds only on the scavenging mode without any supplemental feeding. Fortnight body weight was recorded. The 10 and 12 weeks body weight was significantly higher among the group fed supplemental diet compared to those maintained only on scavenging mode.

Production of chelated selenium, zinc and copper through yeast cells

To select the suitable inorganic source of Zn, a study was conducted using Zinc Sulphate, Zinc Chloride and Zinc Nitrate at 0, 30, 60, 90 and 120 ppm with *Saccharomyces cerevisiae* (050 strain) grown in the YEPD broth (Fig. 19). The biomass yield was higher with Zinc Sulphate compared to Zinc Chloride and Zinc Nitrate. Hence, Zinc Sulphate was selected as the source of inorganic Zn through which the organic Zn could be produced using *S. cerevisiae* for further study. Further, *S. cerevisiae* strain (050) was grown in presence of inorganic Zn at 100, 125, 150, 175, 200, 225 and 250 ppm. The desired CFU and biomass production was recorded

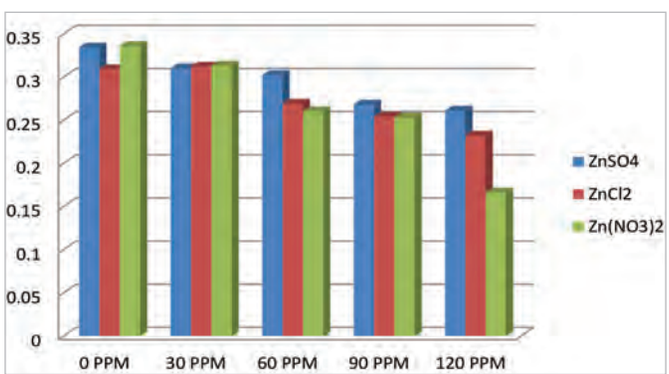


Fig. 19. Effect different inorganic Zn sources on biomass yield (g/50 ml) in *Saccharomyces cerevisiae* strain (050)

at 200 ppm. Therefore, *S. cerevisiae* strain (050) and 200 ppm (Zinc Sulphate) were used for producing organic Zn.

Evaluating the efficacy of organic Se in chickens

Day old chicks of *Vanaraja* (n= 300) were taken and randomly distributed into 5 dietary groups having 12 replicates with 5 chicks in each replicate. Four diets were formulated to contain 0, 0.2 and 0.3 ppm of organic Se and 0.2 and 0.3 ppm of inorganic Se. The experiment was continued till 6 weeks of age. The feed intake did not differ among the various groups (Table 40). However, the body weight gain was significantly higher among the groups fed diets with 0.2 organic Se compared to those groups fed the control or inorganic Se supplemented diets.

Effect of dietary supplementation of bio-fortified maize (QPM) on productive performance in broilers and layers chicken

A total of 175 *Vanaraja* chicks were randomly divided into 5 dietary groups each having 7 replicates with 5 birds each. Five diets were formulated to contain normal yellow maize (NMY), Vivek Hybrid 9, QPM + provit A, QPM and White Maize. All the diets contained equal amount of essential amino acids, protein and energy. The birds fed QPM and QPM + Provit A showed better body weight gain and improved feed efficiency (Table 41). Further, QPM and QPM + Provit A feeding considerably reduced the abdominal fat and increased breast muscle, which are highly desirable for chicken meat.

Table 40. Effect of feeding diets containing organic and inorganic Se in *Vanaraja* birds

Se, ppm	3 weeks			6 weeks		
	FI (g)	BWG (g)	FCR	FI (g)	BWG (g)	FCR
Control	491.1	300.3	1.64	1,641	808.4^{c}	2.03^{a}
0.2 org	498.8	314.4	1.59	1,659	862.9^{a}	1.91^{b}
0.3 org	485.9	298.3	1.63	1,630	813.7^{bc}	1.97^{ab}
0.2 inorg	485.7	309.9	1.57	1,696	849.9^{abc}	2.0^{a}
0.3 inorg	510.4	311.1	1.64	1,702	854.8^{ab}	1.99^{a}
SEM	*4.54*	*2.99*	*0.01*	*12.88*	*6.87*	*0.01*
P value	*0.391*	*0.35*	*0.39*	*0.29*	*0.02*	*0.03*

Table 41. Effect of feeding different sources of maize on performance in *Vanaraja* birds during 3, 6 and 9 weeks of age

	3 weeks		6 weeks		9 weeks	
	BWG,g	FCR	BWG,g	FCR	BWG,g	FCR
Normal Maize	205.3	2.02	529.7	2.18^{ab}	909.2	2.36
VivekHyb 9	213.0	1.98	586.9	2.20^{a}	956.1	2.40
APQH9	210.6	1.98	583.4	2.03^{c}	972.4	2.34
Vivek QPM 9	186.6	2.18	584.8	2.13^{bc}	960.7	2.36
WM	191.4	2.10	563.6	2.18^{ab}	962.0	2.25
N	*7*	*7*	*7*	*7*	*7*	*7*
SEM	*4.98*	*0.02*	*9.93*	*0.02*	*11.7*	*0.02*
P value	*0.36*	*0.08*	*0.32*	*0.01*	*0.48*	*0.08*

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

A project has been initiated to explore the possibility of increasing Fe and Zn content of eggs by supplementing inorganic and organic mineral sources. Inorganic zinc salts such as zinc chloride, zinc sulphate and zinc nitrate were studied for biomass production of *Saccharomyces cerevisiae 050 strain* and biomass production was the highest with zinc sulphate. To optimize the concentration of zinc sulphate for production of organic Zn, *S. cerevisiae* was grown in presence of inorganic Zn (from zinc sulphate) at 100, 125, 150, 175, 200, 225 and 250 ppm cocentration. The desired CFU and biomass production were achieved at 200 ppm Zn and bulk production of organic zinc was done for conducting *in vivo* trial.

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

Freeze dried ATCC cultures of *E.Coli* and *Lactobacillus plantarum* were grown in broth and preserved in 20% glycerol at -20 °C and also on agar slant at 4 °C. During the period, 8 plant bioactive compounds (PBACs) were evaluated for their growth inhibition potential for *E. coli* and sparing potential for *L. plantarum* by measuring OD600 of culture medium at different hours post inoculation and also by measuring drop in media pH at 24 h against un-inoculated media and zero PBAC but inoculated as controls. Some of the PBACs were found to have ability to inhibit *E. coli* at as low dose as 2 ul/30 ml medium with ability to spare *Lactobacillus*.

Physiology

Effect of chicken genotype on semen cryopreservation by vitrification

Semen from two chicken lines (PD-1 and PD-6) was cryopreserved using 6% and 9% dimethylacetamide (DMA) by vitrification method. Semen was vitrified by the method standardized in the lab and stored in plastic vials immersed in liquid nitrogen. Semen was evaluated pre and post cryopreservation for progressive motility, live sperm, abnormal sperm and fertility. The semen pellets were thawed on a hot plate (60°C) and inseminated into hens. All the parameters studied, except abnormal sperm were significantly lower (P<0.05) in cryopreserved semen. There was no difference in *in vitro* semen parameters and fertility between chicken lines (Table 42). In conclusion, the results indicated that cryopreservation using DMA and vitrification produced acceptable post thaw motility, but very low fertility. The chicken lines used in the study did not influence the outcome of semen cryopreservation procedure.

Utility of N-methylacetamide in chicken semen cryopreservation

Chicken semen cryopreservation in French straws was standardized. Semen from PD-6

Table 42. Effect of chicken lines on post thaw semen parameters and fertility of semen cryopreserved by pellet method

Parameters	PD-1			PD-6		
	Control	6% DMA	9% DMA	Control	6% DMA	9% DMA
Progressive sperm motility (%)	64 ± 2.45^{a}	30 ± 1.50^{b}	29.5 ± 1.57^{b}	62.5 ± 2.01^{a}	31.5 ± 1.67^{b}	27.8 ± 1.51^{b}
Live sperm (%)	86.7 ± 1. 20^{a}	34.7 ± 1.93^{b}	37.6 ± 1.62^{b}	87.0 ± 0.96^{a}	38.7 ± 2.03^{b}	36.6 ± 2.15^{b}
Abnormal sperm (%)	2.50 ± 0.33^{a}	1.34 ± 0.2^{b}	1.51 ± 0.23^{ab}	1.74 ± 0.17^{ab}	1.6 ± 0.21^{ab}	1.4 ± 0.30^{b}
Fertility (%)	66.0 ± 4.20^{a}	0^{c}	0.4 ± 0.4^{bc}	56.3 ± 5.02^{a}	9.8 ± 3.44^{b}	3.1 ± 1.71^{bc}
No. of eggs incubated	165	135	206	110	85	141

Values given are mean ± SE
Figures bearing different superscripts in a row differ significantly (P<0.05)

line was cryopreserved using 6%, 9% and 12% N-methylacetamide (MA). Semen collected from roosters was pooled and diluted to have the aforementioned final cryoprotectant concentration and final sperm concentration of 2000 x 10^6/ml. Later, semen was loaded into 0.5 ml French straws, sealed and kept on Styrofoam float 4.5 cm above liquid nitrogen, thus exposing the straws to the nitrogen vapours for 30 min. The straws were then immersed in liquid nitrogen and stored till further evaluation. Semen cryopreserved by this procedure was evaluated after thawing in ice water on eleven different occasions for progressive sperm motility, live and abnormal sperm, MTT dye reduction test and seminal plasma lipid peroxidation. Sperm motility and live sperm were significantly lower (P<0.05) in cryopreserved semen. Lipid peroxidation was significantly higher (P<0.05) in cryopreserved semen. Fertility trial was carried out by inseminating PD-3 line hens six times at three days interval. The percent fertility with 6%, 9% and 12% MA cryopreserved semen were 1.5, 0 and 5.3, respectively, whereas the control group inseminated with fresh semen produced 94.3% fertility.

Effect of vitamin E analogues supplementation on post thaw semen parameters and fertility

An experiment was conducted to study the effect of supplementing water soluble vitamin E analogue 6-Hydroxy-2,5,7,8-tetramethylchromane-2-carboxylic acid (Trolox) at 0.2, 0.4 and 0.8mM final concentrations along with N-methylacetamide (12%) on cryopreserved chicken semen. Semen from PD-6 rooster was cryopreserved in 0.5 ml French straws by exposing to liquid nitrogen vapours and then plunging in liquid nitrogen. The straws were thawed in ice water at 5 ^{0}C for 100 sec and semen was inseminated into PD-3 hens. Different semen parameters and fertility were assessed in post-thaw semen samples. Sperm motility, live sperm and mitochondrial activity were significantly lower (P<0.05) in cryopreserved semen (Table 43). Lipid peroxidation was significantly higher (P<0.05) in cryopreserved semen. The percent fertility was significantly lower (P<0.05) in cryopreserved semen compared to fresh semen. Trolox supplementation at 0.2mM level produced significantly higher (P<0.05) fertility than that of only methylacetamide. In conclusion, Trolox supplementation at 0.2 mM concentration during semen cryopreservation improved fertility.

In another experiment, the effect of supplementing Butylated Hydroxy Toluene (BHT) at 0.25, 0.5 and 1mM concentrations along with N-Methylacetamide on cryopreserved semen was studied. Semen from PD-6 rooster was cryopreserved in 0.5 ml French straws. Post-thaw different semen parameters such as sperm motility, live and abnormal sperm, seminal plasma lipid peroxidation, MTT dye reduction test and sperm chromatin dispersion (SCD) test, and fertility were evaluated. Sperm motility, live sperm and MTT dye reduction test were significantly lower (P<0.05) in cryopreserved semen. Abnormal sperm was significantly higher (P<0.05) in the BHT supplemented samples (Table 44). The sperm chromatin dispersion test was significantly higher (P<0.05) in cryopreserved samples. The percent fertility was significantly lower (P<0.05) in cryopreserved semen. In conclusion, BHT supplementation in cryopreservation mixture at the tested levels was detrimental to sperm.

Effect of L-glycine and L-carnitine during chicken semen cryopreservation

The effect of supplementing L-glycine and L-carnitine in cryopreservation mixture on post-thaw semen and fertility parameters was studied using PD-6 semen. The amino acid L-glycine (5, 15 mM), and L-carnitine (1mM) were supplemented along with cryoprotectant 4% dimethylsulfoxide (DMSO) and semen was cryopreserved in 0.5ml French straws. Different *in vitro* semen quality parameters, fertility and hatchability were assessed in post thaw samples. Post-thaw sperm motility, live and abnormal sperm, MTT dye reduction test and seminal plasma lipid peroxidation were not affected by L-glycine and L-carnitine supplementation (Table 45). Fertility was significantly (P<0.05) lower in L-glycine and L-carnitine supplemented treatments compared to fresh semen; however, hatchability on fertile eggs set was similar in all the treatments. Fertility obtained with 4% DMSO was similar to that of fresh semen (control). In conclusion, L-glycine and L-carnitine supplementation in the cryopreservation mixture at the tested concentrations did not improve post thaw semen parameters and fertility.

Evaluation of different cryoprotectants for Nicobari semen cryopreservation

A study was carried to evaluate different cryoprotectants for Nicobari chicken semen cryopreservation. Semen from adult Nicobari chicken was cryopreserved using Red Jungle

Fowl Extender in 0.5ml French straws using 12% methylacetamide (MA), 9% dimethylacetamide (DMA) and 4% dimethylsulfoxide (DMSO). The semen straws were thawed at 5 ^{0}C for 100 sec and inseminated into hens with a sperm concentration of 200 million/0.1 ml. Post thaw sperm motility, live sperm, MTT dye reduction test and fertility were significantly (P<0.05) lower in cryopreservation treatments. The abnormal sperm percent was significantly (P<0.05) higher in all cryopreservation treatments. The seminal plasma lipid peroxidation was significantly (P<0.05) higher in 9% DMA and 4% DMSO treatments. No fertile egg was obtained in 12% MA and 9% DMA treatments and in 4% DMSO treatment, very low fertility of 1.9% was obtained. In conclusion, the three cryoprotectants at the tested concentrations were not useful for cryopreserving Nicobari chicken semen.

Table 43. Effect of vitamin E analogue Trolox on post thaw semen parameters and fertility of cryopreserved chicken semen

Parameters	Control (Fresh semen)	12% MA	12% MA + Vitamin E 0.2 mM	12% MA + Vitamin E 0.4 mM	12% MA + Vitamin E 0.8 mM
Progressive sperm motility (%)	75.5 ± 1.2^{a}	28.82 ± 0.82^{bc}	25.5 ± 0.5^{c}	27 ± 0.82^{bc}	29 ± 0.7^{b}
Live sperm (%)	80.7 ± 2^{a}	32.1 ± 0.95^{b}	27.5 ± 0.69^{b}	29.1 ± 0.7^{b}	31.6 ± 0.81^{b}
Abnormal sperm (%)	1.35 ± 0.11	1.5 ± 0.13	1.75 ± 0.15	1.7 ± 0.15	1.8 ± 0.15
Mitochondrial activity (%)	70.5 ± 1.17^{a}	27.6 ± 0.73^{b}	23.4 ± 0.6^{c}	25.45 ± 0.86^{bc}	26.95 ± 0.73^{bc}
Seminal plasma lipid peroxidation (nM MDA/ml)	0.87 ± 0.04^{c}	2.90 ± 0.18^{a}	2.44 ± 0.08^{b}	2.45 ± 0.06^{b}	2.46 ± 0.11^{b}
Fertility (%)	89.4 ± 4.11^{a}	3.71 ± 1.67^{c}	18.66 ± 4.78^{b}	7.84 ± 3.15^{bc}	9.47 ± 2.22^{bc}
Number of eggs incubated	175	168	159	155	167

Values are mean±SE
Figures bearing different superscripts in a row differ significantly ($P < 0.05$)

Table 44. Effect of different levels of BHT on post thaw semen parameters and fertility of cryopreserved chicken semen

Parameters	Control (Fresh semen)	12% MA	12% MA+ BHT 0.25 mM	12% MA+ BHT 0.5 mM	12% MA+ BHT 1 mM
Progressive sperm motility (%)	79 ± 1^{a}	26.5 ± 0.76^{b}	24.5 ± 0.9^{bc}	21 ± 1^{c}	14.5 ± 1.17^{d}
Live sperm (%)	86.85 ± 2^{a}	30 ± 0.72^{b}	27.6 ± 0.93^{bc}	23.3 ± 0.99^{cd}	19.45 ± 0.87^{d}
Abnormal sperm (%)	1.35 ± 0.22^{b}	2 ± 0.22^{ab}	2.2 ± 0.2^{a}	2.25 ± 0.15^{a}	2.5 ± 0.17^{a}
MTT dye reduction test (nM of MTT Formazan/min/million sperm)	102.17 ± 2^{a}	68.9 ± 2.6^{b}	59.54 ± 3.77^{bc}	51.1 ± 4.26^{c}	35.48 ± 2.87^{d}
Sperm Chromatin Dispersion (% damaged)	8.4 ± 0.76^{c}	41.46 ± 1.05^{b}	44.02 ± 1.01^{b}	50.66 ± 0.66^{a}	52.52 ± 1.66^{a}
Seminal plasma lipid peroxidation (nM MDA/ml)	5.41 ± 0.38	6.47 ± 0.51	6.6 ± 0.57	6.37 ± 0.47	6.71 ± 0.54
Fertility (%)	74.82 ± 4.09^{a}	10 ± 2.96^{b}	6.73 ± 2.65^{b}	3.04 ± 1.44^{b}	3.15 ± 1.71^{b}
Number of eggs incubated	160	116	98	121	105

Values are mean±SE
Figures bearing different superscripts in a row differ significantly ($P < 0.05$)

Table 45. Effect of L-Glycine and L-Carnitine on post thaw semen parameters, fertility and hatchability of cryopreserved chicken semen

Parameters	Control (fresh semen)	4% DMSO	4% DMSO + L-Carnitine 1mM	4% DMSO + L-Glycine 5mM	4% DMSO + L-Glycine 15mM
Progressive sperm motility (%)	78 ± 0.82^{a}	21.5 ± 0.76^{bc}	24 ± 1.25^{b}	21.5 ± 0.76^{bc}	19 ± 1^{c}
Live sperm (%)	89.75 ± 1.45^{a}	24 ± 0.54^{bc}	27.55 ± 1.07^{b}	24.9 ± 0.78^{bc}	22.15 ± 1.01^{c}
Abnormal sperm (%)	1.5 ± 0.18^{b}	2.15 ± 0.18^{a}	2.05 ± 0.11^{ab}	2.25 ± 0.11^{a}	2.35 ± 0.18^{a}
MTT dye reduction test (nM of MTTFormazan/min/ million sperm)	95.14 ± 2.31^{a}	39.3 ± 1.55^{b}	40.7 ± 1.9^{b}	39.61 ± 1.46^{b}	40.26 ± 0.93^{b}
Seminal plasma lipid peroxidation (nM MDA/ml)	1.5 ± 0.06	1.37 ± 0.03	1.35 ± 0.04	1.39 ± 0.04	1.41 ± 0.03
Fertility (%)	96.05 ± 2.06^{a}	78.14 ± 5.46^{ab}	59.34 ± 7.68^{b}	54.73 ± 10.04^{b}	51.45 ± 7.43^{b}
Hatchability on FES (%)	77.03 ± 3.98	78.65 ± 3.98	84.32 ± 8.87	69.54 ± 8.77	76.10 ± 8.91
No. of eggs incubated	87	86	85	84	82

Values are mean±SE

^{a,b,c} Figures bearing different superscripts in a row differ significantly (P<0.05)

Role of plasma leptin, ghrelin and growth hormone in regulation of physiological functions of chicken during summer season

Supplementation of fermented yeast culture (FYC), has been explored for its possible beneficial effects in alleviating summer stress indirectly through increase in production performance through its effect on physiological parameters. FYC is a source of amino acids, vitamins and minerals. It also decreases the number of pathogens in gut and also acts as an antioxidant.

During summer season in PD-3 chicken line, at an ambient temperature ranging between 37- 29^{o}C and RH 46-59%, the lipogenic genes Steroyl Co A desaturase and Fatty acyl synthase were expressed more (P<0.05) in liver and brain when compared with the yeast culture supplemented group. The receptor for hormones, leptin, ghrelin and GH were also downregulated (P<0.05) in liver, brain and magnum portion of the reproductive tract in the yeast culture supplemented group when compared with the control group. Experiments were also conducted to evaluate the effect of heat stress in Nicobari, which is a native bird. It was observed that higher ambient temperature during summer season resulted in increase in plasma leptin (P<0.05) during the first three weeks of summer period and decrease in plasma ghrelin (P<0.01) hormones in the control group, whereas in the other group upon supplementation of yeast culture it had an opposite effect. Supplementation of yeast culture also had a protective effect on the histomorphology of the jejunum, indicating nil or mild necrosis of villi of the jejunum, whereas in control group, the severity of the necrosis observed was of medium severity. The supplementation of yeast culture continued in post summer period also, which caused significant increase (P<0.05) in body weight and egg weight.

Sustainable poultry waste management through composting

For taking samples of litter, two cage houses were selected and litter samples were collected from five different locations in the cage house and the samples were mixed properly so as to avoid any biasness. Like this, five samples were collected and average values of these observations were recorded. Analysis for all these samples was done for DM, organic carbon, C/N ratio, total nitrogen and other trace elements and minerals. The dry matter (%) was found to be 92.3, organic carbon (%) was 45.2, C/N ratio on dry matter basis was 16.03, Total N (%) was 2.82, Fe (ppm) was 1002 and Mg (%) 0.52 in the litter samples. In litter and dry leaves samples, Ca (%) was 1.03 and 2.38, and phosphorus (%) was 2.38 and 0.45, respectively.

Health

The ALV screening in breeding flocks of four lines was done by P27 antigen ELISA. The ALV carrier status was 2.4% in PB-1, 2.07% in PB-2, 2.01% in PD-4 and 0.79% in PD-6. The percentage decrease in carrier status from earlier generation was 1.64% in PB-1, 6.43% in PB-2, 20.89% in PD-4 and 7.16% in PD-6, respectively.

Assessment of immune response to virosome vaccine prepared from mesogenic Newcastle disease virus in chicken

Virosomes vaccine (two doses) group induced equivalent HI titre response to Lasota vaccine during first and second week of immunization (HI titres 3.67± 0.39; 3.40±0.02, respectively). However, during third and fourth week, Lasota vaccine induced higher antibody titres (5.16±0.20; 4.20±0.31). At 9 and 10 weeks again virosome vaccine could induce equivalent antibody response (4.75 ±0.28; 3.08±0.31). No significant differences were observed among the three groups in stimulation indices at 4 and 10 weeks. Prime immunization with virosome vaccine induced antibody titres equivalent to currently used multiple doses of lentogenic live vaccine.

Characterization of pathogenicity of IBV –DPR isolate

Infectious bronchitis virus isolate (IND/HYD/16/01) from layer flock of DPR with gout and peritonitis outbreak was characterized and its pathogenicity was studied. EID_{50} of the isolate was calculated by Reed & Muench (1938) method in embryonated chicken eggs and arrived at $10^{4.7}$. Serum neutralization assay was performed to check the cross-neutralization by Mass type vaccine strain following beta method. Serum induced by Mass 41 vaccine was used for neutralization of 100 EID_{50} virus and titration was performed as per OIE protocol in embryonated chicken eggs. The index was 2.28 indicating it as heterologous strain having poor cross neutralization with Mass type strains.

Fig. 20. IBV infected embryos showing dwarfing, curling, haemorrhages on head and toes and urate deposits on CAM

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

Isolation of enteropathogens

Isolated 7 isolates of *E. coli* and 8 isolates of *Salmonella spp* based on colony morphology and biochemical characteristics using standard techniques. On MacConkey agar (MCA), *E.coli* colonies revealed lactose fermenter, flat, dry, pink colonies with a surrounding area of precipitated bile salts and *Salmonella spp* revealed non-lactose fermenter, colourless and small colonies. On Eosin Methylene Blue agar (EMB), *E. coli* colonies revealed smooth, circular, black or green colour colonies with metallic sheen. On Xylose-Lysine-Desoxycolate (XLD) agar plates, red colonies with black centres were observed.

Biochemical characterization

All were gram negative organisms and the IMViC tests showed Indole and Methyl red positive for *E. coli* and Methyl red and citrate positive for *Salmonella spp*. Carbohydrate fermentation test was positive for glucose with gas production for both *E.coli* and *Salmonella* spp. The results of Triple Sugar Iron (TSI) slant revealed acid butt (yellow colour) with gas production for *E. coli* isolates, whereas for *Salmonella* it was black colour indicating H_2S production.

Serotyping of *E.coli* isolates

Sixteen isolates of *E. coli* were sent for serotyping to NSEC, Kasauli which revealed O118 (2 isolates), O7 (2 isolates), O157 (4 isolates), UT (2 isolates), O22, O11, O35, O149, O88 and O20.

In vitro antibiotic sensitivity test against enteropathogens *viz., E. coli* and *Salmonella*

In vitro antibiotic sensitivity testing using various antibiotics, Erythromycin (15 mcg/disc), Chloramphenicol (30 mcg/disc), Ofloxacin (5 mcg/disc), Ampicillin (10 mcg/disc), Streptomycin (10 mcg/disc), Norfloxacin (10 mcg/disc), Gentamicin (10 mcg/disc), Penicillin-G (10 units/disc), Ciprofloxacin (5 mcg/disc) and Rifampicin (5 mcg/disc) was done for *E.coli* and *Salmonella* isolates. The data was interpreted based on CLSI standards, 2017.All *E. coli* isolates were resistant to Erythromycin (Macrolides), Penicillin-G (Penicillins), Rifampicin (Ansamycins) and sensitive to aminoglycosides (Gentamycin and Streptomycin) as depicted in Fig. 21. All *Salmonella* isolates were resistant to Erythromycin (Macrolides), Penicillin-G (Penicillins), Rifampicin (Ansamycins) and Tetracycline (Tetracyclines) and susceptible to Chloramphenicol (Phenicols) as depicted in Fig. 22.

In vitro evaluation of medicinal herbs for antibacterial activity against enteropathogens

In vitro antimicrobial susceptibility studies using certain herbal extracts *viz.*, aqueous, methanolic and ether extracts of garlic, ginger, turmeric, tulsi, cinnamon, citrus, clove and amla and essential oils of garlic, ginger, turmeric, tulsi, cinnamon, citrus and clove were done for all the isolates. All the aqueous extracts did not show any zone of inhibition. Table 46 and 47 shows the antibacterial effect of various extracts against *E. coli* and *Salmonella* isolates.

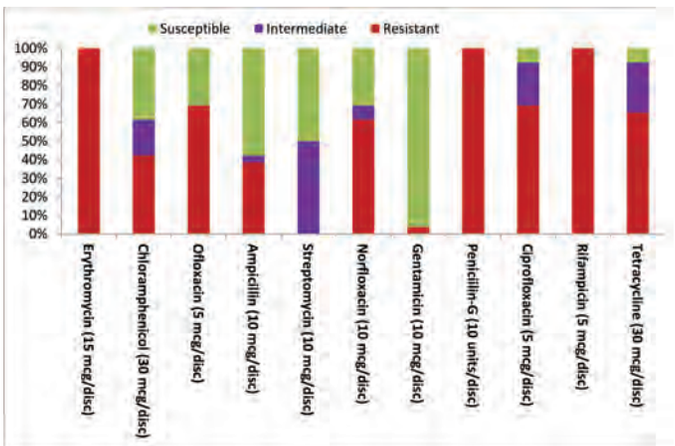


Fig. 21. Antibiotic sensitivity test for *E.coli* isolates

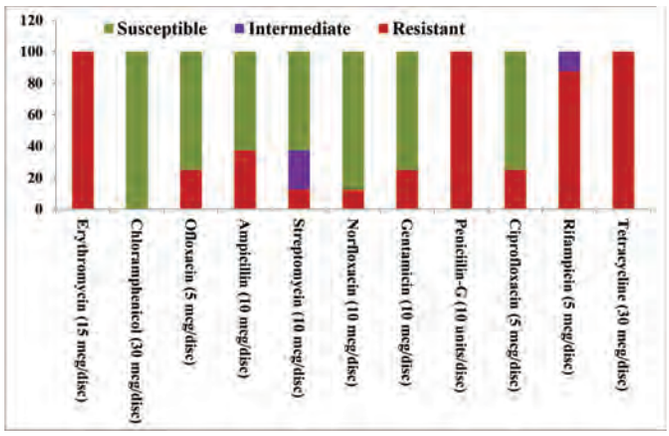


Fig. 22. Antibiotic sensitivity test for *Salmonella* isolates

Table 46. Antimicrobial activity of different herbal extracts against *E.coli* and *Salmonella* isolates

Isolates	*Escherichia coli*				*Salmonella spp.*			
Extracts	Aqueous	Alcoholic	Ether	Essential oils	Aqueous	Alcoholic	Ether	Essential oils
Garlic								
Ginger								
Turmeric								
Tulsi								
Cinnamon								
Amla								
Citrus								
Clove								

3. Technologies Assessed and Transferred

Germplasm supply

The improved rural chicken varieties *Vanaraja* and *Gramapriya* developed at this Directorate were supplied in majority of states of the country. These birds have been preferred due to their physical characteristics, greater adaptability to the diversified agro-climatic conditions and production potential with minimum investment. A total of 18.7 lakhs of improved germplasm was distributed from ICAR-DPR, AICRP and PSP centres (Table 1).

Table 1. Germplasm supplied during 2017-18

Sl. No.	Particulars	Number
I	**DPR**	
A.	**Hatching Eggs**	
	Krishibro	169
	Vanaraja	47,448
	Gramapriya	10,004
	Srindhi	3,764
	Aseel	467
	Control layer	835
	Control broiler	787
	Layer	6,808
	Embryonated eggs	6,681
	Total	**76,963**
B.	**Day Old Chicks**	
	Krishibro	10,587
	Vanaraja	1,94,489
	Gramapriya	55,495
	Srindhi	10,864
	Aseel	553
	PD4	614
	Layer	1,261
	Total	**2,73,863**
C	**Parents**	
	Vanaraja	17,064
	Gramapriya	9,174
	Srindhi	4,860
	Total	**31,098**
D	**Grownup birds**	**2,292**
	Net Total (A+B+C+D)	**3,84,216**
II	AICRP on Poultry Breeding	**8,54,261**
III	**Poultry Seed Project**	**6,31,543**
	Grand Total (I+II+III)	**18,70,020**

Mera Gaon Mera Gaurav Program

During this reporting period two new villages were added to previous eleven adopted villages. About 825 grown up chicks were distributed to the beneficiary farmers in different villages. Teams of Scientists visited their adopted villages and conducted interface meetings with farmers. Scientists also conducted demonstrations on supplementary feeding, diet formulations, tick control strategies, vaccination and health care measures for the birds that are reared under scavenging mode. The farmers were also provided information in the form of printed literature on rearing birds under backyard conditions. Further, mobile-based advisory system is in place with some of the scientists, who are regularly delivering the advisories to the poultry farmers.

Poultry India 2017

ICAR-DPR participated in Poultry India 2017 exhibition organized by IPEMA at Hitex, Hyderabad from 22th to 24th November 2017. DPR stall attracted the attention of the delegates and poultry farmers. The technologies developed by the institute especially the improved chicken varieties; *Vanaraja, Gramapriya* and *Srinidhi* attracted the poultry farmers.

Training Programme for Agripreneurs

ICAR-DPR in collaboration with National Institute of Agricultural Extension Management (MANAGE), Hyderabad organized two Refresher Training Programmes on "Modern poultry management for established Agripreneurs" during 2–5 May and 18-21 September 2017. The program was sponsored by MANAGE, Hyderabad under Agri-Clinics and Agri-Business Centres (AC&ABC) scheme. A total of 45 agripreneurs from different states attended the training programme. The participants were exposed to various aspects of poultry production such as breeding, nutrition, management and health care practices. The training module had practical demonstrations and hands on experience on farm and hatchery operations. A field visit to a commercial poultry unit of 4 lakh layer capacity was arranged for the benefit of the participants. The participants expressed their satisfaction on the training program and methodology adopted during the training programme.

Participants of Training Programme for Agripreneurs

Model Training Course

A model training course on "Commercial poultry production and management" was organized from 11 - 18 December 2017. The course was sponsored by the Directorate of Extension, Govt. of India and attended by 20 senior veterinary officers from different states.

Participants of Training Programme for AH officers

Training Programme for Animal Husbandry Officers

ICAR-Directorate of Poultry Research, Hyderabad organized a Training Programme on "Certified Livestock Advisor Program on Poultry (Module – II)" during 24 January – 7 February 2018, sponsored by MANAGE, Hyderabad. A total of 25 Animal Husbandry Officers from 13 states attended the programme. The trainees were exposed to various aspects of poultry production such as breeding, nutrition, management and health care. The training module included theory, practical demonstrations and hands on experience on farm and hatchery operations. A field visit to a commercial poultry unit of 1 lakh layer capacity, feed mill and NRC on Meat, Hyderabad was arranged for the benefit of the participants.

Dr. R.N. Chatterjee giving away the participation certificate

Krishi Unnati Mela 2018

ICAR-DPR participated in Krishi Unnati Mela organized at PUSA, New Delhi from 16-18 March 2018. Union Minister of Agriculture and Farmers Welfare, Hon'ble Sri Radha Mohan Singh inaugurated the Mela. Different technologies developed at the institute were depicted in the mela. About 350-400 farmers visited DPR stall and gained knowledge on different scientific methods of rearing poultry to get maximum return for improving socioeconomic and nutritional status.

Pashudhan Vikas Sammelan and Krishi Goshthy

Pashudhan Vikas Sammelan and Krishi Goshthy was organised at Semuapur Village, Kesariya Block, Motihari, Bihar during 28-29 October 2017. Union Minister of Agriculture and Farmers Welfare, Hon'ble Sri Radha Mohan Singh inaugurated the Mela. ICAR-DPR participated and displayed different technologies like low input chicken varieties, nutritional and health packages for poultry rearing. About 300-350 farmers visited DPR stall and gained knowledge on different scientific methods of rearing poultry. The scientist from the institute also participated in Kisan Goshthy and delivered a lecture on "Scientific rearing of backyard chicken".

Participation in other Farmers' Fairs

The Directorate participated in various Farmer Fairs to disseminate information about innovative technologies developed and good chicken farming practices.

- Kisan Mela at Hayatnagar Research Farm, CRIDA, Hyderabad on 4 May 2017
- PUSA Mela at Kotwa, Motihari, Bihar, July 2017
- Kisan Mela at ICAR-IIOR, Hyderabad, 10 – 11 September 2017

Farmers Awareness Programme under NICRA

The research outcome of the studies conducted at DPR was shared with poultry farmers of Telangana and Karnataka by Dr. S.V. Rama Rao, PI, NICRA during February 2018 i.e. before onset of summer season. These meetings were supported by Kemin India and JAPFA Comfeed India Pvt Ltd, respectively at Hospet, Karnataka and Chitanpally, Ranga Reddy, Telangana. During the seminar, the scientist has explained the mechanisms of heat stress in chicken and the probable losses during summer. Both nutritional and managemental means were suggested to reduce heat stress losses in layer and broiler chicken. About 40 farmers at Hospet representing about 45 lakh layers and more than 100 farmers having 30 lakh chicken housing capacity at Chitanpally took part in the program. Many farmers have interacted with the scientist and got clarifications on various nutritional and managemental means to minimize the loss in productivity of chicken during hot summer season.

Seminar on Summer Management of Poultry

A seminar on "Management of poultry farm during summer season" was organised on 7 April 2017 at Hanamakonda, Telangana for the benefit of poultry farmers in the region. The event was co-sponsored by AP (Hyderabad) Chapter of IPSA and Chalimeda Feeds Pvt Ltd, Karimnagar.

4. Training and Capacity Building

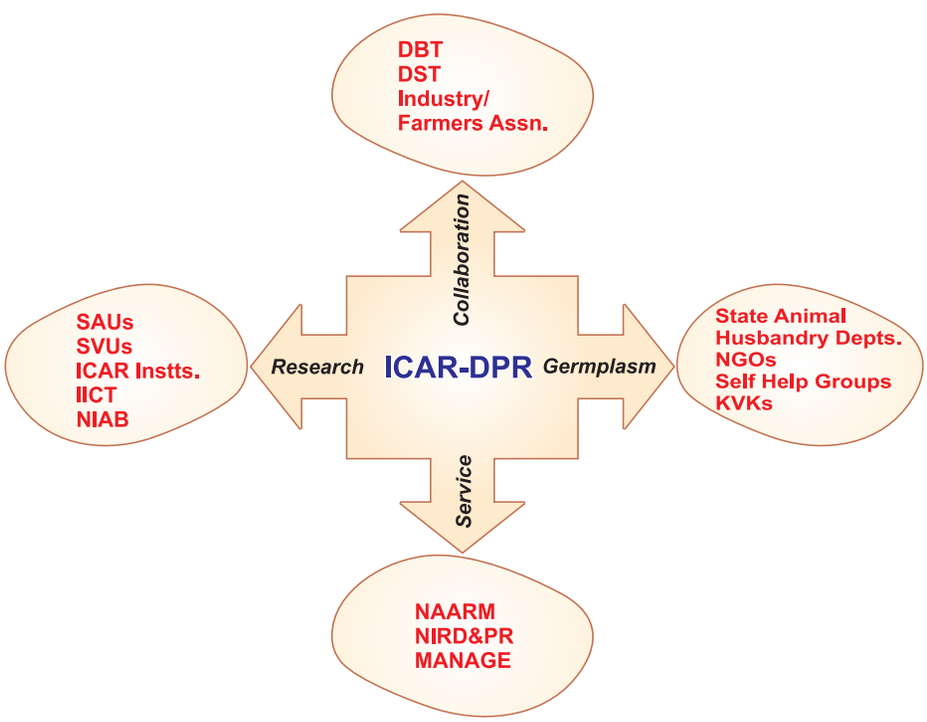
In the training programmes organized by different organizations, staff of the Directorate participated to update and gather knowledge in different aspects including science and technology, administration and financial management. The details of training programmes attended by the staff have been stated in the following Table.

Table 1. Participation of DPR staff in Training and Capacity building activities

Sl. No.	Particulars of training	Official (s)	Duration	Venue
1	Training Programme for Nominees of CPCSEA	Dr. T.R. Kannaki, Sr. Scientist	23-24 May, 2017	Indira Paryavaran Bhawan, New Delhi
2	Training programme on Impact Assessment of Agricultural Research and Technologies	Dr. M. Shanmugam, Sr. Scientist	12-16 September, 2017	ICAR-NAARM, Hyderabad
3	Training Programme on Priority setting, Monitoring and Evaluation (PME) of Agricultural Research Projects	Dr. A. Kannan, Pr. Scientist	06-11 October, 2017	ICAR-NAARM, Hyderabad
4	Multivariate Data Analysis	Dr. M.V.L.N. Raju, Pr. Scientist	14-20 December, 2017	ICAR-NAARM, Hyderabad

5. Linkages and Collaboration

The Directorate is well equipped with the state of art infrastructure facilities for conducting advanced research in the fields of Poultry Genetics and Breeding, Nutrition and Health. The facilities available at this Institute were utilized by the students of institutions like PVNRTVU, Hyderabad; PJTSAU, Hyderabad; KVAFSU, Bangalore and JNTU, Hyderabad for carrying out their dissertation works. The scientists of this Institute guided the research work of the students as Co-chairmen/members of the students' advisory committee. The library facilities were also utilized by the faculty and students of the local Institutions. Several trainees/students from neighbouring Institutions like NAARM, SVVU, PJTSAU, MANAGE, NIRD&PR etc. visited the Directorate to have an exposure to the applied aspects of poultry farming, research and extension. The Directorate is having links with various SAUs, SVUs and ICAR institutions across the country. The Directorate is supplying germplasm through State Animal Husbandry Departments, NGOs, KVKs etc., besides two network research programmes (AICRP and Poultry Seed Project).



Collaboration of ICAR-DPR with different agencies

6. All India Coordinated Research Project on Poultry Breeding

The AICRP on Poultry Breeding is being operated at twelve centres viz. KVASU, Mannuthy; AAU, Anand; KVAFSU, Bangalore; GADVASU, Ludhiana; OUAT, Bhubaneswar; CARI, Izatnagar; ICAR Research Complex for NEH Region, Agartala; MPPCVVV, Jabalpur; AAU, Guwahati; BAU, Ranchi; MPUAT, Udaipur and CSKHPKVV, Palampur. The main objective of the project was development of location specific chicken varieties, conservation, improvement, characterization and application of local native, elite layer and broiler germplasm; development of package of practices for village poultry and entrepreneurships in rural, tribal and backward areas. In addition, KVASU, Mannuthy and AAU, Anand centres are maintaining two elite layer germplasm (IWN and IWP). KVAFSU, Bangalore; GADVASU, Ludhiana; OUAT, Bhubaneswar and CARI, Izatnagar are mandated to maintain four elite broiler germplasm (PB-1, PB-2, CSML and CSFL).

Two pedigreed random bred control populations (one for layer and the other for broiler) were evaluated and reproduced at ICAR-DPR. Samples of hatching eggs from these populations were sent to different centres of AICRP on Poultry Breeding to measure the genetic progress. As per the decision taken by the Council, the strains maintained at different AICRP centres and ICAR-DPR were duplicated at various AICRP centres to be utilized in case of exigencies and as a resource population by the centre for production of three and four-way crosses. The strains being duplicated at different AICRP centres are IWF at Mannuthy, IWD and IWK at Anand and M-1 and M-2 at Jabalpur. During the year, a total of 8,54,261 chicken germplasm was distributed to the farmers from different centres with a total revenue generation of Rs. 261.11 lakhs.

KVASU, Mannuthy centre has evaluated the S-2 generation of native chicken germplasm up to 40 weeks of age. Egg production of this germplasm up to 40 weeks of age was 75.96 eggs with average egg weight of 42.47 g. Egg production increased by 3.88 eggs and egg weight increased by 0.7 g in the S-2 generation. Good fertility (90.04%) and hatchability (94.27 and 84.89 % on FES and TES) was observed in S-3 generation. Age at sexual maturity was 154.2 days in S-3 generation. Farm and field testing of three way cross (NDR) was carried out. Hen housed egg production up to 40 weeks of age of NDR in farm condition was 80.87 eggs and in field condition it was 49.73 eggs. Besides, the centre evaluated IWN and IWP strains up to 40 weeks of age in S-30 generation along with layer control population. In this generation hen housed egg production up to 40 weeks of age decreased by 2.51 eggs in IWN (120.23), whereas it increased by 3.8 eggs in IWP (124.83) strain on phenotypic scale. Average egg weight at 28 weeks of age was improved by 0.78g (48.11 g) in IWN and 0.23g (48.62 g) in IWP strains, respectively. The centre has generated the revenue of Rs. 53.84 lakhs, which was 218.15 % of the total expenditure on feed (Rs. 24.68 lakhs). The centre has supplied a total of 2,16,397 germplasm during the year.

At AAU, Anand, birds of S1 generation of native and RIR breeds and their F1 and three way crosses were evaluated up to 40 weeks (RIR & Native) and 64 weeks (F1 & Three way cross) of age. Egg production up to 40 weeks of age was higher in native chicken (71.3) as compared to RIR (68.5), while, body weight and egg weight at 40 weeks of age were higher in RIR breed. Chicks of native (S-2), RIR (S-0) and F1 cross and three way cross were generated. Hatchability was better in RIR birds (81.35%) as compared to native birds (77.10%). Egg production up to 40 weeks of age was higher in IWN (120.7) than IWP strain (110.4), which has improved over previous generation. The centre has generated the revenue of Rs. 18.41 lakhs, which was 71.62 % of the expenditure of feed cost (25.62 lakhs). The centre has supplied a total of 49,036 germplasm.

At Bengaluru centre, performance of local indigenous chicken germplasm was evaluated. A total of 2238 chicks were housed and body weight at 8, 12 and 20 weeks of age was 477.8, 785.6 and 1110 g, respectively. The average age at sexual maturity was 165.47 days. PB-1 males were crossed with local non-descript variety and 315 chicks were produced. The average 8th week body weight of the F1 males was 886.9 g and that of females was 768.8 g. The FCR was 2.98. The body weight at day old and 5 week of age increased in PB-1 and PB-2 line. The average egg production at 40 weeks of age (survivor basis) in PB-1, PB-2 and Control lines was 57.01, 56.9 and 66.1eggs, respectively. The average phenotypic and

genetic response of body weight at 5 weeks over 11 generations in PB-1 was 14.4 and 24.4g, respectively. Corresponding values in PB-2 at 5 weeks over 12 generations were 9.25 and 17.08 g, respectively. The average body weights at 6 and 7 weeks of age were 1692 and 2080 g in Raja - II (PB-1 x PB-2) at 47th RSPPT, Gurgaon. The feed efficiency was 1.56 between 0 - 7 weeks. The dressing percentage was 71.5. A total of 2,10,086 germplasm (1,91,922 day old chicks and 18,164 hatching eggs) were supplied to 397 beneficiaries. The centre generated revenue of Rs. 54.98 lakhs, which is 168.18% of expenditure on feed cost (Rs. 32.69 lakhs).

At Ludhiana centre, the evaluation of local native chicken germplasm was carried out and a total of 1435 good chicks of local native chicken were hatched. The body weight of native germplasm at day one, 4 and 8 weeks of age was 38.47, 572.1 and 737.9 g. The body weight of PB-2 x Desi at 4 weeks of age was 612.0 g in farm and 359.1 g in field. Egg production up to 40 weeks of PB2 X Local was 77.2 eggs. Average body weight at 5 weeks of age was 1200, 934.4 and 871.3 g in PB-1, PB-2 and Control lines, respectively. The body weight at 5 weeks of age increased in PB-1 line and decreased in PB-2 and control lines as compared to previous generation. Genetic response over last 11 generations for 5 week body weight was 22.09 g in PB-1 and 11.9g in PB-2 population. A total of 68,829 germplasm (64,413 day old chicks and 4,416 adult birds) were supplied to 170 beneficiaries. The centre generated revenue of Rs. 16.96 lakhs, which is 105.33% of expenditure on feed cost (Rs. 16.1 lakhs).

CARI centre evaluated the local native chicken germplasm and 744 good chicks were produced. The body weight of local native chicken germplasm at day old, 2, 4 and 6 weeks was 38.4, 124, 291.03 and 543.9 g, respectively, The mortality up to 5 weeks was 3.45% and 6-20 weeks period was 9.79% in desi chicken. The Desi X Desi and Desi X CSML crosses were obtained and different parameters were recorded. A total of 1180 and 1170 good chicks of CSML and CSFL were produced during first hatch. The body weight of CSML x Desi chicks at day old, 2, 4 and 6 weeks was 35.86, 152.7, 420.4 and 794.1 g, respectively. The body weight at 5 weeks increased in CSML and CSFL. The FCR at 5 weeks of age in CSML, CSFL and control was 2.12, 2.02 and 2.25, respectively. The 40 week egg production increased in CSML as compared to previous generation. The phenotypic response of body weight at 5 weeks per generation was 15.96 and 15.85 g in CSML and CSFL, respectively. The genetic response was 14.34 and 14.19 g, respectively. A total of 43084 germplasm (11795 fertile eggs and 31289 DOC's) were supplied to about 22 beneficiaries including farmers & entrepreneurs, AH dept., KVKs, etc. belonging to 6 states. Revenue generation was Rs. 35 lakhs.

At Bhubaneswar centre, native *Hansli* chicken population has been registered with ICAR-NBAGR with Accession Number INDIA_CHICKEN_1500_*HANSLI*_12018. A total of 1,148 good chicks of *Hansli* were produced. The fertility percent was 84.05% in *Hansli* and the hatchability percent on TES and FES basis was 74.17 and 88.31%, respectively. The average body weight at day one and 8 week of native chicken was 30.29 and 556.5 g. The egg production up to 40 weeks in *Hansli* was 20.18. The evaluation of CSML X *Hansli* and *Hansli* X CSML crosses is in progress. Body weight at day old and 5 weeks of age in CSML X *Hansli* was 30.44 and 548.8 g, respectively. Corresponding body weights of *Hansli* X CSML were 40.20 and 566.2 g, respectively. The mortality during 0-5 weeks in CSFL and CSML line was 4.52 and 4.84%, respectively. In the current year, the body weight at 5 weeks remained static in CSFL and CSML. EP40 and EP 52 has increased in both CSFL and CSML lines. The mean 7th week body weight, FCR and mortality were 2152g, 2.12 and 0.67% respectively in the field. Centre has supplied 31,685 day old chicks to farmers. The centre has generated revenue of Rs. 8. 76 lakhs, which is 50.78 percent of total feed cost.

Tripura centre evaluated Tripura Black, *Dahlem Red*, broiler dam line, and BN cross. Three way cross was evaluated in E-2 generation. Performance of dual variety chicken (BND Cross) is evaluated at institute farm as well as the farmer's field. The hatchability on total eggs set improved in all the lines as compared to previous generation. The mortality during brooding period was lowest in Tripura black (4.30%) and *Dahlem Red* populations (4.70%). The body weight at 8 weeks was 316.4, 544.2, 1044 and 550.1 g in Tripura Black, *Dahlem Red*, Coloured broiler dam line and BN cross, respectively. The 20 week body weight was 1105.68, 1720.28, 3240 and 1590 g in Tripura Black, *Dahlem Red*, Coloured broiler dam line and BN cross, respectively. During E-2 evaluation, the 72 week egg production was 141 and 119 eggs under farm and field conditions, respectively in BND cross. A total of 20,913 germplasm (20,913 chicks) were supplied to 501 beneficiaries during

2017-18. The centre generated revenue of Rs. 10.54 lakhs, which is 48.88 % of expenditure on feed cost (Rs. 21.56 lakhs).

Jabalpur centre evaluated G-8 generation of *Kadaknath* and Jabalpur colour populations up to 52 weeks of age. *Narmadanidhi* birds were evaluated in farm and field up to 52 weeks of age. The 6 week body weight was 397 and 827g in *Kadaknath* and Jabalpur colour population, respectively. The egg weight at 40 weeks of age was 58.7g in Jabalpur colour and 47.8 gin *Kadaknath*, respectively. The hen housed egg production up to 40 weeks of age was 88.9 eggs in JBC and 54.6 eggs in *Kadaknath*. In CSFL 40 week egg weight and production were 60.1g and 62.0 eggs, respectively. *Narmadanidhi*, produced 66 eggs up to 40 weeks of age in farm conditions. It produced 44, 85.2 and 168 eggs up to 40, 52 and 72 weeks, respectively in field conditions. The egg production reduced both at farm and field conditions. A total of 51,851 germplasm (20796 chicks, growers, pullets and 31,055 hatching eggs) were supplied to 217 beneficiaries. The centre generated revenue of Rs. 14.46 lakhs, which is 73.5% of expenditure on feed cost (Rs. 19.97 lakhs).

Guwahati centre evaluated native, *Dahlem Red*, PB-2 and BN populations up to 52 weeks of age. *Kamrupa* was evaluated up to 52 weeks of age under farm and field conditions. The average fertility of all the flocks was found to be 87.67%. The mortality during brooding and growing periods was below 9.96% in all the lines. The 5 week body weight was 126.6g in indigenous, 1035g in PB-2 and 350.2g in *Dahlem Red*. Indigenous birds matured early by 1.95 days and *Dahlem Red* pullets matured late by 1.95 days compared to previous generation. In native population, the egg weight and egg production up to 52 weeks was 39.25g and 66.85 eggs, respectively. In *Dahlem Red,* egg production improved by 2 eggs. The five weeks body weight was 260.2 g and FCR was 3.15 in BN cross. The age at sexual maturity was 151.3 days in the farm and 171.1 days in the field in *Kamrupa*. The hen housed egg production up to 40 and 52 weeks of age was 48.30 and 88.90 eggs in the farm and corresponding values in the field were 42.80 and 72.90 eggs, respectively. The centre supplied 28,057 germplasm to farmers. The centre realized receipt of Rs. 7.41 lakhs during the current financial year which is 58.39% of expenditure on feed cost (Rs.12.69 lakhs).

Ranchi centre evaluated G6 generation of native population up to 52 weeks of age. DBN cross(*Jharsim*) was evaluated up to 64 weeks during E6 evaluation. The fertility recorded was 86.93% in native and 94.54% in DBN cross (*Jharsim*) during current year. The fertility has improved in native population. The hatchability on total eggs set recorded was 78.35 in native and 83.08% in DBN cross (*Jharsim*) and it improved marginally in DBN cross (*Jharsim*).The hen housed egg production up to 52 weeks was 52.89 eggs in native population (G-6) and it declined marginally. In BN cross (E6), hen housed egg production up to 64 weeks of age was 92.73 eggs. The hen day egg production in E6 up to 64 weeks of age was more in DBN *(Jharsim)* cross (131.4 eggs) than BND cross (87.2 eggs) during E5 evaluation under farm conditions. Centre supplied 21,235 germplasm to the farmers. The centre generated revenue of Rs. 9.70 lakhs which is 64.66% of expenditure on feed cost (15 lakhs).

Udaipur centre evaluated G-7 generation of *Mewari* breed up to 52 weeks. *Pratapdhan* was evaluated from 21 to 72 weeks during E-6 and E-7 was produced and evaluated up to 20 weeks of age. The fertility ranged from 78.44 – 92.97% in all the populations. The fertility and hatchability on total and fertile eggs set in all populations increased in this year. In Mewari breed, the juvenile body weights at 8 weeks marginally reduced during G-7 generation. However, 20 weeks and 40 weeks body weight increased by 109 g and 196 g in G-7 generation. The age at sexual maturity has decreased by 12.3 days as compared to previous (G-6) generation. The hen housed egg production up to 52 weeks of age decreased by 1.62 eggs, while hen day egg production increased by 2.27 eggs. Hen housed hen day and survivors egg production up to 40 weeks of age of *Pratapdhan* decreased by 15.69, 13 and 50.06 eggs in the E-6. The hen day egg production up to 72 weeks of age decreased by 3.39 eggs while hen housed egg production increased by 3.91 eggs in E-6 generation. Body weight of *Pratapdhan* at 8 weeks of age has increased by 316g. A total of 83471 germplasm was supplied during the current year. The centre realized a receipt of Rs. 20.33 lakhs during the current financial year.

The Palampur centre released the location specific dual purpose chicken variety *Himsamridhi* suitable for backyard poultry farming in hilly areas. The centre is now focusing on propagation of the developed variety among farmers. The native

germplasm (G-5) was evaluated up to 52 weeks of age with hen-day egg production of 44.75 and 84.58 eggs. In *Dahlem Red* (G-4), the 72 weeks hen-housed, hen-day and survivors' egg production recorded was 141.9 175.0 and 215.9 eggs, respectively. *Himsamridhi* birds completed 72 weeks on-farm evaluation with hen housed egg production of 58.94, 90.85 and 153.99 eggs up to 40, 52 and 72 weeks of age showing improvement of 5.42 eggs over previous year. The average egg weight at 28 and 40 weeks of age was 50.85±0.25 and 53.66±0.23 g, respectively. At farmers' level, the 52 weeks HHEP and HDEP of *Himsamridhi* birds were 81.62 and 96.98 eggs, respectively. The centre supplied 29617 chicks of *Himsamridhi*, native and other crosses to farmers (316 farm units) and realized receipt of Rs. 11.13 lakhs, which is 59.42% of expenditure on feed (Rs.18.73 lakhs).

Himsamridhi, a location specific rural chicken variety released

A promising dual purpose location specific rural chicken variety, *Himsamridhi* suitable for rural/ backyard poultry farming for hilly region was released during the inaugural session of the Annual Review Meeting of AICRP on Poultry Breeding and Poultry Seed Project by Dr. R.S. Gandhi, ADG (AP&B) in presence of Dr R.N. Chatterjee, Director, ICAR-DPR, Hyderabad and Prof. A.K. Sarial, Vice-Chancellor, CSKHPKVV, Palampur. Dr. Arjava Sharma, Director, ICAR-NBAGR, Karnal also graced the occasion. Dr. Y.P. Thakur, PI of the centre briefed the genesis and features of the new variety. These birds have attractive reddish-brown coloured plumage, perform better on low plane of nutrition and have good growth, early start of egg laying, good escaping ability and better adaptability to agro-climatic conditions of Himachal Pradesh. Birds weigh around 1500-2000 g at 20 weeks of age under backyard system. The age at first egg was 24 weeks and the hens lay brown shelled eggs weighing around 52-55 g at 40 weeks of age. The birds have demonstrated potential to lay 180 eggs under farm condition and 140-150 eggs under backyard system.

Table 1. Germplasm supply and revenue generation during 2017-18

Centre	Germ-plasm	Revenue (Rs. Lakhs)
Kerala Veterinary and Animal Science University, Mannuthy	2,16,397	53.43
Anand Agricultural University, Anand	49,036	18.41
Karnataka Veterinary, Animal and Fishery Sciences University, Bangalore	2,10,086	54.98
Guru Angad Dev Veterinary and Animal Science University, Ludhiana	68,829	16.96
Orissa University of Agriculture and Technology, Bhubaneswar	31,685	8.76
Central Avian Research Institute, Izatnagar	43,084	35.00
Maharana Pratap University of Agriculture & Technology, Udaipur	83,471	20.33
Nanaji Deshmukh Veterinary Science University, Jabalpur	51,851	14.46
Assam Agricultural University, Guwahati	28,057	7.41
CSK Himachal Pradesh Krishi Viswavidyalaya, Palampur	29,617	11.13
Birsa Agricultural University, Ranchi	21,235	9.70
ICAR Research Complex for NEH region, Agartala	20,913	10.54
Total	8,54,261	261.11

7. Poultry Seed Project

The Poultry Seed Project was evolved with an objective to increase the availability of rural chicken germplasm in the remote areas of the 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 stere 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. In addition, one non funding centre is also functioning. 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 West Bengal University of Animal and Fishery Sciences, Kolkata; Bihar Agricultural 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 and Sher-e-Kashmir University of Agricultural Sciences and Technology, Srinagar. The project was further strengthened with addition of three more centres viz., PVNR Telanagna Veterinary University, Warangal; Sri Venkateswara Veterinary University, Tirupati and ICAR Research Complex for NEH Region, Umiam. Two centres viz., Chhattisgarh Kamadhenu Viswa Vidyalaya, Durg and ICAR-IVRI Regional Station, Mukteswar were discontinued from 2017-18.

The Directorate as a coordinating unit, supplies parent chicks and co-ordinates, monitors the activities of different centres to enable them to achieve the set targets for each centre. The Seed Project was launched on 15 May, 2009. The target set for supplying chicks for mainland and north-east centres during the year under report (2017-18) were between 0.3 and 1.0 lakhs chicks per annum for different centres and to collect feedback on the performance of the germplasm under backyard farm conditions. A total of 6,31,543 improved chicken varieties have been distributed in their respective regions/states during the year. A total of Rs. 176.71 lakhs revenue was generated from the Poultry Seed Project.

Six batches of *Vanaraja* parents were reared during the year at Kolkata centre, out of which, four are in laying, one in growing and one in brooding phase. The egg production of 50% was achieved at 32 weeks and maintained up to 64 weeks. Fertility ranged from 60.3% to 90.8%. Hatchability on total eggs set (TES) and fertile eggs set (FES) was consistent throughout the life cycle reaching up to 78.5% (TES) and 87.1% (FES). A total of 79,390 *Vanaraja* chicks were distributed to the farmers in various parts of West Bengal during the year 2017-18. The total revenue generated was Rs. 11.02 lakhs.

Three batches of *Vanaraja* parents were reared under deep litter at Patna Centre. The average age at sexual maturity of three batches was 172 days in *Vanaraja* female parents. The HDEP in *Vanaraja* at 40 weeks of age was 51.27% with an egg weight of 51.56 g. The peak production of 72% was attained at 42 weeks. The average fertility percentage was 86.58 and the average hatchability on TES and FES were 67.06% and 85.54%, respectively in *Vanaraja* female line. A total of 60,008 *Vanaraja* chicken germplasm was distributed to the farmers in Bihar during the year 2017-18 with an amount of Rs. 10.43 lakhs as revenue.

A total of 2,250 parents of *Vanaraja* and *Srinidhi* were in position at present in four batches at Jharnapani centre. The production of 50% was attained at 36 weeks of age in both *Vanaraja* and *Srinidhi* parents. The overall fertility rate was 89.3 and 88.08 in *Vanaraja* and *Srinidhi* female lines, respectively. The hatchability on fertile eggs set was 81% in *Vanaraja* and 77%, in *Srinidhi* parents, respectively. A total of 1,36,828 improved chicken germplasm was distributed to farmers of Nagaland

and neighbouring states during the year 2017-18. A total of Rs. 57.42 lakh revenue was generated under PSP at Jharnapani Centre. The centre achieved the target of germplasm.

Two batches of *Vanaraja* parents were reared at ICAR, NOFRI, Gangtok, Sikkim. The average HDEP in *Vanaraja* was 50 (24-72 weeks) during the year. Peak production (70%) was attained at 31-34 weeks of age. The average fertility and hatchability (TES) rates in *Vanaraja* female line were 85.58 and 80.42%, respectively. A total of 94,800 improved chicken germplasm of *Vanaraja* was distributed to 3,360 farmers covering 917 village habitats in Sikkim with an amount of Rs. 38.81 lakhs revenue. The centre achieved the set target of germplasm.

Three batches of *Vanaraja* and *Srinidhi* parents were reared at Manipur Centre during the year. The average HDEP was 39% (28-72 weeks) in *Vanaraja* and 46% (24-72 weeks) in *Srinidhi* parents. Peak production (58%) was attained at 45 weeks of age. The average fertility was 84.02 and 84.96% in *Vanaraja* and *Srinidhi* parents, respectively. The hatchability on TES was 65.47% in *Vanaraja* and 68.39% in *Srinidhi* parents. A total 75,126 improved chicken germplasm was distributed to the farmers in Manipur. The Centre has generated Rs. 20.26 lakhs of revenue during the year 2017-18.

Two batches of *Vanaraja* and *Gramapriya* parents were reared at Hosur Centre during the reporting period. The average egg production was 67% (32-78 weeks) in *Vanaraja* and 69% (28-74 weeks) in *Gramapriya*, respectively. The peak production was 80.4% (37 wks) in *Vanaraja* and 88% (28 wks) in *Gramapriya*. The average fertility was 79.06 (26-78 wks) in *Vanaraja* and 77.71% (25-72 wks) in *Gramapriya*, respectively. A total of 1,26,870 (1,02,185 DOC and 24685 fertile eggs) improved rural chicken (*Vanaraja* and *Gramapriya*) germplasm was distributed to 843 farmers in Tamil Nadu. The Centre has generated total revenue of Rs. 25.70 lakhs during the year. The centre has achieved the target germplasm supply.

One batch each of *Gramapriya* and *Srinidhi* parents were reared at Goa during the year. The egg production ranged from 7.67 to 38.8%, which was not consistent. The fertility ranged from 46.44 to 94.57% and hatchability from 51.53 to 91.47%, respectively. The construction of poultry houses was completed. A total of 3,749 improved chicken germplasm was distributed to the farmers of Goa during the year 2017-18.

Two batches of *Vanaraja* and one batch of *Gramapriya* parents were reared under deep litter system at Port Blair. The age at sexual maturity (ASM) was 170 days in *Gramapriya* female line. The highest egg production (38%) was recorded at 35-38 weeks of age in the entire laying cycle. A total 10,759 improved chicken germplasm were distributed to 170 farmers in Andaman & Nicobar Islands with revenue of Rs. 1.96 lakhs during the year.

At Srinagar centre, two batches of *Vanaraja* breeders were reared during the year. The average egg production was above 60% (59-62%) from 56 weeks to 72 weeks of age. The hatchability on total egg set ranged from 27.09 to 76.04% in *Vanaraja* parents. A total of 21,401 *Vanaraja* chicks were distributed to farmers in Jammu and Kashmir.

Two batches of *Vanaraja* and *Srinidhi* parents were reared at ICAR-RC for NEH Region, Umiam, Barapani. The HDEP at 36 weeks of age was 43% in *Vanaraja* and 28% in *Srinidhi* parents. The fertility and hatchability (TES) ranged from 76-83% and 49-75% in *Vanaraja* and 71-79% and 50-62% in *Srinidhi* parents, respectively. A total of 22,612 improved chicken germplasm was distributed to the farmers in Meghalaya with an amount of Rs. 11.11 lakhs of revenue during the year 2017-18.

Two new centres, one at SVVU, Tirupati, Andhra Pradesh and the other at PVNRTVU, Warangal, Telangana were added from 2017-18 to popularize backyard poultry in respective regions. The two centres were launched on 1 February and 22 March 2018, respectively. The centres initiated the parent rearing in the existing facilities.

Centre wise distribution of germplasm under Poultry Seed Project

Sl. No.	Centre	Germplasm	Revenue Rs. in lakhs
1	West Bengal University of Animal and Fishery Sciences, Kolkata	79,390	11.02
2	Bihar Animal Sciences University, Patna	60,008	10.43
3	Regional Centre, ICAR Research complex for NEH Region, Jharnapani	1,36,828	57.42
4	ICAR- National Organic Farming Research Institute, Gangtok	94,800	38.81
5	Regional Centre, ICAR Research complex for NEH Region, Imphal	75,126	20.26
6	Tamil Nadu Veterinary and Animal Sciences University, Hosur	1,26,870	25.70
7	ICAR-Central Coastal Agricultural Research Institute, Goa	3,749	
8	ICAR-Central Island Agricultural Research Institute, Port Blair	10,759	1.96
9	Sher-e-Kashmir University of Agricultural Sciences and Technology, Srinagar	21,401	
10	ICAR Research Complex for NEH Region, Umiam, Barapani	22,612	11.11
11	PVNR Telangana Veterinary University, Warangal	-	-
12	Sri Venkateswara Veterinary University, Tirupati	-	-
	Total	**6,31,543**	**176.71**

8. Publications

Research papers

Anand Laxmi, N., Shanmugam, M., Mahapatra, R.K. and Prakash, B. 2017. Effect of fermented yeast culture (*Saccharomyces cerevisiae*) during and post summer season on plasma hormones egg production potential and feed efficiency of PD3 chicken line. *International Journal of Advanced Biological Research*, 7: 456-464.

Anand Laxmi, N., Shanmugam, M., Reddy, M.R. and Mahapatra, R.K. 2017. Improvement in egg production of PD3 chicken line with histopathological conditions of the jejunum upon supplementation of fermented yeast culture during and post summer season. *International Journal of Current Microbiology and Applied Sciences,* 6:379-385.

Divya, D., Bhattacharya, T.K., Gnana Prakash, M., Chatterjee, R.N., Shukla, R., Guru Vishnu, P., Vinoth, A. and Dushyanth, K. 2018. Molecular characterization and expression profiling of BMP 3 gene in chicken (*Gallus gallus*). *Molecular Biology Reports*, DOI: 10.1007/s11033-018-4184-x.

Haunshi, S., Arun Kumar B., Kannaki, T.R., Rajaravindra, K.S. and Chatterjee, R.N. 2017. Pattern recognition receptor genes expression profiling in indigenous chickens of India and White Leghorn. *Poultry Science,* 96:3052-3057.

Kannaki T.R. and Reddy, M.R. 2017. Differential mRNA expression of antimicrobial peptides β-defensins in Indian native chickens and White Leghorn. *Indian Journal of Poultry Science,* 52: 212-216.

Kannaki, T.R., Verma, P.C. and Reddy, M.R. 2017. Antimicrobial activity of recombinant *E. coli* expressed chicken AvBD-2 and its mRNA expression in Indian native Aseel and Kadaknath chicken breeds. *Indian Journal of Animal Research*, DOI:10.18805/ijar.v0iOF.7811.

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Kannaki, T.R., Reddy, M.R. Rajaravindra K.S. and Chatterjee, R.N. 2017. Molecular and functional characterization of Toll-like receptor 5 (TLR5) in Aseel and White Leghorn chicken. *Indian Journal of Animal Research*, DOI:10.18805/ijar.v0iOF.7810.

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Kannaki, T.R., Shanmugam, M., Dhanutha N.R. and Haunshi., S. 2017. Toll-like receptor mRNA expression in the ejaculated spermatozoa of chicken. *Indian Journal of Poultry Science*, 52: 234-235.

Kannaki, T.R., Verma, P.C., Reddy, M.R. and Shanmugam, M. 2017. Molecular characterization of duck (*Anas platyrynhos*) Toll-like receptors, mRNA expressions profile in day-old duckling's tissues and cytokine response to *in vitro* TLR agonsists stimulation. *Indian Journal of Animal Research*, DOI: 10.18805/ijar.B-3290.

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Lee, S. A., Nagalakshmi, D., Raju, M.V.L.N., Rama Rao, S.V. and Bedford, M. R. 2017. Effect of phytase super dosing, myo-inositol and available phosphorus concentrations on performance and bone mineralization in broilers. *Animal*

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Parashuram, S., Srnivasa Rao, D., Rama Rao, S.V., Ramana, J. V. and Ravi, A. 2017. Derivation of substrate specific non starch polysaccharide enzymes cocktail for commercial layer diets containing alternate protein supplements. *Indian Journal of Poultry Science*, 52: 33-41.

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Raju, M.V.L.N., Chakrabarti, P.P., Sujatha, V., Reddy, J.R.C., Rama Rao, S.V., Rao, B.V.S.K., Panda, A.K., Prabhavathi Devi, B.L.A., Shyam Sunder, G. and Prasad, R.B.N. 2017. Comparative evaluation of lysolecithin from rice bran oil vis-à-vis lipotropic agents in broiler chicken diet. *Indian Journal of Animal Sciences,* 87: 241-244.

Raju, M.V.L.N., Prakash, B., Nagarjuna, B.V.R., Nischala, T., Rama Rao, S.V., Reddy, M.R. and Panda, A.K. 2016. Inclusion of solvent extracted Karanj (*Pongamia glabra*) cake in the diet and production performance of layer chicken. *Indian Journal of Animal Nutrition,* 33: 81-85.

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Selvaramesh, A.S., Pushpendra Kumar, Mishra, C., Bhattacharya, T.K., Bhushan, B. Tiwari, A.K., Saxena, V.K. and Arjava Sharma. 2018. Molecular Characterization of Mx1 gene in native Indian breeds of chicken. *Animal Biotechnology,* DOI: 10.1080/10495398.2018.1439845.

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Tirupathi Reddy E., Ravinder Reddy,V., Chinni Preetham, V., Rama Rao, S.V. and Srinivasa Rao, D. 2017. Effect of dietary inclusion of graded levels of toasted guar meal on performance, nutrient digestibility, carcass traits, and serum parameters in commercial broiler chickens. *Tropical Animal Health and Production,* 49: 1409-1414.

Sujatha, T., Sunder, J., Kannaki, T.R. and Kundu, A. 2018. In vivo effect of Andrographis panniculatanees and Morinda citrifolia on expression of Toll-like receptors in indigenous Nicobari fowl. *Indian Journal of Poultry Science*, DOI: 10.5958/0974-8180.2017.00070.

Swathi, B., Gupta, P.S.P., Nagalakshmi, D. and Raju, M.V.L.N. 2016. Efficacy of turmeric (*Curcuma longa*) as antioxidant in combating heat stress in broiler chicken. *Indian Journal of Poultry Science*, 51: 48-53.

Vijay Bhaskar, T., Gowda, N.K.S., Mondal, S., Pal, D.T., Aithal, H.P., Pattanaik, A.K., Rama Rao, S.V. and Karthik Bhat, K. 2017. Boron supplementation influences bone mineralization by modulating expression of gene regulating calcium utilization. *Animal Nutrition and Feed Technology*, 17: 2015-215.

Vinoth, A., Thirunalasundari, T., Shanmugam, M., Uthrakumar, A., Suji, S. and Rajkumar, U. 2017. Evaluation of DNA methylation and mRNA expression of heat shock proteins in thermal manipulated chicken. *Cell Stress & Chaperones,* 23: 235-252.

Review

Anand Laxmi N., Shamugam M. and Mahapatra R.K. 2017. Effect of heat stress on physiological parameters of layers - A Review. *International Journal of Livestock Research* 7(4) Apr 17 DOI: 10.5455/ijlr.20170312042324.

Invited Papers in Seminars / Symposia/ Conferences

Bhattacharya, T.K. and Chatterjee, R.N. 2017. Transgenesis for production of designer eggs and gene silencing for improving growth in chicken. Proceedings of XXIII Annual Convention of Indian Society for Veterinary Immunology and Biotechnology & National Conference on Challenges in Livestock and Poultry Production-Solutions with Biotechnology held at KN Patil College of veterinary Science, Shirwal, Satara, Pune during April, 17-19, Pp. 30-37.

Bhattacharya, T.K. and Chatterjee, R.N. 2017. Functional Genomics in Chicken – Role for enhancing quality and productivity. Proceedings of XXXIV Annual Conference and National Symposium of Indian Poultry Science Association (IPSACON-2017) held at ICAR-NIANP, Bengaluru during November, 28-30, Pp. 109-123.

Raju, M.V.L.N. and Rama Rao, S.V. 2017. Feeding of poultry in summer. Technical Seminar on "Management of poultry farms during summer season", organized jointly by AP (Hyderabad) Chapter of Indian Poultry Science Association and Chalimeda Feeds Pvt. Ltd., Hanamkonda, Warangal, Telangana, April, 7.

Research Abstracts presented in Symposia/ Conferences

International

Anand Laxmi, N., Rajaravindra, K.S., Reddy, M.R. Ramusubbu, P.K. Shanmugam, M. and Mahapatra, R.K. 2017. Effect of supplementation of fermented yeast culture during summer on plasma Leptin Ghrelin and their expression of receptors in different tissues and on production performance during post summer period in PD 3 Chicken line. VI International Conference on Sustainable Animal Agriculture for Developing Countries, Jl. Veteran, Malang, Jawa Timur, Indonesia. Date and Pp

Mahapatra, R.K., Pankaj, P.K., Prakash, B., Osman, M., Anand Laxmi, N., Shanmugam, M., Bhanja, S.K. and Yadav, S.P. 2017. Composition of poultry litter for compost preparation. International Conference & Expo on Agriculture & Veterinary Sciences: Research and Technology, PJTSAU, Hyderabad, October 23-25, Pp 17.

Yadav, S.P., Kannaki, T.R. Mahapatra, R.K. Chandan, P., Bhattacharya, T.K., Sarkar, S.K. and Chatterjee, R.N. 2017. Immunocompetence and physiological responses in native vs exotic chicken breeds. International Conference & Expo on Agriculture & Veterinary Sciences: Research and Technology held at PJTSAU, Hyderabad, October 23-25, Pp 14

National

Anand Laxmi, N., Shanmugam M., Reddy, M.R. and Mahapatra, R.K. 2017. Improvement in egg production of PD3 chicken line with histopathological conditions of the jejunum upon supplementation of fermented yeast culture during and post summer season. National Conference on Revisiting Agricultural Extension Strategies for Enhancing Food and Nutritional Security Sustainable Livelihoods and Resilience to Climate Change, held at Hyderabad, April 22 -24, Pp 87-88.

Dande, S.S. and Prakash, B. 2017. Antimicrobial activity of different antibiotics and few herbal extracts on *Escherichia Coli* isolated from chicken. Proceedings of XXXIV Annual Conference of Indian Poultry Science Association on "Innovations for Safe and Sustainable Poultry Production" held at ICAR-NIANP, Bengaluru, November 28 -30, Pp 159.

Gaurav, A, Bhar, R, Kannan, A. and Kumar, M. 2017. Effect of feeding triterpenoid and steroidal type saponins on performance of broiler chickens. Proceedings of XXXIV Annual Conference of Indian Poultry Science Association on "Innovations for Safe and Sustainable Poultry Production" held at ICAR-NIANP, Bengaluru, November 28 -30.

Mahapatra, R.K. Shanmugam, M., Bhanja, S.K., Niranjan, M., Yadav, S.P. and Anand Laxmi, N. 2017. Effect of short term storage of chicken semen on fertility and hatchability. Proceedings of XXXIV Annual Conference of Indian Poultry Science Association on "Innovations for Safe and Sustainable Poultry Production" held at ICAR-NIANP, Bengaluru, November 28 -30, Pp 236.

Mahapatra, R.K. Shanmugam, M., Bhanja, S.K., Niranjan, M., Yadav, S.P. and Anand Laxmi, N. 2017. Effect of supplementations and storage times on spermatozoa chromatin damage and acrosome reaction in chicken. Proceedings of XXXIV Annual Conference of Indian Poultry Science Association on "Innovations for Safe and Sustainable Poultry Production" held at ICAR-NIANP, Bengaluru, November 28 -30, Pp 57.

Mahapatra, R.K. Shanmugam, M., Bhanja, S.K., Niranjan, M., Yadav, S.P. and Anand Laxmi, N. 2017. Effect of supplementations and storage times on spermatozoa membrane proteins in chicken. Proceedings of XXXIV Annual Conference of Indian Poultry Science Association on "Innovations for Safe and Sustainable Poultry Production" held at ICAR-NIANP, Bengaluru, November 28 -30, Pp58.

Haunshi, S., Arun Kumar, B., and Kannaki, T.R. 2017. Genetic variation in CDS of TLR3 and TLR1LA genes in indigenous and White Leghorn breeds of chicken. XXXIV Annual Conference of Indian Poultry Science Association on "Innovations for Safe and Sustainable Poultry Production" held at ICAR-NIANP, Bengaluru, November 28 -30, Pp 43.

Rajkumar, U., Raju, M.V.L.N., Haunshi, S., Paswan C. and S.K. Bhanja. 2017. Characterizations of Aseel chicken breed for growth and production performance in a complete laying cycle of 72 weeks. Proceedings of XXXIV Annual Conference of Indian Poultry Science Association on "Innovations for Safe and Sustainable Poultry Production" held at ICAR-NIANP, Bengaluru, November 28 -30, Pp 49.

Raju, M.V.L.N., Rama Rao, S.V., Prakash, B. and Verma, S.K. 2017. Evaluation of nutrient profile of rice DDGS and its feeding value for *Vanaraja* chicks. Proceedings of XXXIV Annual Conference of Indian Poultry Science Association on "Innovations for Safe and Sustainable Poultry Production" held at ICAR-NIANP, Bengaluru, November 28 -30, Pp 92.

Prakash, B., Rama Rao, S.V., Raju, M.V.L.N. and Sreenivasa Reddy, C. 2017. Effect of supplementing selenized yeast on performance and antioxidant responses in *Vanaraja* and

commercial broiler chicken. Proceedings of XXXIV Annual Conference of Indian Poultry Science Association on "Innovations for Safe and Sustainable Poultry Production" held at ICAR-NIANP, Bengaluru, November 28 -30, Pp 114.

Rama Rao, S.V., Raju, M.V.L.N., Prakash, B., Rajkumar, U., Srilatha, T. and Reddy, E.P.K. 2017. Effect of feeding graded levels of toasted guar (*Cyamopsis tetragonoloba*) meal on performance, slaughter variables and protein retention in *Vanaraja* chicken fed two concentrations of limiting amino acids. Proceedings of XXXIV Annual Conference of Indian Poultry Science Association on "Innovations for Safe and Sustainable Poultry Production" held at ICAR-NIANP, Bengaluru, November 28 -30, Pp118.

Rama Rao, S.V., Raju, M.V.L.N., Prakash, B., Rajkumar, U. and Reddy, E.P.K. 2017. Effect of supplementing moringa (*Moringa oleifera*) leaf meal and pomegranate (*Punica granatum*) peel meal on performance, carcass attributes, immune and anti-oxidant responses in commercial broiler chickens. Proceedings of XXXIV Annual Conference of Indian Poultry Science Association on "Innovations for Safe and Sustainable Poultry Production" held at ICAR-NIANP, Bengaluru, November 28 -30, Pp 187.

Reddy, B.L.N., Rajaravindra, K.S. and Rajkumar, U. 2017. Studies on the effect of heat stress on juvenile body weights and carcass quality traits in different genetic groups of broilers. Proceedings of XXXIV Annual Conference of Indian Poultry Science Association on "Innovations for Safe and Sustainable Poultry Production" held at ICAR-NIANP, Bengaluru, November 28 -30, Pp 44.

Shanmugam, M. and Kannaki, T.R. 2017. Effect of age, egg laying status and insemination on TGF β and ER α gene expression in the utero vaginal junction tissues of two chicken breeds. XXVI Annual Conference of Society of Animal Physiologists of Indian (SAPI) and National Symposium, Veterinary College, Karnataka Veterinary Animal and Fisheries Sciences University, Bidar, Karnataka, December 21-22, Pp 15.

Shanmugam, M. and Mahapatra, R.K. 2017. Effect chicken lines on characteristics of cryopreserved chicken semen. XXVI Annual Conference of Society of Animal Physiology of India on "Physiological Innovations to Forecast the impact of Climate change and to Evolve Strategies for Sustainable Livestock Production", held at Bidar, Karnataka, December 21-22, Pp 84-85.

Shirisha, R., Krishna Daida, Raju, M.V.L.N. and Sai Reddy, S. 2017. Effect of a probiotic feed supplements commercial broiler chicken. Proceedings of XXXIV Annual Conference of Indian Poultry Science Association on "Innovations for Safe and Sustainable Poultry Production" held at ICAR-NIANP, Bengaluru, November 28 -30, Pp 248.

Books/ Book chapter

एस.वी. रामाराव, एस.पी. यादव, यू. राजकुमार, आर. के. महापात्रा, एम. वी.एल.एन. राजू, चंदन पासवान, आर. एन. चटर्जी (2018)। ग्रामीण कक्कुट पालन के नए आयाम। पृष्ठ :105

Shanmugam, M., Rajkumar, U. and Vinoth, A. 2017. Heat Shock Protein and thermal stress in chicken. In: Heat Shock Proteins in Veterinary Medicine and Sciences. Ed. Alexzander A. A. Asea, Punit Kaur, Springer International Publishing, Switzerland, Pp 179-193. ISBN No. 978-3-319-73376-0.DOI:10.1007/978-3-319-73377-7_6.

Technical/Popular articles

महापात्रा, आर. के., यादव, एस. पी., श्रीनिवास राव, जे. एवं आनंदलक्ष्मी एन. 2017. कुक्कुट अपशिष्ट प्रबंधन और बायोगैस के रूप में उपयोग. हिंद पोल्ट्री Vol. XVI No. 5, Pp 47-50.

Training manuals

1. Shanmugam, M. and Rajkumar U. 2017. Modern Poultry Management for Established Agripreneurs. ICAR-Directorate of Poultry Research, Rajendranagar, Hyderabad.
2. Prince, L.L.L. and Shanmugam, M. 2018. Certified Livestock Advisor Program on Poultry. ICAR-Directorate of Poultry Research, Rajendranagar, Hyderabad, pages 115.

TV and Radio talks

Raju, M.V.L.N. 2017. Poultry feed quality and its management (Kolla daana naanyatha - parirakshana). October 7, for 20 minutes in the

evening programme (7.15 PM) entitled "Illu Vakili" of All India Radio, Hyderabad.

Raju, M.V.L.N. 2017. Broiler production: facts and figures. August 24, Live program, 6.00-6.25 PM, TV9 (Telugu)

Rama Rao, S.V. 2017. Interview in All India Radio on October 21 on "*kodiguddu, kodimamsamlalo poshaka viluvalu – apohalu*" (Telugu program)

Rama Rao, S.V. 2017.Interview and discussion on "*kolladana lo poshaka viluvavlu 2. Kola pempakam lo hormone and steriodla vadakam lo apohalu*" in TV (Live program) on TV5 and Doordhashan channels

Awards and recognition

Dr. Bhattacharya, T.K. and co-workers received the IPSA Dr. P. Kothandaraman Memorial Award for the best oral presentation during the XXXIV Annual Conference & national Symposium of Indian Poultry Science Association (IPSACON-2017) held at ICAR-NIANP, Bengaluru during 28-30 November, 2017.

9. Ongoing Research Projects

Institute Projects

S. No.	Project Code	Project Title	PI	Co-PIs
1.	ANSCDPRSIL 201500100050	Development and improvement of male lines for production of backyard chicken varieties for free range farming	U. Rajkumar	M. Niranjan (Upto Aug. 2017) Santosh Haunshi Chandan Paswan S.P. Yadav L. Leslie Leo Prince (from Nov. 2017)
2.	ANSCDPRSIL 201500200051	Improvement and evaluation of female lines for backyard/ free range farming	M. Niranjan (upto Aug. 2017) U. Rajkumar	Chandan Paswan S.P. Yadav L. Leslie Leo Prince (from Nov. 2017)
3.	ANSCDPRSIL 201500300052	Genetic characterization and conservation of indigenous chicken germplasm	Santosh Haunshi	U. Rajkumar
4.	ANSCDPRSIL 201500400053	Genetic evaluation of elite layer germplasm	Chandan Paswan	R.N. Chatterjee T.K. Bhattarcharya
5.	ANSCDPRSIL 201500500054	Maintenance of coloured broiler populations for intensive and semi intensive broiler farming	B.L.N. Reddy	K.S. Rajaravindra (upto Aug. 2017) L. Leslie Leo Prince (from Nov. 2017)
6.	ANSCDPRSIL 201400100046	Genetic improvement of a synthetic coloured broiler female line (PB-2)	K.S. Rajaravindra (upto Aug. 2017) L. Leslie Leo Prince	U. Rajkumar B.L.N. Reddy
7.	ANSCDPRSIL 201600100059	Characterization of chicken ovalbumin and growth hormone receptor genes for development of transgenic cassette	T.K. Bhattacharya	R.N. Chatterjee Chandan Paswan
8.	ANSCDPRSIL 201500600055	Genotyping MHC class I loading complex genes (TAP1, TAP2 and Tapasin) for their association with immunocompetence traits in chicken	S.P Yadav	T.R. Kannaki
9.	ANSCDPRSIL 201700100062	Utilization of distillery by-products in poultry diets: the nutritional implications and strategies for improving the nutritional value	M.V.L.N. Raju	S.V. Rama Rao B. Prakash S.S. Paul (from Nov. 2017) A. Kannan (from Nov. 2017)
10.	ANSCDPRSIL 201600200060	Development of nutritional package of practices for backyard chicken production	B. Prakash	M. Niranjan (Upto Aug. 2017) S. S. Paul (from Nov. 2017) A. Kannan (from Nov. 2017)
11.	ANSCDPRSIL 201700300065	Development of a composite feed additive using promising organic acids and plant bioactive compounds for improving gut health and productivity in chicken	SS Paul	M.V.L.N. Raju B. Prakash S.V. Rama Rao S.P. Yadav
12.	ANSCDPRSIL 201700400066)	Production of designer eggs enriched with critical trace minerals relevant to human nutrition	A Kannan	M.V.L.N. Raju B. Prakash S.V. Rama Rao
13.	ANSCDPRSIL 201500700056	Exploring medicinal plants as alternative to antibiotic growth promoters (AGP) in broiler production	D. Suchitra Sena	M.R. Reddy (upto Aug. 2017) B. Prakash

14.	ANSCDPRSIL 201500800057	Disease resistance/tolerance in backyard chicken varieties and strategies for improving vaccine mediated immune response	T.R. Kannaki	Santosh Haunshi D. Suchitra Sena
15.	ANSCDPRSIL 201700200064	Disease diagnosis, vaccination & sero-monitoring in pureline chickens	T.R. Kannaki	S.K. Bhanja
16.	ANSCDPRSIL 201400300048	Assessment of disease incidence, immune competence and disease resistance among pure line chicken populations	M.R. Reddy	D. Suchitra Sena T.R. Kannaki
17.	ANSCDPRSIL 201600300061	Role of leptin, ghrelin and GH in regulation of physiological functions of chicken during summer season	Anand Laxmi	R.K. Mahapatra M. Shanmugam
18.	ANSCDPRSIL 201700700063	Sustainable poultry waste management through composting	R.K. Mahapatra	N. Anand Laxmi M. Shanmugam B. Prakash S. K. Bhanja P. K. Pankaj (CRIDA) Mohd. Osman (CRIDA)
19.	ANSCDPRSIL 201500900058	Analysis of fertility and hatchability from cryopreserved semen	M. Shanmugam	R.K. Mahapatra

Externally Funded Research Projects

S. No.	Project Title	PI	Co-PIs
1.	Functional genomics, epigenetics and gene silencing technology for improving productivity in poultry (National Fellow)	T.K. Bhattacharya	
2.	Adaptation and mitigation strategies in poultry to thermal stress through nutritional and environmental manipulation (NICRA)	S.V. Rama Rao	M.V.L.N. Raju U. Rajkumar B. Prakash M.R. Reddy (upto August 2017) T.R. Kannaki
3.	Production of chelated selenium, zinc and copper through yeast cells and their supplemental effect on performance and anti-oxidant status in broiler chicken (DST-SERB)	B. Prakash	S.V. Rama Rao M.V.L.N. Raju
4.	Effect of dietary supplementation of biofortified maize (QPM) on productive performance in broiler chickens (Network project)	B. Prakash	S.V. Rama Rao M.V.L.N. Raju
5.	Genetic analysis of innate immune-competence and survivability for identification of genetic markers in indigenous chicken breeds (DST-SERB)	Santosh Haunshi	T.R. Kannaki

10. Consultancy, Contract Research and Commercialization of Technologies

Commercialization of Technologies

ICAR-Directorate of Poultry Research has developed three rural chicken varieties suitable for backyard farming (*Vanaraja, Gramapriya* and *Srinidhi*) and two varieties for intensive poultry (*Krishibro* and *Krishilayer*). There is huge demand for these chicken varieties across the country. For wide and efficient distribution of these varieties of chicken throughout the country, a national project in the form of "Poultry Seed Project" funded by the ICAR has been initiated during the XI plan. These chicken varieties are supplied to State Animal Husbandry Departments, State Agriculture Universities, ICAR Institutions, NGOs and farmers.

The Directorate has supplied a total of 76,963 hatching eggs, 2,76,155 day old and grown up chicks of *Vanaraja*, *Gramapriya*, *Srinidhi*, *Krishibro* and *Krishilayer* during 2017-18 through which a revenue of Rs. 200 lakhs was generated.

Consultancy Project

ICAR- Directorate of Poultry Research offers technical inputs to the poultry industry for the research and development activity. Advisory consultancy was extended to M/s Sri Ramadhoota Poultry Research Farm, Ranga Reddy District, Telangana on "techno scientific advisory services in nutrition and health care of chickens".

Workshop on Intellectual Property Rights

The ITMU, ICAR-DPR organized a workshop on "Intellectual Property Rights (IPR)" on 26th March 2018. The Director, scientists and technical staff participated in the workshop. The purpose of the workshop was to enhance awareness about Intellectual Property Rights for effective IP management.

IPR workshop in progress

A Guest lecture was delivered by Dr. Rijuta Garapaty, registered Indian Patent Agent, Avid-Invent IP services, Hyderabad.

NCBI GenBank Accession

Bhattacharya, T.K., Chatterjee, R.N., Dange, M. and Bhanja, S.K. (2017). *Gallus gallus* Breed White Leghorn strain IWH chicken prolactin receptor (PRLR) mRNA. NCBI Accession No. MG517522

Bhattacharya, T.K., Chatterjee, R.N. and Dange, M. (2017). *Gallus gallus* breed Aseel chicken growth hormone receptopr (GHR) gene partial coding-h1 haplotype. NCBI Accession No. MG049684

Bhattacharya, T.K., Chatterjee, R.N. and Dange, M. (2017). *Gallus gallus* breed Aseel chicken growth hormone receptopr (GHR)gene partial coding-h2 haplotype. NCBI Accession No. MG049685

Bhattacharya, T.K., Chatterjee, R.N. and Dange, M. (2017). *Gallus gallus* breed Aseel chicken growth hormone receptopr (GHR) gene partial coding-h3 haplotype. NCBI Accession No. MG049686.

Bhattacharya, T.K., Chatterjee, R.N. and Dange, M. (2017). *Gallus gallus* breed Aseel chicken growth hormone receptopr (GHR) gene partial coding-h4 haplotype. NCBI Accession No. MG049687.

Bhattacharya, T.K., Chatterjee, R.N. and Dange, M. (2017). *Gallus gallus* breed Aseel chicken growth hormone receptopr (GHR) gene partial coding-h5 haplotype. NCBI Accession No. MG049688.

Bhattacharya, T.K., Chatterjee, R.N. and Dange, M. (2017). *Gallus gallus* breed Aseel chicken growth hormone receptopr (GHR) gene partial coding-h5 haplotype. NCBI Accession No. MG049688.

Bhattacharya, T.K., Chatterjee, R.N. and Dange, M. (2017). *Gallus gallus* breed Aseel chicken growth hormone receptopr (GHR) gene partial coding-h6 haplotype. NCBI Accession No. MG049689.

Bhattacharya, T.K., Chatterjee, R.N. and Dange, M. (2017). *Gallus gallus* breed Aseel chicken growth hormone receptopr (GHR) gene partial coding-h7 haplotype. NCBI Accession No. MG049690.

Bhattacharya,T.K., Chatterjee, R.N. and Dange, M. (2017). *Gallus gallus* breed Aseel chicken growth hormone receptopr (GHR) gene partial coding-h8 haplotype. NCBI Accession No. MG049691.

Bhattacharya, T.K. and Chatterjee, R.N. (2017). *Gallus gallus* breed Aseel chicken prolactin receptopr (PRLR) gene partial coding-h1 haplotype. NCBI Accession No. MF974537.

Bhattacharya,T.K. and Chatterjee, R.N. (2017). *Gallus gallus* breed Aseel chicken prolactin receptopr (PRLR) gene partial coding-h2 haplotype. NCBI Accession No. MF974538.

Bhattacharya, T.K., Chatterjee, R.N., Dange, M. and Bhanja, S.K. (2017). *Gallus gallus* breed Aseel chicken prolactin receptopr (PRLR) gene partial coding-h3 haplotype. NCBI Accession No. MF974539.

Bhattacharya, T.K., Chatterjee, R.N., Bhanja, S.K. and Dange, M. (2017). *Gallus gallus* breed Aseel chicken prolactin receptopr (PRLR) gene partial coding-h4 haplotype. NCBI Accession No. MF974540.

Divya, D., GnanaPrakash, M., Chatterjee, R.N. and Bhattacharya, T.K. (2018). *Gallus gallus* Line control broiler chicken bone morphogenetic protein4 (BMP4) partial promoter-h1 haplotype. NCBI Accession No. MH161347.

Divya, D., Gnana Prakash, M., Chatterjee, R.N. and Bhattacharya, T.K. (2018). *Gallus gallus* Line control broiler chicken bone morphogenetic protein 4 (BMP4) partial promoter-h2 haplotype. NCBI Accession No. MH161348.

Divya, D., Gnana Prakash, M., Chatterjee, R.N. and Bhattacharya, T.K. (2018). *Gallus gallus* Line control broiler chicken bone morphogenetic protein4 (BMP4) partial promoter-h3 haplotype. NCBI Accession No. MH161349.

Divya,D., Bhattacharya, T.K., Gnana Prakash, M., Chatterjee, R.N., Shukla, R. and Ravinder Reddy, V. (2017). *Gallus gallus* Line control broiler chicken bone morphogenetic protein3 (BMP3) gene, partial promoter. NCBI Accession No. KY795991.

Divya, D., Bhattacharya, T.K., Gnana Prakash, M., Chatterjee, R.N., Reddy, Y.N., Dange, M. and Rajendra Prasad, A. (2017). *Gallus gallus* Line control broiler chicken bone morphogenetic protein3 (BMP3) partial promoter-h1 haplotype. NCBI Accession No. KY795992.

Divya, D., Bhattacharya, T.K., Gnana Prakash, M., Chatterjee, R.N., Dange, M., Guru Vishnu, P. and Sagar, N.G. (2017). *Gallus gallus* Line control broiler chicken bone morphogenetic protein 3 (BMP3) partial promoter-h2 haplotype. NCBI Accession No. KY795993.

Divya, D., Bhattacharya, T.K., Gnana Prakash, M., Chatterjee, R.N., Ravinder Reddy, V., Viroji Rao, S.T. and Shukla, R. (2017). *Gallus gallus* Line control broiler chicken bone morphogenetic protein 3 (BMP3) partial promoter-h3 haplotype. NCBI Accession No. KY795994.

Divya, D., Bhattacharya, T.K., Gnana Prakash, M., Chatterjee, R.N., Reddy, Y.N., Gupta, M., Rajendra Prasad, A. and Govar Sagar, N. (2017). *Gallus gallus* Line control broiler chicken bone morphogenetic protein4 (BMP4) gene, 5'UTR. NCBI Accession No. KY795995.

Divya, D., Bhattacharya, T.K., Gnana Prakash, M., Chatterjee, R.N., Paswan, C., Guru Vishnu, P. and Vinoth, A. (2017). *Gallus gallus* Line control layer chicken bone morphogenetic protein4 (BMP4) gene, 5'UTR. NCBI Accession No. KY795996

T.R. Kannaki and co-workers

Complete coding sequences of *TLR1A, TLR3, LGP2, MDA5, NOD1,* B-*NK* and *B-lec* genes from three breeds were deposited in GenBank database. The accession numbers are:

TLR3: MF576160 (WLH), MF576161 (NB) and MF576162 (GH), TLR1LA: MF563596 (WLH), MF563597 (NB) and MF563598 (GH), MDA5: MF563590 (GH), MF563591 (WLH) and MF563592 (NB), LGP2: MF563593 (WLH), MF563594 (NB) and MF563595 (GH), NOD1: MF576163 (WLH), MF576164 (NB) and MF576165 (GH). *B-NK*: MF563587 (WLH), MF563588 (NB) and MF563589 (GH) and *B-Lec*: MF563584 (WLH), MF563585 (NB) and MF563586 (GH).

11.Committees

Research Advisory Committee

The 11th Meeting of the Common Research Advisory Committee of ICAR-DPR and ICAR-CARI, Izatnagar was held on 28 and 29 June 2017 at ICAR-DPR, Hyderabad under the Chairmanship of Dr. V. Prabhakar Rao, Former Vice Chancellor, SVVU, Tirupati. All the RAC members, Dr. R.S. Gandhi, ADG (AP&B), ICAR and Directors of both the institutes attended the meeting. The HODs/Scientists presented the research progress in different disciplines. The Chairman expressed satisfaction over the work done and progress made by both the institutes in the last year. The RAC suggested to strengthen linkages with other ICAR institutes, SAUs, Govt. organisations and explore opportunities for more extramural funding for research work, besides laying emphasis on research for addressing the issues of the poultry sector.

Dr. V. Prabhakar Rao conducting the RAC meeting

Fourth Quinquennial Review Team (2012-17)

The fourth Quinquennial Review Team (QRT) has been constituted by ICAR for evaluating the performance of ICAR-DPR during the period 2012-2017 under the Chairmanship of Prof. Purnendu Biswas, Vice Chancellor, West Bengal University of Animal & Fishery Sciences, Kolkata. The QRT held its first meeting on 17 and 18 January 2018 at ICAR-DPR and reviewed the work done under different research projects at the head quarter, the overall progress under AICRP on Poultry Breeding and Poultry Seed Project and action taken on the previous QRT recommendations. The QRT also visited the laboratories, farm, hatchery and other facilities of the institute. Discussions were also held with scientific, administrative, technical and supporting staff of the Directorate.

Prof. P. Biswas conducting the QRT meeting

QRT visiting DPR farm

The Chairman and Members, QRT also visited some centres of AICRP on Poultry Breeding (ICAR-CARI, Izatnagar on 15 February 2018 and GADVASU, Ludhiana on 24 to 26 March 2018) and Poultry Seed Project (WBUAFS, Kolkata on 19 February 2018 and ICAR-RC for NEH, Regional Centre Nagaland on 13 and 14 March 2018) and reviewed the work done during the period. The members visited villages where improved germplasm has been supplied by the centres and interacted with stakeholders/ farmers.

QRT interacting with tribal farmer in Nagaland

Institute Research Committee

The Annual IRC meeting was held on 3 June 2017 and half yearly IRC meeting was held on 8 November 2017 at the Directorate. The meetings were chaired by Dr. R.N. Chatterjee, Director and Dr. T.K. Bhattacharya acted as the Member Secretary. Principal Investigators presented the achievements of their respective projects. The Chairman, IRC suggested measures for overcoming the difficulties in achieving desired targets.

IRC meeting in progress

IAEC Meeting

The XIX Institutional Animal Ethics Committee Meeting was conducted on 21 October, 2017. CPCSEA nominees, Dr. Ramavat Ravindar Naik, Technical Officer, National Centre for Laboratory Animal Sciences (NCLAS), Dr. K. Rajender Rao, Scientist D, NCLAS, Dr. Uma Mahesh Yelisetti and Dr. Krishna Kumar, Biological E Ltd were present in the meeting.

IAEC meeting in progress

AICRP and PSP Annual Review Meeting at Palampur

The Annual Review Meeting of AICRP on Poultry Breeding and Poultry Seed Project was held at College of Veterinary and Animal Sciences, CSKHPKVV, Palampur on 24 and 25 June 2017. The inaugural session was chaired by Dr. R.S. Gandhi, ADG (AP&B) and presided by Prof. A.K. Sarial, Vice-Chancellor, CSKHPKV, Palampur. Dr. R.N. Chatterjee, Director, ICAR-DPR, briefed the objectives and achievements of AICRP and PSP and presented the PC report. He informed that AICRP has developed five location specific chicken rural varieties which have been well accepted by local farmers.

Folders and germplasm released at the review meeting

All the PIs presented the progress report in detail, which was extensively reviewed by ADG (AP&B, ICAR), and Director, ICAR-DPR, Hyderabad. Dr. Arjava Sharma, Director, ICAR-NBAGR described the process of registering chicken breeds and varieties. In concluding remarks, Dr. R.S. Gandhi emphasized the need of popularizing the developed varieties among farmers through print and electronic media.

Meetings of IJSC, IGC and Women's cell

The meetings of Institute Joint Staff Council, Institute Grievance Committee and Women's Cell were held on quarterly basis.

12. Participation in Seminars, Conferences, Meetings and Workshops

Sl. No.	Particulars of Training	Official(s)	Schedule	Organisers and Venue
1.	Technical seminar on "Management of poultry farm during summer season"	Dr. S.V. Rama Rao, Pr. Scientist Dr. M.V.L.N. Raju, Pr. Scientist M.R. Reddy, Pr. Scientist Dr. M. Niranjan, Pr. Scientist Dr. U. Rajkumar, Pr. Scientist	April 7, 2017	AP (Hyderabad) Chapter, IPSA, Warangal, Telangana
2.	Town Official Language Implementation Committee-2, Hyderabad	Dr. S.P. Yadav, Pr. Sceintist	April 18, 2017	NIRDPR, Hyderabad
3.	National Conference on "Revisiting Agril. Extension strategies for enhancing Food and Nutritional Security, Sustainable livelihoods and Resilience to climate change – Towards Transforming Agriculture"	Dr. N. Anand Laxmi, Pr. Scientist	April 22, 2017	PJTSAU, Hyderabad
4.	XXIII Annual convention of Indian Society for Veterinary Immunology & Biotechnology & National Conference on "Challenges in Livestock and Poultry Production-Solutions with Biotechnology"	Dr. T.K. Bhattacharya, National Fellow	April 17-19, 2017	Kranti Singh Nana Patil College of Vety. Science, Satara
5.	Technical Seminar on "Recent Nutritional Concepts for Economization of Poultry Diets"	Dr. S.V. Rama Rao, Pr. Scientist	June 20, 2017	Pune, Maharastra
6.	Stakeholder Consultation Workshop on Sustainable Agriculture in Backdrop of Climate Change	Dr. Santosh, Haunshi, Pr. Scientist	July 13, 2017	NAARM, Hyderabad
7.	Technical Seminar on "Economic Feed Formulation for Poultry with Newer Concepts"	Dr. S.V. Rama Rao, Pr. Scientist	July 24, 2017	Anaparthy, East Godavari, Andhra Pradesh
8.	Technical seminar on "Economization of Feed Cost for Sustainable Egg Production"	Dr. S.V. Rama Rao, Pr. Scientist	September 15, 2017	Davangere, Karnataka
9.	International Conference on Sustainable Animal Agriculture for Developing Countries (SAADC)	Dr. N. Anand Laxmi, Pr. Scientist	October 16-19, 2017	University of Brawijaya Batu, Indonesia
10.	International Conference & Expo on Agriculture & Veterinary Sciences: Research and Technology	Dr. R.K. Mahapatra, Pr. Scientist Dr. S.P. Yadav, Pr. Scientist	October 23-25, 2017	PJTSAU, Hyderabad
11.	Meeting on Natural Products Chemistry, *in vitro* and *in vivo* studies, Cell culture, Gene expression, Nutrigenomics and Performance trials in poultry	Dr. Suchitra Sena, Pr. Scientist	October 24, 2017	Indian Institute of Chemical Technology, Hyderabad

12.	Knowledge Day Seminar on "Evolving Demands and Changing Mindsets"	Dr. M.V.L.N. Raju, Pr. Scientist Dr. B.L.N. Reddy, Pr. Scientist Dr. U. Rajkumar, Pr. Scientist Dr. R.K. Mahapatra, Pr. Scientist Dr. S.P. Yadav, Pr. Scientist Dr. A. Kannan, Pr. Scientist Dr. L.L.L. Prince, Sr. Scientist Dr. M. Shanmugam, Sr. Scientist Dr. T.R. Kannaki, Sr. Scientist Dr. B. Prakash, Sr. Scientist Dr. T.K. Bhattacharya, National Fellow	November 21, 2017	IPEMA, HICC Complex, Hyderabad
13.	National Conference and Annual Symposium of IPSA on "Innovations for Safe and Sustainable Poultry Production (IPSACON 2017)	Dr. S.V. Rama Rao, Pr. Scientist Dr. M.V.L.N. Raju, Pr. Scientist Dr. B.L.N. Reddy, Pr. Scientist Dr. U. Rajkumar, Pr. Scientist Dr. D. Suchitra Sena, Pr. Scientist Dr. Santosh Haunshi, Pr. Scientist Dr. A. Kannan, Pr. Scientist Dr. B. Prakash, Sr. Scientist Dr. T.R. Kannaki, Sr. Scientist Dr. T.K. Bhattacharya, National Fellow	November 28-30, 2017	ICAR-NIANP, Bengaluru
14.	XV Biennial Conference & National Symposium on "Role of Women Veterinarians in Enhancement of Livestock Productivity, Health and Welfare"	Dr. D. Suchitra Sena, Pr. Scientist	November 21-22, 2017	College of Vety. Science, Hyderabad
15.	XXVI Annual Conference of Society of Animal Physiologists of India (SAPI) & National Symposium	Dr. N. Anand Laxmi, Pr. Scientist Dr. M. Shanmugam, Sr. Scientist	December 21-22, 2017	KVAFSU, Bidar
16.	State Level Consultation Workshop on Mainstreaming Biodiversity, NBTs, NBAP and India's National Sixth Report to Convention on Biological Diversity	Dr. Santosh Haunshi, Pr. Scientist	January 10, 2018	TSBDB, Hyderabad
17.	Workshop on "Current status and future strategies in countering anti-microbial resistance (AMR) in livestock" for development of Telangana state action plan	Dr. D. Suchitra Sena, Pr. Scientist	January 24, 2018	Directorate of Animal Husbandry, Shantinagar, Hyderabad
18.	36th Annual Convention & National Symposium on Animal Health service delivery-The Priority of the Professionals for enhancing Farmer's income	Dr. D. Suchitra Sena, Pr. Scientist	February 1-3, 2018	OUAT, Bubhaneswar
19.	33rd Annual Convention & National Symposium of Indian Society for Study of Animal Reproduction	Dr. R.N. Chatterjee, Director	February 10, 2018	WBUAFS, Kolkata
20.	IX Asian Buffalo Congress	Dr. Shyam Sundar Paul, Pr. Scientist	February 1-4, 2018	CIRB, Hisar

13. Distinguished Visitors

- Dr. J.K. Jena, Deputy Director General (AS), ICAR, New Delhi
- Prof. Purnendu Biswas, Vice Chancellor, WBUAFS, Kolkata
- Dr. A.K. Mishra, Vice Chancellor, GBPUAT, Pantnagar, Uttarakhand
- Smt. V. Usha Rani, Director General, MANAGE, Hyderabad
- Dr. R.S. Gandhi, Asstt. Director General (AP&B), ICAR, New Delhi
- Dr. M.L. Madan, Former DDG (AS), ICAR, New Delhi
- Dr. V. Prabhakar Rao, Former Vice Chancellor, SVVU, Tirupati (A.P.)
- Dr. N. Sreenivasa Gowda, Former Vice Chancellor, KVAFSU, Bidar, Karnataka
- Dr. A. Padma Raju, Former Vice Chancellor, ANGRAU, Hyderabad
- Dr. S.S. Majumdar, Director, NIAB, Hyderabad
- Dr. R.P. Sharma, Former Director, PDP, Hyderabad
- Dr. S. Vaithiyanathan, Director (Acting), NRC on Meat, Hyderabad
- Dr. C.S. Prasad, Former Director, NIANP, Bengaluru
- Dr. S.K. Agarwal, Ex Director, CIRG, Makhdom, UP
- Dr. S.D. Singh, Head (Retd.), Avian Diseases, IVRI, Izatnagar, Barielly
- Dr. S. Pan, Professor (Retd.), WBUAFS, Kolkata

DDG Visiting DPR farm

14. Personnel

Research & Management Position

Dr. R.N. Chatterjee, Director

Scientific

Dr. S.V. Rama Rao Pr. Scientist
Dr. M.V.L.N. Raju, Pr. Scientist
Dr. B.L.N. Reddy, Pr. Scientist
Dr. (Mrs.) N. Anand Laxmi, Pr. Scientist
Dr. Shyam Sundar Paul, Pr. Scientist
Dr. U. Rajkumar, Pr. Scientist
Dr. R.K. Mahapatra, Pr. Scientist
Dr. (Mrs.) D. Suchitra Sena, Pr. Scientist
Dr. Santosh Haunshi, Pr. Scientist
Dr. S.P. Yadav, Pr. Scientist
Dr. A. Kannan, Pr. Scientist
Dr. L. Leslie Leo Prince, Sr. Scientist
Dr. B. Prakash, Sr. Scientist
Dr. M. Shanmugam, Sr. Scientist
Dr. (Mrs.) T.R. Kannaki, Sr. Scientist
Dr. Chandan Paswan, Scientist

National fellow

Dr. T.K. Bhattacharjya, National Fellow

Technical

Dr. S.K. Bhanja, C.T.O. (Farm Manager)
Dr. R.V. Rao, C.T.O.
Sri V.V. Rao, A.C.T.O.
Smt. Minakshi Dange, A.C.T.O.
Sri D. Pratap, A.C.T.O.
Sri J. Srinivas Rao, A.C.T.O.
Sri A. Ravi Kumar, Tech. Officer
Sri G. Rajeshwar Goud, Tech. Officer
Sri A. Subrahmanyam, Tech. Officer
Sri Md. Maqbul, Tech. Officer (Driver)
Smt. N.R. Dhanutha, Sr. Tech. Asst.
Sri M. Pantulu, Sr. Tech. Asst. (Driver)
Sri Md. Yousufuddin, Tech. Asst. (Driver)

Administration

Sri A.V.G.K. Murthy, A.O.
Sri C. Bagaiah, A.F. & A.O.
Smt. R.T. Nirmala Veronica, A.A.O.
Sri R. Sudarshan, J.A.O.
Smt. T.R. Vijaya Lakshmi, Assistant
Smt. M. Kamala, Assistant
Sri Rajesh Parashar, U.D.C.
Sri L.V.B. Prasad, U.D.C.

Secretarial Staff

Smt. O. Suneeta, P.S.

Skilled Support Staff

Sri G. Vijay Kumar
Sri Syed Mujtaba Ali
Sri D. Ashok Kumar
Sri N. Manyam
Sri K. Charles
Sri G. Narsimha
Sri Manzoor Ahmed
Sri D. Srinivas
Sri M. Narsing Rao
Sri V. Ravinder Reddy
Sri P. Shankaraiah
Sri K. Venkataiah
Sri D. Shiva Kumar
Smt. K. Vimala

Promotions

- Dr. S.P. Yadav, Sr. Scientist has been promoted as Prl. Scientist w.e.f. 17 January 2017.
- Dr. A. Kannan, Sr. Scientist has been promoted as Prl. Scientist w.e.f. 25 March 2017.
- Dr. M. Shanmugam, Scientist has been promoted as Sr. Scientist w.e.f. 07 January 2017.
- Dr. T.R. Kannaki, Scientist has been promoted as Sr. Scientist w.e.f. 07 January 2017.

- Sri D. Pratap, Sr. Tech. Officer has been promoted as Asst. Chief Tech. Officer w.e.f. 1 January 2016.
- Sri J. Srinivas Rao, Sr. Tech. Officer has been promoted as Asst. Chief Tech. Officer w.e.f. 29 June 2016.

Transfers

- Dr. Shyam Sundar Paul, Pr. Scientist (Animal Nutrition) has joined on 19 June 2017 on transfer from ICAR - Central Institute for Research on Buffaloes, Hisar.
- Dr. A. Kannan, Sr. Scientist (Animal Nutrition) has joined on 28 June 2017 on transfer from ICAR - Indian Veterinary Research Institute, Izatnagar.
- Dr. L. Leslie Leo Prince, Sr. Scientist (Animal Genetics & Breeding) has joined on 01 July 2017 on transfer from ICAR- Central Sheep and Wool Research Institute, Avikanagar.
- Dr. M.R. Reddy, Pr. Scientist has been transferred to ICAR - IVRI, Izatnagar on 24 August 2017.
- Dr. M. Niranjan, Pr. Scientist has been transferred to ICAR - Research Complex for NEH Region, Umiam on 24 August 2017.
- Dr. K.S. Rajaravindra, Scientist has been transferred to ICAR-Central Sheep and Wool Research Institute, Avikanagar on 24 August 2017.

15. Other relevant information

Experimental Hatchery

ICAR-DPR is having an experimental hatchery with state of art equipment and infrastructure to conduct high end research programs. Hatchery has been the central facility of the Directorate in which fumigation and storage of hatching eggs, incubation and hatching of pedigreed and commercial chicks are performed throughout the year. As a part of automation, data loggers have been installed in the hatchery to monitor and control humidity and temperature in the setters, hatchers and in cold room. During the current year, a total of 70,155 hatching eggs, 2,73,863 day old chicks, 31,098 parents and 2,292 grown up birds were supplied to the farmers across the country. In addition, 6,681 embryonated eggs were made available for diagnosis and vaccine production to different organizations.

Experimental Farm

The experimental poultry farm with state of art facilities is located inside the campus and has two units, Pureline and Commercial Units. Pureline farm is for carrying out research whereas the Commercial one is for supplying germ plasm to different stakeholders. Two new cage houses have been added during the year to strengthen research activities. During the period under report, the average livestock reared at the farm was 21,529 per month. A total of 15,52,422 eggs were produced out of which 6,42,539 were hatching eggs and the remaining were table eggs.

Dr. J.K. Jena inaugurating the cage house

Feed Processing Unit

The required raw materials were procured for compounding balanced rations for chick, grower and adult breeding stocks of both layer and broiler types at feed processing unit of the Directorate. During the year, about 843 MT of feed was compounded and supplied to experimental farm. In addition, a small quantity of feed was made available to the farmers who bought chicks from the Directorate.

Sales and Marketing Unit

Supply of hatching eggs and day-old chicks of parent stock and terminal crosses of germplasm was the main activity of this unit. The birds culled in the breeding programme, dressed birds and surplus eggs for table purpose were sold for table purpose. The grownup birds of about 6 weeks age of rural germplasm were supplied to the farmers for rearing purpose.

Agricultural Knowledge Management Unit (AKMU)

The Agricultural Knowledge Management Unit (AKMU) is equipped with desktops, server and other peripheral systems, integrated with user terminals within the Directorate through Local Area Network (LAN). SPSS software (version 12) and SAS software have been used in statistical analyses of research data generated at the Directorate. Symantec Endpoint protection (version 14) for cyber security from viruses, spyware, malware and firewall etc. was ensured for the server as well as nodes on the Local Area network. Local Area Network of the Directorate is enabling users to communicate, store and transfer data within and outside the Organization. The Website of Institute (www.pdonpoultry.org) is being maintained and updated for projection of Institute's activities on the public domain. As per the Council's directive, public notices like tenders, quotations, recruitment advertisements etc. have been posted on website for wider publicity. Internet facility has been provided through fibre optic cable networks from BSNL to all the users on LAN with 20 Mbps bandwidth. Electronic mail facility is also used extensively for communicating and exchanging the information among the users in the Directorate as well as Council and other Institutes/agencies. Biometric attendance of employees is made mandatory by the Government of India. In this connection, Directorate is maintaining three wall-mounted bio-metric devices and one desktop device under the supervision of AKMU unit. Attendance related

reports are regularly generated and submitted to Director's Cell as well as Administration for taking further action on these reports. Circuit Camera surveillance system is also maintained using ten cameras and its associated equipment.

Library and Information Centre

The Directorate has a well-organized library with an impressive collection of literature on Poultry Science and related subjects which is helpful to the readers like scientific and technical staff of the institute. The Library facilities are also offered to the faculty and students of Veterinary Colleges, Universities, researchers and other ICAR Institute officials for their reference work. The library is subscribing 14 foreign journals and eight Indian journals and has more than 700 books on different aspects of poultry science, livestock as well as other general subjects to keep the scientists and technical staff abreast of the latest scientific and technical developments. Additionally the library subscribes general magazines, six newspapers in Hindi, Telugu and English (two from each language) and Employment news for the benefit of staff and visitors. Under e-CERA, Institute is getting access to online journals. Necessary services are being exchanged with the member libraries under the consortium. Library has also rendered reprographic services to the staff, trainees and students.

Swachh Bharat Activities

The Swatch Bharath Abhiyan was launched by the Government of India to inculcate the habit of keeping the surroundings clean and tidy. Accordingly, the Directorate's staff actively participated in cleaning the institute premises every Wednesday. Under the program, steps have been taken to keep the institute premises clean. Under this objective, proposal has been accepted from ITC Limited for the implementation of Wellbeing out of Waste (WOW) program in the institute. International Yoga Day was conducted on 21 June, 2017 where the staff of the institute actively participated at NAARM campus."Earth Hour Campaign 2018" was conducted on 24 March, 2018 with the objective to save Mother Earth and environment by taking pledge, taking part in plantation program by the institute staff members and also by making human chain in the public place to spread awareness for keeping the environment clean, among the general public. Conducted "Swachhta Hi Sewa Campaign" from 15 September to 2 October, 2017. Under "Swachhta Hi Sewa Campaign" different activities were conducted as detailed below.

- "Swachhta Hi Sewa" Pledge was taken by all the staff members.
- Visited adopted village for cleaning.
- Swachh Bharat Quiz was organized.
- Plantation was done inside the institute premises.
- Cleaning of areas inside the campus was done.
- Formed Human chain in public place by the staff members to spread awareness about Swachhta among general public.

Swachh Bharath Activities

Institute Foundation Day

ICAR-Directorate of Poultry Research, Hyderabad celebrated Science Day on 28 February 2018 and 31st Foundation Day at institute campus on 1 March 2018.

Dr. Subeer S. Majumdar, Director, National Institute of Animal biotechnology, Hyderabad graced the Science Day celebration as the Chief Guest. In his address, he emphasized

strengthening of biotechnology research especially in the area of genome editing and transgenic to cope with emerging and future challenges of food security, vaccine and therapeutic development for climate change related emerging diseases. Shri P. Ashok, ACP, Rajendranagar and Dr. K. Kondal Reddy, Registrar of PV Narsimha Rao Telangana Veterinary University were Guests of Honour on the occasion. Dr. R.N. Chatterjee, Director, DPR briefed about the achievements of institute including future flagship research areas. An exhibition to showcase new technologies, varieties developed by the institute and information on chicken and eggs was also organized where about 200 school children from four Schools of Hyderabad visited the institute stall.

Dr. S.S. Majumdar addressing the staff

Dr. R.S. Gandhi, ADG (AP&B) graced the Foundation Day celebrations as Chief Guest and Dr. R.P. Sharma, former Director , PDP and Dr. S. Vaithyanathan, Acting Director, ICAR-NRC on Meat, Hyderabad were Guests of Honour. Dr. Gandhi appreciated the institute for its contribution in ensuring livelihood security of rural population. The books entitled 'Improved Chicken Varieties' and 'Gramin kukkatpalan ke nayaayam' published by the institute were released. About 35 farmers from a village adopted by the institute under MGMG program also participated in the program and interacted with scientists and chief guests.

Dr. R.S. Gandhi addressing the farmers and staff

Hindi Implementation Activities

Dr. V.V. Kulkarni addressing the staff on Hindi Day

As part of official language implementation, this Directorate conducted four quarterly meetings of Official Language Implementation Committee (OLIC) on 30 June 2017, 8 September 2017, 9 December 2017 and 25 March 2018 in which different issues related to effective implementation of Hindi Language in office were discussed and necessary action has been initiated. The Directorate also conducted four Hindi workshops for upgrading the Official Hindi language skills as well Hindi typing work on computers by using UNICODE to staff in day to day official work.

The Hindi cell of the Directorate also celebrated Hindi Fortnight celebrations during 1 to 15 September, 2017 and Hindi Day was celebrated on 14 September, 2017. Dr. V.V. Kulkarni, Director, ICAR-NRC on Meat, Hyderabad graced the occasion as Chief Guest. During the Hindi Fortnight celebrations, various literary competitions were conducted for the institute staff members and winners were awarded prizes.

Independence Day and Republic Day

ICAR-DPR celebrated the Independence Day on 15 August 2017 and Republic Day on 26 January 2018. On these occasions, the Director hoisted national flag and addressed the staff of the institute.

Games and sports

The staff of the Directorate participated in the ICAR sports meet organized by ICAR-SBI, Coimbatore from 9-13 October 2017.

DPR awarded ISO 9001:2015

This Directorate was awarded ISO 9001:2015 (certificate Number: 83854/A/0001/NB/En dated 10 November 2017 with the scope "Research and Development in the Field of Poultry Germplasm Development, Improvement, Conservation and Transfer of Technology".

Certificate of Registration

This certificate has been awarded to

ICAR – Directorate of Poultry Research

Pillar No. 216, Rajendra Nagar, Hyderabad, Telangana State, 500030, India

In recognition of the organization's Quality Management System which complies with

ISO 9001:2015

The scope of activities covered by this certificate is defined below

Research and Development in the Field of Poultry Germplasm Development, Improvement, Conservation and Transfer of Technology

Certificate Number: 83854/A/0001/NB/En

Date of Issue: (Original) 10 November 2017

Date of Issue: 10 November 2017

Issue No: 1

Expiry Date: 09 November 2020

Issued by:

On behalf of the Scheme's Manager


RURAL POULTRY FARMING IN NORTH-EAST
Sikkim
West Bengal
Assam
Nagaland
Meghalaya
Manipur
Mizoram
Tripura
Project Directorate on Poultry
(Indian Council of Agricultural Research)
Rajendranagar, Hyderabad 500 030, A.P., India
Email : pdpoult@ap.nic.in; Website : www.pdonpoultry.org


QUALITY PROTEIN MAIZE
AS POULTRY FEED
Project Directorate on Poultry
(Indian Council of Agricultural Research)
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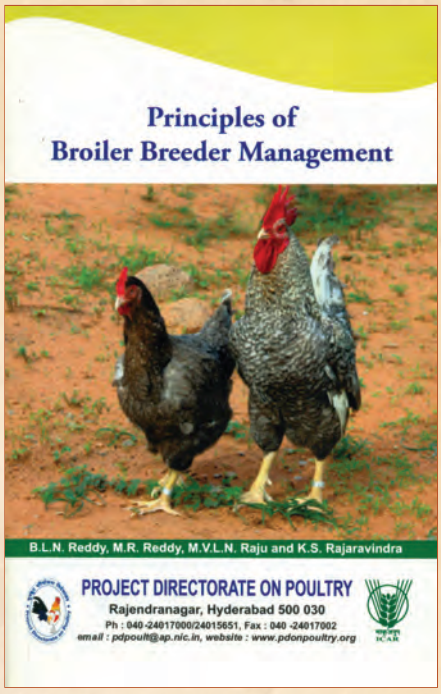
Email: pdpoult@ap.nic.in I Website: www.pdonpoultryorg


Principles of
Broiler Breeder Management
B.L.N. Reddy, M.R. Reddy, M.V.L.N. Raju and K.S. Rajaravindra
PROJECT DIRECTORATE ON POULTRY
Rajendranagar, Hyderabad 500 030
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email : pdpoult@ap.nic.in, website : www.pdonpoultry.org


MAIZE IN POULTRY NUTRITION
Edited by
A.K. Panda
Project Directorate on Poultry
(Indian Council of Agricultural Research)
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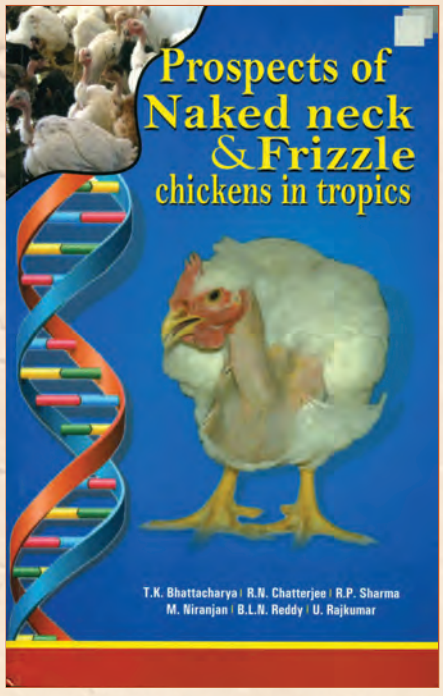
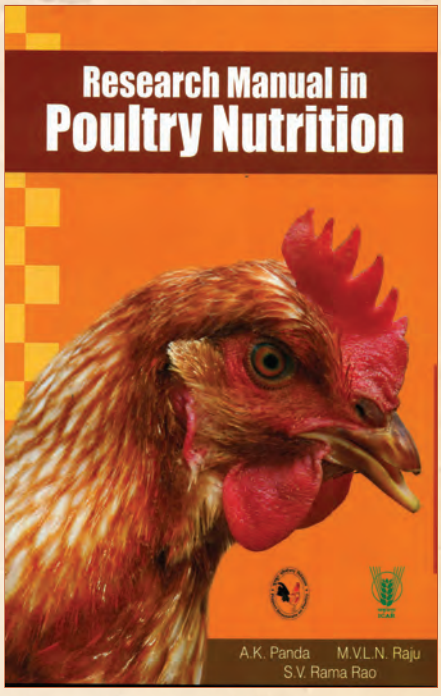
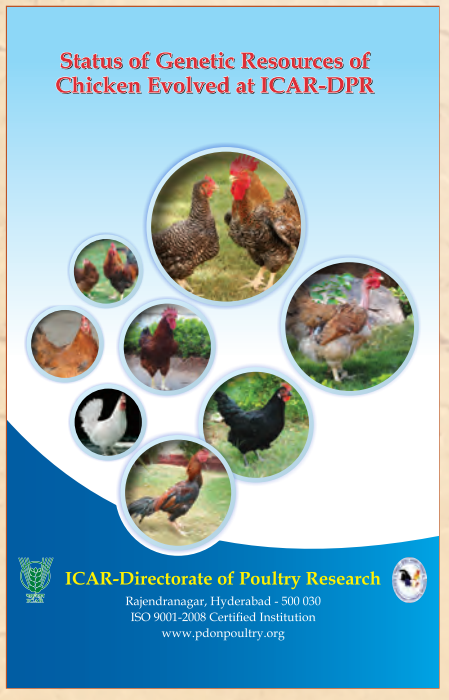

Prospects of
Naked neck
& Frizzle
chickens in tropics
T.K. Bhattacharya I R.N. Chatterjee I R.P. Sharma
M. Niranjan I B.L.N. Reddy I U. Rajkumar


Research Manual in
Poultry Nutrition
A.K. Panda
M.V.L.N. Raju
S.V. Rama Rao


Status of Genetic Resources of
Chicken Evolved at ICAR-DPR
ICAR-Directorate of Poultry Research
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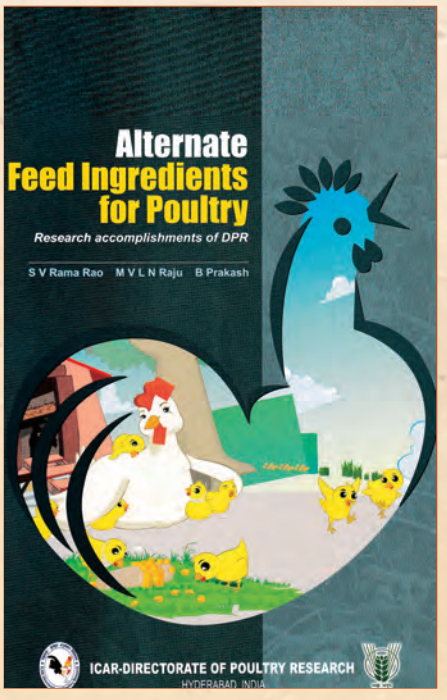
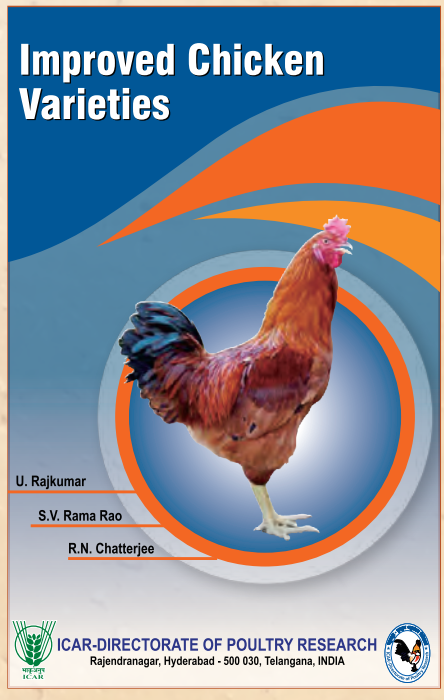
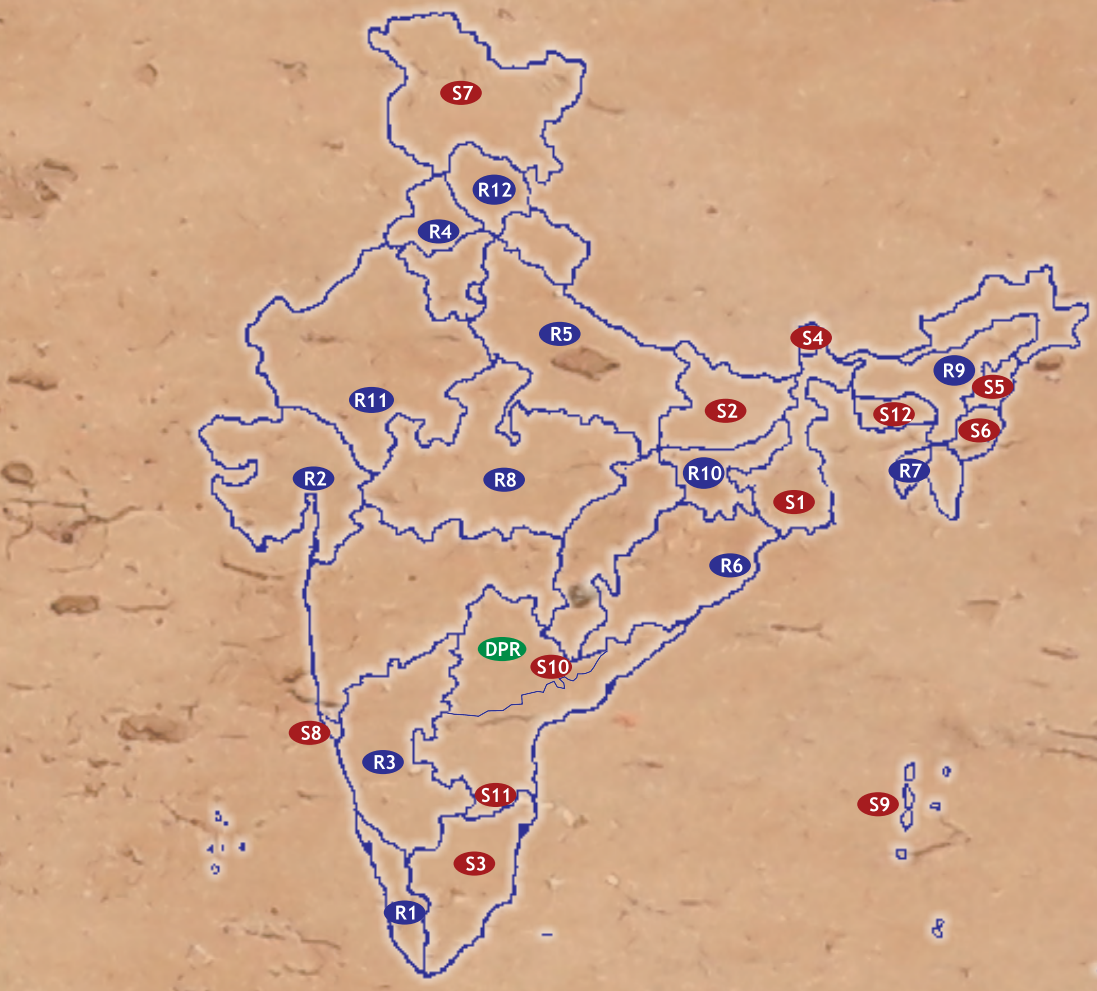

Alternate
Feed Ingredients
for Poultry
Research accomplishments of DPR
S V Rama Rao M V L N Raju B Prakash
ICAR-DIRECTORATE OF POULTRY RESEARCH
HYDERABAD, INDIA


Improved Chicken
Varieties
U. Rajkumar
S.V. Rama Rao
R.N. Chatterjee
ICAR-DIRECTORATE OF POULTRY RESEARCH
Rajendranagar, Hyderabad - 500 030, Telangana, INDIA

AICRP on Poultry Breeding and Poultry Seed Project

Centres across the Nation



ICAR - DPR

AICRP Centres

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
R10.	BAU, Ranchi
R11.	MPUAT, Udaipur
R12.	CSKHPKVV, Palampur

PSP Centres

S1.	WBUAFS, Kolkata
S2.	BASU, Patna
S3.	TANUVAS, Hosur
S4.	ICAR RC, Sikkim
S5.	ICAR RC, Nagaland
S6.	ICAR RC, Manipur
S7.	SKUAST, Srinagar
S8.	ICAR-CCARI, Goa
S9.	ICAR-CIARI, Portblair
S10.	PVNRTVU, Warangal
S11.	SVVU, Tirupati
S12.	ICAR-RC for NEHR, Barapani

भाकृअनुप - कुक्कुट अनुसंधान निदेशालय

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