Annual Report
2015-16

भाकृअनुज-कुक्कुट अनुसंधान निदेशालय

ICAR-Directorate of Poultry Research

ISO 9001 - 2008

Rajendranagar, Hyderabad - 500 030

Sardar Patel Outstanding ICAR Institution 2013

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
S1. BAU, Patna
S3. CKVV, Durg
S4. ICAR RC, Sikkim
S5. ICAR RC, Nagaland
S6. ICAR RC, Manipur
S7. TANUVAS, Hosur
S8. ICAR-CCARI, Goa
S9. ICAR-CIARI, Portblair
S10. ICAR-IVRI, Mukteswar
S11. SKUAST, Srinagar
S12. ICAR-RC for NEHR, Barapani (NFC)

Annual Report
2015-16

भाकृअनुप
ICAR

ICAR- Directorate of Poultry Research

Rajendranagar, Hyderabad

www.pdonpoultry.org

ICAR-Directorate of Poultry Research

ICAR-DPR
Annual Report

Correct Citation
Annual Report 2015-16
ICAR-Directorate of Poultry Research
Rajendranagar, Hyderabad-500 030
Telangana, India

Published by
Dr. R.N. Chatterjee
Director

Compilation and Editing
Dr. U. Rajkumar
Dr. M. Shanmugam
Dr. S.P. Yadav
Dr. M.V.L.N. Raju

Front Cover
Aseel Cocks

Inside Front Cover
Location of AICRP on Poultry Breeding and Poultry Seed Project centres

Inside Back Cover
Hon'ble DDG (AS) Prof. K.M.L. Pathak releasing *Narmadanidhi* chicken variety

Back Cover
Hon'ble Sri Radha Mohan Singh, Minister of Agriculture & Farmers Welfare, Govt. of India distributing *Vanaraja* chicks to the farmer at Gangtok, Sikkim

Designed & Printed at
Balaji Scan Pvt. Ltd.
Beside Singareni Bhavan, Lakadikapul,
Hyderabad-500004.
Tel: 23303424/25, 9848032644
www.balajiscan.com

Preface

The Directorate has completed twenty eight years of dedicated service for the developemnt of poultry production in general and rural poultry in particular in the country. Continuous efforts of committed staff helped in fulfilling the mandated responsibilities of coordinating and monitoring ICAR-network projects, applied research and extension in poultry and establishing leadership role in development and propagation of improved germplasm for rural poultry farming. I feel privileged to present the Annual Report for the year 2015-16.

The two rural chicken varieties i.e. *Vanaraja* and *Gramapriya* developed by the Directorate have reached throughout the length and breadth of the nation. The birds are performing extremely well in low input system. This has made possible to alleviate protein hunger and malnutrition, and increase socio-economic condition of the farmers in rural areas.

The AICRP on Poultry Breeding has ben reoriented towards the rural poutlry and all the centres are working on development of location specific rural chicken varieties suitable for their local conditions. The elite layer and broiler pure lines are being maintained for improvement of economic traits and utilised for development of rural crosess. During the year a dual purpose variety *Narmadanidhi* was developed at Jabalpur centre and has been released for the benefit of rural and tribal farmers. A total of 5.29 lakhs of chicken germplams was supplied to the farmers across the country under AICRP component.

Twelve Poultry Seed Project centres spread across the country are in operation with aim of increasing the availability of improved germplasm throughout the country. A total of 2.48 lakhs of improved chicken germplasm was distributed in rural and tribal areas under seed project component. The famers have shown greater satisfaction over the performance of the birds at their doorsteps.

The pure lines (Rural, Broiler, Layer) maintained at this Directorate have been constantly improved for various economic traits based on the feedback from farmers. Research is under progress in poultry genomics through Functional Genomics, Epigenetics and Gene Silencing Technology for augmenting poultry production. Mitochondrial DNA work has been initiated to study the genetic diversity of the different indigenous breeds and pure lines of chicken available at the Directorate. The research conducted in the area of nutrition and physiology and health is aiding in developing package of practices for different pure lines and crosses developed by this Directorate. Further, several extramural projects funded by DBT, DST, NICRA and NAIP and collaborative projects with the industry under PPP mode were also undertaken by the Directorate. Besides, a few contract research projects are also under way. The research output was communicated through peer reviewed journals, magazines and electronic media.

The propagation of germplasm is being strengthened through brochure, visual media and participating in the exhibitions. I am happy to inform that the Directorate has distributed 3.62 lakhs of improved germplasm and realised an amount of 167 lakhs of revenue.

I am extremely grateful to Dr. S. Ayyappan, the former Secretary, DARE and Director General, ICAR and Dr. Trilochan Mohapatra, the current 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 in the development of the Directorate.

I am extremely thankful to Dr. K.M.L. Pathak, the former DDG (AS) and Dr. H. Rahman, the current DDG (AS) for their 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. I am highly thankful to them. I also thank all other staff for supporting the scientists in their research endeavour. I also thank the editorial committee in bringing out this report in an appreciable manner.

Date: 25 June 2016

(R.N. Chatterjee)
Director

Abbreviations

AAU	Anand Agricultural University/Assam Agricultural University
AICRP	All India Coordinated Research Project
ANGRAU	Acharya N. G. Ranga Agricultural University
APARD	Andhra Pradesh Academy of Rural Development
APAU	Andhra Pradesh Agricultural University
ARIS	Argicultural Research Information System
ARS	Agriculrural Research Service
ASM	Age at Sexual Maturity
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
DOR	Directorate of Oilseeds Research
DST	Department of Science and Technology
EP	Egg Production
FCR	Feed Conversion Ratio
g	Gram(s)
GP	Glutathione Peroxidase
GR	Glutathione Reductase
H:L ratio	Heterophyl : Lymphocyte Ratio
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

KAU	Kerala Agricultural University
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
NIRD	National Institute of Rural Development
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
SPVNRTSUVAFS	Sri P.V. Narasimha Rao Telangana State University for Veterinary Animal and Fishery Sciences
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

ICAR-Directorate of Poultry Research is a premier Institute under the aegis of Indian Council of Agricultural Research is mandated to coordinate and monitor the ICAR-sponsored network program i.e., AICRP on Poultry Breeding and Poultry Seed Project and to undertake applied research with emphasis on developing rural chicken varieties to meet the needs of rural, tribal and other underprivileged sections of the society. The Directorate also undertakes sponsored research projects from other agencies i.e., DBT, DST and contract research programs under PPP mode. The salient achievements for the year 2015-16 are summarized briefly.

Research at the Directorate

Genetics and Breeding

The main focus of research in Genetics and Breeding includes development of rural chicken varieties, improvement of rural pure lines, maintenance and evaluation of layer, broiler, gene lines and conservation of native chicken germplasm.

Germplasm for rural poultry farming

Two male lines, PD-1 (*Vanaraja* male line), GML (*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.The egg production up to 40 weeks of age was 50.25± 0.04 eggs in S-9 generation, which decreased by 2 eggs compared to last generation in PD-1 line. The least squares means for 6 weeks body weight and Shank length in PD-1 were 701.94±0.04 g and 77.88±0.002 mm, respectively. The primary trait (SL6) decreased from the previous generation. The least squares means for body weight at 4 and 6 weeks of age were 367.29±0.01 and 705.21±0.08 g in GML chicken. The primary trait (SL6) was 78.91±0.002 mm, in PD-6 (GML) line which increased considerably by about 4 mm in SL-5 generation. The part period egg production at 40 and 52 weeks of age was 78.02± 0.04 and 128.96±0.08 eggs. In PD-2 line, the body weight at 4 and 6 weeks of age was 257.24 and 471.31g, respectively. The juvenile body weight is showing decreasing trend over generations in PD-2 line due to selection for part period egg production. The age at sexual maturity was 161.59±0.02days, which decreased from the last generation. The egg production and egg mass up to 40 weeks of age were 74.95±0.02 eggs and 4018.07±1.98g PD-3 population. The phenotypic and genetic response for part period egg mass upto 40 weeks of age was 210g and 65.8 g per generation, respectively over last five generations. A random bred rural control population evolved for comparing the performance of different rural lines was also evaluated and maintained.

Native chicken populations

Three native chickens (Aseel, Ghagus and Nicobari) were conserved and PD-4 (Improved Aseel) was under improvement for better body weight and egg production. In PD-4, there was an improvement of 12 g in body weight (primary trait) and 1.33 mm in shank length at 8 weeks of age on pooled sex in S-6 generation. Survivors' egg production up to 40 weeks of age improved by 2.81 eggs to 62.54±1.39 in S-6 generation. Aseel birds are characterized by multi coloured plumage (predominantly dark brown, black, golden etc.) with solid feather pattern and normal distribution, pea comb (98%) with dark red colour (82%). In native pure Aseel, the body weight at 6, 12 and 16 weeks was 313.69, 857.32 and 1312.24 g, respectively with corresponding shank lengths of 72.34, 97.80 and 110.854 mm. The annual egg production up to 72 weeks of age was 64.47 ±6.27 eggs during the G-2 generation. In Ghagus, body weight recorded at 20 weeks of age in male and female birds was 1809±20.6 and 1320±11.32 g respectively in G-3. The ASM was 161.4 ± 1.13 days.The survivors egg production up to 40 weeks of age was 33.71 ± 1.77 eggs in G-4 generation.The body weight at 20 weeks of age in female and male Nicobari was 1102 ± 25.7 and 1527 ± 31.1g, respectively. Field and farm evaluation of 2 and 3 way crosses was carried out in two villages.

Layer populations

Six layer chicken lines, IWH, IWI, IWK. IWD, IWF and layer control (LC) maintained at the Institute farm were evaluated. The average egg production up to 64 weeks (EP64) in IWH, IWI, IWK and Layer control were 254.34±1.34, 235.12±1.64, 227.80±1.47 and 223.24±1.67, respectively. The EP64 improved in IWH, IWI and LC but decreased in IWK lines over previous generation. Egg weight at 64 weeks (EW64) of age in IWH, IWI, IWK and LC were 52.15±0.24, 51.76±0.23, 55.21±0.2 2 and 53.39±0.25 g, respectively. The genetic responses of selection at EP64 in IWH, IWI and IWK were 8.03,-0.34 and 2.048 eggs. IWD and IWF were recently added from AICRP Hyderabad Centre.

Broiler populations

Three coloured broiler lines i.e. synthetic coloured broiler male line (PB-1), synthetic coloured female line (PB-2) and control broiler (CB) populations were maintained and evaluated. Genetic and phenotypic responses in 5 weeks body weight over the last five generations were 38.6 and 31.9g, respectively. The egg production upto 40 weeks decreased by 5 eggs as compared to the last generation. The ASM was 156.5±0.20 days. In PB-2, the egg production at 40 weeks reduced by four eggs compared to last generation.The phenotypic and genetic response to selection for the 40 week part period egg production over the last ten generations was 0.73 and 1.49 egg per generation. The 5 week body weight was 770.14±3.57g which decreased from last generation. Naked neck and dwarf gene lines were maintained as resource populations.

Molecular Genetics

Polymorphism in BMP3 and BMP4 genes in chicken was studied during the current year.The 786 bp promoter of BMP3 and 1123 bp promoter of BMP4 genes were analysed in control broiler (CB) and control layer (CL) chicken to determine polymorphism in the promoters. The h1h2 was the most predominant haplogroup and h1h1 was the least frequent one. Accordingly, three haplotypes were observed in these lines, in which h1 was the most predominant haplotype and h3 was the least frequent haplotype in both the lines. In BMP4 promoter, three haplogroups have been observed of which h1h1 was the most frequent in CB line and h1h2 was the most frequent in CL line. The least frequent haplogroup was h1h3 in both the lines. Accordingly, three haplotypes were found in these lines.The haplogroups of the BMP3 promoter showed significant effect ($P<0.05$) on body weights at 28th and 42nd day of age.

Nutrition, Physiology and Health

Oreganol at 200g/ton numerically improved the performance and significantly feed intake in *Vanaraja*. In commercial broilers, body weight gain and feed efficiency were not affected by replacing antibiotic growth promoter with Oreganol at 250 g / kg diet. Higher inclusion levels of oragenol did not show improvement in broiler performance. HI and CMI responses were not affected with oreganol supplementation. Lipid peroxidation was reduced while GPRx and FRAP increased significantly with oreganol supplementation both in *Vanaraja* and broiler chicken.Body weight gain, feed efficiency and breast weight were significantly higher in DL Met group followed by L Met and MHA in broilers. Antibody titre against ND vaccine was significantly higher in DLM groups followed by MHA and L Meth. In PD-3, the egg production and number of eggs were higher in birds fed the diet containing calcium 3.25% and P 0.35% compared to other groups during the 37-40 weeks. However, the feed intake and egg quality parameters did not differ ($P>0.05$) among the various dietary groups during the 33 to 44 weeks period. Production of chelated selenium, zinc and copper through yeast cells and their supplemental effect on performance and anti-oxidant status in broiler chicken was studied. The concentration of Se (sodium selenite) increased from 0 to 200 ppm in the YEPD broth that resulted in gradual decrease in biomass yield was recorded in 050 strain of Saccharomyces cerevisiae. However, the selenium (mg/g) concentration in biomass increased gradually from 0 to 200 ppm and observed best at 30 ppm, where the biomass and Se uptake was optimum compared to the other concentrations. Supplementation of *Mentha Aquatica* (0.50 ml) and Ginger officinale (1.5 ml) extracts resulted in higher *Saccharomyces cerevisiae* growth in terms of CFU/ml compared to other herbal extracts. The higher body weight gain was recorded among the group fed the diets supplemented with Selenized-yeast compared to control diet. Further, among the Selenized-yeast supplemented groups the higher body weight gain was recorded at 0.2 ppm Se. Supplementation of cotton seed cake and guar meal along with QPM or ordinary maize significantly depressed the body weight gain, FCR, slaughter variables in commercial broilers.

Based on semen parameters, BPSE showed better results as compared to TES-NaCl. The fertility rate was 72.44% in BPSE group and 65.15% in TES-NaCl group at 0 h storage of semen. The hatchability was 60.23% in BPSE group and 56.08% in TES-NaCl group. Vit. C (10 mg) supplemented with BPSE showed better results in terms of motility (59.16±0.99%), MTT (25.70±0.77%), which were significantly higher than TES-NaCl and sperm abnormality (21.91±0.62) was also significantly lower. Dietary CP level (9%) had no effect on semen and fertility parameters. Dietary energy and protein level combinations influenced the percent abnormal sperm, fertility and hatchability in layer breeder males. ERx and TGF-β Gene expression results revealed no difference in mRNA expression of both the genes in the UVJ tissue between the repeatedly inseminated and never inseminated birds.

Thus it can be concluded that these genes play no role in declining fertility due to repeated insemination in chicken.

The overall incidence of ALV was 3.35% (189/5649). All positive birds (189) were culled prior to regeneration to prevent vertical transmission. The mortality pattern and immunecompetence of Nicobari, Gaghus, Aseel and layers were evaluated. The total mortality was 6.16%, 9.5%, 0% and 5.2% in Nicobari, Gaghus, Aseel and layer, respectively. The mean ND antibody titers did not differ among four breeds at 0, 14, 28 and 42 d. MDV serotype 1 copies were detected in spleen, feather pulp and lymphocytes at all the 16 time intervals in vaccinated (HVT+SB1 or HVT) and unvaccinated groups of birds under natural field conditions. These findings revealed that the birds in all the groups were exposed to existing MDV-1 circulating in the environment where the birds were housed. Gross and microscopic lesions were more severe in unvaccinated, less severe in HVT vaccinated and mild in HVT+SB1vaccinated birds. Antibody monitoring at 4 weeks interval revealed that by 38 weeks 52% birds were positive for *Mycoplasma galisepticum* (MG) and 100% posistive for *Mycoplasma synoviae (*MS) in PD-3. The major predisposing factors contributing to mortality were multiple age groups and high density. Antibiogram profile indicated that all *E. coli* isolates showed 100% susceptibility to Streptomycin (Aminoglycoside) followed by chloramphenicol (44.4%) and Gentamicin (33.3%). Mesogenic Newcastle disease virus (NDV) strain was characterized and virosome preparation was standardized.

AICRP on Poultry Breeding

The AICRP on Poultry Breeding has been re oriented towards the rural poultry during XII five year plan with three objectives; (1) To develop location specific chicken varieties and their dissemination for village poultry; (2) Conservation, improvement, characterization and application of local native, and elite layer & broiler germplasm and (3) To develop package of practices for village poultry and entrepreneurships in rural, tribal and backward areas. All the centres were working on the development of location specific rural poultry varieties utilizing the local native chicken germplasm in addition to the conservation of elite layer and broiler lines at some centres. During the current year, 12 AICRP centres supplied 5,28,578 germ plasm and an amount of about Rs. 2.02 crores has been generated as receipts by AICRP centres.

The KVASU, Mannuthy centre has evaluated S-0 generation of native chicken germplasm up to 40 weeks of age. Egg production of native chicken germplasm up to 40 weeks of age was 69.83±0.96 eggs with average egg weight of 43.65±0.20 g. The centre has generated an amount of Rs. 39.82 lakhs, which was 101.9% of the total expenditure on feed (Rs. 39.07 lakhs) as revenue. The centre has supplied a total of 35,873 number germplasm during the year. At AAU, Anand, chicks of S-0 generation of native birds and RIR were produced by pedigreed mating. Three way cross was produced with F1 (IWN X Native) XRIR and evaluated. Egg production up to 64 weeks of age was higher in IWN (253.1) than IWP(243.6) strain. The centre has generated revenue of Rs. 20.43 lakhs which was 50.48% of the expenditure on feed cost. Thecentre supplied a total of 44,337 number germplasm during the present year. Bengaluru Centre has initiated purification of indigenous germplasm. The body weight of indigenous germplasm at day old, 8, 12 and 20 weeks of age was 32.20, 470.13, 987.12 and 1311.05 g, respectively. The body weight at 5th week of age increased in PB-1, PB-2 and Control lines over previous generation. The FCR showed marginal improvement in all lines as compared to previous year. The average phenotypic and genetic response of body weight at 5th week over 10 generations in PB-2 was 14.07 and 8.218 g, respectively. A total of 1,17,998 germplasm were supplied to farmers and other stakeholders during the current year. The center generated revenue of Rs. 33.79 lakhs which is 126.66 % of expenditure on feed cost (Rs. 26.67 lakhs). The average body weight of local chicks at day one, 4th and 8th week was 36.68±0.17, 235.88±3.71 and 745.55±10.8g, respectively at Ludhiana. The body weight at 5 weeks of age decreased in both the lines (PB-1 and PB-2) from previous generation. The feed efficiency up to 5 weeks of age decreased in PB-1, PB-2 and Control lines over last generation. The phenotypic and genetic response at 5 week body weight over last 10 generations was 9.03 and 39.61g in PB-2 population.The Centre supplied 33,528 germplasm to the farmers. The center generated a revenue of Rs. 14.67 lakhs. CARI, Izatnagar Centre has regenerated native chicken collected from farmers. The body weight of native birds at day one and 5th week was 32.27±0.62 and 216.44±17.24 g respectively. The body weight at 5th week decreased in CSML, CSFL and Control over last generation. The center supplied 48,787 germplasm to the stakeholders. Bhubaneswar centre completed regeneration of new population of native chicken germplasm.The body weight at 5

weeks of age of CSML and CSFL increased both in CSFL, CSML and Control population in the current generation. FCR up to 5 week of age increased marginally in CSFL but decreased in CSML and Control population over previous generation. The centre generated revenue of Rs 8.2 lakh which is 31.72% of cost incurred on feed. During current year center supplied 38,754 germplasm to the farmers.

Agartala Centre evaluated Tripura black and Dahlem Red up to 72 weeks; ND cross and CSFL populations up to 40 weeks of age. The pullets matured late by 2days in Tripura black and 1 day late in Dahlem Red population. The 72 week egg production was 89.34 eggs in Tripura black and 139.56 eggs in Dahlem Red population. The egg production at 40 and 52 weeks of age was 46.15 and 82.50 eggs in three way cross. The centre supplied 14,193 chicks of Dual purpose (NBD), native (Tripura black) and other crosses. The centre realized overall receipt of Rs.9.54 lakhs which was 35.43% of the expenditure on feed cost.The Jabalpur centre released *Narmadanidhi,* a dual type chicken having 25% Kd: 75% JBP colour inheritance. The pullets of Kadaknath and Jabalpur colour populations matured early by 2 and 4 days, respectively. The hen housed egg production up to 40 weeks of age was 86.20 eggs in JBL and 49.10 eggs in Kadaknath population. *Narmadanidhi,* produced 71 and 142 eggs up to 40 and 52 weeks at farm. It produced 49, 79 and 178.2 eggs, respectively, up to 40, 52 and 72 weeks in field conditions. The germplasm supplied during the year was 58,236. The center realized overall receipt of Rs. 13.16 lakhs which was 50.13% of the expenditure on feed. Guwahati centre evaluated the native, Dahlem Red, PB-2 and BN populations up to 52 weeks of age. Indigenous birds matured late by 2 days and Dahlem Red pullets by one day as compared to previous generation. The hen housed egg production in *Kamrupa* upto 40 and 52 weeks of age was 46.90 and 87.30 eggs in the farm and 41.90 and 71.50 eggs in the field, respectively. The centre supplied 3195 hatching eggs and 20,936 chicks of *Kamrupa* to farmers. The center realized receipt of Rs. 4.53 lakhs during the financial year which is 34.68% of expenditure on feed cost. Ranchi centre evaluated G-4 generation of native population upto 72 weeks of age. Native pullets matured 7 days late as compared to G-4 generation. The annual hen housed egg production of native population was 73.48 eggs in G-4. The hen day egg production up to 72 weeks of age was more in DNB cross (139.82 eggs) than BND cross (126.82 eggs) during E-4 evaluation under farm conditions. Under field conditions, DNB cross (111.13 eggs) produced more eggs than BND cross (96.19 eggs) up to 72 weeks of age. The Centre supplied 8755 hatching eggs and 7020 chicks to the farmers. The center realized a receipt of Rs. 3.68 lakhs during the financial year which is 21.42% of expenditure on feed cost. CSKHPKV, Palampur centre evaluated Native (G-3) and Dahlem Red (G-3) birds upto 52 weeks of age. The pullets of native and Dahlem Red matured early by 6days in this generation. The hen housed egg production up to 52 weeks of age was 83.26, 72.46 and 120.14 eggs in Dahlem Red, native and DRxN populations, respectively. The 20 week body weight was 1602.81g in farm and 1447.76 g in field condition in DNxD cross. The hen housed egg production in DNxD cross was 52.74 eggs in farm and 42.37 eggs in field conditions up to 40 weeks. The centre supplied 26,715 chicks of various crosses to farmers. The center realized receipt of Rs. 12.95 lakhs during the financial year which is 70.97% of expenditure on feed cost. MPUAT, Udaipur evaluated G-4 generation of Native germplasm from 52-72 weeks of age and G-5 generation was regenerated and evaluated up to 52 weeks of age. In Mewari population the juvenile body weights at 8 weeks marginally reduced (651.75g) during G-5 generation. The 20 weeks body weight improved by 245.97g and 40 weeks body weight by 178.53g in G-5 generation. The pullets matured 4.38 days late as compared to previous generation. The hen day egg production upto 52 weeks was 70.58 eggs. A total of 75,604 germplasm were supplied to farmers during the current year. The center realized a receipt of Rs. 11.33 lakhs during the current financial year which is 42.88% of expenditure on feed cost.

Poultry Seed Project

The Poultry Seed Project was evolved with sole aim to increase the availability of rural chicken germplasm in remote areas of the country.

The centres are located at Bihar Agricultural University, Patna; West Bengal University of Animal and Fishery Sciences, Kolkata; Chattisgarh KamadenuViswaVidyalaya, Durg, ICAR Research complex, Nagaland regional centre, Jharnapani; ICAR Research complex, Sikkim regional centre, Gangtok; ICAR Research complex, Manipur regional centre, Imphal. The PSP was strengthened in XII plan by adding centres at TANUVAS, Hosur, ICAR -CCARI, Panaji; ICAR-CIARI, Port Blair; ICAR-IVRI Regional Station, Mukteswar and SKUSAT, Srinagar. ICAR barapani was included as a non funding Centre. The target set for supplying chicks for mainland and north-east centres during the year

2015-16 varies between 0.3 to 1.0 lakhs chicks per annum and to collect feedback on the performance of the germplasm supplied under backyard farm conditions. During the period under report a total of 2,48,097 improved chicken varieties have been distributed in their respective regions/states. A total of 52,408 chicks of *Vanaraja* were distributed to farmers in various parts of West Bengal with revenue generation of Rs. 6.24 lakhs at Kolkata. A total of 53 farmers/NGO/self help groups were benefited by rearing *Vanaraja* birds in West Bengal. The economic viability of *Vanaraja* farming was demonstrated with a net profit of Rs. 3060/- from a flock of 100 birds. At Patna, a total of 31,049 day old chicks and grown up birds were distributed among the farmers in Bihar and an amount of Rs. 7.8 lakhs revenue was generated. Durg centre has supplied a total of 28,976 improved chicken germplasm of *Vanaraja* and *Gramapriya* was distributed to the farmers across Chattisgarh and an amount of Rs. 6.36 lakhs revenue was generated. A total of 39,061 improved chicken germplasm was distributed to 173 farmers in Nagaland and neighbouring states. A total of 14.91 lakh revenue was generated from Jharnapani centre. A total of 53,407 improved chicken germplasm was distributed to farmers across Sikkim and a total 1965 farmers from 406 villages in Sikkim were benefited with the *Vanaraja* farming. This centre generated revenue of Rs. 22.19 lakh and exceeded the target of germplasm supply. At Imphal centre, a total of 9,860 improved rural chicken germplasm was distributed to the farmers in Manipur. Entire flock was liquidated due to Avian Influenza outbreak in 2015. A total of 18, 896 improved rural chicken germplasm was distributed to 193 farmers in Tamil Nadu with an amount of Rs. 3.24 lakhs revenue generation.The civil works is in progress at Goa centre. A total of 3,885 improved rural chicken germplasm was distributed to 135 farmers in Goa. An amount of Rs. 3.47 lakhs revenue was generated. The civil works and procurement of equipment is in progress at Port Blair. A total 939 *Vanaraja* chicks were distributed in Andaman & Nicobar Islands utilizing the old facilities. At Srinagar, the construction of brooder house (1000 sqft) was completed. A total 9616 *Vanaraja* chicks were distributed among 700 farmers in Jammu and Kashmir with a revenue generation of Rs. 2.63 lakhs.

Technology Transferred

During this year, the Directorate has participated in several exhibitions and Kisan melas and propagated the varieties and technologies developed by the Institute. Training was imparted to the farmers and other beneficiaries at the Directorate. *Vanaraja* and *Gramapriya*, the two rural chicken varieties developed by this Directorate reached majority of states in the country. About 76,7871 hatching eggs were supplied to different organizations. A total of 2,28,592 day old chicks of *Vanaraja*, *Gramapriya* and *Krishibro* were supplied to the farmers across the country during the period. The Directorate has supplied 45,771 day old parent chicks of *Gramapriya*, *Vanaraja* and *Krishibro*. The Directorate has been constantly working in partnership mode with related line departments for the benefit of the stakeholders.

Awards and Recognitions

The scientists of this institute have bagged several awards from different Organizations/ Associations/ Societies in recognition of their contribution in the field of poultry research and development.

Other Activities

The Directorate has taken up different activities like organising stakeholders meeting, conducting short courses, training and Scientists-Industry interface meeting which have benefitted the poultry farmers and Industry personnel. The Research Advisory Committee, Institute Research Committee and Institute Management Committee constantly monitored and suggested improvement in research, administration and financial management of the Institute. The budget utilized during the period was Rs. 559.48 lakhs (Plan) and Rs. 932.44 lakhs (Non-Plan) at the Directorate and Rs. 674.00 lakhs and Rs. 540.54 lakhs were utilized by the AICRP and Seed Project, respectively under plan expenditure. The Directorate generated revenue of Rs. 169.90 lakhs during the current year.

1. Introduction

History

The ICAR-Directorate of Poultry Research is one of the premier institutions in the field of poultry science research and extension in the country. This institute was established on 1 March 1988 at Hyderabad, Telangana 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 network 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 was operated from Central Avian Research Institute, Izatnagar till its elevation to the Directorate status in 1988. In addition to this, the activities of the Directorate were expanded by introducing new research programmes in Poultry Nutrition, Housing & Management under separate network programmes in selected SAUs, where the breeding units were already in existence. The research works 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 18 September 2013.

The primary research focus of the Institute has been towards the application of quantitative genetic principles to enhance productivity of various chicken germplasm. To support the core programme of 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/industry 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 or 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, Bengaluru. Further, three dual purpose varieties i.e., *Pratapdhan* (MPUAT, Udaipur), *Kamrupa* (Guwahati) and *Narmadanidhi* (Jabalpur) have been released by AICRP centres. The rural poultry component of AICRP programme has been strengthened with introduction of four new centres, besides the existing two centres for development of location specific crosses for rearing under backyard/ extensive systems. During XI plan the activities of the Directorate 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 country. In the financial year 2014-15 five new centres were added under the Poultry Seed Project in addition to one non funding centre. 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, through research two promising chicken crosses for rural poultry farming 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 new 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 recognized as 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. India is basically an agrarian country where more than 65% 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. Global RPF has been one of the farmer technologies for all livestock of the animal poverty and nutritional security. 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 a small number 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 all 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, 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 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.

- To coordinate and monitor ICAR-sponsored network research programmes
- To undertake applied research on genetics and breeding, and conservation of improved chicken germplasm with supportive research on nutrition, disease control and management
- To lay emphasis on development of chicken varieties to meet the needs of rural/tribal and other under-privileged sections of the society

Organogram

The Directorate is working with different wings and sections with required infrastructure and well devised functionalities. Different committees/disciplines formulated and approved by the Council are guiding the Directorate for efficient and quick functioning of the Institute with greater transparency.

Financial outlay

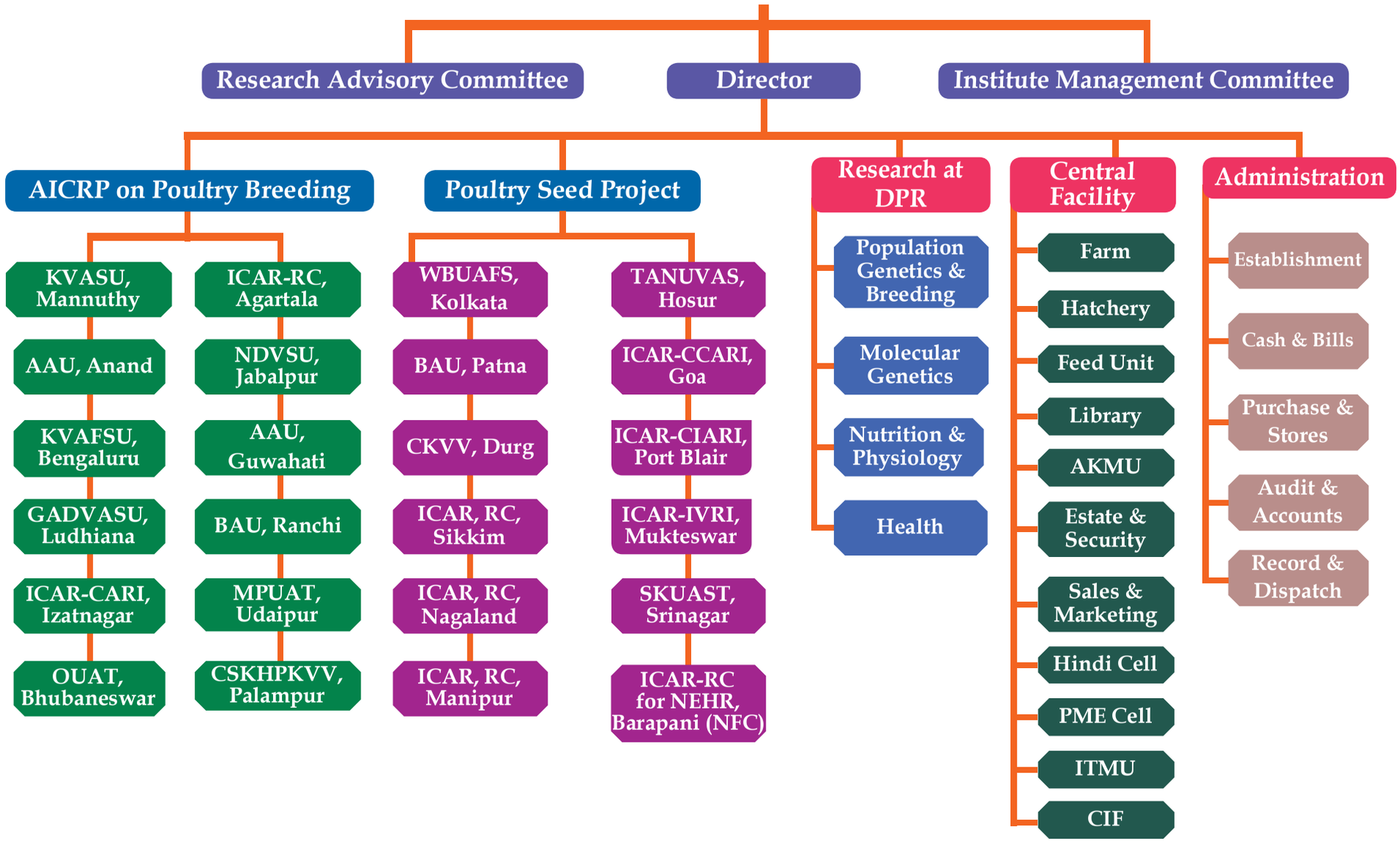
(Rs lakhs)

Component	Plan		Non-Plan		Receipts
	Budget	Expenditure	Budget	Expenditure	
ICAR-DPR	560.00	559.48	933.00	932.44	166.90
AICRP	674.00	674.00	--	--	--
Seed Project	585.00	540.54	--	--	--

Staff position

Cadre	Sanctioned	Cadre in position as on March 31, 2016
RMP	01	01
Scientists	15	18
Technical	16	13
Administrative	14	10
Skilled support	15	14
TOTAL	**61**	**56**

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
CKVV, Durg
ICAR, RC, Sikkim
ICAR, RC, Nagaland
ICAR, RC, Manipur
TANUVAS, Hosur
ICAR-CCARI, Goa
ICAR-CIARI, Port Blair
ICAR-IVRI, Mukteswar
SKUAST, Srinagar
ICAR-RC for NEHR, Barapani (NFC)
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

Poultry Genetics and Breeding

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

Evaluation of PD-1 line

Production performance up to 40 weeks of age was evaluated in PD-1 line in S-9 generation (Table 1). The least square estimates for body weight at 20 and 40 weeks of age were 2207.62± 0.45 and 2939.24± 0.71g, respectively. Body weight increased marginally from the last generation. The estimate for age at sexual maturity (ASM) was 169.62 0.05± days, which decreased significantly from 185 days from the last generation. Estimates for egg production up to 40 weeks of age were 50.25± 0.04 eggs. In S-9 generation, laying period body weight increased, ASM decreased and egg production decreased by 2 eggs compared to last generation. Egg weight at 28, 32, 36 and 40 weeks of age was 49.81±0.001, 51.99± 0.007, 53.89±0.008 and 55.30±0.008 g, respectively. The egg weight at 40 weeks increased in the present generation. Heritability estimates were low to moderate in magnitude for different traits

PD-1 line was regenerated in pedigreed mating with 50 sires and 250 dams in three hatches during S-10 generation. Rural control and Vanaraja, a terminal cross hatch was taken along with second hatch for comparison. A total of 3248 chicks were produced in S-10 generation. The fertility and hatchability on FES and TES were 90.19 and 90.04 and 81.22 percent respectively.

Table 1 Production performance of PD1 line (S-9)

Traits	*Means*	$h^2_{(S+D)}$
ASM (days)	169.62 ±0.05	0.44±0.17
Body wt. (g)		
20 wks	2207.62± 0.45	0.30±0.16
40 wks	2939.24± 0.71	--
Shank length (mm)		
20 wks	108.99±0.09	--
40 wks	111.01±0.08	--
Egg wt. (g)		
28 wks	49.81±0.001	
32 wks	51.99± 0.007	
36 wks	53.89±0.008	
40 wks	55.30±0.008	0.19±0.11
Egg prodn.		
40 wks	50.25± 0.04	0.10±0.15

Table 2. Body weights at different ages

Parameters	Body weight (g)	Shank length (mm)
Day old	37.74±0.001	
2 wks	146.27±0.07	
4 wks	364.92±0.02	60.96±0.001
6 wks	701.73±0.02	77.88±0.002

PD-1 population was evaluated for juvenile traits in S-10 generation. The least squares means for body weight at 4 and 6 weeks of age in PD-1 was 364.93±0.02 and 701.94±0.04 g, respectively (Table 2). The corresponding shank length at 4 and 6 week (the primary trait) was 60.96±0.003 and 77.88±0.002 mm, respectively which decreased from last generation. The heritability of 6 week body weight and shank length was 0.20 and 0.25, respectively (Table 3). 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 (Table 4).

FCR in PD-1 line

A pilot study was carried out to estimate FCR and its genetic parameters on sire family basis. About 600 representing 30 sires with four replicates were reared battery brooder cages from 4th to 6 week and feed intake and body weights were measured. The FI was 908.29±7.5 g/bird and FCR was 2.25±0.005. The FI and FCR were significantly (P≤0.05) varied among the sires. The heritability for FCR was 0.76±0.38 on half sib basis.

A pair of PD-1 birds

Table 3 Heritability estimates in PD-1

Parameter	Sire (h^2_S)	Dam (h^2_D)	Sire+Dam (h^2_{S+D})
Body wt. (g)			
Day old	0.22±0.14	--	--
2 wks	0.08 ±0.04	0.34 ±0.06	0.21 ±0.04
4 wks	0.17 ±0.05	0.25 ±0.05	0.20 ±0.04
6 wks	0.18 ±0.05	0.28 ±0.05	0.20 ±0.05
Shank length (mm)			
4 wks	0.21 ±0.06	0.20±0.05	0.20±0.04
6 wks	0.25±0.07	0.27±0.06	0.25±0.06

Table 4. Correlation co efficient for juvenile traits

	0 BW	2 BW	4 SL	4 BW	6 SL	6 BW
0 BW	*	0.58	0.29	0.25	0.22	0.36
2 BW	0.21	*	0.58	0.89	0.47	0.64
4 SL	0.11	0.56	*	0.79	0.95	0.76
4 BW	0.12	0.57	0.79	*	0.81	0.90
6 SL	0.11	0.46	0.72	0.71	*	0.83
6 BW	0.16	0.50	0.66	0.76	0.83	*

Evaluation of PD-6 (GML)

The juvenile traits from day old to 6 weeks of age were studied utilizing data on 3272 chicks from three hatches. The least squares means for body weight at 4 and 6 weeks of age was 367.29±0.01 and 705.21±0.08 g in PD-6 chicken (Table 5). The corresponding shank length was 60.62±0.001 and 78.91±0.002 mm, respectively. The shank length increased considerably by about 4 mm compared to last generation. The heritability estimates were moderate to high for all the traits indicating the scope for further improvement. The h^2 estimate for shank length at 6 weeks of age was 0.20±0.09 (Table 6). The body weight and shank length were positively correlated with high correlation co efficient (Table 7).

The selected population was evaluated for production traits up to 52 weeks of age. The least squares means for production parameters are presented in Table 8. The ASM was 164.91 ±0.02 days. The least squares means for body weight at 20 and 40 weeks was 1897.62± 0.69 and 2666.67± 0.62 g, respectively. The shank length at 20 weeks of age was 109.23±0.07 mm. The targeted body weight at 20 weeks is maintained below 2100 g for better egg production during the laying phase as per the standard. The egg weights at 28, 32, 36, 40 and 52 weeks were 49.10±0.007, 50.23± 0.003, 53. 23±0.002, 55.49 ±0.002 and 58.65±0.001 g respectively. The egg weight improved marginally compared to previous generation. The part period egg production at 40 and 52 weeks of age was 78.02± 0.04 and 128.96±0.08 eggs. The heritability estimates for production traits were low to high from sire & dam components variance. Body weights and egg weights

A pair of PD-6 birds

are positively correlated while body weights and egg production is negatively correlated. Heavier birds layed less number of eggs but heavier eggs.

Table 5 Juvenile traits at different weeks in PD-6 (SL-5)

Parameter	Body weight (g)	Shank length (mm)
Day old	37.70±0.009	
2 wks	141.98±0.06	
4 wks	367.29±0.01	60.62±0.001
6 wks	705.21±0.08	78.91±0.002

Table 6 Heritability estimates in PD-6 (SL-5)

Parameter	Sire (h^2_S)	Dam (h^2_D)	Sire+Dam (h^2_{S+D})
Body wt (g)			
2 wks	0.29 ±0.08	0.33 ±0.06	0.31 ±0.12
4 wks	0.27 ±0.07	0.25 ±0.05	0.26 ±0.09
6 wks	0.30 ±0.08	0.24 ±0.05	0.27 ±0.09
Shank length (mm)			
4 wks	0.32 ±0.09	0.19±0.05	0.25±0.10
6 wks	0.29±0.07	0.12±0.04	0.20±0.09

Table 7. Correlation co-efficients for juvenile traits

	0BW	2BW	4BW	6BW	4SL	6SL
0BW	*	0.40	0.35	0.28	0.29	0.25
2 BW	0.19	*	0.89	0.68	0.76	0.67
4 BW	0.15	0.66	*	0.91	0.79	0.71
6 BW	0.11	0.51	0.30	*	0.77	0.79
4 SL	0.11	0.59	0.69	0.75	*	0.93
6 SL	0.09	0.50	0.75	0.81	0.85	*

Table 8 Production performance of PD-6 (SL-5)

Traits	Means	h2(S+D)
ASM (days)	164.91 0.02±	0.27±0.15
Body wt. (g)		
20 wks	1897.62± 0.69	--
40 wks	2666.67± 0.62	0.28±0.16
Shank length (mm)		
20 wks	109.23±0.07	--
Egg wt. (g)		
28 wks	49.10±0.007	0.46±0.19
32 wks	50.23± 0.003	
36 wks	53.23±0.002	
40 wks	55.49±0.002	0.28±0.18
Egg prodn		
40 wks	78.02± 0.04	0.13±0.15
52 wks	128.96±0.08	--

PD-6 chicken was regenerated in pedigreed mating with 50 sires and 250 dams in three hatches during S-6 generation. A total of 3336 chicks were produced in S-6 generation. The fertility and hatchability on FES and TES were 87.25 and 93.18 and 81.30 percent respectively.

Improvement of PD-2 line

PD-2 line is synthetic female line used for production of Vanaraja chicks. S-13 generation was reproduced utilizing 50 sires and 250 dams selected based on Osborne Index for 52 week egg mass. The fertility was 75.45% and hatchability on total and fertile eggs set was 66.77 and 88.49% respectively. The body weight at 2, 4 and 6 weeks of age was 102.81, 257.24 and 471.31g respectively. The shank length, keel length and breast angle was 66.95 mm, 72.49 mm and 75.38°, respectively. In rural control body weight at 2, 4 and 6 weeks of age was 90.15, 299.55 and 480.80g respectively. The juvenile body weight is showing decreasing trend over generations in PD-2 line due to selection for part period egg production.

Among production traits the body weight at 20 weeks was 1930.17±0.21, age at sexual maturity was 161.59±0.02 days and egg weight was 46.57±0.05g.

A pair of PD-2 birds

Improvement of PD-3 line

PD-3 line is used as a female line for production of coloured germ plasm for free range farming. The criteria of selection were part period egg mass upto 40 weeks of age. The egg production and egg mass up to 40 weeks of age was 74.950.02± eggs and 4018.07±1.98g Dahlem Red population (Table 9). Corresponding values for Dahlem Red control population was 67.56±0.05 eggs and 3532.20±4.35g, respectively. The phenotypic response for part period egg mass upto 40 weeks of age was 210g per generation over last five generations. The genetic response was 65.8 g per generation. Regeneration of G-5 generation was completed utilizing 200 dams and 50 sires selected for part period egg mass to 40 weeks of age based on Osborne index. Around 2346 chicks were produced in 4 hatches.

Table 9 Means of production traits in PD-3 line (G-4)

Traits	Selected (n=524)	Control (n=97)	h^2_{S+D}
ASM (days)	165.95 ± 0.04	172.88±0.06	0.07±0.08
Body wt (g)			
20 wks	1339.14±0.53	1336.38±0.73	0.21±0.13
40 wks	1697.96±0.46	1598.20±0.74	0.61±0.13
Egg wt (g)			
28 wks	49.64±0.02	47.35±0.01	0.23±0.12
32 wks	50.23±0.01	50.12±0.01	0.21±0.16
40 wks	54.49±0.05	52.30±0.02	0.31±0.20
Egg Prodn. (no.)			
40 wks	72.73±0.04	67.56±0.05	0.14±0.07
Egg Mass (g)			
40 wks	3960.98±3.89 (3923.23±3.16)	3532.30±4.35	0.16±0.09

Value in the parenthesis indicates last generation mean

A pair of PD-3 birds

Maintenance and evaluation of native chicken germplasm

Conservation and evaluation of Aseel

A total of 436 good chicks were produced in third generation. The fertility was 69.86 %, and hatchability on total egg set was low (54.29%) while on fertile egg set it was 77.71%. The mortality recorded during third generation was 30 percent. The breed was also evaluated for growth traits up to 12 weeks of age in G-3 generation. The body weight at 0 day, 4, 6, 8, 12 and 16 weeks was 28.82, 151.40, 313.69, 504.68, 857.32 and 1312.24 g, respectively. The corresponding shank lengths were 44.73, 60.63, 72.34, 81.97, 97.80 and 110.854 mm, respectively. The ASM was 214.13 ±5.92 days. The egg production up to 64 and 72 weeks of age was 47.44±4.14 (64 birds) and 64.47 ±6.27 eggs (46 birds) during the G2 generation. The egg production at 40 and 52 weeks of age was 18.2 ± 1.24 (88 birds) and 30.07±1.99 (76 birds) eggs. The egg weight at 40 weeks of age was 40.27±0.42 g. Broodiness was observed in all the hens with an average pause period of 62.30 days spreading across 4 pause periods in 72 weeks of laying cycle.

Morphology and physical characteristics

A total of 236 Aseel birds (2nd generation) were characterized for physical and morphological parameters with standard procedures. Birds are characterized by multi coloured plumage (predominantly dark brown, black, golden etc.) with solid feather pattern and normal distribution. The long glossy tail feathers add to the beauty of the bird. The birds are characterized by pea comb (98%) with dark

Aseel variants available at DPR

red colour (82%). The small size comb is predominant (64%). Ear lobes were red (92%). The shank colour was yellow in majority (65%) of the birds followed by black (19%) and white (16%). Spur was observed in majority of the cocks with varying sizes (96%).

Evaluation of PD-4

PD-4 (S-6) birds were evaluated up to 40 weeks of age. Means along with their heritability estimates determined on sire component of variance for growth traits on pooled sex up to 14 weeks of age is presented in Table 10. In this generation, there was an improvement of 12 g in body weight (Primary trait) and 1.33 mm in shank length at 8 weeks of age on pooled sex. Heritability estimates determined on sire component of variance for body weight at 0 day, 4 and 8 weeks of age were higher in magnitude indicating presence of adequate additive genetic variation and these findings show that this variety could continue to be improved for body weight at 8 weeks of age being the primary trait of selection. Positive and high genetic (0.93±0.05) and phenotypic (0.85) correlations between body weight and shank length at 8 weeks of age were observed. Sex wise body weight and shank length recorded at 20 and 40 weeks of age (Table 11). Egg production traits Survivors' egg production up to 40 weeks of age improved by 2.81 eggs to 62.54±1.39 in S-6 generation as compared to previous generation. There was an improvement of 1.7 g in 40 weeks egg weight as well (Table 12).

Fifty males and one hundred and fifty female birds tested negative for ALV shedding were used for regeneration. However, only 125 dams contributed to the next generation. Males were selected for higher body weight at 8 weeks of age while female birds were further selected for higher egg production up to 40 weeks of age besides body weight at 8 weeks of age. Effective population size was 142.9 days, rate of inbreeding was 0.0035 and selection differential was 49.57 g for 8 week body weight.

Table 10 Means and estimates of heritability of growth traits of PD-4 birds on pooled sex

Traits	N	Mean±S.E.	$h^2_{(Sire)}$
Body weight (g)			
0 day	1065	32.9 ± 0.09	0.77±0.24
4 wks	1043	175.9 ± 1.1	0.26±0.12
8 wks	993	473.4±2.58	0.33±0.12
14 wks	867	917 ± 5.12	0.25±0.11
Shank length (mm)			
8 wks	993	74.74±0.17	0.36±0.12

Table 11 Means of growth traits of female and male PD-4 birds

Traits	Female	Male
Body weight (g)		
20 wks	1387±6.59	1928±10.9
40 wks	1956±15.19	2929±18.4
Shank length (mm)		
20 wks	104.4±0.24	128.7±0.39
40 wks	105.5±0.24	131.3±0.44

Table 12 Production traits in PD-4 birds

Trait	Mean
Age at fist egg in the flock (d)	144
Age at sexual maturity (d)	168.3±0.81
Egg Production (Nos.)	
EP 40 wks	62.54±1.39
HHEP 40 wks	60.71
HDEP 40 wks	59.71
Egg weight (g)	
28 wks	42.62±0.25
32 wks	45.14±0.26
36 wks	47.39±0.25
40 wks	49.30±0.27

A pair of PD-4 birds

Characterization of Ghagus breed (G-3)

Ghagus birds (G-3) were evaluated for growth and production traits from 24 to 40 weeks of age. Female and male birds of Ghagus were selected for uniform plumage and comb patterns and housed respectively in layer and grower cage house for recording growth and production performance. Average body weights and shank lengths of male birds recorded at 40 weeks of age were 2780 ± 47.0 g and 130.4 ± 0.77 mm respectively. Production traits recorded in G-3 generation are presented in Table 13. However, low egg production is still less in this breed due to incidence of higher broodiness during peak egg production period. Average weekly broodiness observed in the flock was 36.4% and 54.9 during 27 and 38 weeks of age respectively with peak broodiness of 59.8% observed during 36 weeks of age.

Table 13 Production traits in G-3 generation in Ghagus breed

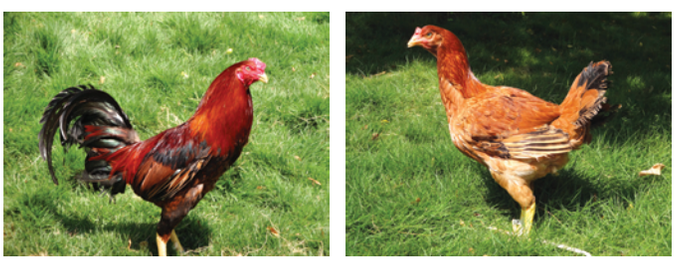
Traits	Mean ± S.E.
Age at first egg in the flock (d)	139
ASM (d)	161.4 ± 1.13
Egg production (Nos.)	
EP 40 wks	33.71 ± 1.77
HDEP 40 wks	31.42
Body weight (g)	
40 wks	1754 ± 25.8
Shank length (mm)	
40 wks	102.5 ± 0.68
Egg weight (g)	
28 wks	41.91 **± 0.59**
32 wks	43.55 ± 0.51
36 wks	45.78 ± 0.48
40 wks	46.66 ± 0.48

G-4 generation

Performance evaluation of G-4 generation birds was completed up to 20 weeks of age during the reporting period. Growth traits recorded on pooled sex up to 8 weeks of age are presented in Table 14. Heritability estimates for the juvenile growth traits were on higher side indicating that there is a scope for improvement of this breed for growth traits. Genetic (0.98±0.01) and phenotypic (0.904) correlations between body weight and shank length recorded at 8 weeks of age were positive and on higher side. Body weight recorded at 20 weeks of age in male and female birds was 1809±20.6 and 1320±11.32 g respectively while shank length of corresponding sex was 127.5±0.58 and 103.1±0.38 mm respectively.

Table 14 Growth traits of Ghagus breed in G-4 generation on pooled sex

Traits	Mean ± S.E.	$h^2_{(Sire+Dam)}$
Body weight (g)		
0 day	30.3 ± 0.12	-
4 wks	151.6 ± 1.58	0.54±0.10
8 wks	401.5±0.18	0.51±0.16
Shank length (mm)		
8 wks	67.39±1.33	0.47±0.15



A pair of Ghagus birds

G-4 generation of Ghagus birds was produced in two hatches by pedigree mating (50 sires and 150 dams). A total of 825 good chicks were hatched and housed in this generation. Fertility recorded was 92.29% while hatchability on fertile and total egg set was 90.58 and 83.60% respectively. Better fertility and hatchability continued to be observed in this breed even with pedigree mating and they have improved over previous generation.

Maintenance of Nicobari breed

Nicobari breed (Brown and Black) was regenerated (G-3) using pooled semen. Overall fertility was 77.57% while hatchability on fertile and total egg set was 87.25 and 67.68% respectively. A total of 230 and 120 good chicks of brown and black Nicobari breed were produced in a single hatch, respectively. No significant differences were observed between brown and black Nicobari birds in body weight and shank length (Table 15). Mortality during 0-8, 9-20 and 0-20 weeks of age in brown Nicobari birds was 3.04, 15.25 and 17.83% respectively while that in black Nicobari birds was 3.33, 11.21 and 14.17% respectively in corresponding period.

Table 15 Growth performance of Nicobari birds (Mean ±S.E.) in G-3 generation

Traits	Brown	Black
Body weight (g)		
0 day	33.1 ± 0.19	27.79 ± 0.24
4 wks	140.2 ± 2.4	154.03 ± 4.2
8 wks	386 ± 8.61	389 ± 12.1
20 wks (F)	1102 ± 25.7	1110 ± 27.2
20 wks (M)	1527 ± 31.1	1536 ± 37.9
Shank length (mm)		
8 wks	56.96 ± 0.75	56.32 ± 0.89
20 wks (F)	79.53 ± 1.24	79.53 ± 1.24
20 wks (M)	99.30 ± 1.52	96.81 ± 2.17

A pair of Nicobari birds

Evaluation of crosses under farm and field conditions

Evaluation of two-way and three-way cross under farm and field conditions wass carriedout. A total of 80 day old chicks and 200 grown up chicks were distributed to the farmers in two adopted villages, i.e., Bavoji Thanda and Korravani Thanda. The body weight at 4 and 6 weeks of age was 320.36± 3.53 and 578.89± 6.21 in 2-way and 291.81± 3.44 and 500.01± 6.01 g in 3-way cross, respectively under farm conditions (Table 16). The shank length at 6 weeks of age was 75.68± 0.32 and 70.95± 0.31 mm in 2 and 3 way crosses, respectively. The body weight and shank length from field (Bavoji Thanda) at this age was 228. 26 g and 51.90 mm in 2 way and 246.75 g and 51.84 mm in 3 way cross, respectively. The 20 week body weight in 2 and 3 way and crosses was 1960.84 and 1643.87 g, in farm conditions while in field condition for 2 way cross it was 1712.42 and 1765.40 g and for 3 way cross it was 1652.84 and 1305.23 at Bavoji Thanda and Korravani Thanda, respectively. Further data generation is in progress

Table 16 Juvenile performance of 2 way and 3 way crosses under farm condition

Traits	2-way cross	3-way cross	Prob.
Body weight (g)			
0 day	32.54±0.24	31.96±0.24	0.086
2 wks	117.89±1.34	115.80±1.31	0.265
4 wks	320.36±3.53	291.81±3.44	0.000
6 wks	578.89±6.21	500.01±6.01	0.000
Shank length (mm)			
4 wks	58.04±0.29	55.96±0.28	0.000
6 wks	75.68±0.32	70.95±0.31	0.000

Adults birds of 2 way cross at Bavoji Thanda

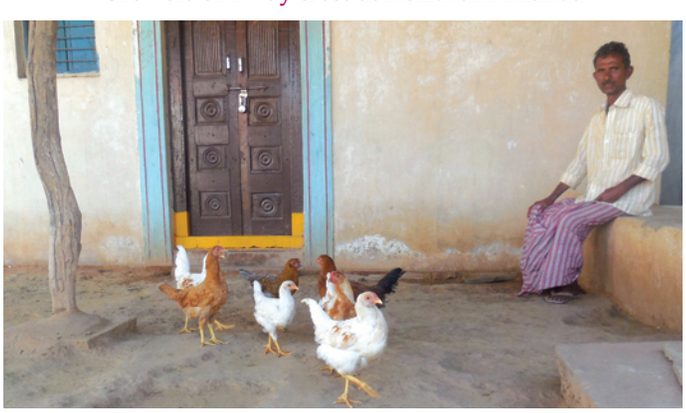
Slaughter parameters

The cocks of 2 way and 3 way crosses we sacrificed and slaughter parameters were studied at 14 weeks of age. Live weight and dressing percentage was significantly higher in 2 way cross (Table 17). Cut up parts were similar in both except for leg proportion which was significantly higher in 2 way cross. Gizzard was significantly higher in 3 ways cross. Abdominal fat very low (less than 1%) in both the cross which was desirable.

Table 17 Slaughter parameters expressed as percentage of live weight in cocks of crosses

Parameters	2-way cross	3-way cross	SEM	Prob.
Live weight, g	1987.80	1496.00	47.30	0.000
Dressing Percentage, %	68.51	66.21	2.82	0.009
Cut up parts				
Breast	16.20	15.73	0.18	0.196
Legs	21.90	20.09	0.23	0.043
Wings	10.01	9.48	0.15	0.824
Back	20.40	20.10	0.23	0.824
Giblets				
Heart	0.45	0.44	0.012	0.708
liver	1.92	2.10	0.044	0.043
Gizzard	1.78	2.30	0.063	0.000
Abdominal fat	0.50	0.75	0.084	0.166
Offals				
Blood	3.78	3.90	0.23	0.785
Head	3.81	4.38	0.08	0.000
Feather	4.23	6.39	0.39	0.005
Bursa	0.10	0.11	0.010	0.362
Spleen	0.18	0.19	0.008	0.878

Growers of 2 way cross at Korravani Thanda



Growers of 3 way cross at Korravani Thanda

Maintenance and evaluation of coloured broilers

Coloured Broiler Male Line (PB-1)

During the period under report S-25 Generation of PB-1 was regenerated with 70 Sires and 349 Dams and a total of 2865 Chicks were produced. Fertility, hatchability percent on total eggs set and fertile eggs set were 83.12. 72.26 and 87.06 respectively. Dead in shell and weakling percentage were 10.35 was 2.23 respectively. As compared to last generation fertility was decreased and hatchability remained similar. Intensity of selection was 1.38 while expected response in 5 week body weight was 69 g. Rate of inbreeding calculated was 0.0042 (Table 18).

Table 18 Summary of Selection Records of PB-1 (S-25)

Particulars	Magnitude
No of sires	70
No of Dams	350
No of sires contributed	70
No of dams contributed	350
Effective number	116.66
Rate of inbreeding	0.0042
Average selection differential (5 wks bwt), g	160
Intensity of selection	1.38
Expected response (5 wks bwt), g	69

Table 19 Juvenile Traits Performance of PB-1 (S-25)

Traits	Mean±S.E(S-24)	Mean±S.E(S-25)
Body weight (g)		
4 wks	621±0.62	620±0.53
5 wks	926±0.67	976±0.71
6 wks	1190±0.51	1201±0.63
Shank length (mm)		
5 wks	73.27±0.09	73.41±0.08
Breast angle (Degrees)		
5 wks	83.80±0.08	82.28±0.07

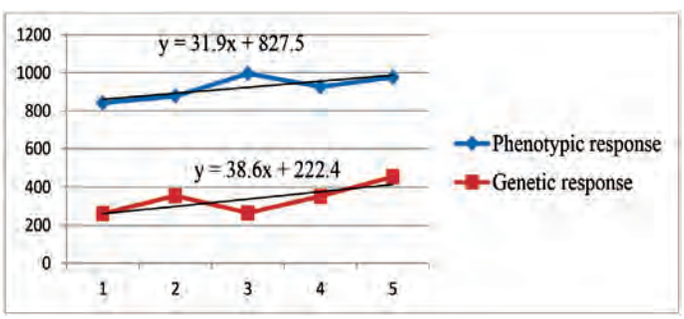


Fig. 1 Genetic and phenotypic response for body weights inPB-1

As compared to last generation some of the traits are marginally decreased. Genetic response in 5 week body weight was 38.6g. Phenotypic response was 31.9 g.

Body weight at 20 weeks increased, ASM decreased and egg production decreased in PB-1 during S-25 generation (Table 20).

Table 20 Production Performance of PB-1 (S-25)

Trait		Mean (S-24)	Mean (S-25)
Body weight (g)			
	20 wks	2444±0.72	2518±1.20
	40 wks	3555±0.90	3360±1.30
Age at sexual maturity (days)		160.14±0.04	156.5±0.20
Egg weight (g)			
	32 wks	54.72±0.03	54.90±0.04
	40 wks	58.78±0.06	61.72±0.10
Egg Production	40 wks	60.15±0.08	55.03±0.09

A pair of PB-1 birds

Coloured Broiler Female line (PB-2)

PB-2 line was evaluated for production parameters in S-24 generation (Table 21) The average ASM has increased by eight days compared to the last generation (162.60±0.57days). The egg weight at 40 weeks increased by one gram compared to the last generation. The egg production at 40 weeks reduced by four eggs compared to last generation. The phenotypic and genetic response to selection for the 40 week part period egg production over the last 10 generations was 0.73 and 1.49 egg per generation, respectively (Fig. 2). The layer house mortality up to 40 weeks of age was 30.8% with a range of 21% to 34% among the four hatches.

PB-2 was regenerated with 60 sires and 300 dams in pedigreed mating in S-25 generation. A total of 4306 eggs were set out of which 2629 healthy chicks were obtained in three hatches. The average percent fertility, hatchability on TES and FES were 72.06, 61.05 and 84.72 %, respectively. The selection differential for 5 week body weight was 126 g on combined sex basis with 0.78 σ intensity of selection.

The effective population size was 200 and the level of inbreeding was 0.003. The fitness traits reduced in the present generation compared to the last generation.

Table 21 Production performance in PB-2

Trait		S-24
Age at sexual maturity (d)		170.87±1.83
Body weight (g)	40 wks	3328.22±26.91
Egg production (no.)		
	32 wks	34.30±0.67
	40 wks	67.26±0.83
Egg weight (g)		
	28 wks	49.75±0.21 g
	32 wks	54.33±0.26 g
	40 wks	58.47±0.44 g

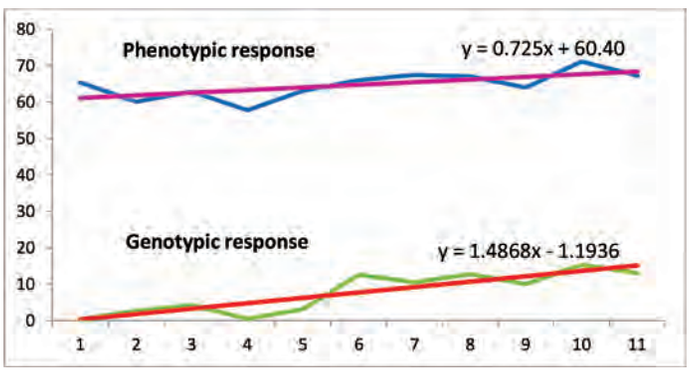


Fig. 2 Phenotypic and genetic response of 40 week egg production in PB-2 over last ten generations

The juvenile conformational traits were recorded in all the chicks. The least square means for day old, two and four weeks body weight was 41.02±0.08, 200.01±0.64, and 557.44±2.47 g, respectively. The body weight, shank length and breast angle at five weeks was 770.14±3.57g, 74.14±0.14mm and 79.41±0.11°, respectively. The five week body weight decreased by 217g compared to last generation. The overall mortality up to 5 weeks of age was 7.61% which was higher than last generation (4.36%). The phenotypic and genetic response to selection for the five week body weight over the last seven generations was 12.36 and 20.46 grams per generation, respectively (Fig. 3).

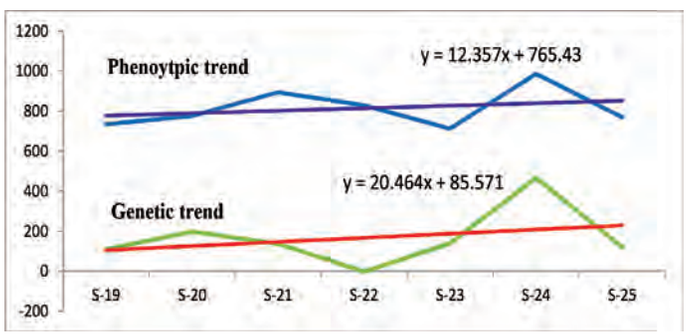


Fig. 3 Phenotypic and genetic response of 5 week body weight in PB-2 over last six generations

A pair of PB-2 birds

In order to analyse the polymorphism in growth related genes in PB-2, blood samples (n=3079) were collected from young birds of 2-3 weeks of age from S-24 generation and genomic DNA isolated, concentration, purity and integrity checked. PCR amplification of the candidate genes viz., IGF-I, apoVLDL-II, GH and MSTN were carriedout.

Control Broiler

Control broiler was regenerated (G-14) with 50 Sires and 250 Dams. Fertility, hatchability percent on total eggs set and fertile eggs set were 62.67 54.81 and 87.46 respectively. Fertility and Hatchability on total eggs set were decreased in the present generation due to summer stress as compared to previous generation. Juvenile traits performance of control broiler is presented in Table 22.

Table 22 Performance of Juvenile Traits of Control Broiler (G-14)

Trait		Mean(G-13)	Mean(G-14)
Body weight (g)			
	4 wks	333	320
	5 wks	573	520
	6 wks	993	663
Shank length (mm)	5 wks	69.16	64.78
Breast angle (^{0})	5 wks	75.67	75.14

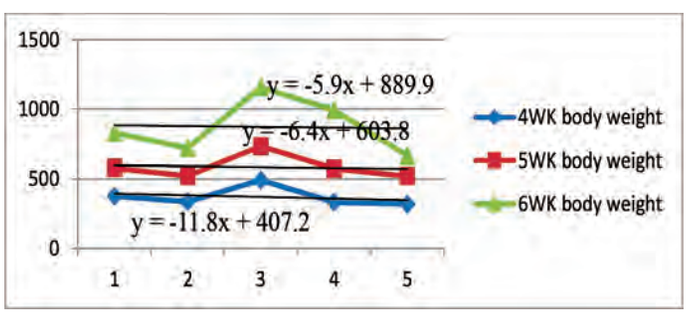


Fig. 4 Time trend of Juvenile body weights in control broiler

Production traits of control broiler

When compared to last generation age at sexual maturity (ASM) was decreased by 0.4 days. Body weight at 20 weeks body weight was increased by 126 g while at 40 weeks it was increased by 118 g (Table 23). At 32 weeks of age the egg weight was increased by 1.54 g. Egg production and egg weight at 40 weeks of age was more or less similar to previous generation.

Table 23 Production traits of control broiler

Trait	Mean (G-13)	Mean (G-14)
Bodyweight (g)	2279±0.89	2405±1.06
20 wks	2279±0.89	2405±1.06
40 wks	3033±0.93	3151±1.20
Age at sexual maturity (d)	174±0.09	173.6±0.08
Egg Weight (g)		
32 wks	50.96±0.04	52.50±0.06
40 wks	55.80±0.01	56.20±0.08
Egg production 40 wks	55.82±0.09	56.59±0.10

Maintenance of gene lines

Naked neck (Na) and Dwarf (Dw) gene lines

The gene lines were evaluated for their juvenile growth and production traits in the S-13 generation. The gene lines were regenerated using 19 sires and 57 dams in naked neck and 20 sires and 60 dams in the dwarf population. A total of 410 naked neck chicks and 640 dwarf chicks were produced. The average percent fertility, hatchability on TES and FES were 82.3, 79.7 and 89.6, respectively, in the naked neck line while the corresponding parameters in the dwarf line was 78.6, 65.6 and 70.4, respectively. The fitness traits improved in both the gene lines compared to their last generation. The 6 week body weight increased by 103 g in the naked neck line compared to last generation while it reduced by 29 g in the dwarf line compared to its last generation (Table 24).

The production traits of the naked neck and dwarf gene lines in their S-13 generation are given in the table below. The ASM decreased by two and seven days in NN and DW line, respectively compared to their last generation. The egg weights increased in both the gene lines compared to their previous generation. The 40 week egg production remained stable in naked neck while it reduced b three eggs in the Dwarf gene line.

Table 24 Juvenile and production performance in gene lines

Trait	Naked Neck (S-13)	Dwarf (S-13)
Body weight (g)		
0 day	41.63±0.81	40.04±0.42
2 wks	258.46±3.21	211.72±2.93
6 wks	852.57±6.52	653.40±6.55
20 wks	2417.36±24.32	2096.24±23.32
Shank lentgh (mm)		
6 wks	86.09±0.39 mm	74.61±0.36
Breast Angle (°)		
6 wks	80.21±0.34	82.70±0.39
ASM (days)	159.26±2.88	140.21**±1.**54
Egg weight (g)		
32 wks	56.27**±0.6**7	50.12**±0.**49
40 wks	58.92**±0.5**2	56.21**±0.6**8
Egg Production (No.)		
32 wks	42.51**±2.**02	47.22**±1.**51
40 wks	66.73**±2.**32	72.84**±2.**72

Maintenance and evaluation of layer populations

Three layer chicken lines (IWH, IWI, and IWK) along with the layer control lines were maintained and evaluated for economic trades. During the current year two more lines IWD and IWF were added from AICRP, Hyderabad centre.

Production performances of IWH and IWI for S-3 generation and IWK and Layer Control (LC) for S-11 were recorded. The average egg production up to 64 weeks (EP64) in IWH, IWI, IWK and Layer control were 254.34±1.34, 235.12±1.64, 227.80±1.47 and 223.24±1.67, respectively. Whereas, the egg production up to 72 weeks (EP72) in respective lines was 291.56±1.59, 261.35±2.34, 260.03±1.80 and 257.52±2.14 eggs, respectively. The EP64 improved in IWH, IWI and CL but decreased in IWK lines over previous generation. EP72 improved in case of IWH and LC but decreased in IWI and IWK. Egg weight at 64 weeks (EW64) of age in IWH, IWI, IWK and LC were 52.15±0.24, 51.76±0.23, 55.21±0.22 and 53.39±0.25g, respectively. Similarly the egg weights of IWH, IWI, IWK and LC at 72 weeks were 53.61±0.25, 53.49±0.30, 56.91±0.27 and 54.24±0.32g, respectively. EW64 decreased across four lines in the current generation as compared to previous generation. The phenotypic response of selection for EP64 was 22.45, 14.08 and 7.14 eggs in IWH, IWI and

IWK, respectively. The genetic responses of selection at EP64 in respective genetic groups were 8.03,-0.34 and 2.048 eggs.

During current year S-4 generation of IWH, IWI and S-12 generation IWK, Control layer populations were regenerated. The average selection differential of the parents at EP64 was 9.37, 9.29 and 9.86 eggs in IWH, IWI and IWK, respectively. The selection intensity of dams in the respective groups was 0.44, 0.38 and 0.58, respectively. The number of chicks regenerated in IWH, IWI, IWK and LC were 1375, 1180, 1785 and 1117, respectively. The Fertility percent in IWH, IWI, IWK and LC were 76, 73, 78 and 62%, respectively. The hatchability percent on total egg set basis was 57, 58, 67 and 53 % in IWH, IWI, IWK and LC, respectively. However, hatchability percent on fertile egg set basis in respective lines was 75, 79, 84 and 85 %, respectively. The body weight of day old chicks in IWH, IWI, IWK and LC was 32.56±0.13, 33.41±0.1, 36.41±0.15 and 36.55±0.11g, respectively. Corresponding values of respective lines at 8th week was 469.92±2.64, 550±4.23, 531.08±2.47 and 482.10±3.42g. Regeneration of IWD and IWF layers lines through random breeding was initiated.

Molecular Genetics

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

Polymorphism at promoter of Bone morphogenetic protein 3 (BMP3) and Bone morphogenetic protein 4 (BMP4) genes and their association with growth traits: The 786 bp promoter of BMP3 and 1123 bp promoter of BMP4 genes were analysed in control broiler (CB) and control layer (CL) chicken to determine polymorphism in the promoters. A total of 446 birds of CB line and 489 birds of control layer line were studied where 3 haplogroups were observed in BMP3 gene promoter. The h1h2 was the most predominant haplogroup and h1h1 was the least frequent one. Accordingly, three haplotypes were observed in these lines, in which h1 was the most predominant haplotype and h3 was the least frequent haplotype in both the lines. The comparison of nucleotide sequences of h1, h2 and h3 haplotypes revealed that there were nucleotide substitutions at 5 places at 24th, 142nd, 308th, 414th and 765th position of the promoter. At 24th position, the nucleotide was G>G>C in h1, h2 and h3 haplotypes. Subsequently, at 142nd, 308th, 414th and 765th position, the nucleotide substitutions were G>G>C, C>T>C, C>C>G and T>T>C in h1, h2 and h3 haplotypes, respectively.

In BMP4 promoter, three haplogroups have been observed of which h1h1 was the most frequent in CB line and h1h2 was the most frequent in CL line. The least frequent haplogroup was h1h3 in both the lines. Accordingly, three haplotypes were found in these lines. The h1 haplotype was the most predominant with the frequency of 0.71 in CB and 0.66 in CL lines while h3 was the least frequent in CB (0.10) and CL (0.07) lines. The alignment of sequences of haplotypes revealed nucleotide substitutions at three locations i.e. 912th, 987th and 1062nd in the promoter. At 912th position, the substitution was G>C>G in h1, h2 and h3 haplotypes. At 987th and 1062nd position, the substitution was C>C>T and A>G>G respectively, in h1, h2 and h3 haplotypes.

The haplogroups of the BMP3 promoter showed significant effect (P<0.05) on body weights at 28th and 42nd day of age. At 28th day, h1h2 haplogroup

Table 25 The Production Performance of Layer Pure Lines

Traits	IWH (S-3)	IWI (S-3)	IWK (S-11)	Control (S-11)
Body weight (g)				
64 wks	1422.52±11.08 (328)	1354.22±10.90 (346)	1473.39±44.22 (428)	1594.71±12.48(340)
72 wks	1420.59±11.84 (314)	1371±11.01 (205)	1417.48±14.45 (198)	1562.22±21.87 (118)
Egg Production (No)				
64 wks	254.34±1.34 (454)	235.12±1.64 (414)	227.80±1.47 (383)	223.24±1.67 (350)
72 wks	291.56±1.59 (433)	261.35±2.34 (327)	260.03±1.80 (326)	257.52±2.14 (334)
Egg Weight (g)				
64 wks	52.15±0.24 (332)	51.76±0.23 (347)	55.21±0.22 (335)	53.39±0.25 (346)
72 wks	53.61±0.25 (315)	53.49±0.30 (204)	56.91±0.27 (273)	54.24±0.32 (196)
Body weight (g)	IWH (S-4)	IWI (S-4)	IWK (S-12)	Control (S-12)
Day of Hatch	32.56±0.13 (1375)	33.41±0.1 (1180)	36.41±0.15 (1785)	36.55±0.11 (1117)
8 wks	469.92±2.64 (1201)	550±4.23 (1113)	531.08±2.47 (1669)	482.10±3.42 (1047)

showed the highest body weight (336.4±4.8g) while h2h3 showed the lowest body weight (272.5±6.1g). At 42nd day, h1h2 haplogroup showed the highest body weight while h1h1 had the lowest body weight. The h1h2 haplogroup had 29.5% higher body weight than h1h1 haplogroup.

The BMP4 promoter haplogroups showed significant effect (P<0.05) on body weights at 28th and 42nd day of age. At 28th day, h1h1 haplogroup showed the highest body weight (326.5±14.3 g) while h1h3 had the lowest body weight. At 42nd day, the h1h1 and h1h3 haplogroups showed the highest and lowest body weights, respectively where the h1h1 haplogroup had 29.8% higher body weight than h1h3 haplogroup. The haplogroups also showed significant effect (P<0.05) on shank length at 42nd day of age where the h1h1 haplogroup had the highest shank length (78±1.3mm) and h1h3 had the lowest shank length (71.2±1.2mm).

Expression of BMP3, BMP4 and ACVR2A genes: The expression of BMP3 gene was higher in control layer line compared to control broiler line during embryonic period in particular day 5 to day18. The highest expression was found at embryonic day7 in control layer line and embryonic day9 in control broiler line. The lowest expression was found at embryonic day8 in control layer line and at embryonic day5 in control broiler line. During post hatch period, on day1, expression in bone marrow was higher than day18 of embryonic period. After that there were no significant differences of expression among day 14, day28 and day42 in control layer line. The pattern of expression was similar in control broiler line during post hatch period except a bit higher expression on day 42. We found significantly (P<0.05) higher expression of BMP3 gene during post-hatch period than embryonic period in control broiler line. But, in layer line, there was no significant differences of expression between embryonic and post hatch period.

The expression of BMP4 gene was more or less similar from embryonic day 5 to 16 in control layer line. On day17 of embryonic period, the expression was found as the highest while on day10, it was the lowest in control layer line. But, during post hatch period, the level of expression was not varied significantly from day1 to day42 in control layer line. In control broiler line, the highest expression was found at embryonic day8 while the lowest expression was found at embryonic day16. The expression was gradually decreased from embryonic day8 to 16. The higher expression was found during post hatch period in control broiler line than control layer line. The differential pattern of expression may be one of the causal factors for controlling ossification during embryonic as well as post hatch period.

The expression of ACTVR2A gene was down regulated on 6th, 7th, 8th, 9th, 10th, 11th, 13th and 16th day of embryonic period as compared to ED5 by 0.46, 0.00, 0.08, 0.23, 0.02, 0.00, 0.02 and 0.07 fold, respectively in CB population while the highest up-regulation was found on 18th day of embryonic stage. In CL line, the ACTVR2A gene was up regulated on 6th, 10th, 12th, 14th, 15th, 17th and 18th embryonic day by 2.70, 1.30, 9.70, 11.3, 10.54, 6.72 and 19.68 folds, respectively. It was down regulated on 7th, 8th, 9th, 11th and 13th day of embryonic period by 0.01, 0.07, 0.26, 0.00, 0.06 and 0.41 folds, respectively. Post hatch expression of ACVR2A gene as compared to day1 expression was up regulated by 8, 2 and 1.48 folds on 14th, 28th and 42nd day of age in CB population. The expression of ACVR2A gene was up-regulated by 6.08 and 1.40 folds on 14th and 42nd days of age in CL line. However, it was down regulated by 0.042 folds on 28th day of age.

Genotyping MHC class I loading complex genes (TAP1, TAP2 and Tapasin) for their association with immunocompetence traits in chicken.

To observe the Immune-competence traits in different breeds of chicken (*viz.* Ghagus, Dahlem Red and Nicoabri) total count of T lymphocyte bearing CD8 molecule in the peripheral blood of chicken was carried out by flowcytometry assay using mouse anti-chicken CD8α-PE. The study revealed a significant difference (P<0.05) between the three breeds. The T cell number bearing CD8 was found to be highest in Ghagus (2132.34±69.526) followed by Nicobari (2023.53±75.14) and least in Dahlem Red (1649.49± 64.54). A cutaneous basophil hypersensitivity (CBH), response to phytohemagglutinin-P (100µg/ per bird) to seven week old birds of different breeds of chicken showed significant difference (P<0.05) in the wattle thickness (% increase, after 24 hours) across the breeds and sexes. Highest response was reported in Ghagus (375.836±15.04) and least in Dahlem Red (267.603±13.99). Sex wise female (346.35 ±10.27) was having high % increase in wattle thickness compared to male (270.22 ±14.11). Heamagglutination Inhibition assay for Newcastle disease virus (NDV) titre was carried out for the birds (7 week old) immunized

with 2 doses of lentogenic NDV (LaSota) through eye drops at 7 days and 28 days. Serum samples were analyzed by haemagglutination inhibition (HI) test using 1% chicken red blood cells (RBCs) according to the OIE protocol. The HI titre was determined as the highest dilution of serum samples that inhibited NDV agglutination of chicken RBCs. 4HA LaSota virus was used for the assay. Haemagglutination inhibition titre (log_2) to ND vaccine was found to be highest in Dahlem Red chicken (2.44 ±0.12) which significantly differ (P<0.05) with the other two breeds. Sex wise analysis also revealed that females were having significantly higher titre (2.12 ±.09) compared to males (1.75 ±0.12). Titres are low as birds were given only two doses of lentogenic vaccine, only after R2B vaccine, the titres go up.

Genetic analysis of innate immune-competence and survivability for identification of genetic markers (DST project)

Three pedigreed experimental populations such as Ghagus, Nicobari and White Leghorn-Layer control (WLH) breeds were used in this study. Experimental chicks of three breeds were hatched simultaneously and reared under similar management conditions. In Ghagus, 49 sires were mated with 148 dams in 1:3 ratio, in WLH, 50 sires were mated with 200 dams in 1:4 ratio while in Nicobari breed 33 sires were mated with 101 dams in 1:3 ratio to produce chicks.

Fertility was better in Ghagus (89.74%) breed as compared to the WLH (70.79%) and Nicobari (67.91%) breeds while hatchability on fertile eggs set was almost similar in Ghagus (87.50%) and WLH (87.88%) breeds and better than Nicobari breed (79.36%). Hatchability on total eggs set was better in Ghagus (78.53%) followed by WLH (62.21%) as compared to Nicobari breed (53.89%).

Day old body weight was significantly higher in WLH followed by Ghagus and Nicobari breeds. Similarly, four weeks body weight of WLH and Nicobari breeds was significantly higher than Ghagus breed indicating the presence of maternal effect. However, eight weeks body weight was significantly higher in Ghagus as compared to Nicobari and WLH breeds while shank length was significantly higher in Ghagus followed by WLH and Nicobari breed (Table 26). Higher survivability (2-8 weeks of age) was observed in WLH as compared to Ghagus and Nicobari breeds.

Table 26 Growth traits during 0-8 weeks of age

Traits	Ghagus	Nicobari	WLH
	Mean±S.E.	Mean±S.E.	Mean±S.E.
Body weight (g)			
0 day	33.4±0.15^b	30.9±0.21^c	37.7±0.20^a
4 wks	125.9±1.9^b	130.8±2.1^a	132.2±1.48^a
8 wks	402±5.39^a	387±6.30^b	375±4.19^c
Shank length (mm)			
8 wks	68.58±0.42^a	56.53±0.53^c	65.10±0.31^b
Survivability (%)			
2-8 wks	95.47	95.78	98.60

A total of 12 male birds from each breed were slaughtered and weights of three immunological organs such as spleen, bursa, and thymus as well as liver, heart, gizzard and ready to cook (meat) yield were recorded (Table 27). A total of 14 lobes of thymus (7 on each side) were present in every bird of all three breeds. Relative size of thymus (to body weight) was significantly higher in Nicobari breed when compared to Ghagus and WLH. However, relative size of heart in Ghagus was significantly lower than Nicobari and WLH breeds. Overall, meat (Ready to cook) yield was significantly higher in Ghagus followed by WLH and Nicobari breeds.

Table 27 Relative size of immunological organs at 8 weeks of age

Traits	Ghagus	Nicobari	WLH
Body weight (g)	690.7±27.2^a	578.4±27.5^b	515.7±17.6^b
Thumus (%)	0.34 ± 0.04^b	0.46 ± 0.02^a	0.35 ± 0.03^b
Spleen (%)	0.19 ± 0.01	0.21 ± 0.01	0.18 ± 0.01
Bursa (%)	0.14 ± 0.02	0.14 ± 0.02	0.11 ± 0.02
Heart (%)	0.46 ± 0.01^b	0.56 ± 0.02^a	0.54 ± 0.01^a
Liver (%)	2.56 ± 0.11	2.68 ± 0.10	2.80 ± 0.12
Gizzard (%)	3.26 ± 0.18	3.37 ± 0.25	3.76 ± 0.12
RTC yield (%)	58.5 ± 0.53^a	56.4 ± 0.43^b	53.1 ± 0.42^c

Coding region of pattern recognition receptor (PRR) genes such as *B-NK, B-lec and MDA5* were sequenced in bi-direction using cDNA extracted from spleen samples. Comparison of sequences of PRR genes of three breeds with reference sequence showed significant variations. In *B-NK* gene, a 6 bp insertion was observed in WLH and Nicobari breeds but no insertion was found in Ghagus breed. In this gene, higher NS substitutions were detected in Ghagus and Nicobari breeds as compared to WLH breed (Table 28). Further, fewer synonymous and non-synonymous substitutions were detected in *B-Lec* and *LGP2* genes among three breeds. The domain location of NS substitutions in each gene among three breeds was studied.

Table 28 Synonymous and Non-synonymous substitutions in three PRR genes

Breeds/ Genes	*B-NK*			*B-Lec*		*LGP2*	
	Syn	NS	Ins (6 bp)	Syn	NS	Syn	NS
WLH	2	14	3 Nos.	1	2	7	3
Ghagus	1	23	Nil	3	4	8	2
Nicobari	0	23	2 Nos.	0	2	7	4

Ins- Insertions

Poultry Nutrition

Adaptation and mitigation strategies in poultry to thermal stress through nutritional and environmental manipulations (NICRA)

The main objective of the project was to study various dietary modulations to minimize ill effects of heat stress in commercial and backyard chicken varieties. Under this project four experiments were conducted to ameliorate the ill effects of heat / environmental stress through dietary modulations. In experiment 1 and 2, oreganol, a plant derivative from *Oregano vulgaris* and *Thymus vulgaris* was supplemented at graded concentrations in diets *Vanaraja* and commercial broilers, respectively. Different methionine analogues (DL methionine, L methionine and methy hydroxyl analogue) were used as a source supplemental methionine on iso molar basis in experiment 3 with commercial broilers. In 4th experiment, mannon oligo saccharides (MOS) from yeast cell wall was incorporated at 5 graded concentrations (1, 1.5, 2, 2.5 and 3 g/kg) in *Vanaraja* chicken diet. Effect of MOS was compared with diets containing anti-biotic growth promoter (AGP) or diet without AGP. Commercial broilers in 3 experiments and *Vanaraja* birds in one experiment were used. All the experiments were conducted in either stainless steel or GI battery brooders by placing 5 (Broilers) / 6 (*Vanaraja*) birds per replicate and 9-15 replications per treatment. Feed and water were provided *ad libitum* and standard vaccination schedule was followed for all the trials. During week 3 and 6, blood water samples were collected from a bird / replicate to estimate blood anti-oxidant variables (lipid peroxidation, superoxide dismulatase, glutathione peroxidise, glutathione reductase, ferric reducing ability in plasma) and immune responses (tittres against ND vaccine and CMI response to phytohaemogglutinin) Performance variables (body weight gain and feed efficiency) on weekly basis and slaughter variables at the end of experiment were studied.

In the first two experiments, effect of supplementing anti-oxidant premix (Oreganol, extract from plant sources) on performance, immune and anti-oxidant responses in *Vanaraja* and commercial broilers was studied. Oreganol is a plant derivative from *Oregano vulgaris* and *Thymus vulgaris* plants, which is rich in Carvacrol and Thymol, which are potent anti-oxidants. Oragnol was supplemented at two different concentrations in diets of *Vanaraja* from 1-42 d of age during late monsoons season (max temp 32.5 ^{o}C+1.18; min temp 25.6 ^{o}C+1.86; max humidity 74%+2.62; min humidity 46.8+8.28%). Two control diets with and without chemical growth promoter was prepared. The CD without growth promoter was supplemented with orygenol at 0, 100 and 200 g / ton. Each diet was fed *ad libitum* to 17 replications containing 5 *Vanaraja*. Oreganol at 200g/ton numerically improved the performance and significantly feed intake (Fig 1, Table 29).

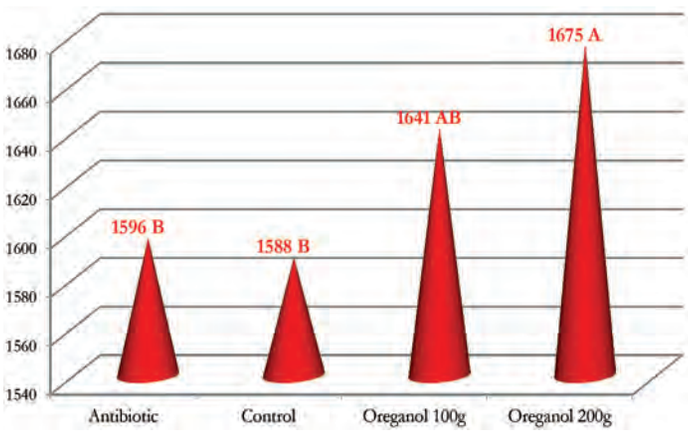


Fig. 5. Effect of suplementing oreganol on feed intake (g) in *Vanaraja* chicks (6 wks)

Table 29 Effect of supplementing Oreganol on performance of *Vanaraja* chicken

Treatment	Week 3			Week 6		
	BWG, g	FI, g	FI/ BWG	BWG, g	FI, g	FI/ BWG
Antibiotic	278.0a	449.4ab	1.616b	712.7	1596b	2.244
Control	259.9b	436.9b	1.684a	707.0	1588b	2.249
Oreganol 100g	272.2a	450.3ab	1.655a	721.1	1641ab	2.277
Oreganol 200g	280.9a	463.0a	1.649ab	742.3	1675a	2.258
P	0.006	0.062	0.005	0.279	0.044	0.618
N	17	17	17	17	17	17
SEM	1.999	3.218	0.0059	5.363	10.58	0.008

BWG: body weight gain; FI:feed intake, FCR:feed conversion ratio
^{abc} means having common superscript in a column do not vary significantly (P<0.05)

Similarly in commercial broiler diets Oragenol was supplemented at 3 graded concentrations (250, 500 and 750 g/Ton) and a control diet with antibiotic was used to compared the possibility of replacing the chemical growth promoter with Oragenol (max temp 31.1 °C+0.652; min temp 26.0 °C+1.39; max humidity 70%+3.10; min humidity 46.0+8.42%). Body weight gain and feed efficiency were not affected by replacing antibiotic growth promoter with Oreganol at 250 g / kg diet. Higher inclusion levels of oragenol did not show improvement in broiler performance. HI and CMI responses were not affected with oreganol supplementation. Lipid peroxidation was reduced (Fig 6), while GPRx and FRAP increased significantly with oreganol supplementation both in *Vanaraja* and broiler chicken (Table 30).

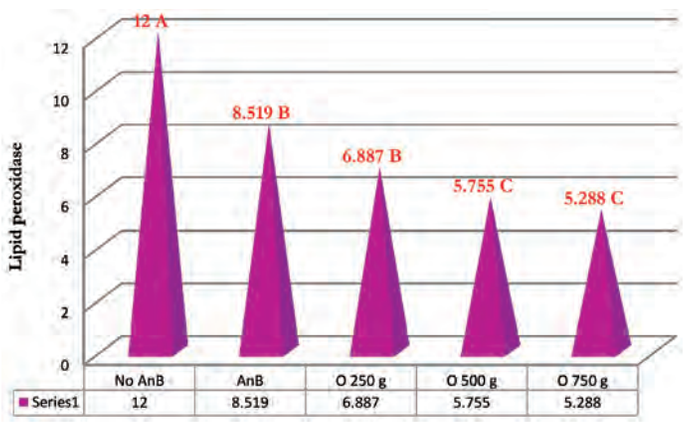


Fig. 6. Effect of suplementing oreganol on lipid peroxidation in commercial broilers (6 wks)

Table 30 Effect of supplementing Oreganol on anti-oxidant variables in commercial broiler chicken

Treatment	GSHPx, u/ml	GSHRx, u/ml	FRAP, µM/L	SOD, %
Without antibiotic	703.3^{b}	838.4^{ab}	953.7	5.359^{a}
With antibiotic	704.8^{b}	912.2^{a}	960.4	4.198^{ab}
Oreganol 250g	794.3^{a}	916.3^{a}	982.2	4.876^{a}
Oreganol 500g	617.1^{c}	835.9^{ab}	1065	4.182^{ab}
Oreganol 750g	607.0^{c}	776.6^{b}	1005	3.475^{b}
P	0.001	0.013	0.263	0.047
N	15	15	15	15
SEM	12.37	15.13	17.53	0.211

GSHPx glutathione peroxidise; GSHRx glutathione reductase; FRAP ferric reducing ability in plasma; SOD superoxide dismutase

^{abc} means having common superscript in a column do not vary significantly (P<0.05)

The third experiment was conducted with commercial broiler chicken to study the relative effect of 3 methionine isomers (DL methionine, MHA Ca and L methionine) on performance, immunity and anti-oxidant activity during tropical summer (max temp 34.7 °C+1.07; min temp 26.3 °C+1.16; max humidity 69.0%+4.82; min humidity 33.6+6.01%). A basal diet without supplemental methionine was fed to compare the treatment effect. Experiment was conducted on floor pens (6.6 x 4 feet) containing 22 commercial broilers in each pen. Body weight gain, feed efficiency (Fig 7) and breast weight were significantly higher in DL Met group followed by L Met and MHA in order. Anti-oxidant variables were not affected due to variation in methionine source in diet. Anti-body titre against ND vaccine was significantly higher in DLM groups followed by MHA and L Meth in order (Fig 8).

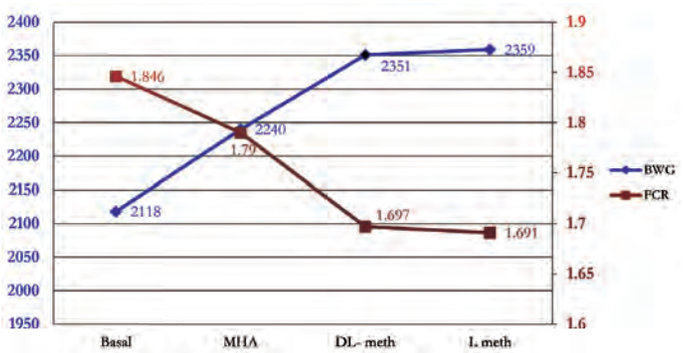


Fig. 7. performance of broiler (42 d) for varoius methionine isomers

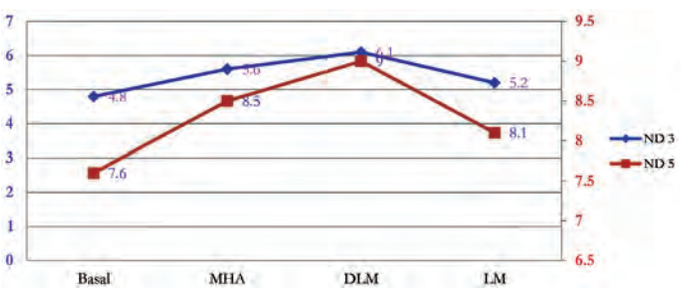


Fig. 8. Effect of methionine isomers on HI Titre in broiler chicken

The fourth experiment was conducted on *Vanaraja* chicken to study the possible benefits of incorporating graded levels (1, 1.5, 2, 2.5 and 3 g/kg diet) mannon olygosaccharides (MOS from yeast cell wall) as a substitute for antibiotic growth promoter on performance, immune responses and anti-oxidant variables. Experiment was conducted during May and June 2015 in battery brooder pens (max temp 38.1 °C+0.19; min temp 29.4 °C+0.51; max humidity 56.3%+2.65; min humidity 38.3+8.16%). Due to outbreak of ND the experiment was terminated during 4th week and therefore results up to week 3 were presented. The results up to week 3 indicated

that performance (Fig 9) and immune responses of *Vanaraja* in MOS fed groups was similar to those fed the antibiotic growth promoter. GSHPx and GSHRx were significantly higher sera of birds fed 1.5 and 1 g MOS/kg diet, respectively compared to those fed the antibiotic growth promoter (Table 31).

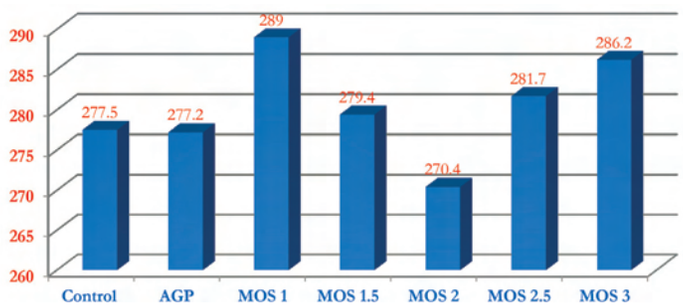


Fig. 9. Effect of supplementing graded concentrations of MOS on body weight gain in *Vanaraja* chicken (21 days)

Table 31 Anti-oxidant variables in *Vanaraja* chicken fed graded levels of MOS in place of AGP during tropical summer

Treatment	LP	GSHPx	GSHRx	FRAP	SOD
	nM MDA	u/ml	u/ml	µM/L	%
Control	2.88	558.4^{bc}	1023^{ab}	670	4.02
AGP	3.43	442.8^{c}	755^{bc}	715	3.27
MOS 1	3.72	334.6^{c}	1166^{a}	705	4.02
MOS 1.5	3.08	850.9^{a}	833^{bc}	764	3.20
MOS 2	3.19	539.4^{bc}	895^{abc}	679	3.75
MOS 2.5	2.59	754.3^{ab}	601^{c}	678	3.50
MOS 3	3.24	391.7^{c}	697^{c}	666	3.54
P	0.737	0.003	0.003	0.315	0.594
N	10	10	10	10	10
SEM	0.177	41.27	42.50	12.01	0.142

LP lipid peroxidation; GSHPx glutathione peroxidise; GSHRx glutathione reductase; FRAP ferric reducing ability in plasma; SOD superoxide dismutase

^{abc} means having common superscript in a column do not vary significantly (P<0.05)

Optimization of dietary allowances for production and reproduction in Dahlem Red layers (PD-3)

Optimising the calcium and phosphorous for PD-3 chicken

The experiment was conducted to optimize the calcium and phosphorous requirement for PD-3 birds during the 33 to 44 weeks of age (2 periods).The basal diet was formulated to contain ME 2650 kcal/kg, CP 16%, Lysine 0.76% and methionine 0.35%. The basal diet was supplemented shell grit 8.26% and DCP 1.21% (Diet I), 8.10% and 1.53% (Diet II), 9.60% and 1.20% (Diet III), 9.40% and 1.51% (Diet IV), 10.81% and 1.17% (Diet V), and 10.44% and 1.46% (Diet VI), respectively so as the experimental diets to contain 3 levels of calcium (3.25%, 3.75% and 4.25%) and 2 levels of phosphorous (0.30% and 0.35%). The daily feed intake, hen house egg production was recorded through the experiment. The egg production and number of eggs were higher in birds fed the diet contained calcium 3.25% and P 0.35% compared to other groups during the 37-40 weeks (Table 32). However, the feed intake and egg quality parameters did not differ (P>0.05) among the various dietary groups during the 33 to 44 weeks period (Table 33).

Screening the Saccharomyces cerevisiae strains to withstand the concentration of sodium selenite (inorganic selenium)

Nine different *Saccharomyces cerevisiae* strains were collected from various sources and the collected strains were revived in the YEPD broth and subsequently shifted to agar plates. All the strains were challenged with 10 ppm Sodium selenite (in-organic source of selenium). The colony forming unit were higher in 050strains compared to other strains in the YEPD broth contained 10 ppmselenium as sodium selenite (Table 34). Further, the percent decrease in CFU/ml was lower in the *Saccharomyces*

Table 32 Feeding varying concentrations of Ca and P from 33-44 weeks on egg production and number of eggs in Dahlem Red layers

	Age (wks)	Ca 3.25	Ca 3.25	Ca 3.75	Ca 3.75	Ca 4.25	Ca 4.25	SEM	P Value
		P 0.35	P 0.30	P 0.35	P 0.30	P 0.35	P 0.30		
EP	33-36	49.49	51.12	42.45	49.59	45.10	45.00	1.22	0.27
	37-40	45.31^{a}	32.45^{ab}	31.63b	35.82^{ab}	37.65^{ab}	27.86^{b}	1.33	0.01
	41-44	43.98	37.86	33.16	37.55	36.63	33.16	1.15	0.08
No. of eggs	33-36	13.86	14.31	11.89	13.89	12.63	12.60	0.34	0.27
	37-40	12.69^{a}	9.09^{ab}	8.86b	10.03^{ab}	10.54^{ab}	7.80^{b}	0.37	0.01
	41-44	12.31	10.60	9.29	10.51	10.26	9.29	0.32	0.08

Table 33 Feeding varying concentrations of Ca and P on egg quality and blood biochemical parameters in Dahlem Red layers

Egg quality parameters	Ca 3.25 P 0.35	Ca 3.25 P 0.30	Ca 3.75 P 0.35	Ca 3.75 P 0.30	Ca 4.25 P 0.35	Ca 4.25 P 0.30	SEM	P Value
Density, g/cm^3	1.077	1.074	1.076	1.076	1.076	1.077	0.003	0.64
Egg weight, g	54.18	50.45	54.51	53.97	53.93	50.03	1.65	0.24
Strength, N	18.85	23.44	21.95	21.37	23.12	24.41	2.92	0.07
Haugh unit	81.56	78.00	83.50	81.20	83.60	77.90	1.89	0.94
Shell weight, g	3.220	3.470	3.910	3.730	3.600	4.250	0.27	0.59
Shell thick, mm	0.324	0.331	0.329	0.328	0.316	0.340	0.00	0.59
Blood bio-chemicals								
ND Titre	7.14	5.57	7.29	6.14	6.71	7.29	0.95	0.57
Cholesterol, mg/dl	123	125	109	85	81	135	25.6	0.20
Total protein, g/dl	3.47	2.98	3.31	2.14	2.90	1.34	1.15	0.44

cerevisiae strain 050 compared to other strains (Fig. 10). Therefore, 050 strain of *Saccharomyces cerevisiae* was selected for subsequent studies to produce the organic selenium.

Table 34 Effect of supplementing the 10 ppm of selenium on growth of various strains of *Saccharomyces cerevisiae*

Strain	CFU /ml	
	Without Sod. Selenate	Sod. Selenate 10 ppm
050	$0.34x10^{12}$	$0.32x10^{12}$
186	$0.23x10^{12}$	$0.11x10^{12}$
Wy	$0.2x10^{12}$	$0.174x10^{12}$
Scsb	$0.22x10^{12}$	$0.16x10^{12}$
045	$0.294x10^{12}$	$0.196x10^{12}$
F	$0.25x10^{12}$	$0.17x10^{12}$
042	$0.43x10^{12}$	$0.22x10^{12}$
Sc101	$0.49x10^{12}$	$0.28x10^{12}$
3455	$0.29x10^{12}$	$0.24x10^{12}$

CFU; Colony forming unit

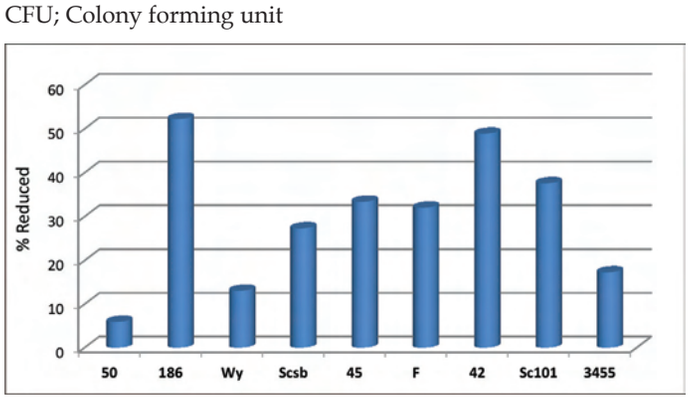


Fig. 1. Percent decrease in the growth (CFU/ml) of various strains of *Saccharomyces cerevisiae* **due to supplementation of 10 ppm Se**

Table 35 Effect of increased concentration of Se on biomass yield in 050 strain of *Saccharomyces cerevisiae*

Conc (ppm)	g/l	(Se mg/g)	(Se mg in biomass produced)
0	14.67	0.00	0
10	13.48	1.96	26.42
20	12.30	3.25	39.97
30	10.91	5.92	64.37
40	10.03	6.12	61.18
50	7.244	9.08	65.92
80	5.645	10.69	62.09
100	4.640	14.28	64.96
150	3.532	18.33	63.58
200	2.436	24.57	60.90

The concentration of the Se (sodium selenite) increased from 0 to 200 ppm in the YEPD broth resulted in gradual decrease in biomass yieldwas recorded in 050 strain of *Saccharomyces cerevisiae*. However, the selenium (mg/g)concentration in biomass was increased gradually from 0 to 200 ppm and observed best at 30 ppm, where the biomass and Se uptake was optimum compared to the other concentrations (Table 35).

Further, some of the herbal extract like, *Murraya koenigii* (Currivepaku), *Coriandrum sativum* (kottimera), *Mentha aquatica* (Pudina), *Alium sativum* (Vellulli) and *Ginger officinale* (Allam) were added to the culture media and it was found that the media supplemented the extract of *Mentha aquatica* (0.50 ml) and *Ginger officinale* (1.5 ml) showed the better *Saccharomyces cerevisiae* growthin terms of CFU/ml compared to other herbal extracts (Fig. 11).

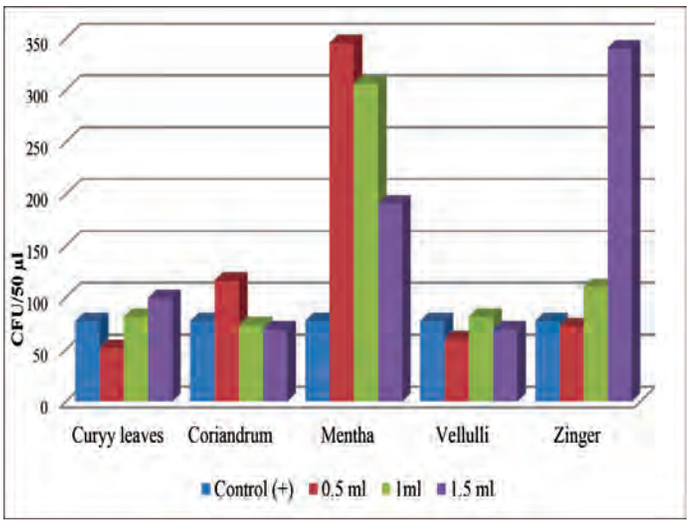


Fig. 11. Effect of supplementing the different herbal extract on number of CFU/50 µl of broth

Dietary supplementation of Selenized-Yeast on performance in *Vanaraja* parents (PD-1)

The experiment was conducted to determine the effect of supplementing the Selenized-yeast in Vanarja parents (PD-1 female) in battery brooder house from 3-8 weeks. The basal diet was formulated to contain ME 3050 kcal/kg, CP 21.5%, Lysine 1.20% and methionine 0.50%.The basal diet (Diet I) was supplemented Selenized-yeast to contain Se at 0.2 ppm (Diet II), 0.3 ppm (Diet III) and 0.4 ppm (Diet IV). The daily feed intake, body weight was recorded through the experiment. The better body weight gain was recorded among the group fed the diets supplemented the Selenized-yeast compared to control diet. Further, among the Selenized-yeast supplemented groups the best body weight gain was recorded at 0.2 ppm Se (Table 36). However, the feed intake and feed conversion ratio did not differ (P>0.05) among the various dietary groups.

Table 36 Effect of feeding the diets contained varying concentration of organic Se on body weight gain in *Vanaraja* parents.

Treatment	8 week		
	BWG, g	Feed intake, g	FCR (FI/BWG)
Control	772.0^{b}	1688	2.188
0.2 ppm	801.5^{ab}	1743	2.180
0.3 ppm	841.2^{a}	1779	2.118
0.4 ppm	808.0^{ab}	1727	2.140
P value	0.05	0.14	0.41
N	8	8	8
SEM	8.98	13.96	0.02

Utilization of alternate protein sources with Quality Protein Maize (QPM) in broiler diets

The experiment was conducted to study the effect of QPM along with alternate protein source-based diets on nutrient utilization, body weight gain and feed efficiency in commercial broiler chicken. The biological trial was conducted in commercial broiler chicks (n=240) and were randomly divided into 6 dietary groups having 8 replicates with 5 chicks in each replicate. The six diets were formulated to contain the ordinary maize (OM) (Diet I), QPM (Diet II), OM + Cotton Seed Meal (CSM) 8%+Guar meal (GM) 4% (Diet III), OM + CSM 12%+GM 6% (Diet IV), QPM+CSM 8%+GM 4% (Diet V) and QPM+CSM 12%+GM 6% (Diet VI). The weekly body weight and feed intake was recorded. Supplementation of cotton seed cake and guar meal along with QPM or ordinary maize significantly depressed the body weight gain, FCR, slaughter variables in commercial broilers. However, the numerical improvement for body weight, FCR and slaughter parameters (Table 37) was recorded among the groups supplemented the cotton seed cake at 8% and guar meal at 4%

Table 37 Effect of feeding ordinary maize and QPM on performance and slaughter parameters in commercial broiler chicken

Treatment	6 wks		Slaughter variables/kg live body weight				
	BW, g	FCR	RTC	DP	L, g	AF, g	BrW, g
OM	2490^{a}	1.485^{ab}	777.5^{ab}	77.75^{ab}	47.7	29.85^{b}	682.1^{ab}
QPM	2545^{a}	1.448^{b}	788.8^{a}	78.89^{a}	43.0	19.88^{bc}	717.6^{a}
OM+CSM 8%+GM 4%	2275^{b}	1.538^{a}	775.3^{ab}	77.53^{ab}	44.1	29.85^{a}	606.9^{abc}
OM + CSM 12%+GM 6%	2126^{c}	1.542^{a}	762.8^{ab}	76.29^{ab}	40.9	13.1^{cd}	517.5^{c}
QPM+CSM 8%+GM 4%	2291^{b}	1.521^{a}	773.6^{ab}	77.36^{ab}	41.9	20.3^{b}	665.6^{ab}
QPM+CSM 12%+GM 6%	2160^{bc}	1.506^{ab}	757.1^{b}	75.7^{b}	50.0	12.27^{d}	571.6^{bc}
SEM	25.97	0.01	10.21	1.02	3.59	2.24	41.39
P value	0.01	0.01	0.05	0.05	0.13	0.01	0.01

BW, body weight; FCR feed conversion ratio; RTC, ready to cock yield; DP, dressing percentage; L liver; AF, abdominal fat; BrW, breast weight

along with QPM based diet compared to those groups fed higher proportion of cotton seed cake and guar meal with or without QPM. Further, the activity of the anti-oxidant enzymes did not differ among the different dietary groups. The efficiency of energy utilisationwas higher in groups fed diet supplemented QPM compared to group fed on normal maize supplemented diets (Table 38).

Table 38. Effect of feeding ordinary maize and QPM on anti-oxidant enzyme status and Energy Retention in commercial broiler chicken

Treatment	Anti-oxidant enzymes (Units/ml)		Energy retention (%)
	G Peroxidase	G Reductase	
OM	1023.2	746.7	72.91^{a}
QPM	901.7	594.5	73.08^{a}
M + CSM 8% + GM 4%	876.2	554.8	70.31^{ab}
M + CSM 12% + GM 6%	819.5	539.2	67.47^{b}
QPM + CSM 8% + GM 4%	817.1	525.1	72.17^{a}
QPM + CSM 12% + GM 6%	816.2	544.9	69.3^{ab}
P value	0.236	0.067	0.05
SEM	28.22	24.06	1.622

Optimization of dietary protein concentration for minimising nitrogen excretion and economising on feed cost

A total of 5 feeding experiments were conducted with the primary objective of optimizing dietary protein content for rural poultry germplasm. In the 1st expt., reduced CP content (-2%) in Srinidhi chick diet (0-42d) when tested with and without protease supplementation (8500 to 21400 units/kg) showed no effect on the performance of chicks and slaughter parameters. In the 2nd expt., Vanaraja and Srinidhi chicks were fed standard CP (19%), medium (17%) and low (15%) protein levels with and without protease supplementation (15000 protease units/ kg diet) till 6 weeks of age. Body weight and FCR were similar in standard and medium protein fed groups, while low protein significantly reduced body weight and feed conversion efficiency. Feed intake was higher in the medium and low protein groups. Protease enzyme showed no effect.

In the 3rd expt., Vanaraja chicks were fed graded levels of dietary protein (18, 16, 14 and 12% CP). The latter 3 levels of dietary protein were tested with and without balancing for critical amino acids. Body weight remained unaffected by marginal reduction in CP (16%), but 4% reduction in CP (14%) depressed body weight, which was improved by amino acid balancing (Table 39). Drastic depression in growth was observed in the group fed the lowest CP level (12%), which could improve marginally with amino acid balancing. Feed conversion efficiency was improved at the low CP levels (14 and 12%) by balancing for critical amino acids. Abdominal fat weight was higher and the serum protein content decreased at the low CP levels (14 and 12%).

In the 4th expt., Vanaraja chicks were fed graded CP levels (18, 16 and 14%). The critical amino acids content at each CP level was maintained at ideal ratio to the protein content considering either total amino acid or digestible amino acid content of the diet. The data indicated a positive response when diets were formulated based on digestible amino acid content than total amino acid content, particularly at optimum or marginally low CP levels (18 and 16%). In the 5th expt., the response of Vanaraja chicks to protease supplementation (300 units/kg diet) to

Table 39 Effect of dietary protein level and amino acid balancing on performance of *Vanaraja* chicks

Trt	CP%	Amino acid balancing	Body wt, g		Feed intake, g		FCR	
			Week		Week		Week	
			3	6	3	6	3	6
1	18.0	-	310.28^{a}	875.79^{a}	487.03^{bc}	1831.49^{bc}	1.79^{e}	2.19^{e}
2	16.0	-	301.13^{a}	859.93^{ab}	502.60^{ab}	1872.99^{ab}	1.92^{cd}	2.28^{d}
3	16.0	+	308.53^{a}	863.17^{ab}	504.27^{ab}	1853.02^{abc}	1.87^{d}	2.25^{d}
4	14.0	-	277.51^{b}	821.20^{c}	508.30^{a}	1914.18^{a}	2.13^{b}	2.45^{b}
5	14.0	+	300.62^{a}	838.21^{bc}	511.93^{a}	1873.26^{ab}	1.96^{c}	2.35^{c}
6	12.0	-	240.71^{c}	710.63^{e}	480.02^{c}	1793.51^{c}	2.38^{a}	2.67^{a}
7	12.0	+	270.77^{b}	780.32^{d}	498.48^{b}	1844.62^{bc}	2.16^{b}	2.49^{b}
n			15	15	15	15	15	15
P			0.0001	0.0001	0.001	0.011	0.0001	0.0001
SEM			2.744	6.804	2.354	8.792	0.02	0.016

Table 40 Effect of different levels of dietary energy and protein on semen parameters in layer breeders. Values given are Mean±SE

Parameters	HEHP	HELP	LELP	LELP + EM
Volume (ml)	0.52 ± 0.02	0.52 ± 0.02	0.49 ± 0.02	0.47 ± 0.02
Appearance	4.18 ± 0.11	3.86 ± 0.12	3.77 ± 0.10	4.05 ± 0.15
Progressive sperm motility (%)	59.25 ± 0.90	58.75 ± 1.09	60.11 ± 1.03	58.24 ± 1.87
Sperm Concentration (million / µl)	5.43 ± 0.23	5.08 ± 0.17	4.93 ± 0.12	5.12 ± 0.21
MTT dye reduction test (nM of MTT Formazan / min/ million sperm)	21.30 ± 0.68	22.05 ± 0.73	21.62 ± 0.52	21.20 ± 0.85
Live sperm %	86.83 ± 1.20	87.22 ± 1.18	89.29 ± 0.73	85.72 ± 2.58
Abnormal sperm %	2.82 ± 0.44 ^{ab}	5.82 ± 0.72^{a}	2.84 ± 0.44 ^{b}	2.90 ± 0.51 ^{ab}

HEHP - high energy high protein (2950 kcal/kg ME, 16% CP); HELP- high energy low protein (2950 kcal/kg ME, 8.97% CP); LELP (2360 kcal/kg ME, 9% CP); LELP+EM (2360 kcal/kg ME, 9% CP + Emulsifier).

Figures bearing different superscripts in a row differ significantly (P<0.05).

diets containing guar meal (12%) at marginally low CP content of 16% was evaluated. The performance during early age indicated reduced body weight and feed conversion efficiency with guar meal inclusion in diet, while protease supplementation showed a trend of marginal improvement in performance.

Avian Physiology

Studies on short term storage of chicken semen for optimal fertility

A study was conducted to study the effect of semen extenders with different supplements for optimal fertility of breeder rooster semen.Adult roosters of PD-1 were taken for semen collection. Collected semen was pooled and analysed for different semen parameters. The dose of the semen was 100 µl having 100 – 200 millions of sperm. The hens (PD-2) of 27 to 40 weeks of age were inseminated once in a week for four weeks and eggs were tested for fertility for one month. Two extenders were used viz. BPSE and TES-NaCl for dilution of the semen. The semen samples were diluted with the diluents at two different dilutions i.e. 1:2 and 1:4. The diluted semen samples were stored at 4-6 ^{0}C for 0 hr., 6 hrs. and 24 hrs. The semen parameters studied were % motility of spermatozoa, % live and dead count of sperm, proportion of abnormal spermatozoa, dye reduction test as a measure of metabolic activity, lipid peroxidation and finally fertility and hatchability were also recorded. The above study was conducted for the comparison of diluents BPSE and TES-NaCl at optimum dilution and period of storage based on semen parameters, to observe the fertility and hatchability. Based on semen parameters, comparison of diluents BPSE and TES-NaCl with supplements Vitamin C, Vitamin E, calcium chloride and potassium chloride at different concentrations at two storage periods (0hr. and 24 hrs.) was also done.

Based on semen parameters, BPSE showed better results as compared to TES-NaCl. The fertility rate was 72.44% in BPSE group and 65.15% in TES-NaCl group at 0 hr. storage of semen. The hatchability was 60.23% in BPSE group and 56.08% in TES-NaCl group. 10 mg Vit.C concentration supplemented with BPSE showed better results in terms of % motility (59.16±0.99), MTT (25.70±0.77), which were significantly higher than TES-NaCl and % sperm abnormality (21.91±0.62) was also significantly low. 100µM Vit.E supplementation worked well and showed better results in terms of % sperm motility (43.22±0.99), % live spermatozoa (86.58±0.53) and significantly less % abnormal spermatozoa (32.63±0.81) was recorded as compared to other concentrations of Vit. E. Calcium chloride was supplemented with both the diluents and it was observed that % sperm motility (47.03±1.13) was better in TES-NaCl group. 100 µM concentration of calcium chloride showed better results in terms of % motility (45.00±1.60) and MTT (0.44±11.62) as compared to all other concentrations. However, supplementation of potassium chloride did not show significant effect on the semen parameters. There was not much difference between the two groups of diluents on % motility, MTT, LPO and % live spermatozoa. In control group, the % abnormality was significantly less as compared to all other different concentrations of potassium chloride treated groups.

Effect of dietary energy and protein on layer breeder male semen quality, fertility and hatchability

Two experiments were conducted to evaluate different levels of dietary energy and crude protein on semen parameters and fertility in layer breeder males. In Experiment 1, Dahlem Red roosters (n=45, age=48 weeks) were equally distributed and fed

isocaloric diets with different levels of crude protein (CP) high energy high protein (HEHP-2950 kcal/kg ME, 16% CP), high energy low protein (HELP-2950 kcal/kg ME, 8.97% CP) and HELP+LM where amino acids lysine, methionine and threonine were supplemented to be on par with HEHP diet for seventeen weeks. In Experiment 2, Dahlem Red roosters (n=44, age=34 weeks) were assigned to four groups randomly. The birds were fed with HEHP, HELP, low energy low protein (LELP-2360 kcal/kg ME, 9% CP) and LELP+EM (Emulsifier-25g/100kg feed) diets for thirteen weeks. Different semen parameters were evaluated at 0, 4, 8, and 12 weeks of feeding. The semen from the groups was inseminated in hens to study the fertility and hatchability. Roosters fed with different CP level diets or lower CP diet supplemented with amino acids in Experiment 1 had no effect (P>0.05) on the semen parameters or fertility and hatchability. In Experiment 2 the percent abnormal sperm was significantly (P<0.05) lower in the LELP group and other semen parameters were not influenced by different dietary treatments (Table 40). The average fertility was significantly (P<0.05) higher in the HELP group and the average hatchability was lower in the LELP group (Table 40). In conclusion, dietary CP levels had no effect on semen and fertility parameters. Dietary energy and protein level combinations influenced the percent abnormal sperm, fertility and hatchability in layer breeder males.

Screening of pure line males for semen quality

Semen quality was evaluated in the pedigree sires of PB1 (n=80), PD1 (n=67), Ghagus (n=60), PB2 (n=65), GML (n=70), CB (n=69), and PD4 (n=125). Sires with poor semen quality were identified and recommended for removal from the breeding program.

Table 41 Effect of different levels of dietary energy and protein on semen parameters in layer breeders

Parameters	HEHP	HELP	LELP	LELP+EM	SEM
Avg fertility (%)	47^{b}	63^{a}	51^{b}	44^{b}	1.66
Avg hatchability (%)	87^{ab}	85^{ab}	78^{b}	87^{a}	1.46
Avg body weight (kg) at 34 wks	2.32	2.33	2.32	2.33	0.26
Avg body weight (kg) at 47 wks	2.49	2.57	2.55	2.64	0.36
Avg feed intake (g/bird/day)	66.36^{c}	70.2^{b}	86.16^{a}	88.82^{a}	0.83

Figures bearing different superscripts in a row differ significantly (P<0.05)

Effect of repeated insemination on TGF β, ER α gene expression in chicken UVJ tissue.

The gene expression of Transforming Growth Factor β (TGFβ) and Estrogen Receptor (ERα) was studied in PD3 and WL hen utero-vaginal junction (UVJ) tissue by real time PCR. Two groups of hens were maintained in each line where one group was repeatedly artificially inseminated at weekly intervals for ten weeks and another group was never inseminated. After 10 weeks randomly selected birds were slaughtered and the UVJ tissue was processed for gene expression and histology (Fig. 12). The results revealed no difference in the mRNA expression of both the genes in the UVJ tissue between the repeatedly inseminated and never inseminated birds. Thus it can be concluded that these genes play no role in declining fertility due to repeated insemination in chicken.

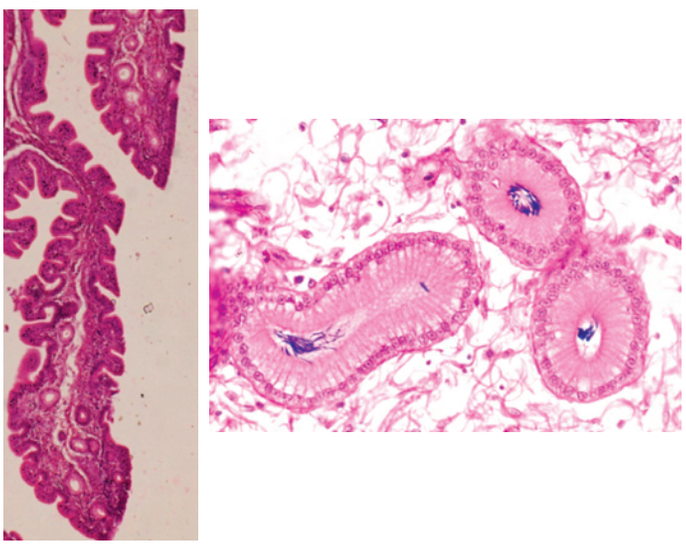


Fig. 12. Histological section of uterovaginal junction containing sperm storage tubules (SSTs). (a) 10x magnification (SSTs indicated by arrows). (b) Sperm storage tubules (SSTs) containing sperm in the lumen (pointed by arrows). 60x magnification.

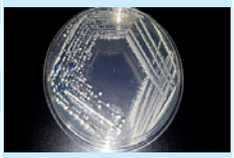
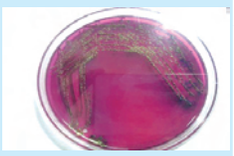
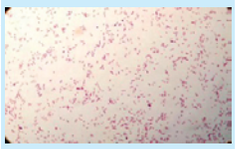
Avian health

Disease monitoring and controling pure line chicken

Under ALV eradication program, a total of 5649 pure line chickens including PB1 (422), PB2 (500), PD1 (460), PD3 (541), IWH (440), IWI (694), IWK (590), Lr Control (576), GML (507), PD4 (323), Naked Neck (120), Dwarf (146), and broiler control (330), were tested for ALV using group specific antigen ELISA. The overall incidence of ALV was 3.35% (189/5649). All positive birds (189) were culled prior to regeneration to prevent vertical transmission.

An experiment was conducted to assess the mortality pattern and immunecompetence of Nicobari, Gaghus, Aseel and layer lines/breeds. Birds were maintained up to 16 weeks.Mortality rate and immune response to ND vaccine estimated. The total mortality was 6.16%, 9.5%, 0% and 5.2% in Nicobari, Gaghus, Aseel

Table 42 Isolation of enteropathogenic cultures

Bacterial Isolates	Colony morphology			Gram Staining	Total bacterial count (CFU's/ml)	Remarks
	Nutrient Agar	MacConkey Agar	EMB Agar			
P_1-DPR					$7.2x10^5$	All isolates belong to *Escherichia coli* based on colony morphology and gram staining
P_2-DPR					$1.53x10^7$	
P_3-DPR					$1.79x10^7$	
P_4-DPR					$4.90x10^7$	
S_1-DPR	Large, thick, greyish white, moist, smooth and opaque colonies	Lactose fermenter; Flat, dry, pink colonies with a surrounding area of precipitated bile salts.	Smooth, circular, black or green color colonies with metallicsheen	Gram-negative, short plump rod shaped bacteria, arranged in single, paired or in short chains	$9.30x10^7$	
S_2-DPR					$1.95x10^{10}$	
S_3-DPR					$2.20x10^9$	
S_4-DPR					$7.50x10^8$	
S_5-DPR					6.30x107	

and layer, respectively. The mean ND antibody titers did not differ among four breeds at 0 d, 14 d 28 d, and 42d. However, at 56 days of age the antibody titers are significantly high in layers and low in Gaghus.

PCR analysis of tumour samples using 132bp repeat gene specific primers yielded 434bp and 300bp products. One representative sample from each product was sequenced and compared with reference strains. Sequence analysis revealed that the 300bp product contains single 132 bp repeat, whereas 432 bp product had double 132 bp repeats. Phylogenetic analysis revealed that 434bp product was closely related to vv+MDV (648A), whereas 300bp sequence was also clustered with same node containing +MDV (648A), vvMDV (MD5) and mMDV (CU-2). Sequence analysis of full length Meq gene from lymphomas obtained from birds vaccinated with bivalent (HVT+SB1) vaccine, monovalent (HVT) vaccine and unvaccinated were identical and there were no major insertions or deletions.

MDV serotype 1 copies were detected in spleen, feather pulp and lymphocytes at all the 16 time intervals in vaccinated (HVT+SB1 or HVT) and unvaccinated groups of birds under natural field conditions. These findings revealed that the birds in all the groups were exposed to existing MDV-1 circulating in the environment where the birds were housed. The mean viral loads in feather pulps and lymphocytes were higher than in spleens in all three experimental groups. Gross and microscopic lesions were more severe in unvaccinated, less severe in HVT vaccinated and mild in HVT+SB1vaccinated birds.

Antibody to MG and MS were monitored at 4 week intervels between 24 to 38wks of age in PD3 line. Results indicate that by 38 weeks 52% birds were positive for MG and 100% posistive for MS. The major predisposing factors contributing mortality were multiple age groups and high density. Health care measures including vaccination and medication were undertaken to all the flocks maintained at DPR

Isolation of enteropathogenic cultures

Swab samples from intestine of post mortem chicks (4) and cloaca of adult birds (5) were coltured in nutrient broth and incubated at 37°C overnight. A loopful of enriched nutrient broth culture was then streaked onto nutrient agar, MacConkey agar and Eosin Methylene Blue (EMB) agar plates and incubated at 37°C for 18-24 hours, aerobically. The results of colony morphology, gram staining along with the total bacterial count (CFU's/ml) were depicted in Table 42.

Antimicrobial susceptibility studies of the herbal/ plant extracts

Antimicrobial drug sensitivity test was performed for all the 9 isolates with 11 antibiotic discs by disc diffusion method as per the standard guidelines. Antimirobial drug senstitivity for the procured 19 essential oils of medical plants were done by agar well diffusion method as per standard guidelines. Based on zones of inhibition recommended by NCCLS (2007), isolates were classified as either sensitive (S), Intermediate (I) or resistant (R). The isolates resistant to three or more antibiotics were classified as multi-drug resistant (MDR) strains. All these isolates were totally resistant to Fluroquinolones, Penicillins, Ansamycins. Antibiogram profileindicated that all *E. coli* isolates showed 100% susceptibility to Streptomycin (Aminoglycoside) followed by chloramphenicol (44.4%) and Gentamicin (33.3%).

The prevalence of resistant, intermediate and susceptible sensitivity profiles of *E. coli* against

11 antibiotics were shown in Fig. 13. Among the antimicrobials Streptomycin showed highest sensitivity (Fig. 14) and among the herbal essential oils, Cinnamon bark oil exhibited maximum zone of inhibition (Fig. 15) for all the isolates of *E. coli* ranging from 19-30 mm.

Propagation of mesogenic Newcastle disease virus (NDV), characterization and purification for virosome preparation

Mesogenic Newcastle disease virus (NDV) strain –Komarov was obtained from VBRI (Vaccine seed stock) and propagated in 7 day old embryonated chicken eggs. Purity and titre of the virus were checked by PCR and Haemagglutination titre. The virus stock was bulk propagated in embryonated eggs and the allantoic fluid was harvested. The titre of the fluid was around 210. Mean death time in eggs was around 56h and occipital haemarrages were found as virus specific lesions in embryos. The allantoic fluid (120 ml) was clarified at 15,000 rpm for 15 min and virus purification was done by sucrose density gradient separation in ultracentrifugation. The purified virus was harvested and protein content was estimated to be around 2.3 mg/ml. The purified virus sample was checked for specific protein by SDS-PAGE. Virus specific fractions were observed. Both HA and fusion protein fractions were observed. Western blotting of the purified virus using NDV specific chicken antiserum also revealed immunogenic fraction in the virus.

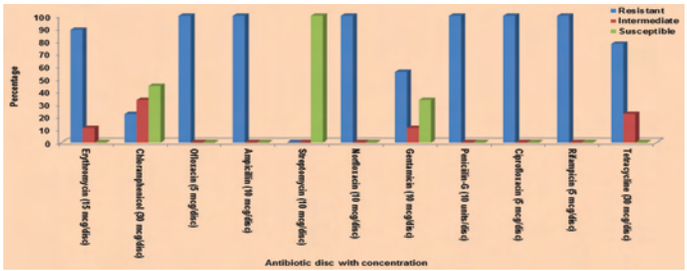


Fig. 13. Prevalence of resistant, intermediate and sensitive pattern of different antibiotics to E.coli isolates

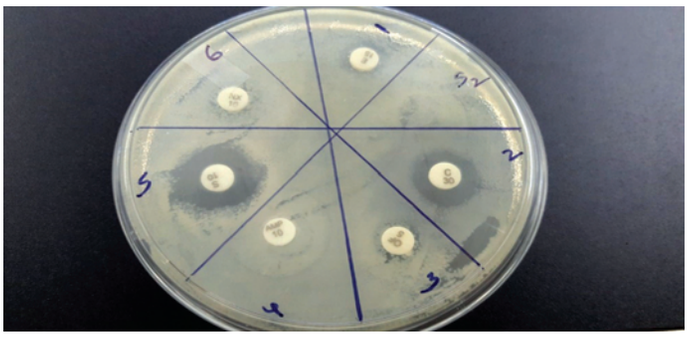


Fig. 14. Streptomycin showing susceptible zone of inhibition for *E. coli* isolates

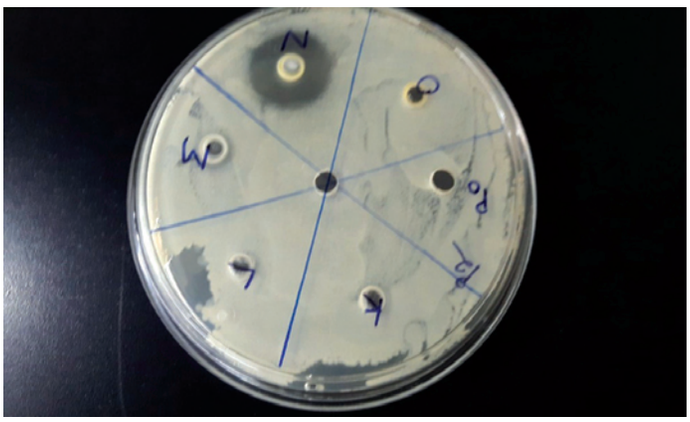


Fig. 15. Cinnamon bark oil showing zone of inhibition for *E. coli* isolates

3. Technologies Assessed and Transferred

Germplasm Supply

The improved chicken germplasm was supplied to various parts of the country from Kasmir to Kanyakumari and Gujarat to Andaman & Nicobar Islands. A total of 3.61lakhs of improved germplasm was distributed from ICAR-DPR (Table 1). In addition, AICRP and PSP centres supplied about 7.7 lakhs of improved germplasm across the country.

Distribution of improved chicken varieties under Mera Gaon and Mera Gaurav program

Directorate of Poultry Research has adopted four villages under "Mera Gaon Mera Gaurav programme" to popularize the technologies developed by the institute; to appraise the socio economic condition of the people; to improve the livelihood condition of the people in rural/tribal areas. Initially, the baseline information was collected from the villages to understand the socioeconomic status of the people. Based on the information four villages which are mainly inhabited by tribals with small land holdings and landless labourers engaged in agricultural and animal husbandry activities were selected. A total of 1470 chicks of improved varieties were distributed in adopted villages to improve the nutritional and socioeconomic status of the tribals. A team of scientists are periodically monitoring their growth, health and nutritional status. The Institute scientists from time to time were providing technical advirsories related to poultry farming as well as allied activities.

Table 1 Germplasm supply

Sl. No.	Particulars	No.
I	**DPR**	
A.	**Hatching eggs**	
	Vanaraja	24,381
	Gramapriya	8,378
	Krishibro	283
	Srinidhi	12,186
	Layer	27,925
	Others	3,634
	Total	***76,787***
	Embryonated eggs	11,933
B.	**Day old chicks**	
	Vanaraja	1,50,181
	Gramapriya	50,183
	Krishibro	10,462
	Srinidhi	17,520
	Layer	246
	Total	***2,28,592***
C.	**Parent chicks**	
	Vanaraja	18,427
	Gramapriya	24,609
	Krishibro	27
	Srindihi	*1,985*
	Aseel	*723*
	Total	***45,771***
D.	**Grownup birds**	***10,651***
	Net total (A+B+C+D)	**3,61,801**
II	**AICRP**	**5,28,578**
III	**Poultry Seed Project**	**2,48,097**
	Grand Total (I+II+III)	**11,38,476**

Distribution of chicks under MGMG programme at Korravani Thanda

Table 2 Number of birds distributed in the adopted village

	Name and address of the adopted villages	No of households	No of birds distributed
1	Bavoji Thanda, Nerellapally (GP), Balanagar (Mandal), Mahbubnagar (District), Telangana	31	450
2	Korravani Thanda, Manchala (Mandal), Ranga Reddy (District)	150	580
3	Punia Naik Thanda, Keshampet (Mandal), Mahbubnagar (District), Telangana	33	120
4	Balijarala Thanda, Keshampet (Mandal), Mahbubnagar (District), Telangana	31	320

Organized Model Training Course on "Rearing and propagation of backyard poultry farming"

Institute organized a Model Training Course on "Rearing and propagation of backyard poultry farming" during 29 October – 5 November 2015, sponsored by Directorate of Extension, Ministry of Agriculture, Govt. of India. A total of 21 Animal Husbandry Officers belonging to nine states attended the training programme. The trainees were exposed to various aspects of poultry production such as breeding, nutrition, management and health care in relation to rural poultry farming. 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 4 lakh layer capacity was arranged.

Trainees along with Director and course faculty

Organized training program on "Scientific Poultry Farming"

A training program on "Scientific Poultry Farming" from 1 - 5 December 2015 was arranged for unemployed youths graduates from NGO, Sayras Welfare Society of Betul district Madhya Pradesh. The training was imparted on different aspects of poultry farming including hatchery management, farm management, feed formulations, bio-security measures, rural chicken varieties, disease control measures etc. A manual containing the basic concepts of poultry management was provided to the participants.

Participated in Poultry India 2015

The Directorate participated in Poultry India 2015 exhibition organized by IPEMA at Hitex, Hyderabad from 25 - 28 November 2015. The Institute 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* fascinated the poultry farmers.

Participated in Farmers day at IIOR

The Institute participated in the Farmer's day organized by ICAR-Indian Institute of Oil Seed Research (IIOR), Hyderabad on 12 September 2015. Farmers took keen interest in the technologies developed by the Institute. During this occasion, literature on the improved chicken varieties were distributed to the farmers.

Participated in Farmers day at IIRR

The Directorate participated in the Farmer's day organized by ICAR-Indian Institute of Rice Research (IIRR), Hyderabad on 7 November 2015. DPR stall attracted the attention of the farmers and visitors at the exhibition. The literature on the improved chicken varieties was distributed to the farmers.

Participated at Southern Regional Agricultural Fair, ANGRAU, Guntur

The Directorate participated in the Southern Regional Agricultural Fair organized by ANGRAU, Guntur from 19 - 21 December 2015. The technologies displayed at the exhibition attracted many farmers and visitors. The literature on the improved chicken varieties was distributed to the farmers.

Participated in Exhibition and National Seminar at NAARM

Institute participated in the exhibition organized by RICAREA on 13 - 14 December 2016 at NAARM, Hyderabad on the occasion of the National Seminar on "Integrated farming systems for improving the livelihood of farmers". DPR stall attracted the attention of scientists and visitors at the exhibition.

Krishi Unnati Mela at IARI, PUSA, New Delhi

ICAR-DPR participated in prestigious Krishi Unnati Mela organized by ICAR and Govt of India, Ministry of Agriculture and Farmers welfare from 19 - 21 March 2015. Institute depicted the various technologies developed at the institute. The improved chicken varieties developed at the institute attracted the attention of the farmers and visitors at the exhibition. Hon'ble Director General Dr.T.Mahapatra visited the stall.

Jai Kishan Jai Vigyan Programme

Organized the Jai Kishan Jai Vigyanprogramme from 23 - 29 December 2015 at our Institute. During this programme, the farmers from Bhavajithanada, Mahbubnagar Dist were made acquainted to the routine poultry farm operations, brooding and poultry feed mixing.

Organised a Training Programme

The Directorate organised a training programme to the trainees from the CPDO&TI, Bangalore from 25 - 27 February 2016. In this training programme a total of eleven trainees participated of which four were national and seven were from overseas.

DPR at different exhibitions

Distribution of chicks under *Mera Gaon Mera Gaurav* programme

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 1.

Table 1 Participation in Training and Capacity building activities

Sl. No.	Particulars of training	Official (s)	Duration	Venue
1	Brainstorming workshop on "Strengthening of KVK as a knowledge centre	Dr. B. Prakash, Scientist Dr. Shanmugam M, Scientist	15 April 2015	NAARM, Hyderabad
2	Molecular Genetic Characterization of Farm Animal Genetic Resources	Dr. S.P. Yadav, Sr. Scientist	20-26 April 2015	NBAGR, Karnal
3	Brainstorming Workshop on Up-scaling Quality Protein Maize (QPM) for Nutrition scaling Quality Protein Maize (QPM) for Nutrition Security	Dr. B. Prakash, Scientist	20-21 May 2015	NASC complex, New Delhi
4	First workshop of Nodal Officers of KRISHI: ICAR Research Data Repository for Knowledge Management	Dr. Santosh Haunshi, Sr. Scientist	4-5 August 2015	NASC complex, New Delhi
5	Workshop on "High throughput Genotyping with Fludigen Technology"	Dr. K.S. Rajaravindra, Scientist	3-4 September 2015	Hyderabad
6	National workshop on "Current Trends in Agricultural Bioinformatics"	Dr. S.P. Yadav, Sr. Scientist	22-24 September 2015	NAARM, Hyderabad
7	Quantitative Techniques for Analysis of Breeding Experiments	Dr. U. Rajkumar, Pr. Scientist	2–7 November 2015	NAARM, Hyderabad
8	Knowledge Day Seminar by Poultry India	Dr. M.V.L.N., Raju, Pr. Scientist Dr. M. Niranjan, Pr. Scientist Dr. U. Rajkumar, Pr. Scientist Dr. D. Suchitra Sena, Pr. Scientist Dr. B. Prakash, Scientist Dr. M. Shanmugam, Scientist Dr. T.R. Kannaki, Scientist Dr. K. S. Rajaravindra, Scientist Dr. S.K. Bhanja, CTO	24 November 2015	Novotel, Hitech City, Hyderabad
9	DAAD Indo-German Workshop on "Biochemical and Molecular Analysis of Medicinal Plants as a Source of Life Saving drugs".	Dr. D. Suchitra Sena, Pr. Scientist	7 December 2015	CSIR-IICT, Hyderabad
10	Workshop on Technical Literature in Hindi	Dr. S.P. Yadav, Sr. Scientist Sri J. Srinivas Rao, Sr. Technical Officer	9 December 2015	MANAGE, Hyderabad
11	Competence Enhancement Programme for Technical Officers of ICAR	Dr. Daryab Singh, CTO Dr. R.V. Rao, CTO	14-23 December 2015	NAARM, Hyderabad
12	Workshop on Multicolour Flow Cytometry	Dr. T.R. Kannaki, Scientist	3-5 February 2016	NIAB, Hyderabad
13	Training Work shop on Competency Development for Human Resource Development Nodal Officers of ICAR	Dr. B.L.N. Reddy, Pr. Scientist	10-12 February 2016	NAARM, Hyderabad
14	Brain Storming Workshop on Transgenic Livestock by Dept. of Biotechnology, Govt. of India	Dr. T.K. Bhattacharya, National Fellow	19-20 February 2016	NIVEDI, Bengaluru

Talks delivered

- Dr. Chandan Paswan, Scientist delivered a talk on "Animal model and its application in animal breeding" on 31 August 2015.
- Dr. S.V. Rama Rao, Pr. Scientist delivered a talk on "Enzyme application in poultry diet" on 11 December 2015.
- Dr. K.S. Raja Ravindra, Scientist delivered a talk on "Concept of Breeding for disease resistance in chicken" on 23 February 2016.

5. Awards and Recognition

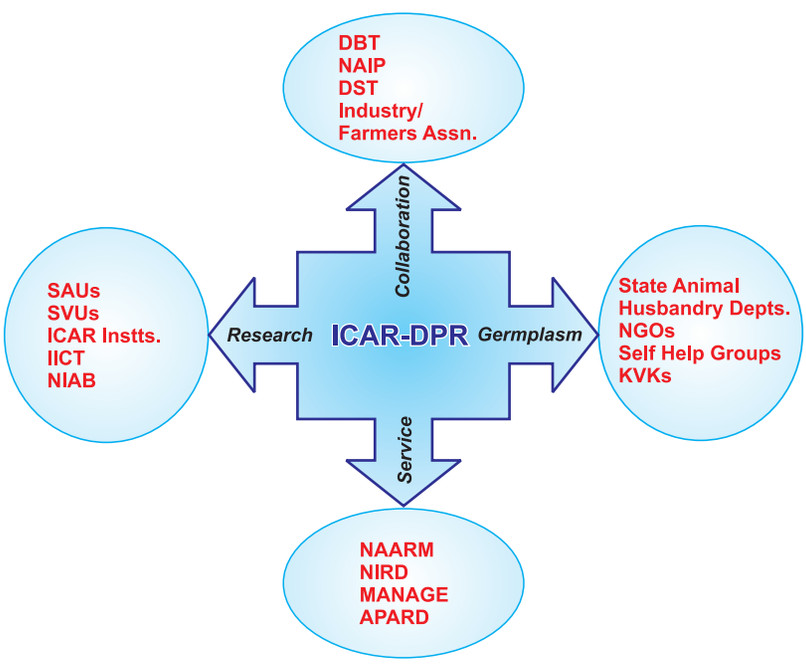
The research and extension services of the Directorate received appreciation from different professional bodies.

- Dr. M. Niranjan, received 2nd Best Oral presentation Award during IPSACON-2015 held at Kerala Veterinary and Animal Sciences University, Pallakad, Kerala.
- Dr. D. Divya, received 2nd Best Oral presentation Award during IPSACON-2015 held at Kerala Veterinary and Animal Sciences University, Pallakad, Kerala.
- Best Poster Award for poster by P. Satheesh Kumar, P., Bhattacharya, T.K., Kumar, P., Chatterjee, R.N. and Paswan, C. at IPSACON-2015 held at Kerala Veterinary and Animal Sciences University, Pallakad, Kerala.
- Dr. S.K. Bhanja received 3rd Best Oral Presentation Award during IPSACON 2015.held at Kerala Veterinary and Animal Sciences University, Pallakad, Kerala.
- Dr. S.V. Rama Rao, received Best Poultry Scientist Award 2015, 3rd Edition, PF Awards, Poultry CEOs Forum India 2015.

Dr. S.V. Rama Rao, Pr. Scientist receiving the award

6. 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 SPVNRTVU, Hyderabad; PJTSAU, Hyderabad; KVAFSU, Bangalore and JNTU, Hyderabad for carrying out their dissertation works. The scientists of this Institute guided the research works of the students as co-chairman/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 neighboring Institutions like NAARM, SVVU, PJTSAU, TANUVAS, MANAGE, NIRD 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

7. AICRP on Poultry Breeding and Poultry Seed Project

AICRP on Poultry Breeding

The AICRP on Poultry Breeding has been in operation with the aim of developing location specific varieties for rural poultry utilizing both indigenous and exotic chicken germplasm. The AICRP on Poultry Breeding has been re oriented towards the rural poultry during XII plan with three objectives; (1) To develop location specific chicken varieties and their dissemination for village poultry; (2) Conservation, improvement, characterization and application of local native, and elite layer and broiler germplasm and (3) To develop package of practices for village poultry and entrepreneurships in rural, tribal and backward areas. All the elite layer strains (IWN, IWP, IWD, IWF, IWI, IWH, IWK and Control) will be conserved at respective centres and subjected to selective breeding through intra-population selection. Selection (using individual, full-sib, and half-sib information) for egg production up to 64 weeks of age with superimposed independent culling level for egg weight at 28 weeks of age and layer house viability has been continued.

The coloured broiler parent lines used in the AICRP were synthetic sire lines (PB-1, CSML), dam line (PB-2 and CSFL) and Control line. All the elite broiler strains will be conserved at respective centres and subjected to selective breeding through mass selection for 5 weeks body weight with due weightage for conformation traits in male lines and 5 weeks body weight and egg production with hatchability in female lines. A total of 6 centres, ICAR Research Complex for NEH region, Agartala; NDVSU, Jabalpur; AAU, Guwahati; BAU, Ranchi; CSKHPKV, Palampur and MPUAT, Udaipur were involved in rural poultry production under AICRP on Poultry Breeding. All the centres were working on the development of location specific rural poultry varieties utilizing the local native chicken germplasm in addition to the conservation of elite layer and broiler lines at some centres.

The KVASU, Mannuthy centre has evaluated S-0 generation of native chicken germplasm up to 40 weeks of age. Egg production of native chicken germplasm up to 40 weeks of age was 69.83±0.96 eggs with average egg weight of 43.65±0.20 g (Table 1). Further, regeneration and evaluation of pedigreed population up to the age of sexual maturity was carried out in S-1 generation. High fertility (94.9%) and hatchability (95.39 and 90.55% on FES and TES) was observed in native chickens. Age at sexual maturity was 157.5±1.19 days in S-1 generation. Besides, the centre evaluated IWN and IWP strains up to 64 weeks of age in S-28 generation along with layer control population (Table 1). Hen housed egg production up to 64 weeks of age decreased by 8.1 in IWN strain but it has increased by 6.2 in IWP strain in S-28 generation on phenotypic scale. Average genetic response for 64 weeks hen housed egg production was 4.04 and 7.74 eggs respectively in IWN and IWP strains during last five generations. The direct response to egg production up to 64 weeks of age in IWN and IWP strains during last 10 generations is presented in Fig. 1. Sample population of IWN and IWP strains evaluated up to 72 weeks of age produced 302.82±2.18 and 308.27±2.34 eggs on hen housed basis during 2015-16. The centre has generated an amount of Rs. 39.82 lakhs, which was 101.9% of the total expenditure on feed (Rs. 39.07 lakhs) as revenue.The centre has supplied a total of 35873 number germplasm during the year.

At AAU, Anand, chicks of S-0 generation of native birds and RIR were produced by pedigreed mating. The chicks of F_1 cross (IWN X Native) were produced by mating IWN males with native chicken females. The chicks of F_1X RIR forfarm testing were produced by crossing F_1 males with RIR females. Fertility of native chicken (85.80%) was lesser as compared to RIR breed (91.75%). However hatchability (FES) was better in native chicken (85.30%) as compared to RIR (72.39%). Further, S-12 generation of IWN and IWP strains along with control layer population was evaluated up to 64 weeks of age during the reporting period. Egg production up to 64 weeks of age was

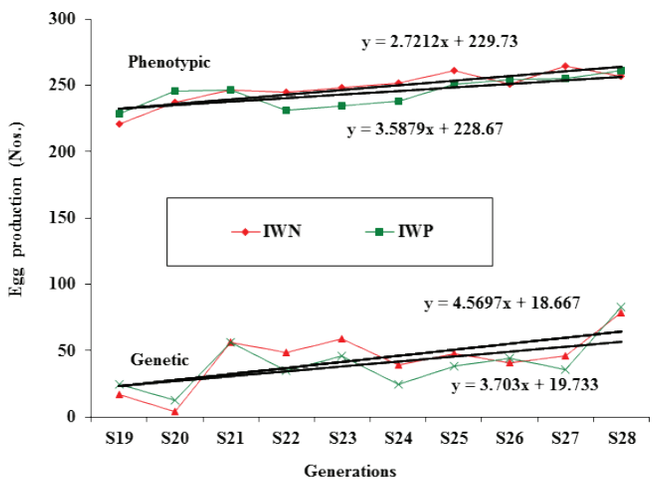


Fig. 1. Direct response to egg production up to 64 weeks of age in IWN and IWP strains at Mannuthy centre

Table 1 Growth and production performances in S-28 generation of IWN and IWP strains and control layer population

Traits	IWN		IWP		Control	
	n	Mean ± SE	n	Mean ± SE	n	Mean ± SE
Body wt. (g)						
16 wks	1051	1036.75±2.62	1034	1054.33±2.72	149	1014.26±6.61
40 wks	1026	1561.01±6.07	993	1530.33±5.79	145	1648.72±19.77
64 wks	**830**	**1544.00 ±6.31**	**921**	**1585.00±6.34**	**133**	**1579.77±20.65**
ASM (days)	1045	144.46±0.43	1030	139.65±0.42	149	153.09±1.23
Egg weight (g)						
28 wks	1014	48.00±0.10	983	48.22±0.09	139	48.11±0.28
40 wks	1006	52.16±0.10	980	51.46±0.11	142	52.21±0.31
64 wks	**849**	**54.16±0.37**	**909**	**55.30±0.13**	**119**	**51.11±0.47**
EP to 40 wks (Nos.)						
Hen housed	1051	122.43±0.73	1034	123.34±0.83	149	89.06±1.88
Survivors'	1029	124.26±0.61	1004	126.45±0.62	145	90.94±1.73
Hen day: 17-40 wks	-	123.74		125.15	-	90.23
Hen day: 21-40 wks	-	121.57		122.18	-	90.11
EP to 64 wks (Nos.)						
Hen housed	**1051**	**256.69±1.52**	**1034**	**261.35±1.4**	**133**	**177.61±4.44**
Survivors'	**923**	**263.76±1.30**	**934**	**268.22±1.03**	**134**	**194.03±3.85**
Hen day: 17-64 wks	-	**261.16**		**266.70**		**192.06**
EP to 72 wks (Nos.)						
Hen housed	**300**	**302.8±2.18**	**300**	**308.3±2.34**	**-**	**-**
Survivors'	**290**	**305.3±1.80**	**291**	**310.7±1.90**	**-**	**-**
Hen day: 17-72wks	**-**	**305.1**		**310.6**	**-**	**-**

higher in IWN (253.1) than IWP (243.6) strain (Table 2). However, it has decreased by 6.5, 11 and 12.5 eggs respectively in IWN, IWP and control population in S-12 generation over previous generation. Similarly, 72 weeks egg production in IWN (294.2) and IWP (275.0) strains decreased by 7.6 and 25.3 eggs respectively in S-12 generation over preceding generation (Table 2).The direct response to egg production up to 64 weeks of age in IWN and IWP strains during last 10 generations is presented in Fig. 2. S-13 generation of IWN and IWP strains was reproduced and evaluated up to the age of sexual maturity. Better fertility was observed in IWN (90.16 %) and IWP (92.24%) strains in S-13 generation as compared to previous generation. Genetic response for egg production up to 64 weeks of age in IWN and IWP strains were 1.03 and 1.51 respectively over last 10 generations. The centre has also evaluated IWD and IWK strains up to 64 weeks of age in S-4 generation (Fig. 2). The S-5 generation of these strains was produced and evaluated up to the age of sexual maturity. The centre has generated revenue of Rs. 20.43 lakhs which was 50.48% of the expenditure on feed cost.The centre supplied a total of 44,337 number germplasm during the present year.

Bangalore centre has initiated purification of indigenous germplasm collected from different parts of Karnataka. The body weight of indigenous

Table 2 Performance of IWN and IWP strains and Control population in S-12 generation

Traits	IWN	IWP	Control
No. of pullets housed	1027	1048	173
ASM (days)	138.3 ±0.35	141.9 ± 0.36	144.7 ±0.71
Body weight (g)			
16 wks	1028± 2.92	1025±2.88	960 ±7.94
40 wks	1629± 5.28	1645±5.42	1640± 12.86
64 wks	**1690 ± 7.60**	**1736 ± 7.55**	**1619± 18.96**
72 wks	**1682 ± 14.9**	**1881 ± 13.8**	**-**
Egg production up to 40 weeks (Nos.)			
Survivors	127.4± 0.45	121.2 ± 0.53	104.0 ± 1.38
Hen housed	124.65	114.42	96.40
Hen day	127.18	116.84	97.31
Egg production up to 64 weeks (Nos.)			
Survivors	**253.1± 0.98**	**243.6 ± 1.12**	**206.1 ± 2.67**
Hen housed	**237.81**	**224.56**	**189.73**
Hen day	**250.28**	**238.18**	**198.04**
Egg production up to 72 weeks (Nos.)			
Survivors	**294.2± 2.17**	**274.96± 2.20**	**-**
Hen housed	**275.91**	**253.23**	**-**
Hen day	**291.27**	**270.78**	**-**
Egg weight (g)			
28 wks	49.32± 0.09	49.77 ± 0.09	47.12 ± 0.16
40 wks	53.57± 0.10	54.49 ± 0.10	54.79 ± 0.27
64 wks	**52.83± 0.13**	**52.76 ± 0.16**	**54.58 ± 0.42**
72 wks	**54.66± 0.18**	**55.61 ± 0.18**	**-**
Feed consumption /bird (kg)			
0-08 wks	1.58	1.56	1.68
9-16 wks	3.41	3.41	3.39
17-40 wks	18.93	18.65	18.78
17-64 wks	**38.03**	**37.62**	**37.66**
17-72 wks	**44.48**	**44.03**	**-**

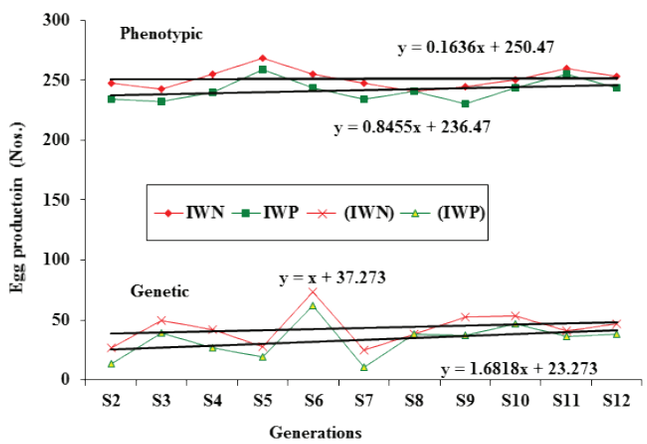


Fig. 2 Direct response to egg production to 64 wks in IWN and IWPstrains at Anand Centre

germplasm at day old, 8, 12 and 20 weeks of age was 32.20, 470.13, 987.12 and 1311.05 g, respectively. The S-8 and S-21 generation of PB-1 and PB-2 along with Control line was regenerated and evaluated for juvenile traits. The average body weight at 5th week of age in PB-1, PB-2 and control lines were 1041 ±2.77, 1171±2.71 and 814±11.51 g, respectively. The body weight at 5th week of age increased in PB-1, PB-2 and Control lines over previous generation. The FCR showed marginal improvement in all lines as compared to previous year. The fertility was 88.37, 89.29 and 84.86 % in PB-1, PB-2 and Control, respectively. The average selection differentials in males and females of PB-1 and PB-2 were 231.14 and 95 g and 188.42 and 82.43 g, respectively. The intensity of selection was 1.52 and 1.64 for PB1 and PB2 populations, respectively. ASM decreased in PB-2 and Control line in S-20 generation as compared to previous generation. The average phenotypic and genetic response of body weight at 5th week over 10 generations in PB-2 was 14.07 and 8.218 g, respectively (Fig. 3). Corresponding values for egg production up to 40 weeks of age over 10 generations in PB-2 was -0.816 and -1.062 egg (Fig. 4). A total of 1, 17,998 germplasm were supplied to farmers and other stakeholders during the current year. The center generated revenue of Rs. 33.79 lakhs which is 126.66 % of expenditure on feed cost (Rs.26.67 lakhs).

Ludhiana center has started evaluation of body weight and egg production performance of native chicken germplasm collected from field. A total of 552 day old native chicks were housed for recording different economic traits. The average body weight of local chicks at day one, 4th and 8th week was 36.68±0.17, 235.88±3.71 and 745.55±10.8g, respectively. The centre regenerated S-40 generation of PB-2 and S-8 generation of PB-1 population along with DPR Control population. The body weight

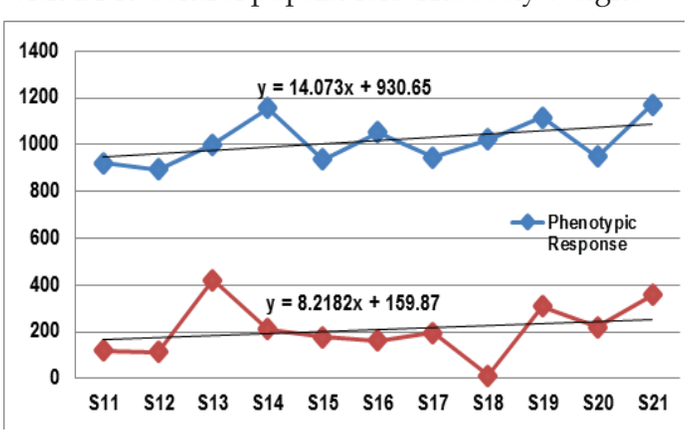


Fig. 3 Genetic and phenotypic response to 5 week body weight in PB-2

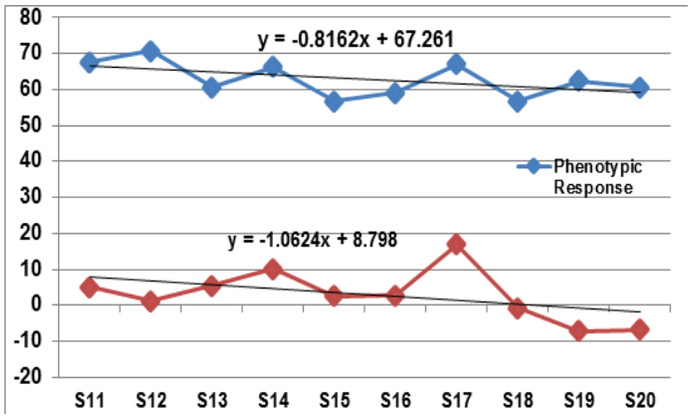


Fig . 4 Genetic and phenotypic response of Egg Production upto 40 wk in PB2

at 5 weeks of age was 1173.89±4.23, 1006.33±3.31 and 784.72±11.07g in PB-1, PB-2 and Control populations, respectively. The body weight at 5 weeks of age decreased in both the lines from previous generation. The feed efficiency up to 5 weeks of age decreased in PB-1, PB-2 and Control lines over last generation. The phenotypic and genetic response at 5 week body weight over last 10 generations was 9.03 and 39.61g in PB-2 population(Fig. 5). The phenotypic response of egg production up to 40 weeks of age was -1.25 egg and genetic response was 1.69 egg over 10 generations (Fig. 6). The fertility was 92 % and hatchability on TES basis was 80% in PB-1 and PB-2. The fertility and hatchability on TES decreased in PB-1 and these values increased in PB-2 and Control lines as compared to last generation. During grower period very high mortality of 21.5 and 20.78% was recorded in PB-1 and Control respectively. Centre needs extra attention on health management of the flock. The age at sexual maturity increased in PB-1, PB-2 and Control population as compared to previous generation. There was appreciable increase in the egg production up to 40 and 52 weeks of age in all the lines. Commercial cross in the field attained body weight of 1057g at 5 weeks of age. Centre supplied 33,528 germplasm to the farmers. The center generated a revenue of Rs. 14.67 lakhs.

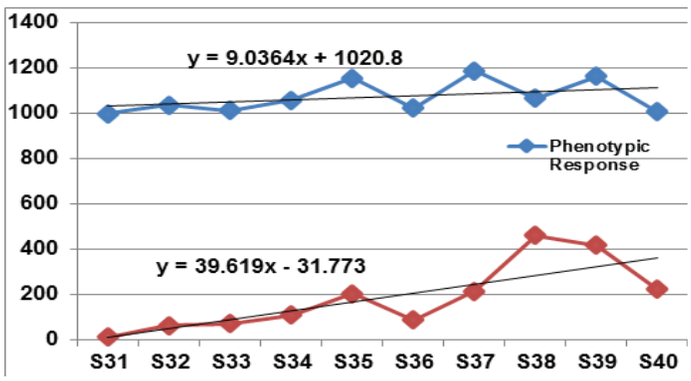


Fig. 5 Genetic and phenotypic response to 5 week body weight in PB2 at Ludhiana

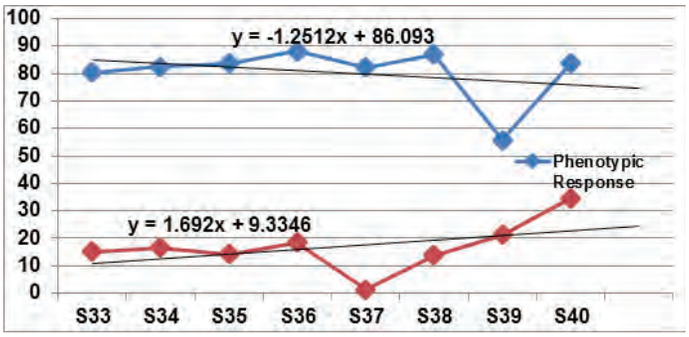


Fig. 6 Genetic and phenotypic response toEP40 in PB2 at Ludhiana

CARI, Izatnagar centre has regenerated native chicken collected from farmers. A total of 78 chicks were hatched in three hatches of native chicken eggs. The average shank length and keel length at 8th week of age of native chicken were 5.05±0.58 and 6.06±0.31 cm, respectively. The breast angle at 8th week was 45.50±2.01 degree. The body weights of native birds at day one and 5th week was 32.27±0.62 and 216.44±17.24 g, respectively. The juvenile traits and production traits up to 52 weeks were recorded in CSML and CSFL populations. The fertility in CSML, CSFL and Control population (S-14) was 88.22, 91.67 and 86.48 %, respectively and the hatchability on TES were 81.87, 85.09 and 75.95%, respectively in these respective populations. The body weight at 5th week decreased in all populations over last generation. The ASM of CSML and CSFL during S-13 were 182.53 and 179.30 days, respectively. The 40 week egg production decreased in CSML and CSFL, while 40 weeks egg weight increased as compared to previous generation. A random bred control population was also evaluated to measure environmental fluctuations. The present generation of elite germplasm was reproduced utilizing 50 sires and 300 dams in CSML and 56 sires and 312 dams in CSFL. The average effective selection differential increased over the last generation in CSML and CSFL. The center supplied 48,787 germplasm to the stakeholders.

Bhubaneswar centre completed regeneration of new population of native chicken germplasm. A hatch of 1093 good chicks of native chicken was taken. The birds were housed for recording of baseline data related to juvenile traits, ASM, body weights, egg production performance and mortality pattern. Center evaluated S-4 generation of CSFL and CSML for juvenile traits and S-3 generation of CSFL and CSML were evaluated for production traits. The overall fertility in CSFL and CSML was 89.86 and 89.86 %. The hatchability on TES and FES in the current generation was lesser than the previous generation. The body weight at 5

weeks of age of CSML, CSFL and Control population were 1102.18±3.69 (3326), 100.9±3.14 (2844) and 787.03±12.21 g, (339) respectively. The body weight at 5 weeks of age of CSML and CSFL increased both in CSFL, CSML and Control population in the current generation. FCR up to 5 weeks of age in respective populations were 1.93, 1.97 and 1.98, respectively. FCR up to 5 week of age increased marginally in CSFL but decreased CSML and Control population over previous generation. ASM of current generation in CSFL and CSML was more as compared to previous generation. Egg production up to 40 and 52 week increased appreciably in CSFL as well as CSML. The centre generated revenue of Rs 8.2 lakh which is 31.72% of cost incurred on feed. During current year center supplied 38,754 germplasm to the farmers.

Random Sample Poultry Performance Test

The Bangalore, Ludhiana and CARI centers participated in the 44th RSPPT at Gurgaon, Haryana during 2015-16. The average body weights of Raja - II (PB1 x PB2) of Bangalore at 6 and 7 weeks of age were 1604 and 1792 g. The feed efficiency was 2.47 between 0 - 6 weeks and 2.93 between 0 - 7 weeks of age .The body weight of IBL-80 of Ludhiana at 6th and 7th week was 1422 and 1782 g, respectively. The FCR at 6th and 7th weeks was 2.638 and 2.711. The dressing per cent was 72.46. The IBL-80 ranked 4th. The Body weight of CARIBRO - Vishal at 6 and 7 weeks of age were 1588 and 1886 g, respectively. FCR up to 0-6 weeks and dressing were 2.3 and 73.9%, respectively. CARIBRO- Vishal of CARI, Izatanagar, ranked 3rd.

Agartala centre evaluated Tripura black and Dahlem Red up to 72 weeks; ND cross and CSFL populations up to 40 weeks of age. Three-way cross ((Tripura black X CSFL) X DR) was evaluated up to 52 weeks of age. The fertility ranged from 69.93 to 82.69%. The body weight at 8 weeks was 312.73, 539.25, 1045.81 and 547.09 g in Tripura Black, Dahlem Red, coloured broiler dam line and three way cross, respectively. The pullets matured late by 2days in Tripura black and 1 day late in Dahlem Red population. Egg production upto 40 weeks of age was 38.90 and 57.22 eggs in Tripura Black and Dahlem Red, respectively. The 72 week egg production was 89.34 eggs in Tripura black and 139.56 eggs in Dahlem Red population. In ND cross, age at first egg was 162 days, egg production upto 40 weeks of age was 47.54 eggs. Tha age at first egg and egg weight at 40 weeks of age was 165 days and 55.88g in three-way cross. The egg production at 40 and 52 weeks of age was 46.15 and 82.50 eggs in three-way cross. During the year, the centre supplied 14,193 chicks of Dual purpose (NBD), native (Tripura black) and other crosses. The centre realized overall receipt of Rs.9.54 lakhs which was 35.43% of the expenditure on feed cost.

During the current year, the Jabalpur centre released *Narmadanidhi,* a dual type chicken having 25% Kd: 75% JBP colour inheritance. The centreevaluated G-6 generation of Kadaknath (Kd) and Jabalpurcolourpopulations up to52 weeks of age. A dual type chicken (25% Kd. 75% Jabalpur colour), *Narmadanidhi* was evaluated in the field up to 72 weeks of age. The fertility remained above 82% in all the populations.During G-6 generation, the 6 week body weight was 339 and 772g in Kadaknath and Jablpur population. The pullets of Kadaknath and Jabalpur colour populations matured early by 2 and 4 days, respectively.In Jabalpur colour, the body weight and egg weight at 40 weeks of age was 2116 g and 59.60g, respectively. In Kadaknath, the 40 week body weight and egg weight were 1520g and 48.3g, respectively.The hen housed egg production up to 40 weeks of age was 86.20 eggs in JBL population and 49.10 eggs in Kadaknath population. In CSFL 40 week egg weight and production were 59.0g and 60.8 eggs, respectively. *Narmadanidhi,* was evaluated under farm and field condition. This variety produced 71 and 142 eggs up to 40 and 52 weeks at farm. This cross produced 49, 79 and 178.2 eggs, respectively, up to 40,52 and 72 weeksin field conditions. The germplasm supplied during the year was 58,236. The center realized overall receipt of Rs.13.16 lakhs which was 50.13% of the expenditure on feed.

Guwahati centre evaluated the native, Dahlem Red, PB-2 and BN populations up to 52 weeks of age. The centre also evaluated Kamrupa (PB-2 X Indigenous) X Dahlem Red female)up to 52 weeks of age in farm and field conditions. The fertility was above 75% in all the population except BN cross (63.25%). The mortality during brooding and growing period was below 3.80% and below 2.11 % during laying period in all lines. The 5 week body weight was 115.90 g in indigenous, 1040.51g in PB-2 and 350.62g in Dahlem Red. The ASM was lowest in Dahlem Red (162 days) and highest in indigenous (180 days). Indigenous birds matured late by 2 days and Dahlem Red pullets by one day as compared to previous generation. In native population the egg weight and egg production up to 52 weeks remained same as compared to previous generation. In BN cross, the five weeks body weight was 230.20 g and FCR was 3.15. The age at sexual maturity was 171.80 days and remained similar

as compared to previous generation. The hen housed egg production up to 52 weeks was 69.86 eggs. During the current year, the *Kamrupa* cross was evaluated up to 52 weeks in farm and field conditions. The 5 week body weight was 210.30g and 160.25g in the farm and field, respectively. The age at sexual maturity was 152.60 days in the farm and 174.80 days in the field. The egg weight at 40 weeks of age was 56.80 and 41.10g, respectively, in farm and field. The hen housed egg production upto 40 and 52 weeks of age was 46.90 and 87.30 eggs in the farm and corresponding values in the field were 41.90 and 71.50 eggs, respectively. The performance of cross was constant over last two generations.The centre supplied 3195 hatching eggs and 20,936 chicks of *Kamrupa* to farmers.The center realized receipt of Rs. 4.53 lakhs during the financial year which is 34.68% of expenditure on feed cost.

Ranchi centre evaluated G-4 generation of native population upto 72 weeks of age. The G-5 generation was reproduced and evaluated up to 20 weeks of ageduring the current year. The BN (PB-2 X Native Female) was evaluated up to 20 weeks of age. BND (PB-2 X Native Female) X Dalhem Red female) and DBN ((Dahlem Red males) X (PB-2 male x Desi female)) crosses were evaluated upto 40-72 weeks under farm and field conditions. The fertility ranged from 80.32 to 94.01% in all the lines. The fertility improved in all the lines and crosses except in DahlemRed population as compared to previous generation. The hatchability on TES was 64.29- 77.03% and it improved in all the poplations in the current year.In native population, production traits were evaluated from 40-72 weeks of age during G-4 and in G-5 generation body weights and age at first lay was recorded. Pullets in the G-5 generation matured 7 days late as compared to G-4 generation. The annual hen housed egg production of native population was 73.48 eggs in G-4. In BN cross (E-2) hen housed egg production up to 72 weeks of age was 93.36 eggs.In three way crosses day old, 4, 8 and 20 week body weights were better in DNB than BND cross during E-5 evaluation. Age at first egg of the flock was higher in DBN (174 d) than BND (168 d) in the farm during E-5 evaluation. The hen day egg production up to 72 weeks of age was more in DNB cross (139.82 eggs) than BND cross (126.82 eggs) during E-4 evaluation under farm conditions. Under field conditions, DNB cross (111.13 eggs) produced more eggs than BND cross (96.19 eggs) up to 72 weeks of age. The centre supplied 8755 hatching eggs and 7020 chicks to the farmers. The center realized a receipt of Rs. 3.68 lakhs during the financial year which is 21.42% of expenditure on feed cost.

During current year, CSKHPKV, Palampur centre evaluated Native (G-3) and Dahlem Red (G-3) birds upto 52 weeks of age. D X Native cross was evaluated upto 52 weeks in the farm. DN X D ((Dahlem RedX Native) X DahlemRed) cross was evaluated in farm upto 52 weeks and in the field up to 40 weeks.The fertility was very good and ranged from 84.44 to 93.37% in all the populations. The hatchability on TES ranged from 58.08 to 71.61% in all the populations. The hatchability on FES ranged from 64.13 to 79.81% in all the populations. The 4 week body weight was 210.7, 184.36g and 199.80g in Dahlem Red, native, and DRxN populations, respectively. The pullets of native and Dahlem Red matured early by 6 days, as compared to previous generation. The egg weight was 55.90, 45.77 and 53.31g in Dahlem Red, native and DRxN population at 40 weeks. The hen housed egg production in Dahlem Red was 56.91 eggs up to 40 weeks of age whereas native population recorded 46.83 eggs. The hen hosed egg production up to 52 weeks of age was 83.26, 72.46 and 120.14 eggs in Dahlem Red, native and DRxN populations, respectively. The 52 week production showed improvement in native populations. The DNxD cross was evaluated under farm and field conditions up to 40 weeks of age. The 20 week body weight was 1602.81g in farm and 1447.76 g in field condition. The egg weight at farm and field condition is around 53g in both the places. The hen housed egg production in DNxD cross was 52.74 eggs in farm and 42.37 eggs in field conditions up to 40 weeks. This cross produced 86.62 eggs up to 52 weeks of age in the farm.The centre supplied 26,715 chicks of various crosses to farmers. The center realized receipt of Rs. 12.95 lakhs during the financial year which is 70.97% of expenditure on feed cost.

MPUAT, Udaipur evaluated G-4 generation of Native germplasm from 52-72 weeks of age and G-5 generation was regenerated and evaluated up to 52 weeks of age. *Pratapdhan* (BNR cross) was evaluated up to 72 weeks during E-4 and and up to 52 weeks in E-5.The fertility ranged from 78.81-84.71% in all the populations. The fertility improved in Mewari chicken and RIR populations and *Pratapdhan* showed marginal improvement. In Mewari population the juvenile body weights at 8 weeks marginally reduced (651.75g) during G-5 generation compared to G-4 generation. The 20 weeks body weight improved by 245.97g and 40 weeks body weight by 178.53g in G-5 generation as compared to G-4 generation. The pullets matured

4.38 days late as compared to previous generation. The hen housed and hen day egg production upto 52 weeks was 39.96 and 70.58 eggs, respectively, in S-5 generation. During S-4 genreration, hen housed and henday egg production was 95.09 and 73.14 eggs, respectively, up to 72 weeks of age. *Pratapdhan* was evaluated up to 72 weeks of age during E-4 evaluation. The age at sexual naturity was 151.27 days during E-4 and 144.54 days during E-5. The hen housed egg production up to 40 and 52 weeks Improved in E-5 as compared to E-4 evaluation. The hen housed and hen day egg production was 80.15 and 159.12 eggs during E-4 evaluations. In E-5 the hen housed and hen day egg production was 75.59 and 105.01 eggs up to 52 weeks of age. A total of 75,604 germplasm were supplied to farmers during the current year. The center realized a receipt of Rs. 11.33 lakhs during the current financial year which is 42.88% of expenditure on feed cost.

IV Receipts generated

During the current year, 12 AICRP centres supplied 5,28,578 germ plasm and an amount of about Rs. 2.02 crores has been generated as receipts by AICRP centres.

Table 3 Germplasm supplied and revenue generated during the year 2015-16

Centre	G. Supply	Revenue (Rs. Lakhs)
Mannuthy	35387	39.82
Anand	44337	20.43
Banglore	117998	33.79
Ludhiana	28195	14.67
Bhubaneswar	38754	8.21
CARI	48787	30.00
Udaipur	75604	11.33
Jabalpur	58236	13.16
Guwahi	24131	4.53
Palampur	26715	12.95
Rachi	15755	3.68
Agartala	14193	9.54
Total	528578	202.09

Poultry Seed Project

"Poultry Seed Project" launched on 15 May, 2009 was evolved with a sole aim to augment the availability of rural chicken germplasm in 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 and sanctioned six centres, three in the northeast region and three in the different state veterinary universities. The project was further strengthening during the XII plan by adding five more centres to cater to needs of the farmers in their respective regions. 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 for augmenting rural poultry production in terms of egg and meat production thereby improving the socio-economic condition of the target groups and linking small scale poultry producers with organized market.

The old centres are located at Bihar Agricultural University, Patna; West Bengal University of Animal and Fishery Sciences, Kolkata; Chattisgarh KamadenuViswaVidyalaya, Durg, ICAR Research complex, Nagaland regional centre, Jharnapani; ICAR Research complex, Sikkim regional centre, Gangtok; ICAR Research complex, Manipur regional centre, Imphal. The new centres at TANUVAS, Hosur, ICAR -CCARI, Panaji; ICAR-CIARI, Port Blair; ICAR-IVRI Regional Station, Mukteswar; SKUSAT, Srinagar were added during 2014-15. The Directorate as a coordinating unit, supplies parent chicks, co-ordinates and monitors the activities of different centres to enable them to achieve the set targets for each centre. The target set for supplying chicks for mainland and north-east centres during the year 2015-16 varies between 0.3 to 1.0 lakhs chicks per annum and to collect feedback on the performance of the germplasm supplied under backyard farm conditions. The germplasm supply targets for Nagaland (0.7 lakhs), Patna (0.50 lakhs) and Durg & Gangtok (0.40 lakhs) centres were revised in consultation with centre in-charges during the annual review meeting held at ICAR head quarters, New Delhi. During the period under report a total of 2, 48, 097 improved chicken varieties have been distributed in their respective regions/states.

Seven batches of *Vanaraja* parents were under rearing at Kolkata centre, out of which three batches were in active laying stage. The average hen day egg production at 40 weeks of age was 51.06 % across the batches in *Vanaraja* parents. The average egg production (HD) in *Vanaraja* parents in different age groups ranges from 22.08 (59-98 weeks) to 60.51% (25-69 weeks). The egg weight varies from 41.12 to 53.91 g in different cycles. The fertility ranged from 81.76 to 86.42% across the batches. In *Vanaraja* female parents' average hatchability on TES and FES ranged from 70 to 75 and 87 to 89 %, respectively. A total of

52,408 chicks of *Vanaraja* were distributed to farmers in various parts of West Bengal fetches a revenue of Rs. 6.24 lakhs. A total of 53 farmers/NGO/self help groups were benefited by rearing *Vanaraja* birds in West Bengal. The economic viability of the *Vanaraja* farming has been demonstrated that a net profit of Rs. 3060/- can be earn from a flock of 100 birds.

At Patna centre two batches of *Vanaraja* and one batch of *Gramapriya* parents were reared under deep litter system. The 20 week body weight was 3216.54±63.96g and 1783.35±40.14 g in *Vanaraja* male and female parents and 2558.20±42.77and 1496.82±33.46 g in *Gramapriya* male and female parents, respectively. The age at sexual maturity was 175 days in *Vanaraja* and 163 days in *Gramapriya* parents. The hen day egg production in *Vanaraja* and *Gramapriya* at 40 weeks of age was 16.43 % and 21.72 % respectively. The average fertility percentage was 80.46 and 82.56 % in *Vanaraja* and *Gramapriya* parents, while the hatchability (TES) was 54.38% and 50.67% in *Vanaraja* and *Gramapriya* parents, respectively. A total of 31,049 day old chicks and grown up birds were distributed among the farmers in Bihar and an amount of Rs. 7.8 lakhs revenue was generated.

At Durg centre three batches of *Vanaraja* and one batch of *Gramapriya* were reared under standard management practices in deep litter system. The body weight of *Vanaraja* and *Gramapriya* female parents at 20 weeks of age was 940.4 g and 1066.9 g which were low as per the standard target body weight. The egg production percentage ranged from 8.9 -54.8 % in *Vanaraja* and 7.2-54.1 % in *Gramapriya* during 56-72 weeks of age. The hatchability on total and fertile egg set in *Vanaraja* female parents was 75.33 and 81.44 %, respectively. A total of 28,976 improved chicken germplasm of *Vanaraja* and *Gramapriya* were distributed to the farmers across Chattisgarh and an amount of Rs. 6.36 lakhs revenue was generated.

A total of 1146 *Vanaraja* parents and 334 *Srinidhi* parents were maintained under deep litter system at Jharnapani centre. The body weight at 6 and 20 weeks of age were 626.73±64.76 and 1907.50 ±149.66 g in *Vanaraja* female parents. The hen day egg production ranged from 37 to 44 % in *Vanraja* parents and 49 to 53 % in *Srinidhi* parents, respectively. The fertility percentage varied from 60 to 64 % in *Vanaraja* and 63 to 72% in *Srinidhi* parents and the hatchability (FES) was 53 to 63 % in *Vanaraja* and 63 to 73 %, in *Srinidhi* parents across different batches. A total of 39,061 improved chicken germplasm was distributed to 173 farmers in Nagaland and neighbouring states. A total of 14.91 lakh revenue was generated.

At Sikkim centre, two batches of *Vanaraja* parents were reared one in laying phase (75 weeks) and another in growing (13 weeks). The body weight of male and female parents of *Vanaraja* at 6 weeks of age was 743 g and 564.4 g, respectively. The average hen day egg production in *Vanaraja* was 44.56 (25-76 weeks) with an average egg weight of 57.94 g. The average fertility and hatchability (TES) was 89 % and 73%, respectively. A total of 53,407 improved chicken germplasm was distributed to farmers across Sikkim and a total 1965 farmers from 406 villages in Sikkim were benefited with the *Vanaraja* farming. This centre generated revenue of Rs. 22.19 lakh and exceeded the target of germplasm supply.

At Imphal centre A total of 934 *Vanaraja* and 386 *Srinidhi* parents were maintained under standard management practices. The body weight at 16 weeks of age in male and female parents was 2262.89 and 2237.30 g in *Vanaraja* and 2779.09 and 1457.50 in *Srinidhi*, respectively. A total of 9,860 improved rural chicken germplasm was distributed to the farmers in Manipur. Entire flock was liquidated due to Avian Influenza outbreak in 2015.

At Hosur centre, one batch of *Vanaraja* and Granapriya parents were in position. The body weight at 6 weeks of age in male and female parents was 794.6 ± 10.4 and 519.3 ± 3.8 g in *Vanaraja* and 712.2 ±12.4 and 295.0 g in *Gramapriya*, respectively. The peak egg production attained at 28 weeks with 75% in *Vanaraja* and 80 % in *Gramapriya* and sustained up to 35 weeks. The fertility ranged from 72 to 92% in *Vanaraja* and 80-89 % in *Gramapriya* while The hatchability (TES) ranged from 68-89 % and 74-83 % in *Vanaraja* and *Gramapriya* female parents, respectively. A total of 18, 896 improved rural chicken germplasm was distributed to 193 farmers in Tamil Nadu with an amount of Rs. 3.24 lakhs revenue generation.

The civil work is in progress at Goa centre. The equipment procurement has been completed. The work was initiated with a batch of *Gramapriya* chicks in the existing facility. The body weight at 20 weeks of age in male and female parents of *Gramapriya* were 1798.67 and 1008.65 g , respectively. At 40 weeks the hen day egg production was 46 % in *Vanaraja*. The fertility and hatchability on total egg set was 82.6 and 60.2 %, respectively. A total of 3,885 improved rural chicken germplasm was distributed to 135 farmers in Goa. An amount of Rs. 3.47 lakhs revenue was generated.

The civil works and procurement of equipment is in progress at Port Blair. Two batches of 570 *Vanaraja* male and female parents in growing stage (9 weeks) were reared under deep litter system. The six week body weight was 397 and 498 g in female and male parents respectively. The age at sexual maturity (ASM) was 168 days. The 40 week hen day egg production was 50 % in *Vanaraja* parents and maintained for 6 weeks (46 weeks). A total 939 *Vanaraja* chicks were distributed in Andaman & Nicobar Islands utilizing the old facilities.

At Srinagar, the construction of brooder house (1000 sqft) was completed. Hatchery building is in final phases of completion. The centre has initiated the rearing of *Vanaraja* parents in the existing facilities. The body weight at 20 and 40 weeks of age was 2535.75±47.70 in male and 1712.32±30.78 g female parents of *Vanaraja*. The egg laying commenced at about 25 weeks of age in *Vanaraja*, and reached 50% production by 38 weeks of age. The age at first egg was 173 days. The egg weight at 40-44 weeks of age was 58.32 g. The hatchability on TES and FES was 65.67 and 80.67 % in *Vanaraja* parents. A total 9616 *Vanaraja* chicks were distributed among 700 farmers in Jammu and Kashmir with a revenue generation of Rs. 2.63 lakhs.

Table 4 Centre wise distribution of germplasm under Poultry Seed Project

Sl. No.	Centre	Germplasm
1	West Bengal University of Animal and Fishery Sciences, Kolkata	52,408
2	Bihar Agricultural University, Patna	31,049
3	ChathisgarhKamadhenuViswa Vidyalay, Durg	28,976
4	Regional Centre, ICAR Research complex, Jharnapani	39,061
5	Regional Centre, ICAR Research complex, Gangtok	53,407
6	Regional Centre, ICAR Research complex, Imphal	9,860
7	Tamil Nadu Veterinary and Animal Sciences University, Hosur	18,896
8	ICAR-Central Coastal Agricultural Research Institute, Goa	3,885
9	ICAR-Central Island Agricultural Research Institute, Port Blair	939
10	IVRI Regional Station, Mukteswar	--
11	Sher-e-Kashmir University of Agricultural Sciences and Technology, Srinagar	9,616
12	ICAR Research Complex, Barapani	
	Total	2,48,097

8. Publications

Research Articles

International

Bhattacharya, T.K., Chatterjee, R.N., Dushyanth, K., Paswan, C., Shukla, R., Shanmugam, M. 2015. Polymorphism and expression of insulin-like growth factor 1 (IGF1) gene and its association with growth traits in chicken. *British Poultry Science*, 17:1-10. DOI: 10.1080/00071668.2015.1041098

Bhattacharya, T.K., Chatterjee, R.N., Dushyanth, K., Paswan, C. and Guru Vishnu, P. 2015. Activin receptor 2A and activin receptor 2B genes in chicken: effect on carcass traits. *Journal of Applied Animal Research*, DOI:10.1080/09712119.2015.1091321.

Kannaki, T. R., Reddy, M. R., Verma, P. C., Shanmugam M. 2015. Differential Toll-like receptors (TLRs) mRNA expression patterns during chicken embryological development. *Animal Biotechnology*, 26: 130-135.

Krishna D., Ravinder Reddy, V., Raju, M.V.L.N., Sanjit, K., Nagarjuna, B.V.R. and Prasad, R.B.N. 2015. Effect of enzymes and liver tonic supplementation on performance of broiler chicken fed processed Pongamia (Pongamia glabra vent) cake. *Asian Journal of Animal Science,* 9:351-360.

Nagaraja Kumari, K., Ravinder Reddy V., Chinni Preetham V., Srinivas Kumar D., Arup Ratan Sen, Rama Rao S.V. 2016. Effect of supplementation of crystalline lyasine on the performance and WL layers in tropics during summer. *Tropical Animal Health and Production*. DOI 10.1007/s11250-016-1003-z

Padhi, M.K., Chatterjee, R.N., Rajkumar, U., Niranjan, M., Haunshi, S. 2016. Evaluation of a three-way cross chicken developed for backyard poultry in respect to growth, production and carcass quality traits under intensive system of rearing. *Journal of Applied Animal Research*, 44: 390-394.

Rajesh Babu, Krishna D., Ravinder Reddy, Nalini Kumari and Raju, M.V.L.N. 2015. Effect of feeding solvent extracted and detoxified karanj (Pongamia glabra vent) cake on egg quality parameters in commercial layer chicken. *International Journal of Agricultural Science and Research,* 5:289-292.

Rajkumar, U., Vinoth, A., Shanmugam M., Rajaravindra, K.S. and Rama Rao S.V. 2015. Effect of embryonic thermal exposure on Hsp-70 mRNA expression and serum T3 concentration in coloured broiler population. *Animal Biotechnology*, 26:260-267.

Rama Rao, S.V., Raju, M.V.L.N., Prakash, B., Pradeep Kumar Reddy E. and Panda, A.K., 2015. Effect of dietary inclusion of toasted guar (Cyamopsis tetragonoloba) meal as a source of protein on performance of White Leghorn layers. *British Poultry Science* 56: 733-739.

Shanmugam, M., Vinoth, A., Rajaravindra, K. S., Rajkumar, U. 2015. Thermal manipulation during embryogenesis improves certain semen parameters in layer breeder chicken during hot climatic conditions. *Animal Reproduction Science*, 161: 112-118.

Vinoth, A., Thirunalasundari, T., Tharian, J. A., Shanmugam, M. and Rajkumar, U. 2015. Effect of thermal manipulation during embryogenesis on liver heat shock protein expression in chronic heat stressed coloured broiler chickens. *Journal of Thermal Biology*, 53: 162-171.

Vinoth, A., Thirunalasundari, T., Shanmugam, M., Rajkumar, U. 2016. Effect of early age thermal conditioning on expression of heat shock proteins in liver tissue and biochemical stress indicators in colored broiler chicken. *European Journal of Experimental Biology*, 6 (2); 53-63.

National

Bhattacharya, T.K., Chatterjee, R.N., Rajkumar, U., Rajaravindra, K.S. and Niranjan, M. 2015. Genetic polymorphism in the promoter of prolactin gene in layer chicken. *Indian Journal of Animal Research,* DOI:10.5958/0976-0555.2015.00075.8.

Chatterjee, R.N. and Rajkumar, U. 2015. An overview of poultry produciton in *India. Indian Journal of Animal Health,* 54: 89-108.

Haunshi, S., Shanmugam, M., Rajkumar, U., Padhi, M. K. and Niranjan, M. 2015. Characterizations of Ghagus breed vis a vis PD–4 birds for production, adaptability, semen and egg quality traits. *Indian Journal of Animal Sciences*, 85: 1338-1342.

Niraj, D.K., Kumar, P., Mishra, C., Narayan, R., Bhattacharya, T.K., Shrivastava, K., Bhushan, B., Tiwari, A.K., Saxena, V.K., Sahoo. N.R. and Sharma, D. 2015. Nucleotide sequence analysis of Mx1 gene in Japanese quail. *Indian Journal of Animal Research,* DOI:10.18805/ijar.7091.

Niraj, D.K., Kumar, P., Mishra, C., Narayan, R., Bhattacharya, T.K., Shrivastava, K., Bhushan, B., Tiwari, A.K., Saxena, V.K., Sahoo. N.R. and Sharma, D. 2015. Single nucleotide polymorphism

mining and nucleotide sequence analysis of Mx1 gene in exonic regions of Japanese quail. *Veterinary World,* 8(12): 1435-1443.

Padhi, M.K., Chatterjee, R.N., Haunshi, S., Rajkumar, U., Niranjan, M. 2015. Evaluation of four different crossbreds developed for backyard poultry farming under intensive system. *Indian Journal of Animal Sciences,* 85: 985-990.

Padhi, M.K., Chatterjee, R.N., Haunshi, S., Rajkumar, U., Bhattacharya, T.K. 2015. Evaluation of male line of *Vanaraja* (PD1), *Vanaraja* and control broiler in respect to juvenile traits and genetic analysis of juvenile traits in PD1. *Indian Journal of Animal Sciences,* 85: 991-995.

Padhi, M.K., Chatterjee, R.N., Rajkumar, U., Bhattacharya, T.K., Bhanja, S.K. 2015. Genetic and phenotypic parameters estimates for body weight, conformation, production and reproduction traits of PD1 (*Vanaraja* male line) during different periods. *Indian Journal of Animal Sciences,* 85: 883-888.

Padhi, M.K., Chatterjee, R.N., Rajkumar, U., Haunshi, S., Niranjan, M., Panda, A.K. 2015. Evaluation of *Vanaraja* male line (PD1) for different production and egg quality traits. *Indian Journal of Animal Sciences,* 85: 634-637.

Panda, A.K., Sridhar, K., Lavanya, G., Prakash, B., Rama Rao, S.V., Raju, M.V.L.N. 2015. Growth performance, carcass characteristics, fatty acid composition and sensory attributes of meat of broiler chicken fed diet incorporated with linseed oil. *Indian Journal of Animal Sciences*, 85: 1354-1357.

Paswan, C., Bhattacharya, T.K., Chatterjee, R.N., Nagaraja, C.S. and Dushyanth, K. 2016. Molecular characterization of promoter of IGF-1 gene in chicken broiler line and its growth performance. *Indian Journal of Animal Research,* 50: 23-26.

Rajkumar, U., Shanmugam M., Vinoth, A., Rajaravindra, K.S., Rama Rao S.V. 2015. Effect of increased incubation temperature on juvenile growth, immune and serum biochemical parameters in selected chicken populations. *Indian Journal of Animal Sciences,* 85: 1328-1333.

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 (1) : 81-85.

Sridhar, K., Nagalakshmi, D and Rama Rao, S.V. 2015. Effect of graded concentrations of organic zinc (zinc glycinate) on skin quality, hematological and serum biochemical constituents in broiler chicken. *Indian Journal of Animal Sciences,* 85: 643-648.

Sridhar, K., Nagalakshmi, D, Srinivasa Rao, D. and Rama Rao, S.V. 2015. Effect of supplementation of graded levels of organic zinc on nutrient utilization and retention of minerals in broiler chicken. *Indian Journal of Animal Nutrition,* 32: 80-85.

Swathi, B., Gupta, P.S.P., Nagalakshmi, D., Rajasekhar Reddy, A. and Raju, M.V.L.N. 2015. Efficacy of Tulsi (Ocimum sanctum) root powder in amelioration of heat stress induced oxidative disturbances in broiler chicken. *Indian Journal of Animal Nutrition,* 32: 232-234.

Research Abstracts presented in Symposia/ Conferences

International

Divya, D., Prakash, M.G., Bhattacharya, T.K., Chatterjee, R.N., Dushyanth, K. and Shukla, R. 2016. Effect of BMP3 promoter on growth traits in broiler chicken. *Proceedings of International Livestock Conference and 23rd Annual Convention of ISAPM* held at College of Veterinary Science, Hyderabad during 28-31 January 2016, Abstract No. LGB 73, pp. 220.

Paswan, C., Bhattacharya, T. K., Chatterjee, R. N., Nagaraja, C.S. and Dushyanth K.. 2016. Expression and epigenetic regulation of IGF1 gene in Control broiler and layer. Proceedings of *International Livestock Conference and 23rd Annual Convention of ISAPM* held at College of Veterinary Science, Hyderabad, India during 28-31 January 2016.

Prakash, B., Rama Rao S.V., Raju M.V.L.N. and Sreenivasa Reddy C. 2015. Production of selenium enriched Saccharomyces cerevisiae using yeast extract peptone dextrose broth. *Proceedings of the World Congress on Beneficial Microbes: Food, Pharma, Aqua & Beverages Industry* held at Valencia, Spain during 25 -27 August 2015.

National

Divya. D., Bhattacharya, T.K., Gnana Prakash, M., Chatterjee, R.N., Dushyanth K., Shukla, R. and Dange, M. 2015. Comparative assessment of expression profile of BMP3 gene during embryonic and post hatch period in broiler and layer chicken. *Proceedings of XXXII Annual Conferecnce and National Symposium of Indian Poultry Science Association* held at Kerala Veterinary and Animal Sciences University, Pallakad, Kerala during 19–21 November 2015.

Haunshi, S., Padhi, M. K., Niranjan M. and Rajkumar U. 2015. Improvement of PD-4, a native chicken germplasm for backyard poultry farming. *Proceedings of XXXII Annual Conferecnce and National Symposium of Indian Poultry Science Association* held at Kerala Veterinary and Animal Sciences University, Pallakad, Kerala during 19–21 November 2015, pp 46.

Kannaki, T. R., Reddy M. R. and Rajaravindra K.S. 2015. Adjuvant potential of Toll- like receptor agonists, Poly I:C and LPS with inactivated Newcastle disease virus (NDV) vaccine in chicken. *Proceedings of XXXII Annual Conferecnce and National Symposium of Indian Poultry Science Association* held at Kerala Veterinary and Animal Sciences University, Pallakad, Kerala during 19–21 November 2015, PPB-3-O.

Nikam, M.G., Ravinder Reddy, V. Raju, M.V.L.N., Rama Rao, S.V., Kondal Reddy, K. and Narasimha, J. 2015. Effect of dietary supplementation of non starch polysaccharide hydrolyzing enzymes on performance, nutrient utilization, carcass traits and economics of broiler production.*Proceedings of XXXII Annual Conferecnce and National Symposium of Indian Poultry Science Association* held at Kerala Veterinary and Animal Sciences University, Pallakad, Kerala during 19–21 November 2015, P 77.

Nikam, M.G., Ravinder Reddy, V. Raju, M.V.L.N., Rama Rao, S.V., Kondal Reddy, K. and Narasimha, J. 2015. Dietary supplementation of non starch polysaccharide hydrolyzing enzymes on growth performance, nutrient utilization, carcass traits and economics of broiler reared on sub-optimal diets.*Proceedings of XXXII Annual Conferecnce and National Symposium of Indian Poultry Science Association* held at Kerala Veterinary and Animal Sciences University, Pallakad, Kerala during 19–21 November 2015, P 101.

Mollier, R.T., R N Ramani Pushpa, Y N Reddy, M R Reddy, K Dhanalakshmi, Kalyani Putty (2015). Pathogenicity of avian nepritis virus isolate HYD 79 in chicken embryo. Proceedings of 33 annual conferance of IAVP and national symposium on challenges and advances in dusease diagnosis of livestock, poultry and fish: redefining the role of veterinary pathologists. December 3-5, 2015. Pp133.

Pradeep M, Kannaki, TR, Suchitra Sena D, and Reddy MR. 2015. Proventriculitis and proventricular dilatation in chicken-a case study. *Proceedings of National symposium on 'Challenges and Advances in disease diagnosis of livestock, Poultry and Fish: Refining the role of Veterinary Pathologists at* Gannavaram, *A.P* during 3-5 December 2015, pp140.

Pradeep M. T R Kannaki, D Suchitra Sena, and M R Reddy 2015. Proventriculitis and proventricular dilatationin chicken – a case study. *Proceedings of 33 annual conferance of IAVP and national symposium on challenges and advances in dusease diagnosis of livestock, poultry and fish: redefining the role of veterinary pathologists,* 3-5 December 2015. pp140.

Prakash, B., Rama Rao S.V., Raju M.V.L.N. and Sreenivasa Reddy C. 2015. Selenium-enriched yeast production for dietary supplementation of Chickens. *Proceedings of XXXII Annual Conferecnce and National Symposium of Indian Poultry Science Association* held at Kerala Veterinary and Animal Sciences University, Pallakad, Kerala during 19–21 November 2015, pp 34.

Rajkumar U, M.Niranjan, Santosh Haunshi, M.V.L.N.Raju and S.V.Rama Rao 2015. Characterization of *Aseel* chicken for growth and production parameters up to 40 weeks of age. *Proceedings of XXXII Annual Conferecnce and National Symposium of Indian Poultry Science Association* held at Kerala Veterinary and Animal Sciences University, Pallakad, Kerala during 19–21 November 2015, P 36.

Rajkumar U, Santosh Haunshi, S.P.Yadav and M.Niranjan. 2015. Inheritance of Juvenile and production traits in *Gramapriya* male line (GML) chicken. *Proceedings of XXXII Annual Conferecnce and National Symposium of Indian Poultry Science Association* held at Kerala Veterinary and Animal Sciences University, Pallakad, Kerala during 19–21 November 2015, P 37.

Raju, M.V.L.N., Rama Rao, S.V., Kanjilal, S., Nagarjuna, B.V.R., Panda, A,K, Prakash, B. and Reddy, M.R. 2016. Response of broiler chickens to dietary inclusion of detoxified Karanj (Pongamia glabra) cake at graded levels. *Proceedings of ANSI Conference*, NDRI, Karnal, Feb. 2016.

Raju, M.V.L.N., Rama Rao, S.V., Nagarjuna, B.V.R., Prakash, B., Panda, A.K. and Reddy, M.R. 2015. Age related responses to feeding solvent extracted karanj (Pongamia glabra) seed cake in Vanaraja chicks.*Proceedings of XXXII Annual Conferecnce and National Symposium of Indian Poultry Science Association* held at Kerala Veterinary and Animal Sciences University, Pallakad, Kerala during 19–21 November 2015, P 90.

Reddy, B.L.N., Rajaravindra, K.S. and Rajkumar U. 2015. Effect of heat stress on juvenile body weights,

feed efficiency and some heat stress parameters in different genetic groups of broilers. *Proceedings of XXXII Annual Conferecnce and National Symposium of Indian Poultry Science Association* held at Kerala Veterinary and Animal Sciences University, Pallakad, Kerala during 19–21 November 2015.

Satheesh kumar, P., Bhattacharya, T.K., Kumar, P., Chatterjee, R.N. and Paswan, C. 2015. Cloning and expression profile of activin receptor type II gene in in two different chicken lines. *Proceedings of XXXII Annual Conferecnce and National Symposium of Indian Poultry Science Association* held at Kerala Veterinary and Animal Sciences University, Pallakad, Kerala during 19–21 November 2015.

Shanmugam M, Kannaki T.R. and Mahapatra R.K. 2015. Sperm maturity, apoptosis and membrane protein expression in two lines of chicken. *Proceedings of XXXII Annual Conferecnce and National Symposium of Indian Poultry Science Association* held at Kerala Veterinary and Animal Sciences University, Pallakad, Kerala during 19–21 November 2015, pp 225-226.

Sujatha, T., Kannaki T.R. 2015. In ovo-immunomodulatory effect of Kalmegh (Andrographis Panniculata Nees) on expression of Toll-like receptors in Nicobari fowl. *Proceedings of XXXII Annual Conferecnce and National Symposium of Indian Poultry Science Association* held at Kerala Veterinary and Animal Sciences University, Pallakad, Kerala during 19–21 November 2015, PPB-6-O.

Susitha Rajkumar, M R Reddy and R Somvanshi 2015. Incidence of Chronic Respiratory Disease in chicken. *Proceedings of 33 annual conferance of IAVP and national symposium on challenges and advances in dusease diagnosis of livestock, poultry and fish: redefining the role of veterinary pathologists*, 3-5 December 2015. pp123.

Susitha Rajkumar, M R Reddy and R Somvanshi 2015. Prevalance of pathogenic mycoplasmas M. gallisepticum and M synoviae in Indian Poultry Flocks.*Proceedings of 33 annual conferance of IAVP and national symposium on challenges and advances in dusease diagnosis of livestock, poultry and fish: redefining the role of veterinary pathologists*, 3-5 December 2015. pp124

Invited /lead Papers

Chatterjee, R.N. and Haunshi, S. 2015. Welfare concerns in poultry production. *Proceedings of XXXII Annual Conferecnce and National Symposium of Indian Poultry Science Association* held at Kerala Veterinary and Animal Sciences University, Pallakad, Kerala during 19–21 November 2015, pp 89-94.

Raju, M.V.L.N. and S.V. Rama Rao. 2015. Aflatoxin and other mycotoxins in poultry diet : ways for minimizing adverse effects. *First National Congress on Advanced Research in Animal Sciences (NCARAS 2015) with particular emphasis on Environmental stress,* 27-28 May 2015, University of Birjand, Birjand, Southern Khorasan, Iran.

Raju, M.V.L.N., Rama Rao, S.V. and Prakash, B. 2015. Novel approaches for effective utilization of alternate protein meals in poultry diets. *Proceedings of the XXXII Annual Conference and National Symposium of IPSA on "Clean and Green Poultry Production"*, Centre for Advanced Studies in Poultry Science, Mannuthy, Kerala, 19- 21 November. pp 53-57.

Reddy M. R. 2015. Application of molecular techniques in diagnosis of poultry diseases. *Proceedings of 33 annual conferance of IAVP and national symposium on challenges and advances in dusease diagnosis of livestock, poultry and fish: redefining the role of veterinary pathologists*, 3-5 December 2015. pp100-112.

Books

Haunshi, S., Reddy, B.L.N., Niranjan, M., Padhi, M.K., Rajkumar, U., Rajaravindra, K.S. and Chatterjee, R.N. 2015. Status of genetic resources of chicken evolved at DPR. ICAR-Directorate of Poultry Research, Rajendranagar, Hyderabad-500030. pp 102.

Book Chapter

Haunshi, S., Padhi, M.K. and Niranjan, M. 2015. Sustainable rural poultry production through conservation and improvement of native chickens. In: Agrobiodiversity and sustainable rural development. Eds: Soam, S. K. and Balakrishnan, M., New India Publishing Agency, New Delhi, pp. 219-228.

Bulletins/Training manuals/Folders

Paswan C. and Shanmugam M. 2015. Training Manual "Model Training Course on Rearing and Propagation of Backyard Poultry Farming". ICAR-Directorate of Poultry Research, Rajendranagar, Hyderabad.

Technical/Popular Articles

Rajkumar, U. and Rama Rao, S.V. 2015. *Gramapriya* a prolific brown egg layer for rural backyards. *Indian Farming* 65 (6): 32-34

Rama Rao, S.V. and Srilatha, T. 2015. Improving nutritional values of cotton seed meal in broiler diets. *Asian Poultry Magazine*, January 20-23.

Rama Rao, S.V. and Srilatha, T. 2015. Utilization of cotton seed meal in layer diets. *Asian Poultry Magazine*, April 18-19.

Rama Rao, S.V. and Srilatha, T. and Nagalakshmi, D. 2015. Using toasted guar meal in layer diets. *Asian Poultry Magazine*, October (10): 26-29.

Rajaravindra, K.S. and Paswan C. 2015. Introduction to chicken breeds, varieties and lines, Indian Native breeds. Training Manual for the Model training Course on "Rearing and propagation of backyard poultry farming" organized at Directorate of Poultry Research, Hyderabad.

Haunshi, S. and Shanmugam M. 2015. Behavioural problems and their management in domestic fowl. *Poultry line* 15(5):63-66.

Shanmugam M. and Kannaki, T.R. 2015. Adverse effects of noise pollution in chicken. *Poultry line* 15(4):15-16.

Shanmugam M. 2015. Avian Reproductive Management. Paswan C. and Shanmugam M. (Eds) Training Manual "Model Training Course on Rearing and Propagation of Backyard Poultry Farming". ICAR-Directorate of Poultry Research, Rajendranagar, Hyderabad.

9. Ongoing Research Projects

Sl. No.	Project Code	Project Title	PI	CO PI
Institute Projects				
1	ANSCDPRSIL201500100050	Development and improvement of male lines for production of backyard chicken varieties for free range farming	U. Rajkumar	M. Niranjan S. Haunshi S. P. Yadav C. Paswan
2	ANSCDPRSIL201500200051	Improvement and evaluation of female lines for backyard/ free range farming	M. Niranjan	U. Rajkumar S. P. Yadav C. Paswan
3	ANSCDPRSIL201500300052	Genetic characterization and conservation of indigenous chicken germplasm	S. Haunshi	U. Rajkumar C. Paswan
4	ANSCDPRSIL201500500054	Genetic evaluation of elite layer germplasm	C. Paswan	R.N. Chatterjee T.K. Bhattacharya
5	ANSCDPRSIL201500500054	Maintenance of coloured broiler populations for intensive and semi intensive broiler farming	B.L.N. Reddy	K.S. Rajaravindra
6	ANSCDPRSIL201400100046	Genetic improvement of a synthetic coloured broiler female line (PB-2)	K.S. Rajaravindra	U. Rajkumar B.L.N. Reddy
7	ANSCDPRSIL201500600055	Genotyping MHC class I loading complex genes (TAP1, TAP2 and Tapasin) for their association with immunocompetence traits in chicken	S.P. Yadav	R.N. Chatterjee T.K. Bhattacharya T.R. Kannaki
8	ANSCDPRSIL201400200047	Optimization of dietary protein concentration for minimising nitrogen excretion and economising on feed cost	M.V.L.N. Raju	S.V. Ramarao B. Prakash
9	ANSCDPRSIL201100100034	Optimization of dietary allowances for production and reproduction in brown laying hens (PD-3)	B. Prakash	M.R. Reddy M. Shanmugam
10	ANSCDPRSIL201400300048	Assessment of Disease incidence, Immune Competence and Disease Resistance among Pure Line Chicken Populations	M.R. Reddy	T.R. Kannaki Suchitra Sena
11	ANSCDPRSIL201500700056	Exploring medicinal plants as alternative to antibiotic growth promoters (AGP) in broiler production	D. Suchitra Sena	M.R. Reddy B. Prakash
12	ANSCDPRSIL201500800057	Disease resistance/tolerance in backyard chicken varieties and strategies for improving vaccine mediated immune response	T.R. Kannaki	M.R. Reddy D.Suchitra Sena K.S. Rajaravindra
13	ANSCDPRSIL201400400049	Studies on short term storage of chicken semen for optimal fertility	R.K. Mahapatra	M. Shanmugam M. Niranjan S.K. Bhanja
14	ANSCDPRSIL201200300045	Cellular and molecular studies of reproductive system in chicken	M. Shanmugam	T.R. Kannaki
15	ANSCDPRSIL201500900058	Analysis of fertility and hatchability from cryopreserved semen	M. Shanmugam	R.K. Mohapatra

Externally Funded Research Projects				
1		Functional genomics, epigenetics and gene silencing technology for improving productivity in poultry (National Fellow)	T.K. Bhattacharya	
2		Expression profiling of cytokines and chemokines: Scope for augmenting general immune competence in chicken (DST-OYS)	K.S. Rajaravindra	
3		Adaptation and mitigation strategies in poultry to thermal stress through nutritional and environmental manipulation (NICRA)	S.V. Rama Rao	M.R. Reddy M.V.L.N. Raju U. Rajkumar B. Prakash T.R. Kannaki
4		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	
5		Effect of dietary supplementation of biofortified maize (QPM) on productive performance in broilers chickens (Network project)	B. Prakash	S.V. Rama Rao M.V.L.N. Raju
6		Genetic analysis of innate immune-competence and survivability for identification of genetic markers in indigenous chicken breeds (DST-SERB)	S. Haunshi	

10. Consultancy, Patents and Commercialization of Technologies

Commercialisation of Technolgies

The 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*). The *Vanaraja* and *Gramapriya* have been widely distributed across the country and have been extremely popular in the rural areas. Being the clolour varieties and high production potential, farmers are fetching more remunerative prices by selling the live birds and their produces. There has been huge demand for these chicken varieties from not only small marginal farmers but also organized farmers. Keeping these facts in mind, a national project in the form of 'Seed Project' funded by the ICAR has been initiated during the XI plan for wide and efficient distribution of these backyard varieties of chicken through out the country. The germplasm supplied during 2015-16 was 11,38,476 from three components of the Institute (ICAR-DPR: 3,61,801; AICRP: 5,28,578; PSP: 2,48,097). The embryonated eggs (11,933) were supplied for production of different cell culture vaccines.

Consultancy

Advisory consultancy was extended to M/s Sri Ramadhootha Poulltry Research Farm, Ranga Reddy Dist., Telangana on techno scientific advisory services in nutrition and health care of chickens.

Contract research

The facilities of the Directorate were extended for the benefit of poultry industry through the contract research mode of ICAR. Two projects were in operation during the year, viz. "Infectious bronchitis (IB) virus isolation and molecular identification from field samples" (Intervet India Pvt. Ltd., Pune, Maharashtra) and "Enhancement of nutritional value of alternate protein sources in broiler and layer diets" (Abhay Cotex Pvt. Ltd., Jalna, Maharashtra).

Accession in the NCBI Genbank

The NCBI Gene bank is the international repository for molecular biology information including gene and protein sequences, SNPs, gene maps etc. A number of gene sequence data were submitted to the Genbank and the accession numbers were received. These sequence information have been listed below.

Faridi, N.F., Dande, S.S. and Sharma, V. 2015. Uncultured archaeon clone NRCCMET1 to 15 16S ribosomal RNA gene, partial sequence. Accession numbers KT164812 to KT164826.

Faridi, N.F., Dande, S.S. and Sharma, V. 2015. Uncultured archaeon clone NRCCMET16 to 20 16S ribosomal RNA gene, partial sequence. Accession numbers KU291382 to KU291386.

Guru Vishnu, P., Bhattacharya,T.K., Kumar, P., Chatterjee, R.N., Paswan, C. and Dushyanth, K. (2016). *Gallus gallus* haplotype h8 ACVR2B-like gene, partial sequence. Accession numberKT240113.

Guru Vishnu,P., Bhattacharya,T.K., Kumar,P., Chatterjee,R.N., Paswan,C. and Dushyanth,K. 2016. *Gallus gallus* haplotype h7 ACVR2B-like gene, partial sequence. Accession number KT240112.

Guru Vishnu,P., Bhattacharya,T.K., Kumar,P., Chatterjee,R.N., Paswan,C. and Dushyanth,K. 2016. *Gallus gallus* haplotype h6 ACVR2B-like gene, partial sequence. Accession number KT240111.

Guru Vishnu,P., Bhattacharya,T.K., Kumar,P., Chatterjee,R.N., Paswan,C. and Dushyanth,K. 2016. *Gallus gallus* haplotype h5 ACVR2B-like gene, partial sequence. Accession number KT240110.

Guru Vishnu,P., Bhattacharya,T.K., Kumar,P., Chatterjee,R.N., Paswan,C. and Dushyanth,K. 2016. *Gallus gallus* haplotype h4 ACVR2B-like gene, partial sequence. Accession number KT240109.

Guru Vishnu,P., Bhattacharya,T.K., Kumar,P., Chatterjee,R.N., Paswan,C. and Dushyanth,K. 2016. *Gallus gallus* haplotype h3 ACVR2B-like gene, partial sequence. Accession number KT240108.

Guru Vishnu,P., Bhattacharya,T.K., Kumar, P., Chatterjee, R.N., Paswan, C. and Dushyanth, K. 2016. *Gallus gallus* haplotype h2 ACVR2B-like gene, partial sequence. Accession number KT240107.

Guru Vishnu, P., Bhattacharya,T.K., Kumar,P., Chatterjee,R.N., Paswan,C. and Dushyanth,K. 2016. *Gallus gallus* haplotype h1 ACVR2B-like gene, partial sequence. Accession number KT240106.

11. Committees

Institute Research Committee

Annual Institute Research Committee meeting was held on 21 & 22 April, and 24 August 2015. Principal investigators of various projects presented the achievements. Chairman IRC suggested measures for overcoming the difficulties in achieving desired targets.

Institute Management Committee (IMC)

Institute Manageemnt Committee meeting was held on 16 July 2015 and 16 December 2015 under the chairmanship of the Director. In this meeting various issues pertaining to administration and finance were discussed and recommendations were made to the council for approval.

Research Advisory Committee

The 9th Meeting of the Common Research Advisory Committee of Central Avian Research Institute, Izatnagar and Directorate of Poultry Research, Hyderabad was held at CARI, Izatnagar, 30 May 2015 under the Chairmanship of Dr. R. Prabakaran, Ex. Vice Chandcellor, TANUVAS, Chennai. The members of RAC alongwith Directors of both CARI and DPR attended the meeting. The action taken by the institutes on previous recommendations and the research progress in various ongoing research projects were presented. The Chairman and members appreciated the work undertaken in different areas of research and recommended to strengthen the infrastructure by providing suitable financial support for intensifying the research work.

Institute Technology Management Unit (ITMU)

Institute Technology Management Unit was established at this Directorate during XI plan. During the period under report an application for accessing Aseel and Gaghus germplasm from their native tracts of Andhra Pradesh (AP) and Karnataka were filed with AP and Karnataka state Biodiversity Boards respectively and permission was obtained. An MOU for advisory consultancy with Sri Ramadhootha Poulltry Research Farm Ltd. was signed by the Directorate.

Institute Animal Ethics Committee (IAEC)

The 17th IAEC meeting of DPR was held on 25 April 2015. The meeting was chaired by Dr. R N Chatterjee, Director and was attended by the CPCSEA nominees Dr. P. Uday Kumar, Dr. N. Hari Shankar and Dr. Syed Y. H. Quadri from NIN, Hyderabad apart from the members.

Annual review meeting of AICRP and PSP

Annual review meeting of AICRP on Poultry Breeding and Poultry Seed Projects were conducted at NASC complex, New Delhi on 15-16 September 2016. Dr. R.N. Chatterjee, Director welcomed Dr. R.S. Gandhi, ADG (AP&B) and chief guest of the function; Dr.Vineet Bhasin, PS, Head Quarter and In-charges from various AICRP and Poultry Seed Project (PSP) centres. Dr. S. Ayyappan, Secretary DARE & Director General, ICAR briefly visited the venue of meeting and exchanged the pleasantries with the participants. He enquired about the best and poor performing centres of AICRP and PSP. Prof. K.M.L. Pathak, DDG (Animal Science) reviewed the progress of the centres. The centre Incharges presented progress of the respective centres. Dr. M. Niranan, Incharge AICRP Cell presented the technical programme of the AICRP project and after deliberation the technical programmes were finalised. Dr. M. R. Reddy, PS explained in brief about the procedure to be followed during the outbreak of Avian Influenza. Dr. S. V. Rama Rao, Incharge, PSP

project elaborated about the feeds, feeding standards and feed additives to extract the maximum genetic potential of the birds. Dr. S V Rama Rao proposed vote of thanks.

Institute joint staff council (IJSC) meeting

The Institute Joint Staff Council meetings held at this Directorate for the period from 1 July 2015 to 31 December 2015 were given below.

- 3rd meeting of 9th IJSC on 28 August 2015
- 4th meeting of 9th IJSC on 16 October 2015
- 5th meeting of 9th IJSC on 22 December 2015

Annual Review meeting of AICRP and PSP at NASC complex, New Delhi

12. Participation of Scientists in Seminars, Conferences, Meetings

Scientists, technical and administrative personnel of the Directorate participated in a number of seminars, symposia, conferences, meetings, workshops etc., to present their research findings and their expertise in different fields of Poultry Science and other related disciplines.

Sl. No.	Symposia / conferences /seminars / meetings/ workshops	Scientist(s)	Duration	Venue
1	Thirteenth meeting of Animal Husbandry, Feeds and Equipment Sectional Committee, FAD 05	Dr. Santosh Haunshi, Sr. Scientist	7 May 2015	Manak Bhavan (Bureau of Indian Standards), New Delhi.
2	First National Congress on Advanced Research in Animal Sciences (NCARAS 2015) with particular emphasis on Environmental stress	Dr. M.V.L.N. Raju, Pr. Scientist	27-28 May 2015	University of Birjand, Birjand, Southern Khorasan, Iran
3	Consultative meeting on Enhanced Utilization of Sorghum exploring Domestic and International market, Sponsored by Agricultural and Processed Food Export Development Authority (APEDA), New Delhi	Dr. B. Prakash, Scientist	30 July 2015	VAMNICOM, Pune
4	World Congress on Beneficial Microbes - 2015	Dr. B. Prakash, Scientist	25-27 August 2015	Valencia, Spain
5	National Conference on Vegetable oils & fats : health and nutrition	Dr. M.V.L.N. Raju, Pr. Scientist	28 August 2015	IICT, Hyderabad
6	Annual Review Meeting of AICRP on Poultry Breeding & Poultry Seed Project	Dr. R.N. Chatterjee, Director Dr. M. Niranjan, Pr. Scientist Dr. U. Rajkumar, Pr. Scientist Dr. Santosh Haunshi, Sr. Scientist	15-16 September 2015	NASC complex, New Delhi
7	XIV NAVS Convocation	Dr. M.R. Reddy, Pr. Scientist	4 November 2015	IVRI, Izatnagar
8	XXXII Annual Conference of Indian Poultry Science Association and National symposium on "Green and clean poultry production"	Dr. R.N. Chatterjee, Director Dr. M.V.L.N. Raju, Pr. Scientist Dr. M. Niranjan, Pr. Scientist Dr. U. Rajkumar, Pr. Scientist Dr. R.K. Mahapatra, Pr. Scientist Dr. S.P. Yadav, Sr. Scientist Dr. B. Prakash, Scientist Dr. T. R. Kannaki, Scientist Dr. K. S. Rajaravindra, Scientist Dr. S. K. Bhanja, CTO	19-21 November 2015	CASM, Thiruvazhamkunnu, Palakkad, Kerala
9	Veterinary Pathology Congress-2015	Dr. M.R. Reddy, Pr. Scientist	2 December 2015	Gannavaram, AP

10	National Seminar on "Integrated Farming Systems for Sustainable Agriculture and Enhancement of Rural Livelihoods	Dr. R.N. Chatterjee, Director Dr. B.L.N. Reddy, Pr. Scientist Dr. M. Niranjan, Pr. Scientist Dr. U. Rajkumar, Pr. Scientist Dr. T.K. Bhattacharya, National Fellow Dr. R.K. Mahapatra, Pr. Scientist Dr. S.P. Yadav, Sr. Scientist Dr. T. R. Kannaki, Scientist Dr. K. S. Rajaravindra, Scientist Dr. Chandan Paswan, Scientist	13-14 December 2015	NAARM, Hyderabad
11	International Livestock Conference and 23rd Annual Convention of ISAPM	Dr. R.N. Chatterjee, Director Dr. M. Niranjan, Prl. Scientist Dr. U. Raj Kumar, Pr. Scientist Dr. T.K. Bhattacharya, National Fellow Dr. B. Prakash, Scientist Dr. Chandan Paswan, Scientist	28-31 January 2016	College of Veterinary Science, Hyderabad
12	XVI Biennial Conference of Animal Nutrition Society of India	Dr. Sanjeev Kumar Verma	6 – 8 February 2016	ICAR-National Dairy Research Institute, Karnal
13	International conference on Climate Change and Food security: Ethical Perspective,	Dr. Anand Laxmi, Pr. Scientist Dr. M. Shanmugam, Scientist Dr. T. R. Kannaki, Scientist	11-13, February 2016	Agri biotech foundation, Hyderabad.
14	19th ADNAI Conference and International Symposium on Microbiology in Health and disease	Dr. R.N. Chatterjee, Director	23-25 February 2016	NIANP, Bangalore
15	Seminar on Sustainable Development of Poultry Sector in India	Dr. T.R. Kannaki, Scientist	21 March 2016	FTAPCCI, Hyderabad

13. Distinguished Visitors

Indian and Foreign dignitaries visited the Directorate during the period and aquainted with on going activities and achievments of the Directorate. The distinguished personalities visited the Directorate during 2015-16 are.

1. Dr. Trilochan Mohapatra, Secretary (DARE) & DG (IACR) New Delhi
2. Dr. Sri Chhabilendra Roul, Additional Secretary (DARE) & Secretary (ICAR) New Delhi
3. Dr. H. Rahman, DDG (AS), ICAR, New Delhi
4. Dr. M.P. Yadav, Former Vice Chancellor, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut
5. Mr. M. Narmadeshwar Lal, Secretary, Animal & Fishery Resources Dept., Govt. of Bihar
6. Dr. Gaya Prasad, ADG (AH), ICAR, New Delhi
7. Dr. R.S. Gandhi, ADG (AP & B), ICAR, New Delhi
8. Dr. V.V. Kulkarni, Director, ICAR-NRC on Meat, Hyderabad
9. Dr. V. Ayyagari, Rtd. Director, ICAR-DPR, Hyderabad
10. Dr. M.K. Chowdhary, Dean, BVC, Patna

Dr. Trilochan Mohapatra, Secretary (DARE) & DG (IACR) New Delhi addressing staff of the Directorate

Dr. Dr. H. Rahman, DDG (AS), ICAR, New Delhi inaugurating the exhibition centre at the Directorate

14. Personnel

Management Position

Dr. R.N. Chatterjee, Director

Scientific staff

Dr. S.V. Rama Rao Pr. Scientist
Dr. M.V.L.N. Raju, Pr. Scientist
Dr. B.L.N. Reddy, Pr. Scientist
Dr. M.R. Reddy, Pr. Scientist
Dr. Anand Laxmi, Pr. Scientist
Dr. M. Niranjan, Pr. Scientist
Dr. U. Rajkumar, Pr. Scientist
Dr. A.K. Panda, Pr. Scientist (upto 30 June 2015)
Dr. R.K. Mahapatra, Pr. Scientist
Dr. D. Suchitra Sena, Pr. Scientist
Dr. Santosh Haunshi, Sr. Scientist
Dr. S.K. Verma, Sr. Scientist
Dr. S.P. Yadav, Sr. Scientist
Dr. B. Prakash, Sr. Scientist
Dr. M. Shanmugam, Scientist
Dr. (Mrs.) T.R. Kannaki, Scientist
Dr. K.S. Rajaravindra, Scientist
Dr. Chandan Paswan, Scientist

National Fellow

Dr. T.K. Bhattacharya, National Fellow

Technical

Dr. Daryab Singh, C.T.O. (Hatchery Manager)
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, Sr. Tech. Officer
Sri J. Srinivas Rao, Sr. Tech. Officer
Sri A. Ravi Kumar, Tech. Officer
Sri G. Rajeshwar Goud Tech. Officer
Sri A. Subrahmanyam, Tech. Officer
Smt. N.R. Dhanutha, Sr. Tech. Asst.
Sri Md. Maqbul, Sr. Tech. Asst. (Driver)
Sri M. Pantulu, Tech. Asst. (Driver)
Sri Md. Yousufuddin, Tech. Asst. (Driver)

Administration

Sri S.R. Meena, Admn. Officer (upto July 2015)

Sri A.V.G.K. Murthy, Admn. Officer
Sri K.V.S. Satyanarayana, Asst. Admn. Officer (upto October 2015)
Sri C. Bagaiah, Asst. Fin. & Acc. Officer
Smt. R.T. Nirmala Veronica, Asst
Sri R. Sudarshan, J.A.O.
Smt. T.R. Vijaya Lakshmi, U.D.C.
Smt. M. Kamala, U.D.C.
Sri Rajesh Parashar, L.D.C.
Sri L.V.B. Prasad, L.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

- Smt. T.R. Vijaya Lakshmi, U.D.C. has been granted 1st MACPS to the next higher Grade Pay of Rs. 2,800/- w.e.f. 5 July 2015.
- Sri K. Venkataiah has been granted 2nd MACPS to the next higher Grade Pay of Rs. 2,000/- w.e.f. 2 September 2014.
- Sri M.S.N. Acharyulu, Assistant has been promoted as A.A.O. w.e.f. 16 October 2015.

Retirements

- Sri S.R. Meena, A.O., has retired from the Council's service on superannuation w.e.f. 31 July 2015.
- Sri M.S.N. Acharyulu, A.A.O. has retired from the Council's service on superannuation w.e.f. 31 March 2016.

Transfers

- Dr. Suchitra Sena, Pr. Scientist joined on 1 May 2015 from ICAR - NRC on Camel, Bikaner, Rajasthan.
- Dr. S.P. Yadav, Sr. Scientist joined on 2 June 2015 from ICAR - Central Institute for Research on Buffaloes, Hisar, Haryana.
- Dr. A.K. Panda, Pr. Scientist, transferred to ICAR-CIWA, Bhubaneswar, 30 June 2015.
- Sri K.V.S. Satyanarayana, A.A.O., transferred on promotion as Admn. Officer to ICAR – Central Institute for Brackish water Aquaculture, Chennai on 14 October 2015.
- Sri A.V.G.K. Murthy joined as Admn. Officer on 15 October 2015 on promotion and transfer from ICAR – Central Tobacco Research Institute, Regional Station, Hunsur.
- Dr. Anand Laxmi, Pr. Scientist joined on 9 December 2015 from ICAR – National Dairy Research Institute, Karnal.
- Dr. S.K. Verma Sr. Scientist joined on 30 December 2015 from ICAR – Central Institute for Research on Cattle, Meerut.
- Dr. Daryab Singh, C.T.O. transferred to Education Division, ICAR Headquarters, ICAR, New Delhi on 16 March 2016.

15. Other Relevant Information

Experimental Hatchery

Experimental hatchery has been central facility of the Directorate in which fumigation and storage of hatching eggs, incubation and hatching of pedigreed and commercial chicks are performed through out 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 76,787 hatching eggs, 228, 592 day old chicks 45,771 parents and 10,651 grown up birds were sold/supplied to the farmers across the country. In addition 11,933 embryonated eggs were made available for diagnosis and vaccine production to different organizations.

Experimental farm

The experimental poultry farm which is lifeline for the Directorate is located inside the campus and is divided in to two units - Pure Line and Commercial farm units. The Pure line farm is located in the farthest point of the campus which is having a disinfectant fog area before taking entry in to it. All the elite pure line germplasm is reared and breeding is done to elicit maximum genetic gain in this Pure Line farm.

During this period a cage House has been constructed. Another cage house has been inaugurated during the period of report. In the Commercial farm, only exploitation of Parent birds is done for commercial gains and for the germplasm supply to cater the

Table Population size of different chicken lines (2015-16)

Strain	Chicks	Adults			
		Grower	Male	Female	Total
A. Rural lines					
1. PD-1	787	610	241	346	1984
2. PD-2	491	1187	203	565	2446
3. PD-3	681	1458	180	600	2919
4. GML	1087	917	124	431	2559
5. PD-4 (Aseel)	425	888	114	248	1675
6. Ghagus	429	555	100	176	1260
7. Nicobari	165	271	55	109	600
8. GML Control	252	300	80	99	731
9. Aseel (pure)	158	100	69	108	435
TOTAL (A)	**4475**	**6286**	**1166**	**2682**	**14609**
B. Colored Broiler lines					
1. PB-1	961	375	100	251	1687
2. PB-2	876	864	115	443	2298
3. Control	412	455	164	275	1306
4. Dwarf	483	171	50	114	818
5. Naked Neck	323	189	49	77	638
TOTAL (B)	**3055**	**2054**	**478**	**1160**	**6747**
C. Layer lines					
1. IWH	475	819	160	360	1814
2. IWI	236	575	178	373	1362
3. IWK	446	1057	152	485	2140
4. IWD	357	0	0	0	357
5. IWF	78	0	0	0	78
6. Control	295	538	148	355	1336
TOTAL (C)	**1887**	**2989**	**638**	**1573**	**7087**
GRAND TOTAL (A+B+C)	**9417**	**11329**	**2282**	**5415**	**28443**

needs of the farmers from across the Country. The monthly average livestock reared in experimental farm were 26,365 (twenty six thousands six hundred and thirty five) birds. In the farm a total of 13, 18, 618 (thirteen lakhs eighteen thousands six hundred and eighteen) eggs were produced during the year, out of which 6,22,017 (six lakhs twenty two thousands and seventeen) nos. were hatching eggs and the remaining ones were table eggs.

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, a total of 769.22 MT of feed was compounded and supplied to experimental farm. In addition, a small quantity of feed was made available to the farmers who buy chicks from this Directorate and to the Nehru Zoological Park in Hyderabad.

Sales and Marketing Unit

Supply of hatching eggs and day-old chicks of parent stock and terminal crosses of germ plasm 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 generating revenue. The grown up birds of about 6 weeks age of rural germplasm were supplied to the farmers for rearing purpose.

Agricultural Knowledge Management Unit (AKMU)

AKMU cell has been one of the central units of the Institute under which several activities like net working facility, computational facility as desired by the scientists, maintenance and up-gradation of Institute web site, preparation and submission of various reports including monthly, quarterly and half yearly reports etc., correspondence to the Council and other Institutions/organizations etc. are being carried out. AKMU cell is equipped with two servers, one file server and another application server. These servers and twenty-two nodes of Local Area Network are connected through CISCO switch. The software used at the cell is Microsoft Office, Adobe creative suite 1.1 premium, SPSS 12.0 statistical software etc. The cell has data terminals to enter data, generated in the farm and laboratories of the Directorate and its analysis using various statistical techniques. The software used for this purpose are SAS 9.3, SPSS 12.0 and other DOS based programs.

Hindi Cell

The Directorate conducted four quarterly meetings of Official Language Implementation Committee (OLIC) on 25 June 2015, 22 August 2015, 17 December 2015 and 23 March 2016, in which different issues related to effective implementation of Hindi Language in this Directorate were discussed. The Directorate also conducted four Hindi workshops, on 10 June 2015, 15 September 2015, 19 December 2015 and 22 March 2016, for upgrading the skills of staff in their day to day official work in Hindi. During this year two officers were awarded under Hindi incentive scheme for their efforts to maximum usage of Hindi in routine official work.

The Directorate celebrated Hindi Fortnight from 1-15 September 2015 and Hindi Day on 15 September 2015. Several literary competitions were conducted among the staff. Dr. Rekha Sharma, Principal and HOD (Hindi Dept.), Vivek Vardhini College of Arts and Science, Hyderabad graced the occasion as the chief guest. On this occasion the winners of different competitions were awarded with cash prizes and certificate by the Chief Guest.

Institute Technology Management Unit (ITMU)

Institute Technology Management Unit was established at this Directorate during XI plan. During the period under report a trademark for chicken line developed at the Directorate was obtained from Indian Trademark office, Chennai for the trademark GRAMAPRIYA® (Trademark No.1868091). Trademark applications for the three chicken lines are under process. Objection raised against trademark VANARAJA™ at the trademark office was defended by submitting documents showing the earliest proof of usage of the name "VANARAJA" by the Directorate. One Patent application for the technology invented at the Directorate has been

filed with Indian Patent office. Research publications of the Directorate from the year 2005-2012 have been compiled and documented with ITMU. Prior art searches for patents were performed. Monthly reports were submitted to ZTMC at CIFT, Cochin. One Scientist from the Directorate has undergone IPR PG-diploma course conducted by NAARM-HCU. Two workshop-cum-training programmes organised by ICAR institutes (NAARM, Hyderabad & CIFT, Cochin) were attended by staff of ITMU to broaden the knowledge and scope of protecting intellectual assets of the Directorate.

Library and Information Centre

The Library of the Directorate has steadily developed to accommodate Indian and Foreign Journals/ Magazines of Poultry Science and allied disciplines. The library is subscribing 23 foreign journals/ magazines and 11 Indian journals/magazines, respectively. At present, around 600 reference books on different topics of poultry science and other subjects are available in the library. The library is also providing reference articles to the scientists and research scholars on demand from different institutes/Universities through Cera consortia. In addition to this, daily newspapers and magazines in three languages i.e. Hindi, Telugu and English were being subscribed. The institute also nominated library personnel for different trainings and workshop programmes organized during the year. The library is providing reprography facility to the staff of the Directorate.

Institute Foundation day celebrated

ICAR-Directorate of Poultry Research celebrated 29th Institute Foundation Day on 1 March 2016. Dr. H. Rahman, Deputy Director General (Animal Science), ICAR, New Delhi was the Chief Guest of the function.

Dr. H. Rahman, DDG (AS) inaugurated a permanent exhibition centre at the DPR campus. The facility provides the glimpses of DPR technologies especially the improved chicken varieties developed at the institute. Children from different schools were invited and appraised about the research programs and technologies developed at the institute. The exhibition centre is open for the farmers during the office hours on all working days. The DDG (AS) laid foundation stone for Farmers Hostel and also inaugurated the new cage house at pure line experimental farm. Dr. S.V. Rama Rao briefed about the institute and its achievements. The chief guest appreciated the efforts of the scientists and other staff members for serving the rural and tribal farmers. He stressed the importance of rural poultry in livelihood security and poverty alleviation in India. Dr. Ravindra Babu, Director, ICAR-IIRR and Dr. V.V. Kulkarni, Director, ICAR-NRCM were the Guests of honour for the function. Dr. R. N. Chatterjee, Director, ICAR-DPR narrated the achievements and impact of the improved chicken varieties (*Vanaraja, Gramapriya, Srinidhi, Krishibro* etc.) across the country.

Swach Bharat Abiyan

The Swach Bharat Abiyan was launched to inculcate the habit of keeping our surroundings clean and tidy. Accordingly, the Directorae's staff actively participated in cleaning the institute premises every Wednesday. The cleaning activity was carried out according to the monthly and yearly plan. Cleaning activities were also conducted in the adopted village Peddamangalaram and the hamlet, Ameerguda along with the villagers and elected representatives of the village.

Independence and Republic Day

ICAR-DPR celebrated the Independence Day on 15 August 2015 and Republic Day on 26 January 2016. On this occasion, the Director hoisted the national flag and addressed the gathering. In his address,

the Director congratulated the untiring efforts in achieving the targets of the institute. He also stressed upon the need for constant and enthusiastic efforts by all the staff to achieve further heights in future.

Games and Sports

The contingent of the Directorate participated in the ICAR sports meet held at Maharaja College ground, Cochin organized by ICAR-CIFT, Cochin.

DPR Contigent at ICAR Sports Meet

DDG (AS) visit to the Directorate

Results-Framework Document (RFD)
for
Directorate of Poultry Research
(2014–2015)

Section 1 : Vision, Mission, Objectives and Functions

Vision

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

Mission

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

Objectives

1) Improvement of pureline chickens and development of crosses
2) Production and supply of improved poultry germplasm

Functions

1) To coordinate and monitor ICAR-sponsored network research programmes
2) To undertake applied research on genetics and breeding, and conservation of improved chicken germplasm with supportive research on nutrition, disease control and management
3) To lay special emphasis on development of chicken varieties for meeting the needs of rural/ tribal and other under-privileged sections of the society

Section 2 : *Inter se* priorities among Key Objectives, Success Indicators and Targets

Sl. No.	Objectives	Weight	Actions	Success Indicators	Unit	Weight	Targets/Criteria Value				
							Excellent	Very Good	Good	Fair	Poor
							100%	90%	80%	70%	60%
1	Improvement of pureline chickens and development of crosses	38	Evaluation of purelines	Chicks evaluated for juvenile traits	Number	12	48000	44000	40000	36000	32000
				Breeders evaluated for production traits	Number	12	34000	32000	30000	28000	26000
			Evaluation of crosses	No. of crosses produced and evaluated	Number	8	8	7	6	5	4
			Candidate gene analysis	Gene fragments analysed	Number	3	11	9	7	5	3
			Balanced nutrition for purelines, crosses and commercial germplasm	Feeds formulated and evaluated	Number	3	48	40	32	24	16
2	Production and supply of improved poultry germplasm	42	Supply of poultry seed	Hatching eggs, chicks & grownup birds distributed (including parents)	Number	42	850000	800000	750000	700000	650000
	Publication/ Documentation	5	Publication of the research articles in the journals having the NAAS rating of 6.0 and above	Research articles published	Number	3	16	14	12	10	8
			Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Date	2	30.06.2014	02.07.2014	04.07.2014	07.07.2014	09.07.2014

	Fiscal resource management	2	Utilization of released plan fund	Plan fund utilized	%	2	98	96	94	92	90
	Efficient Functioning of the RFD System	3	Timely submission of Draft RFD for 2014-2015 for Approval	On-time submission	Date	2	May 15, 2014	May 16, 2014	May 19, 2014	May 20, 2014	May 21, 2014
			Timely submission of Results for 2013-2014	On-time submission	Date	1	May 1 2014	May 2, 2014	May 5 2014	May 6 2014	May 7 2014
	Enhanced Transparency / Improved Service delivery of Ministry/ Department	3	Rating from Independent Audit of implementation of Citizens' / Clients' Charter (CCC)	Degree of implementation of commitments in CCC	%	2	100	95	90	85	80
			Independent Audit of implementation of Grievance Redress Management (GRM) system	Degree of success in implementing GRM	%	1	100	95	90	85	80

	Administrative Reforms	7	Update organizational strategy to align with revised priorities	Date	Date	2	Nov.1, 2014	Nov.2, 2014	Nov.3, 2014	Nov.4, 2014	Nov.5, 2014
			Implementation of agreed milestones of approved Mitigating Strategies for Reduction of potential risk of corruption (MSC).	% of Implementation	%	1	100	90	80	70	60
			Implementation of agreed milestones for ISO 9001	% of implementation	%	2	100	95	90	85	80
			Implementation of milestones of approved Innovation Action Plans (IAPs).	% of implementation	%	2	100	90	80	70	60

Section 3 :Trend Values of the Success Indicators

Sl. No.	Objectives	Actions	Success Indicators	Unit	Actual value for FY 12/13	Actual value for FY 13/14	Target value for FY 14/15	Projected value for FY 15/16	Projected value for FY 16/17
1	Improvement of pureline chickens and development of crosses	Evaluation of purelines	Chicks evaluated for juvenile traits	Number	42351	42567	44000	44000	44000
			Breeders evaluated for production traits	Number	37081	30892	32000	32000	32000
		Evaluation of crosses	No. of crosses produced and evaluated	Number	6	8	7	7	7
		Candidate gene analysis	Gene fragments analysed	Number	4	9	9	10	10
		Balanced nutrition for purelines, crosses and commercial germplasm	Feeds formulated and evaluated	Number	42	59	40	45	50
2	Production and supply of improved poultry germplasm	Supply of poultry seed	Hatching eggs, chicks & grownup birds distributed (including parents)	Number	6,15,376	723920@	800000	850000	900000
	Publication/ Documentation	Publication of the research articles in the journals having the NAAS rating of 6.0 and above	Research articles published	Number	20	14	14	14	14
		Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Date			02.07.2014		
	Fiscal resource management	Utilization of released plan fund	Plan fund utilized	%	99.63	99.76	96	99	99
	Efficient Functioning of the RFD System	Timely submission of Draft RFD for 2014-2015 for Approval	On-time submission	Date			May 16, 2014		
		Timely submission of Results for 2013-2014	On-time submission	Date			May 2, 2014		

	Enhanced Transparency / Improved Service delivery of Ministry/ Department	Rating from Independent Audit of implementation of Citizens' / Clients' Charter (CCC)	Degree of implementation of commitments in CCC	%			95		
		Independent Audit of implementation of Grievance Redress Management (GRM) system	Degree of success in implementing GRM	%			95		
	Administrative Reforms	Update organizational strategy to align with revised priorities	Date	Date			Nov.2, 2014		
		Implementation of agreed milestones of approved Mitigating Strategies for Reduction of potential risk of corruption (MSC).	% of Implementation	%			90		
		Implementation of agreed milestones for ISO 9001	% of implementation	%			95		
		Implementation of milestones of approved Innovation Action Plans (IAPs).	% of implementation	%			90		

@supply from AICRP added

Section 4(a) : Acronyms

Sl.No	Acronym	Description
1.	DPR	Directorate of Poultry Research
2.	ICAR	Indian Council of Agricultural Research
3.	AICRP	All India Coordinated Research Project
4.	SSCP	Short Sequence Confirmation Polymorphism
5.	NGO	Non-Government Organization
6.	KVK	Krishi Vigyan Kendra
7.	ASM	Age At Sexual Maturity
8.	AH	Animal Husbandry
9.	SAU	State Agricultural University
10.	GHR	Growth Hormone Receptor

Section 4 (b): Description and definition of success indicators and proposed measurement methodology

Sl. No.	Success indicator	Description	Definition	Measurement	General Comments
1.	Chicks evaluated for juvenile traits	At DPR, different lines (2 male lines, PD-2, PD-3 & PD-4) will be regenerated after selection for traits of importance. Under AICRP, 800/1000 chicks will be produced in local native birds through random mating at each centre. Coloured broiler pure lines and layer lines will be maintained with mild selection pressure for traits of importance and used in production of improved/location specific germplasm for rural poultry.	Chicks of purelines need to be evaluated for juvenile traits so as to bring about improvement in their growth rate.	Number	Growth rate during young age has considerable importance since meat is the final product from broiler poultry production.
2.	Breeders evaluated for production traits	Production performance in various purelines (rural, layer and broiler lines) and test crosses will be evaluated under intensive system of rearing at DPR and AICRP centres. At the time of housing, 500 pullets and 150 males (rural and broiler), 1000 pullets and 200 males (layer) will be housed for recording production data on egg production, egg weight etc.	Evaluation of rural, layer and broiler chicken purelines (breeders) for production parameters like ASM, body weight, egg production, egg weight etc.	Number	Evaluation of breeders for production traits helps in selection and thereby improves the productivity.
3.	No. of crosses produced and evaluated	At DPR and AICRP centres, the available purelines and native germplasm will be crossed to produce improved/location specific rural germplasm for dual and egg purpose. The performance of crosses will be evaluated for important economic traits (like growth, livability, production etc).	Development of new crosses is necessary for augmenting poultry production in rural, tribal and under developed areas of the country.	Number	Combination of purelines and native germplasm may help in tapping the beneficial effects of heterosis.
4.	Gene fragments analysed	Candidate genes like GHR & Follistatin associated with growth traits, respectively will be analysed by SSCP followed by sequencing. Genotypes will be established. The frequency of the genotypes and alleles for the gene will be estimated in chicken population.	Various candidate genes associated with growth will be studied.	Number	Candidate gene analysis may provide insight into the gene and trait association for important economic traits.
5.	Feeds formulated and evaluated	The purelines, crosses and commercial germplasm will be fed diets formulated to provide balanced nutrition so as to meet their nutrient requirements.	Feed is blend of several raw materials like cereals, protein cakes, vitamins, minerals and feed additives.	Number	To be formulated, prepared and evaluated.

6.	Hatching eggs, chicks & grownup birds distributed (including parents)	The improved chicken germplasm developed by the Directorate (Vanaraja, Gramapriya, Krishibro etc.) will be popularised through print and electronic media, participation in exhibitions etc. The Directorate is maintaining good liaison with the developmental organizations of state and central governmental agencies, NGOs, KVKs etc. The centres of poultry seed project/AICRP also will be popularising the improved germplasm. The germplasm will be supplied in the form of day old chicks, fertile eggs and parents to the farmers and other stakeholders.	Distribution of improved chicken germplasm to improve the poultry production and productivity in the country, particularly in the rural and tribal areas.	Number	Propagation of improved germplasm may help in improving the nutritional and economic status of rural, tribal and other under-privileged sections of the society.

Section 5 : Specific performance requirements from other departments that are essential for delivering agreed results

Location Type	State	Organisation Type	Organisation Name	Relevant Success Indicator	What is your requirement from this organisation	Justification for this requirement	Please quantify your requirement from this Organisation	What happens if your requirement is not met
All India	All	NGOs, Govt. agencies, farmers etc.	State AH Depts., KVKs, Govt. agencies, NGOs etc.	Hatching eggs, chicks & grownup birds distributed (including parents)	Demand for poultry seed	Indent for poultry seed of improved germplasm like Vanaraja, Gramapriya etc.	Poultry seed is produced as per the requirements of stakeholders.	Does not affect as the activities of the institute are basically research oriented and production and supply is demand driven based on the management/ production capacities of the stakeholders. However, in case of disease outbreak, the activity is likely to be affected

Section 6 : Outcome/Impact of activities of Department/Ministry

Sl.No.	Outcome/ impact	Jointly responsible for influencing this outcome/impact with the following organisation (s)/department (s) /ministry (ies)	Success indicator (s)	Unit	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017
1	Improved productivity in layer, broiler and rural chickens	SAUs	Genetic response in pureline chickens	%	2.64	2.69	2.7	2.7	2.7

Past achievements for the success indicators

Sl. No.	Success indicators	Past achievements of the success indicators			Mean of the achievements	Projected value of the success indicator for 2014-15 as per the approved RFD 2013-14
		2011-12	2012-13	2013-14		
		III	II	I		
1.	Chicks evaluated for juvenile traits	47198	42351	42567	44038.6	41000
2.	Breeders evaluated for production traits	29806	37081	30892	32593	31000
3.	No. of crosses produced and evaluated	10	6	8	8	--
4.	Gene fragments analysed	3	4	9	5.33	10
5.	Feeds formulated and evaluated	30	42	59	43.66	--
6.	Hatching eggs, chicks & grownup birds distributed (including parents)	655788	615376	723920	665028	620000

Classification of Success Indicators according to its category

S.No.	Success Indicator(s)	Input	Activity	Internal Output	External Output	Outcome	Measures Qualitative Aspects
1	Chicks evaluated for juvenile traits	FALSE	FALSE	TRUE	FALSE	FALSE	TRUE
2	Breeders evaluated for production traits	FALSE	FALSE	TRUE	FALSE	FALSE	TRUE
3	No. of crosses produced and evaluated	FALSE	FALSE	TRUE	FALSE	FALSE	TRUE
4	Gene fragments analysed	FALSE	FALSE	FALSE	TRUE	FALSE	TRUE
5	Feeds formulated and evaluated	FALSE	FALSE	FALSE	TRUE	FALSE	TRUE
6	Hatching eggs, chicks & grownup birds distributed (including parents)	FALSE	FALSE	TRUE	FALSE	FALSE	TRUE

Annual (April 1, 2014 to March 31, 2015) Performance Evaluation

Name of the Division: Animal Science

Name of the Institution: ICAR-Directorate of Poultry Research

RFD Nodal Officer of the RSC : Dr. M. Niranjan, Principal Scientist

S. No.	Objective (s)	Weight	Action (s)	Success Indicator (s)	Unit	Weight	Target /		
							Excellent 100%	Very Good 90%	Good 80%
1	Improvement of pureline chickens	38	Evaluation of primary traits	Chicks evaluated for juvenile traits	Number	12	48000	44000	40000
				Breeders evaluated for production traits	Number	12	34000	32000	30000
			Evaluation of crosses	No. of crosses produced and evaluated	Number	8	8	7	6
			Candidate gene analysis	Gene fragments analysed	Number	3	11	9	7
			Balanced nutrition to purelines/ parents/ crosses	Feed formulated and evaluated	Number	3	48	40	32
2	Production and supply of improved poultry germplasm	42	Supply of poultry seed	Hatching eggs, chicks & grownup birds distributed (including parents)	Number	42	850000	800000	750000
	Publication / documentation	5	Publication of the research articles in the journals having the NAAS rating of 6.0 and above	Research articles published	Number	3	16	14	12
			Timely publication of the Institute Annual Report (2013-2014)	Annual Report published	Date	2	30.06.2014	02.07.14	04.07.14
	Fiscal resource management	2	Utilization of released plan fund	Plan fund utilized	%	2	98	96	94

Report in respect of RFD 2014-2015 of RSCs i.e. Institutes

Criteria Value		Achievements	Performance		Percent achievements against Target values of 90% Col.	Reasons for shortfalls or excessive achievements, if applicable
Fair 70%	Poor 60%		Raw Score	Weighted Score		
36000	32000	**82,711**	100	12	187.9	Due to change in technical programme as decided in the Annual workshop held in August 2014, the AICRP centres collected and evaluated local germplasm. Thus more number of chicks were hatched and evaluated.
28000	26000	**36,961**	100	12	115.5	As per the revised technical programme, the AICRP centres evaluated local germplasm, contributing to more number of breeders.
5	4	**8**	100	8	114.3	The AICRP centres having established rural purelines and native germplasm produced and evaluated crosses (one additional cross).
5	3	**11**	100	3	122.2	The research leads obtained prompted further analysis of 2 more gene fragments
24	16	**51**	100	3	127.5	The feed formulations exceeded due to additional experiments conducted under contract research project
700000	650000	**1047011**	100	42	130.9	Owing to the increased demand, more number of germplasm were supplied from DPR as well as centres of AICRP and PSP
10	8	**12**	80	2.4	85.7	The delayed review process in respect of few research papers resulted in less number of publications
07.07.14	09.07.14	**28.06.14**	100	2		
92	90	**98.35**	100	2		

	Efficient Functioning of the RFD System	3	Timely submission of Draft RFD (2014-15) for approval	On-time submission	Date	2	May 15, 2014	May 16, 2014	May 19, 2014
			Timely submission of Results for RFD (2013-14)	On-time submission	Date	1	May 1 2014	May 2 2014	May 5 2014
	Enhanced Transparency / Improved Service delivery of Ministry/ Department	3	Rating from Independent Audit of implementation of Citizens' / Clients' Charter (CCC)	Degree of implementation of commitments in CCC	%	2	100	95	90
			Independent Audit of implementation of Grievance Redress Management (GRM) system	Degree of success in implementing GRM	%	1	100	95	90
	Administrative Reforms	7	Update organizational strategy to align with revised priorities	Date	Date	2	Nov. 1 2014	Nov. 2 2014	Nov. 3 2014
			Implementation of agreed milestones of approved Mitigating Strategies for Reduction of potential risk corruption (MSC)	% of implementation	%	1	100	95	90
			Implementation of agreed milestones for ISO 9001	% Implementation	%	2	100	95	90
			Implementation of milestones of approved Innovation action plan (IAPs)	On-time submission	%	2	100	95	90

	May 20, 2014	May 21, 2014	**April 24, 2014**	100	2		
	May 6 2014	May 7 2014	**April 24, 2014**	100	1		
	85	80	**100**	100	2		
	85	80	**100**	100	1		
	Nov. 4 2014	Nov. 5 2014	**Oct 29, 2014**	100	2		
	85	80	**100**	100	1		
	85	80	**100**	100	2		
	85	80	**100**	100	2		

Total Composite Score: 99.40

Rating : Excellent

ANNEXURE-I

Actual Scientific Staff in position in the Institute and their research articles publications published in International and National Journals having NAAS rating 6.00 or more during April 1, 2014-March 31, 2015

Name of the Division: Animal Science

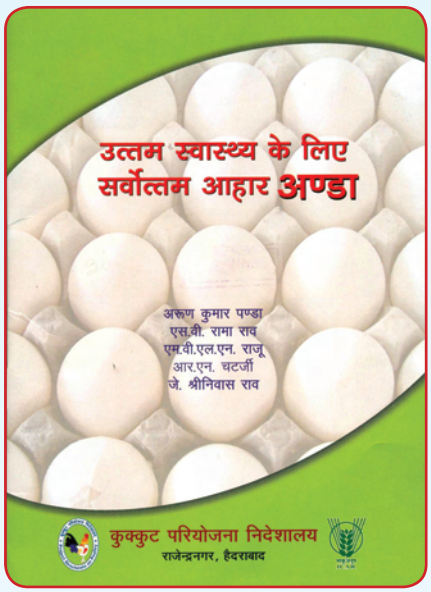
Name of the Institute: Directorate of Poultry Research

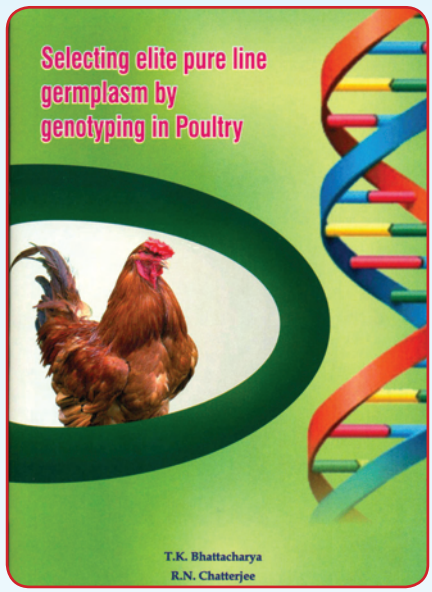
S. No.	Category of Scientific Staff	Actual Scientific Staff in position (Nos.)	Research articles publications as first /corresponding author (Nos.)	Publication productivity (Number of research articles publications divided by number of Scientists)
1.	Principal Scientist	09	10	1.11
2.	Senior Scientist	01	00	00
3.	Scientist	05	02	0.40
Total		15	12	0.80

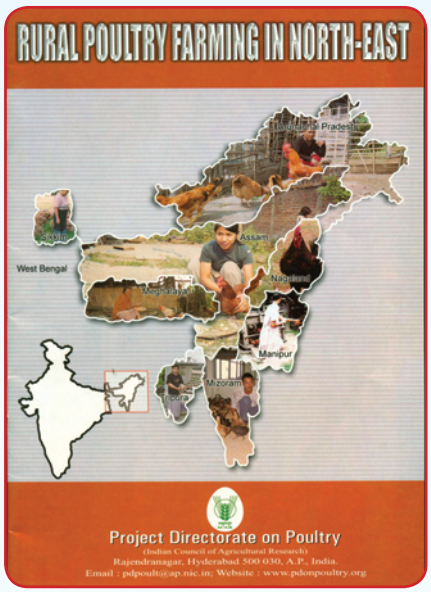
Silver Jubilee Block

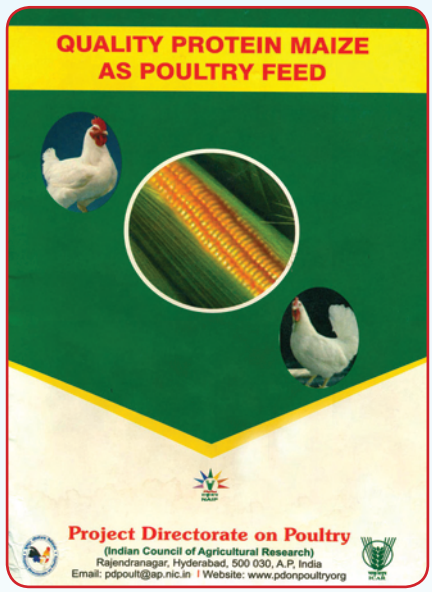
Exhibition Centre

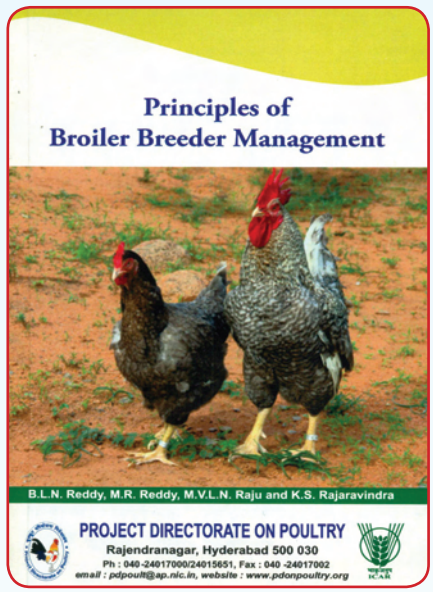
DPR Publications

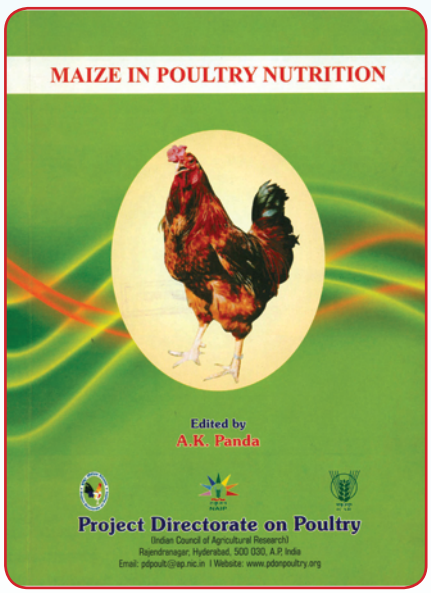


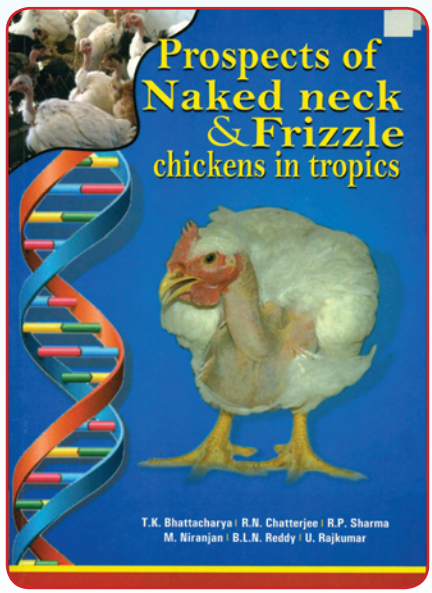


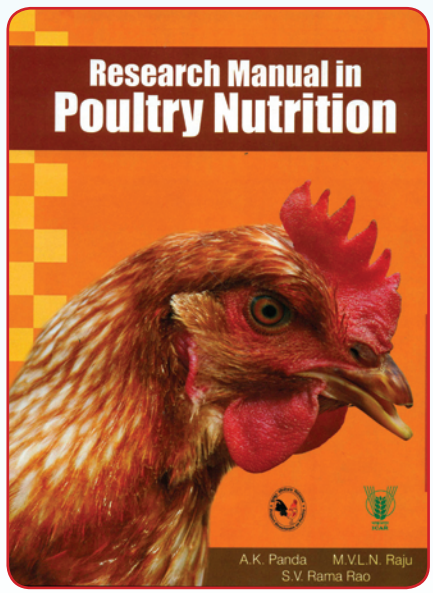













नवविकसित कुक्कुट नस्ल रिलीज समारोह
NEW CHICKEN VARIETY RELEASE

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

Agrisearch with a human touch

भाकृअनुज-कुक्कुट अनुसंधान निदेशालय

ICAR-Directorate of Poultry Research

Rajendranagar, Hyderabad - 500 030
Ph.: +91 (40) 2401 5651/7000/8687
Fax : +91 (40) 2401 7002; E-mail : pdpoult@nic.in
www.pdonpoultry.org