Annual Report
2015-16

भाकृअनुप
ICAR

ICAR-Central Avian Research Institute

Izatnagar, Bareilly-243122 (Uttar Pradesh)

An ISO 9001 : 2008 Certified Institute

ICAR-CARI

Annual Report

2015-16

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Guidance and Supervision: Dr. J.M. Kataria, Director

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Cover page Design: Dr V. K. Saxena, Dr M.P. Sagar and Dr S.Tomar

Design and Layout : Dr V.K. Saxena and Dr J J Rokade

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CONTENTS

Preface

"Chickens, not computers, can eradicate poverty"

-Bill Gates

Recognizing the potential of poultry to eradicate poverty and to address intricate issues like gender equality and women empowerment in the majority agro based Indian rural societies, the institute, since its inception on Nov. 2, 1979 has significantly contributed towards popularization and growth of diversified poultry species such as ducks, turkey, Guinea fowls and quails in the country in addition to native chicken and commercial broilers and layers. The poultry production technologies developed by the institute smoothly fit into various crop-livestock production systems throughout the country ensuring employment generation and women emancipation.

Consistent with the Startup India campaign of the Government of India, the Central Avian Research Institute during the year bygone has developed and refined its poultry production and processing technologies so as to offer ample opportunities for the young entrepreneurs to establish their own agribusiness ventures in poultry and allied sectors. The institute has established an Agri-business Incubator to nurture new business ideas and to assist the prospective entrepreneurs in establishing their businesses.

The research programme executed at the institute yielded several path breaking results in the period under report. Lactobacillus reuteri isolated from the gut of Assam indigenous chicken has been identified as potent probiotic for broiler rations. New feed formulae with Distiller's Dried Grains with Soluble (DDGS) and roasted guar korma as alternative cheaper sources of energy and protein in the poultry rations have been developed leading to substantial savings in feed cost. The institute has also developed a semen diluent for turkey, quail and chicken. The semen diluent is substantially cheaper as compared to other semen diluents available commercially. Novel processed products such as turkey breast fillets, chicken meat bites and poultry meat wafers have been standardized by the institute. The efforts of the scientists to find solution to the menace of poultry waste have yielded encouraging results in the form of a technology to utilize the waste for production of biogas and manure. The institute made significant strides in supply of germplasm with about1.5 lakh units (fertile eggs/ DOC/ adults) of diverse poultry species (ducks, turkey, Guinea fowls and improved native chicken in addition to broilers and layers) supplied throughout the country with increased supply of rural chicken germplasm. The institute is making all out efforts to promote and popularize small scale rural poultry farming by adopting nearby villages and laying field demonstrations as well as training camps. In recognition of the significant contributions, several prestigious fellowships and awards have been bestowed upon the scientists of this institute. The publications of the institute add up to about 227 with quite a good number in the high rated international and national journals. Besides, the scientists and staff of the Institute also actively participated in "Swachch Bharat Mission" as per GOI directives and spread the message of "health and hygiene" in the nearby villages as well. With a view to bring about better organizational efficiency, the institute has implemented the ERP system comprising of MIS-FMS modules. Adhar Enabled Biometric Attendance System has also been made operational in the institute.

I extendmy sincere thanks to Dr T. Mahapatra, Secretary DARE &DG, Dr H. Rahman, DDG (Animal Sciences) and Dr R.S.Gandhi ADG, AP&B, ICAR for their valuable advice and guidance. I am thankful to Dr R. Prabhakaran, Chairman, QRT and RAC of the Institute for his comments and inspiring views which have contributed significantly for the development of this institute.

I present this Annual Report with joy,duly acknowledging the sincere inputs of the dedicated team of scientists and also look forward to the feed-back from the readers. I am sure that the efforts of the institute will bear fruits in near future with India becoming one of the forerunners in eggs and meat production in the world.

(J.M. Kataria)
Director


भाकृअनुप-केन्द्रीय पक्षी अनुसंधान संस्थान
ICAR-CENTRAL AVIAN RESEARCH INSTITUTE
इज्जतनगर / IZATNAGAR
ICAR
CARI

INTRODUCTION

Central Avian Research Institute (CARI) came into existence on **2nd November 1979** by combining the PRD and the Coordination Unit of AICRP on Poultry Breeding. Since its inception the institute has been significantly contributing in development and progress of Indian Poultry Sector (IPS) and emerged as the premier institute on poultry research in Asian sub-continent**.** Presently, its main campus is located at Izatnagar, Bareilly (U.P.) and the regional centre at Bhubaneswar (Odisha). The continued efforts and contributions of CARI in terms of germplasm, technology and process development as well as HRD spport to IPS, have transformed subsistence backyard poultry rearing into a vibrant and aggressive agro-industry with its domestic market currently estimated at about Rs 60,000 crore. The poultry species which were lesser known such as Japanese Quail and Turkey were made popular in the country by devoted and continued efforts of this institute. The institute has indigenously developed not only the layer and broiler commercial and dual purpose crooses for backyard poultry but also enriched the poultry resource basket of the country by releasing high yielding varieties of Ducks, Turkey, Japanese Quail and Guinea Fowl. Being developed and improved in native environment, these stocks are well adapted to varied Indian climate and can give optimum production under low input system in village conditions. Another major contributions from the institute is to lowering the poultry feed cost and evaluation of alternate feed resources to develop feed formulae for computing low cost ration under different climate and regions of the country. Besides, the identification of toxins in feeds and development of their ameliorating methods as well as increasing the nutrient availability for improving feed efficiency are the other contributions in this direction. Institute has developed the protocols for about 18 value added processed products utilizing poultry egg, meat and by-products and development of methods for their shelf-life extension. The semen extender for chicken was developed which can maintain the fertility till 24 h. Similarily, the semen extender and AI technology in Japanse quail is unique and its kind. Besides, the institute has also contributed significantly in frontier areas like molecular genetics and biotechnology, RNAi, metagenomics and in-ovo culture techniques. Institute's HRD programme has been providing trained manpower for manning large commercial poultry houses in the country.

The continued and dedicated efforts of the institute has resulted into an overall growth of about 8-10% per annum of Indian Poultry Sector and contributing 0.7% in National GDP. On its way to achieve this success, the growth path of IPS has never been devoid of hurdles as the poultry industry faced with several challenges like increasing cost of feed ingredients, decreased dividends, slow consumption growth of poultry products, climatic stresses, threats of new emerging poultry diseases like AI, poultry waste management, ethical issues and product quality assurance etc. however, amid this the scientists, teachers, researchers and poultry industry people have find their way to make poultry an economically viable component of Indian agriculture.

Mandate

Main Campus

- To undertake basic, applied and adaptive research in all disciplines relating to production of diversified poultry.
- To develop post-harvest technologies for value-addition, quality assurance, efficient processing and marketing of poultry products and by-products.
- To impart specialized training and post-graduate education in Poultry Science and allied fields.
- To transfer the proven technologies to the end users employing efficient and cost- effective methods.

- To provide referral and consultancy services in all aspects of production, processing and marketing (value chain) of diversified poultry.

Regional Centre

- To conduct research on various aspects of duck production using both native and exotic ones.
- To undertake research on backyard poultry production and develop package of practices on various aspects.
- Conservation and maintenance of indigenous germplasm and testing of high yielding birds developed at CARI.
- Popularization of duck farming amongst beneficiaries.

Major R&D activities

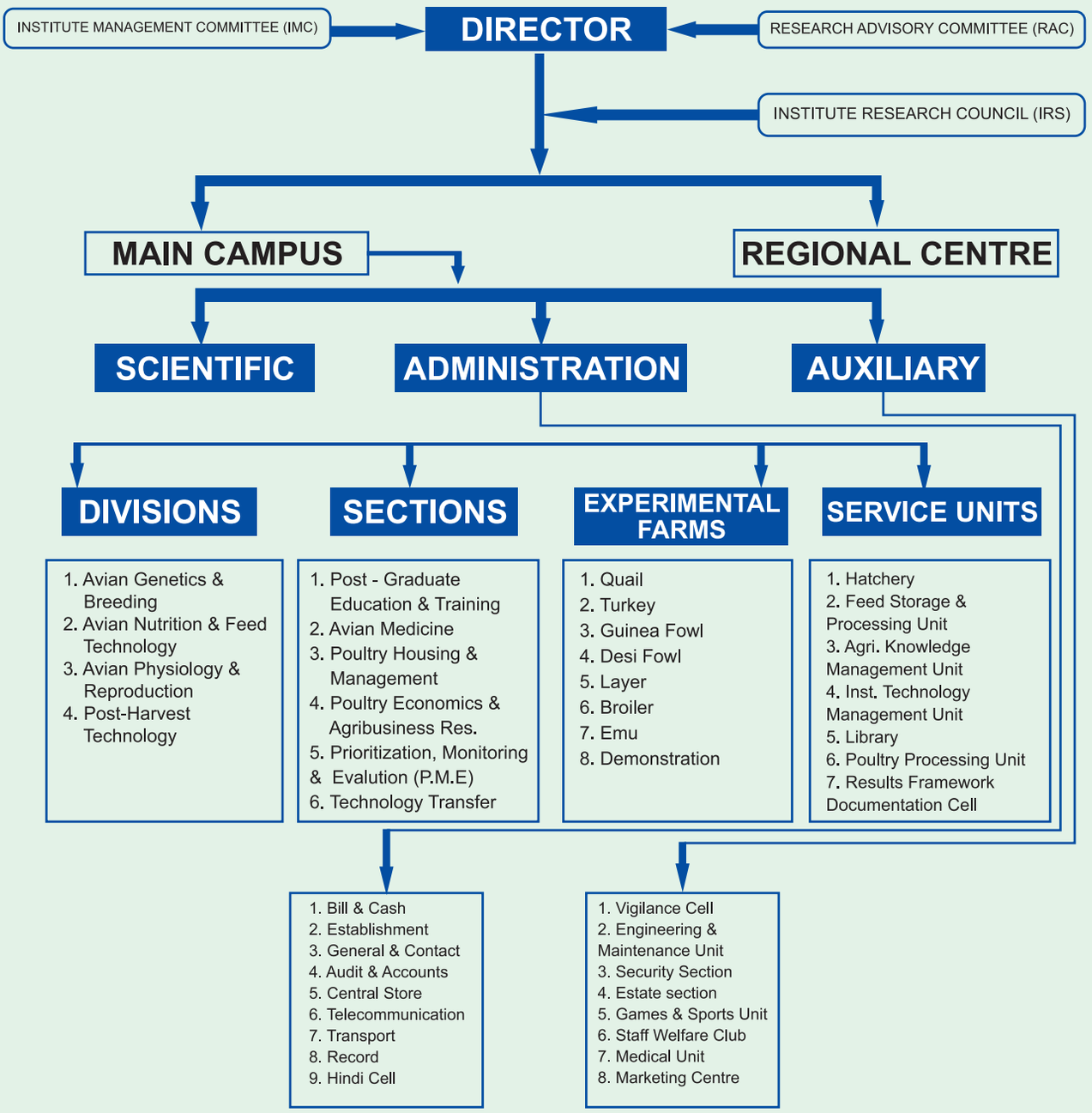
- Presently, total 38 projects (28 institute funded projects and 5 extramural + 2 AICRP and 3 service projecta) are running in the Institute.
- Genetic improvement, characterization and propagation of diversified poultry species through breeding and molecular tools; research in advance areas, conservation of indigenous chicken.
- Poultry waste management and its conversion into green energy
- Conducting research on basic and applied aspects of avian nutrition and rendering diagnostic & consultancy services viz., feed analysis, quality assurance etc.
- Basic advance and applied research on various aspects of avian physiology viz. reproduction, stress, digestion etc.
- Development of value-added poultry products, innovative techniques for preservation, packaging and self-life enhancement, assessment and amelioration of potent bio- and phyto-contaminants as well as processing and utilization of poultry by-products.
- Conducting training, providing advisory and consultancy services, participation in exhibitions, technology assessment and transfer through on-farm trials, germplasm supply and publication of books/bulletins, etc.
- CARI Regional Centre, Bhubaneswar is dedicated for research on genetic improvement of ducks and development of location specific germplasm for catering the needs of Eastern and North-Eastern parts of the country.

Staff Position

(As on 31.03.2016)

Sr. No.	Category	Sanctioned Strength	In- Position	Vacant
1.	Scientific	40+1	34+1	06
2.	Technical	61	38	23
3.	Administrative	31	27	04
4.	Skilled Support Staff	137	105	32

ORGANOGRAM


INSTITUTE MANAGEMENT COMMITTEE (IMC)
DIRECTOR
RESEARCH ADVISORY COMMITTEE (RAC)
INSTITUTE RESEARCH COUNCIL (IRS)
MAIN CAMPUS
REGIONAL CENTRE
SCIENTIFIC
ADMINISTRATION
AUXILIARY
DIVISIONS
SECTIONS
EXPERIMENTAL FARMS
SERVICE UNITS
1. Avian Genetics & Breeding
2. Avian Nutrition & Feed Technology
3. Avian Physiology & Reproduction
4. Post-Harvest Technology
1. Post - Graduate Education & Training
2. Avian Medicine
3. Poultry Housing & Management
4. Poultry Economics & Agribusiness Res.
5. Prioritization, Monitoring & Evalution (P.M.E)
6. Technology Transfer
1. Quail
2. Turkey
3. Guinea Fowl
4. Desi Fowl
5. Layer
6. Broiler
7. Emu
8. Demonstration
1. Hatchery
2. Feed Storage & Processing Unit
3. Agri. Knowledge Management Unit
4. Inst. Technology Management Unit
5. Library
6. Poultry Processing Unit
7. Results Framework Documentation Cell
1. Bill & Cash
2. Establishment
3. General & Contact
4. Audit & Accounts
5. Central Store
6. Telecommunication
7. Transport
8. Record
9. Hindi Cell
1. Vigilance Cell
2. Engineering & Maintenance Unit
3. Security Section
4. Estate section
5. Games & Sports Unit
6. Staff Welfare Club
7. Medical Unit
8. Marketing Centre

EXECUTIVE SUMMARY

Productivity Improvement of Diversified Poultry Species

- The "*Preservation of elite germplasm of Japanese Quail at CARI, Izatnagar was undertaken*" as per the ICAR letter No. AS/11/1/2013/ASR-II dated 27 Feb 2015". Different lines *viz.* CARI UTTAM, CARI UJJAWAL, CARI PEARL, CARI SWETA, CARI SUNEHERI, CARI BROWN, CROSS LINE & CONTROLL LINE were preserved. Hatchability and fertility in these lines ranged from 45.12 to 99.74% with an overall average of 68.49 %.
- In IIIrd generation body weights of pearl, lavender and white varieties at 4, 8 and 12 weeks ranged from 128.0±2.02 to 172.55±1.3, 454.8±4.51 to 516.06±3.8 & 705.4±8.35 to 893±5 g, respectively. In control the respective weights were 157.44±1.4, 494.72±3.7 and 842.72±5.9 g. FCR during 0-4, 5-8 & 9-12 wk of age were 3.76±0.33, 4.01±0.49, & 4.09±0.26. The reproductive seasonality in Guinea fowl was broken through photoperiod and dietary protein manipulation and sizable egg production (1887 eggs from 127 females from 20-35 weeks of age) and hatchability were achieved in winter season (Oct. 2015 - Feb 2016). Among six treatment groups, the photoperiod of 18 h and 20% dietary protein exhibited best results.
- The purebred Aseel Peela (1055), Aseel kagar (793), CARI Red (1520), Nicobari (392), Kadakanath (1028), Ankaleshwar (793), coloured Frizzle (223), coloured Naked Neck (236) and gene pool line chicks (1145) were hatched and utilized for production of 11305 commercial chicks for family poultry production.
- Nicobari and CARI Red cross was adjudged as best cross for family poultry production in a 3×3 complete diallel experiment involving two native chickens *viz.* Ankleshwar (AN) and Nicobari (NC) along with exotic breed CARI Red (CR). On the basis of average performance for body weight of all nine crosses NC x CR should highest body weight among all groups at all ages. Mean body weight gain of both the sexes of all genetic groups also showed similar trend. The CR x NC cross also had higher and positive heterosis percentage for cell mediated immune response against PHA-P.
- Aerobic composting of poultry excreta using 1:20 to 1:30 C/N ratio resulted in organic manure having N, P, K value (%) of 2.2, 0.8 and 3.6, respectively, with almost nil *E. coli* count, about 94% germination potential and value-addition to the tune of 2-3 times based on fertilizer value.
- Conditioning of poultry excreta through dilution (D), carbonization (C) and acidification (A) techniques and its use in various combinations that the ratio of bio-gas production from poultry excreta through D:DC:DCA techniques was 1:2:4. The hydraulic retention time (HRT), bio-gas production, blue flame proportion etc. were significantly better in DCA followed by DC and was lowest in D during summer and winter seasons. The contents of methane (%, V/V), carbon-dioxide (%, V/V), oxygen (%, V/V), hydrogen sulphide (ppmv) and balance gases (N2, VOCs, Moisture etc.) in DC were 58.3, 33.23, 1.33, 22.33 and 7.03, respectively. The respective values in DCA were 55.47, 35.5, 0.83, 57.00 and 8.17.
- Fertility percentages were 87.94 and 88.38 in CSML and SML, respectively. Hatchability percentage on TES and FES were 81.69 and 92.9, respectively in CSML and 77.67 and 87.88 in SML. Fertility percent in control was 86.48 and hatchability percent based on TES and FES were obtained as 75.95 and 87.82, respectively. Overall average body weight of mixed sexes at 5 weeks in SML and control were 1165.49±6.82 g, and 757.4±9.8 g, respectively. Phenotypic and genetic responses in SML were 13.40**±1.40 and 11.17**±1.75 g/generation, respectively. The phenotypic response for 5-week body weight in the control population was non-significant (1.90±1.00 g / generation).

- The fertility percentage was 89.53 and hatchability percentage based on TES and FES were 83.91and 93.73, respectively in CSFL. Corresponding values in SDL were 91.42, 81.21 and 88.83 percent, respectively. The overall average of body weight at 5 weeks in SDL was 1152.84±2.44 with phenotypic response as 12.91**±2.08 and genetic response as 10.99±2.07**. Fertile eggs procured from villages were hatched, body weight and body measurements were recorded at 0, 28, 56 and 84 days. In IR3, IC3, Naked Neck (coloured) and Tropicana, range for fertility was 71.7 to 82.4% and for hatchability (FES) was 73.2 to 84.36 %.
- At 44th RSPPT (Gurgaon) CARIBRO- Dhanraja secured III rank with 6-week weight- 1.59; 7-week weight-1.89 Kg. FCR (0-6 Wks), mortality and dressing percentages were 2.3, 4.6% and 71.56%, respectively. Margin of receipt over feed cost at 6-weeks was Rs 1.94 per bird
- The fertility in RIRs and RIRc was in the range of 83.6 to 86.9% and 86.0 to 87.8%, respectively. The hatchability on fertile eggs transferred basis in RIRs and RIRc was 86.4 and 92.4%, respectively. The body weights at 20th and 40th week in RIRs were 1391.5±5.76g, 1831.4±7.98g; corresponding bodyweight in RIRc were 1031.4±11.84g, 1598.0±16.65g.
- Egg production and egg weight at 40 weeks in RIRs was significantly higher (113.4±0.63 nos. and 50.62±0.11g) than RIRc. The AFE was significantly lower (138.9±0.40 d) in RIRs than RIRc. Genetic response per generation showed significant (P<0.01) decline for ASM (-0.69±0.15 day), whereas for 40 week egg number (1.11±0.11eggs) and egg weight (0.09±0.01g) the estimate were highly significant (P<0.001). Average phenotypic responses for most of the economic traits in control population were non-significant.
- The LS means of ASM, BW16, BW40, EW28, EW40 and EN40 in IWG strain were 135.69 ±0.93 days, 982.37 ± 11.55 g, 1494.35 ±17.54 g, 44.98 ±0 .21 g, 50.40±0.31 g and 123.61 ±1.37 eggs, respectively. The corresponding estimates in IWJ strain were 139.56±1.32 days, 915.99±14.89g, 1349.00±15.64g, 41.96±0.31g, 46.27±0.31g and 118.98±1.36 eggs.
- In the annual production strains, IWH and IWI strains of WLH chicken, the LS means of ASM (d), BW16 (g), BW40(g), EW28, EW40 (g) and EP40 (no) in IWH strain were 137.23±1.62, 867.44±10.54, 1347.21±13.58, 46.23±0.41, 51.03±0.54, 123.19±1.51, resp. and in IWI strain, corresponding means were 137.39±1.33, 879.57±8.96, 1356.93±13.69, 48.05±0.52, 51.88±0.36, 120.00±1.77, respectively.
- Ten, Egg production-associated, polymorphic microsatellite loci in RIR chicken revealed 2-5 alleles. The PIC values at these loci ranged from 0.19 to 0.68, suggesting usefulness of these markers. In RIR population, estimates of Ne were lesser than Na indicating prevalence of heterozygosity. The population was under H-W disequilibrium, Chi square and G-square estimates were significant. Genotypes at polymorphic egg-production associated MS loci had significant influence on growth and layer economic traits. ADL0176 microsatellite loci influenced both growth and layer traits, thereby suggesting usefulness of these markers and ADL0176 in particular, in MAS for associated traits.
- The basal mRNA expression level of CRBP IV gene was higher at 40-weeks of age in kidney as well as in oviduct in comparison to 32- and 12-week's expression. The CRBP IV expression was several folds higher at 40-weeks in kidney and oviduct. MS genotypes at ADL0176 influenced the expression level of CRBP IV gene in oviduct, hence, selection on the basis of ADL0176 genotypes may have role in improvement of egg production.
- Nine out of ten growth-linked microsatellite loci revealed polymorphism in RIR chicken with 1-4 alleles and PIC value ranging from 0.296 to 0.672. Ne was less than Na suggesting prevalence of heterozygosity in the population. The studied population was under H-W disequilibrium, χ^2 and G-square estimates were significant, which suggested that the employed microsatellite markers are useful in assessing population structure of RIR chicken. Genotype at polymorphic growth-linked microsatellite loci had significant influence on growth traits. The microsatellite loci as MCW0010, MCW0058, MCW0068, LEI0071 and ADL0328 microsatellites

can be used as molecular marker in MAS program for genetic improvement of growth traits in chicken.

- Betain supplementation trial in four treatment groups viz. T1 (control), T2 (1 g/kg), T3 (2 g/kg) and T4 (3 g/kg) in broiler breeders during 24-30 weeks age (6 weeks) indicated that supplementation of betaine @ 1 g/kg could improve the broiler breeders egg production and fertility.
- Lactobacillus genus specific primers showed postive results (2013 bp) in 40 out of 52 samples obtained from AAU, Guwahati. Finally with 16S rRNA gene primers only 30 were found positive with an amplification of 900 bp band. The sequencing and analysis was done. All 30 isolates were evaluated for probiotic properties, finally three isolates AJ3, ACE5 and GJ1 were identified to be the best isolates. For in-vivo evlaution, these three isolates were used as probiotic in feeding trial in commercial broilers. The growth parameters, FCR, carcass traits, and immunity parameters were evaluated. The results of feeding trial exhibited best performance with diets supplemented with isolate AJ3 as probiotic. The results of culture typing revealed that isolate GJ had high similarity with Staphylococcus *warneri*, and isolates AJ and ACE with Lactobacillius *reuteri*. The isolate AJ3 may therefore be recommended to be used as probiotic in poultry diet for commercial poultry production

Avian Nutrition and Feed Technology

- The estimated apparent nitrogen-corrected metabolizable energy (AMEn) value of rice based dried distiller grains with solubles (rice DDGS) was 2880 kcal/kg diet in adult cockerels and on supplementation of cock-tail (mixed) enzymes the AMEn value of DDGS was improved by 78 kcal/kg.
- Rice based dried distiller's grain with solubles (DDGS) can be incorporated up to 10% level replacing soybean meal for higher egg production, better egg quality traits and immuno- competence in laying hens.
- A dietary concentration of 0.40% available phosphorus and 1600 IU/kg vitamin D_3 was found adequate to obtain optimum production performance, egg quality traits and blood biochemical parameters in White Leghorn layers during 25-36 weeks of age.
- In broiler chickens a dietary concentration of 0.35 and 0.25% available phosphorus during starting and finishing phase, respectively, and 1500 IU/kg vitamin D_3 with supplementation of phytase @ 500FTU/kg diet was found adequate to obtain optimum blood concentration and retention of calcium and phosphorus.
- Efficacy of synbiotics (mixture of *Bacillus subtilis* and *Bacillus amyloliquifaciens* @ 10^6 cfu/gm and mannan-oligosaccharides @) 1% in diet) was more in improving body weight gain, feed conversion ratio (FCR), immunity, and survivability of poults than those fed either with prebiotics (mannan-oligosaccharides @ 1%) or probiotics (*Bacillus subtilis* and *Bacillus amyloliquifaciens* @ 10^6 cfu/gm) alone in growing turkey poults (0-6wk of age).
- Addition of probiotics (*Lactobacillus acidophilus* @10^6cfu /gm feed) in low-energy and low protein feed improved immune response, increased beneficial bacterial concentration in gut, structural health of ileum in broiler chickens. Moreover, probiotics improved the physio-biochemical characteristics and reduced the total entero-pathogen counts in fresh and stored meat of broiler chickens.
- Experimentally induced ochratoxicosis with 200 ppb ochratoxin resulted in reduced production performance, affected structural gut health and causes immuno-suppression.
- Ochratoxin A was more toxic than aflatoxin B1 assessed through performance, immunity and gut morphometry and there was synergistic relation in their toxicity in broiler chickens.
- Supplementation of vitamin E (200 mg/kg) to the ochratoxin contaminated diet improved the production performance and immune response during 0-6 weeks age of broiler chickens.
- Inclusion of either turmeric powder or oil in diet improved the keeping quality of meat under cold-chain preservation but efficacy of oil was more than that of powder.

Physiological Intervention for Augmentation of Reproductive Efficiency

- Heat stress adversely affect high body weight CARIBRO-Vishal broilers than medium and low body weight broilers. This indicates higher heat tolerance ability in low and medium weight birds.
- Prenatal thermal conditioning increased intestinal activity of pepsin and trypsin, serum glucose levels but compromised pre and post hatch performance in broilers.
- WLH chicken semen showed high fertility rate at 7±1 °C followed by storage at 11±1 °C and 3±1 °C at 24 hrs storage of semen.
- CARI diluent expressed higher fertility rate in 24 hrs stored semen (at low temperature) of WLH chicken in comparison to world class semen diluents like BPSE and Lake. Similar results were observed in broilers.
- Sperm quality can be prominently influenced by the varying concentrations of metabolic constituents and trace elements of seminal plasma and circulating levels of testosterone in broiler breeders.

Poultry Products Technology

- Low-fat, low-salt and fiber enriched health oriented poultry meat wafers can be well stored up to 90 days at ambient temperature under aerobic packaging condition.
- Storability of functional poultry meat finger chips fortified with oregano powder (500 mg/kg) and α-tocopherol acetate (400mg/Kg) was determined up to 75 days at 37 ± 2 ºC under aerobic packaging condition.
- Shelf-life assessment of functional chicken meat bites indicated that it can be well stored more than 3 months without affecting products quality and integrity during storage at – 18 ± 2 ºC under aerobic packaging conditions.
- Processes for development of chicken breast fillets from spent broilers and Egg Rasmalai were standardized.
- Calpain assisted post-mortem ageing of meat from diversified animal species has been standardized.
- Carvacrol (0.06%) was found as an effective antimicrobial for pre-dipping of dressed chicken carcasses before thermal treatment to inactivate *Salmonella* Enteritidis on dressed chicken surface.
- The protocol for decontamination of hardy *Salmonella* Typhimurium on dressed chicken using antimicrobials with subsequent thermal treatment has been standardized and checked in actual processing conditions.

Poultry Shelter Management

- Dry matter metabolizability (DMM) and nitrogen retention were significantly higher ($P<0.05$) in the poults provided 1.25 sq. ft floor space than those 1.90 sq. ft but energy metabolizability (EMM) and fiber utilization did not differ due to floor spaces.
- The DMM and EMM was significantly higher ($P<0.01$) in 2800 kcal/kg ME fed poults, but fibre utilization was better in 2400 kcal/kg ME fed poults.
- The DMM and nitrogen retention did not differ due to enzyme supplementation whereas, fiber utilization improved ($P<0.01$) in enzyme supplemented poults. Interaction of space, energy and enzyme was significant ($P<0.05$) for nitrogen retention only.
- The behavioral study of WLH layers revealed that during winter, the floor reared layers spent significantly more time in sitting (46.4%), walking (7.2%) and investigating behavior (4.0%) than those reared on colony (38.2, 4.8 and 1.4%) or individual cage (30.9, 1.4 and 1.0%). Individual cage layers spent more of time in feeding (40.7%) than the colony (26.6%) or floor birds (22.9%). Feather pecking was more frequent in the colony cages, but individual cage layers had stereotyped feather pecking but in low frequency. Higher ($p<0.05$) fearful response and time for first peck was observed in individual cage layers than the floor and colony birds.

Regional Centre, Bhubaneswar

- The average Duck Day egg production up to 40 week of age (G-2) were recorded as 71.74, 67.10, 55.88, 13.22, 80.67 & 70.27 eggs for Khaki Campbell, Desi, White Pekin, Moti breeds and DK & PK crossbreds, respectively. The egg production of both the crossbreds was better

than their respective purebreds. The mean 40th week egg weights for corresponding breeds/ crossbreds were observed as 63.18, 61.18, 65.60, 66.15, 63.41 & 63.96 g. The average age at 50% egg production was observed as 165.66, 164.33, 173.6, 165.00, 160.5 and 187.5 days for respective breeds/ crossbreds.

- Effect of duration of storage in cooling chamber and egg weight on fertility and hatchablity in ducks was evaluated for standardizing the duration of storage and weight of egg for optimizing fertility and hatchability.
- The sperm storage tubule fully developed and functional by 23rd wks of age in Khaki Campbell ducks. Presence of transparent fluid (pre-ejaculatory fluid) affects the motility of spermatozoa.
- Production of Azolla in silpaulin pit was standardized and effect of Azolla feeding in crossbred ducks was evaluated. There was a saving of Rs. 0.60/day/duck due to feeding of azolla. Ducks fed with azolla had orange colored yolk which might be due to the presence of carotenoid pigments in azolla.
- A total of 1368 ducks were reported to be died this year. The average mortality of duck found to be 3.17 %. Month wise highest mortality was in October (287, 10.14%) and minimum in December (33,0.1.31%). Breed wise highest mortality revealed in white Pekin (751, 1.74%) followed by Khaki Campbell (306,0.70%), Desi –pati (273, 0.63%) and Muscovy Moti (38, 0.008%) respectively.
- Rice based farming system for up-land area was developed. KC ducks attained 1.6 kg (avg both sex) by 6 months of age through natural grazing and scavenging. Rice-Fish-duck model found highest remunerative.
- A total of 26313 duck germplasm were supplied to farmers and enterprneurs.

Education and Training

- During academic year 2015-16, 59 students (30 MVSc, 28 PhD and 1 NDPH) were on roll for different degrees courses in Poultry Science discipline under Deemed University, Indian Veterinary Research Institute, Izatnagar.
- Four PhD and twelve MVSc students submitted their theses and received degrees in Poultry Science discipline under Deemed University, Indian Veterinary Research Institute, Izatnagar.
- Three specialized short-term training courses in different areas of Poultry Science were organized.
- ORW seminar-14, major credit seminar-16, minor credit seminar-05 and pre-thesis submission seminar-17 were organized.

Extension and Transfer of Technology

- To create awareness and disseminate the knowledge about poultry farming, *field day* and *awareness camp cum exhibition* were organized in different villages of U.P.
- Four regular short term training programmes on poultry production management were organized.
- CARI and its regional Centre participated in five national/regional exhibitions and kisan melas .
- CARI organized Poultry Exhibition-2015 at its campus to celebrate 37th foundation day of institute.
- Two *on-farm demonstrations* on CARI Nirbhik were organized in adopted and various other villages of Bareilly district, Uttar Pradesh.
- Two kisan goshthies were organized to address the problems of poultry farmers in different aspects of poultry farming at different locations in UP.
- Swacchhata Pakhwara was organized from 26th Sept. to 11th Oct., 2015

RESEARCH ACHIEVEMENTS

Productivity Enhancement of Selected Poultry Species

Preservation of elite germplasm of Japanese Quails at Izatnagar

As per the ICAR letter No. AS/11/1/2013/ASR-II dated 26 June 2014 the breeding and research work on Japanese Quail was stopped with immediate effect. However, **as per the ICAR letter No. AS/11/1/2013/ ASR-II dated 27 Feb 2015** "*Preservation of elite germplasm of Japanese Quail at CARI, Izatnagar was permitted*".

In order to preserve the quail lines the random pair mating of about 300 families in each line was carried out to produce 1200-1500 chicks in 3 hatches. Different lines *viz.* CARI-Uttam, CARI-Ujjawal, CARI-Sweta and CARI-Pearl, CARI-Suneheri, CARI-Brown, CROSS line and control line were preserved. The population of Japanese quail lines in preservation mode was 11,618 as on 05 April 2016. Reproductive performance of different lines is given in Table-1.

Table 1: Hachibility of different quail lines

Quail Line	Egg set	Good Chicks	H% (TES)
CARI- Uttam	3085	3077	99.74
CARI -Ujjawal	3067	2119	69.09
CARI -Pearl	2144	1275	59.47
CARI -Sweta	3118	1928	61.83
CARI- Sunehari	1773	800	45.12
CARI -Brown	1533	1530	99.80
CROSS	2380	1205	50.63
Control	2095	1212	57.85
Total	**19195**	**13146**	**68.49**

Genetic improvement of guinea fowl varieties

Guinea fowl germplasm is being maintained and improved for high 12th week body weight. In IIIrd generation of selection in Pearl verity 4, 8 and 12 weeks, the body weights were 172.55±1.3, 516.06±3.8 & 893±5g, respoectively, whereas in control 157.44±1.4, 494.72±3.7 and 842.72±5.9 g, respectively. Corresponding body weights were 178.2±1.45, 533.7±3.15 and 888.8±5.16g in Lavender and 128.0±2.02,454.8±4.51 & 705.4±8.35g in white variety. In Pearl, FCR during 0-4, 5-8 & 9-12 wk of age were 3.76±0.33, 4.01±0.49, & 4.09±0.26. The fertility and hatchability in different varieties are shown in Fig.1. Carcass quality traits are given in Table 2. At 12 wks of slaughter age, female have higher (697.43 g ±15.3) eviscerated weight than male (672.30±9.74 g) . At peak egg production egg quality traits such as: egg weight, egg shell thickness, yolk colour, egg shape index, albumin index, yolk index & haugh unit were 43.11±0.32g, 68.73±0.78mm, 8.38±0.19, 78.55±0.52, 77.39±1.18, 39.09±0.23 & 92.78±0.45, respectively.

Fig.1: Fertility & Hatchability in different varity of GF

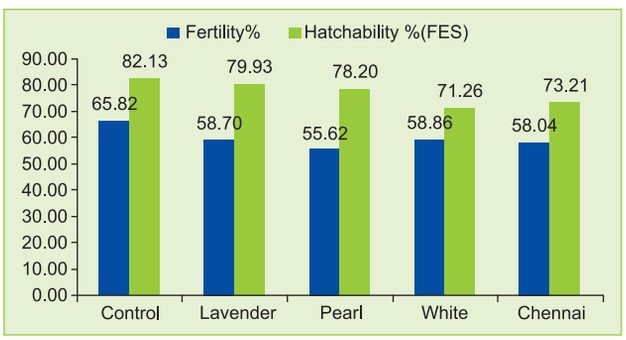


Table 2: Carcass traits in Guinea fowl at 12th week of age in Pearl variety of Guinea Fowl

Sex	Def wt(g)	Evis. Wt.(g)	giblet wt. (g)	Breast (g)	Thigh (g)	Drumstick (g)	Back (g)	Wings (g)	Neck (g)
Female	863.81 ± 18.5	697.43 ±15.3	36.56 ±1.5	186.46 ±6.1	85.0 ±1.9	106.56 ±2.7	165.1 ±5.0	101.15 ±1.8	42.12 ±1.1
Male	835.69 ±11.89	672.30 ±9.74	38.5 ±1.26	177.43 ±3.59	86.71 ±1.93	104.73 ±1.92	156.5 ±3.17	95.60 ±2.14	44.52 ±2.65

Photoperiod and dietary protein crack seasonality of egg production in Guinea Fowl

Experiment was conducted from Oct. 2015 to Feb., 2016 in Pearl variety of guinea fowls (15 to 35 wks of age of birds). In 2X3 Factorial design two variables were Photoperiod (16 & 18 hrs) and dietary protein (16% ,18% & 20%). Total six treatments viz: T1-16 hrs photoperiod × 16% protein,T2-16 hrs photoperiod × 18% protein,T3-16 hrs photoperiod × 20% protein, T4-18 hrs photoperiod × 16% protein,T5-18 hrs photoperiod × 18% protein,T6-18 hrs photoperiod × 20% protein were offered to 36 bird / treatment. Birds were housed at 15 wk of age in individual male & female cages in two separate rooms to maintain two photoperiod levels by installing automatic timer. The production was achieved in both photoperiods (Fig. 2 & 3). The results of present study presented in Table 3 showed significantly high egg weight, high egg production, shape index, albumin index, hatchability at 18 hrs light and 20 % dietary protein. Therefore in conclusion, seasonality in Guinea fowl can be broken by photoperiod and dietary protein manipulation with best results obtained at 18h light and 20% dietary protein.

Table 3: Effects of different levels of dietary protein and photoperiod on reproductive performance in Guinea Fowl

Treatment	Photo period (hrs)	Protein (%)	No.of females at the end	Egg prod. (20-34wks)	D ASM (days)	HHEP (%)	Fertility (%)	Hatchability (% FES)
T1	16	16	16	192	138	13.19	21.05	100.00
T2		18	19	115	140	6.65	55.26	80.95
T3		20	19	185	136	9.94	36.84	71.43
T4	18	16	22	432	136	20.04	70.83	44.12
T5		18	19	426	134	22.88	26.39	21.05
T6		20	22	537	132	24.91	53.52	89.47

Fig. 2: Guinea fowl in layer cage under light management

Fig.3: Egg production in Guinea fowl during Oct, 2015 to Feb 2016

Evaluation of stress tolerance in Guinea Fowl

The experiment was conducted from day old to 14 week of age to examine the effect of feeding *Lactobacillus plantarum* isolate in guinea fowl on heat tolerance through hemato-physiological parameters and HSP70 expression. Four diets were prepared by supplementing probiotic and prebiotic at different combinations in basal ration (BR) *viz*: T-1 = 10^8 cfu *L. plantarum*/gram of BR, T-2= 10^8 cfu *L. plantarum*/ gram of feed + prebiotic MOS @ dose 0.1% of BR, T-3 = multistrain commercial probiotic @ 0.1% of total feed + prebiotic MOS @ 0.1 % of BR and T-4= BR only were used in trial. Grower (14 weeks old) were induced into exposure trial in climatic chamber at 41 ± 1°C temperature and 45 ± 5 % humidity for 4 hrs daily during 7 d exposure trial. During trial parameters such as body weights, physiological (Temperature and respiratory rate) hematological (DLC, H/L Ratio, Hb, PCV and pH) and mRNA expression of HSP70 from Jejunum samples were recorded at 1, 3 and 7 day of experiment. Weight gain in probiotic group (T1,T2,T3) at THI 91 was higher (P<0.05) than control during 1-3 day, 4-7 day. Temperature and respiratory rate among various groups did not differ significantly, but control showed relatively higher values at all time points. Heterophils % at 3rd day was higher (P<0.05) and lymphocyte % at 7th day was lower in control compared to probiotic groups resulting significant differences in H/L ratio at 7th day in control group. Basophils %, blood pH and Hb did not differ significantly among dietary groups. However, PCV was lower (P<0.05) in control during 7th day of exposure as compared to probiotic fed group. Expression of HSP70 was higher (P< 0.05) in T1 compare to control at 7th day exposure only *L. plantarum* feeding (Fig. 4) which might be helping in alleviating tropical stress.

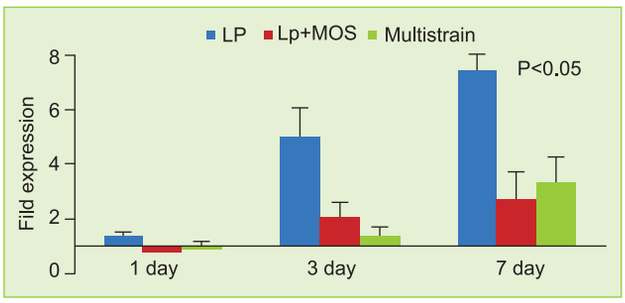


Fig. 4: HSP 70 expression in liver of Guinea fowl under different dietary treatments at THI 91

Conservation and utilization of indigenous chicken

Multiplication and reproduction performance of the various breeds

A total of 7102 purebred chicks comprising of 1055 Aseel Peela, 392 Nicobari, 1028 Kadaknath, 710 Ankaleshwar, 793 Aseel Kagar, 1520 CARI Red, 223 Coloured Frizzle, 236 Naked Neck and 1145 major gene pool line were hatched. Details of reproductive traits of different pure breeds/lines has been presented in Table 4. Highest fertility of 86.67% was observed in Aseel kagar followed by Ankaleshwar (83.89%) and Gene pool line (81.23%). Similar trend was observed on hatchability on TES but on FES Ankaleshwar topped the list (86.63%) followed by Aseel kagar (85.16%) and Coloured Frizzle the least (68.69%).

Table 4. Details of reproductive traits of different pure breeds/lines

Breed	Egg set	Good chicks	Fertility %	Hatchability %	
				TES	FES
Kadaknath	1923	1028	71.60	54.08	75.52
Nicobari	667	392	75.71	59.37	78.74
Ankaleshwar	981	710	83.89	72.68	86.63
Aseel peela	1841	1055	70.83	57.46	81.13
Cari red	3121	1520	64.08	49.15	76.70
Coloured Frizzle	431	223	76.34	52.43	68.69
Naked neck	401	236	78.80	60.09	76.26
Aseel kagar	1081	793	86.67	73.82	85.16
Gene pool line	1790	1145	81.23	65.19	80.26
Total	12236	7102	73.92	58.62	79.30

Diallel Experiment

A 3×3 complete diallel experiment involving two native chickens *viz*. Ankleshwar (AN) and Nicobari (NC) along with exotic breed CARI Red (CR) was undertaken to evaluate efficiency of pure and crossbreeding performance with respect to body weight, body conformation and immunological traits of three purebreds and six crossbreds. A total of 875 chicks were hatched in a single hatch comprising 107, 127, 93, 108, 90, 91, 110, 92 and 82 for crosses of AN×AN, AN×NC, ANK×CR, NCXAN, NCXNC, NCXCR, CR× ANK, CRXNC, CRXCR, respectively. From this population 540 birds (60 birds per genetic group) comprising 245 males and 295 females were chosen randomly for experimental purpose. The traits studied were body weight and weight gain, feed efficiency traits at bi-weekly intervals from day old to 20th week of age. The conformation traits shank length and keel length from 4th week to 20th week and breast angle from 6th to 20th week of age. Humoral immune response at 6th week, cell mediated immune response at 10th week of age and carcass quality traits at 16th week of age were also studied in this experiment. Model A of Griffings method was used for estimation of cross breeding genetic effects *viz*. general and specific combining abilities, reciprocal effect, on growth and production traits.

The least squares analysis of variance revealed a significant effect (P<0.01) of mating systems and genetic groups on growth, conformation traits and immune-competence traits. Crossbreds excelled over purebreds for various economic traits *viz*. growth, body conformation, and immune competence traits. The carcass quality traits and immune organ weight traits were not affected by mating systems and genetic groups.

Growth and body confirmation traits

Among purebreds, CARI Red males (1668 g) and females (1352 g) at 20 weeks of age weighed significantly (P < 0.05) heavier than Nicobari males (1562g) and females (1241g). The lowest body weight was observed in Ankleswar males (1322g) and females (1091g). Among six crossbred groups, NC×CR had highest body weight from day old to 20th week of age followed by AN x CR. Cross AN x NC had lowest body weight compared to other crosses. Among reciprocal crosses CR× AN had highest body weight followed by CR× NC and NC× AN in male, female and combined sex. On the basis of average performance for body weight all nine crosses NC x CR had highest body weight among all groups at all ages. Mean body weight gain of both the sexes of all genetic groups also showed similar trend at all ages. Among purebreds, CARI Red and among crosses NC × CR were the most efficient convertor of feed into body weight. Feed conversion efficiency for crosses *viz*. NC×CR, CR×NC, AN×CR, CR×AN, NC×AN, AN×NC were 4.48, 5.25, 5.76, 5.84,6.27 and 6.54 kg, respectively.

Conformation traits

Study of body conformation traits *viz*. shank length, keel length and breast angle indicated significant differences (P<0.01) between genetic groups for male, female and combined sex at all ages of measurement. In general, male recorded longer shank and keel bones and wider breast than females at all the ages in all the nine genetic groups. Mean shank length and keel length of CARI Red males were significantly (P<0.05) longer than Ankleshwar and Nicobari from 4th to 20th week of age. In general mean breast angle of CARI Red males were significantly (P<0.05) wider than Nicobari and Ankleshwar from day 4th to 20th week of age. The shank and keel length along with breast angle of all the crossbreds were significantly (P<0.01) higher than the purebreds. Among crossbreds AN×CR males and females had the higher shank and keel length at 4th to 20th week of age. Nicobari pure bred had smaller shank length among all genetic groups.

Carcass quality and Immuno-competence traits

Most of the crossbred had lower mortality percentage than the purebred groups. Lowest mortality percentage was observed in CR (3.36%) among purebreds and among crossbred in CR x NC (3.33 %); highest mortality being in CR x AN. Non-significant difference were observed among mating systems and genetic groups for carcass quality and immune organ weight. Immune competence traits differed significantly among all genetic groups. Among the purebreds, CR had higher cellular and humoral immune response against SRBCs by NC

and AN. Among the crossbreds, CR x NC had highest immune response followed by NC x CR .

GCA and SCA

Data were subjected to further analysis using Griffing model of full diallel analysis to estimate the relative importance of the different types of gene action involved in the inheritance of the traits under study. The combining ability analysis revealed that the general and specific combining ability were significant (P<0.01) for growth (body weight and body weight gain), body conformation (shank, keel length and breast angle) and immune competence traits. Heterosis % for body weight, shank length, keel length, breast angle and immune-competence traits ranged from 1.31 to 18.05,-2.16 to 4.77, - 0.18 to 8.22, 0.12 to 5.41, - 1.93 to - 11.45, 13.57 to 25.34, respectively. Highest (positive) heterosis was found in growth traits compared to conformation traits. Taking all the traits under considerations CARI Red was adjudged the best among purebreds followed by Nicobari and Ankleshwar. Nicobari and CARI Red cross was adjudged as best cross in crossbreds followed by its reciprocal cross CARI Red and Nicobari.

Genetic improvement of synthetic broiler lines

Synthetic Broiler Sire Line

So far, fourteen generations of selection based on 5-week body weight have been completed in coloured (CSML) and white (SML) plumaged male parent lines.

***Incubation and Hatchability*:** A total of 1420, 3438 and 880 eggs were set in SML, CSML and control, out of which 1089, **2913** and 709 good chicks were produced in respective lines. Corresponding fertility percentages were 88.38, 87.94 and 86.48. Hatchability percentages on TES and FES were 77.67 and 87.88, respectively in SML, 81.69 and 92.9, respectively in CSML and 75.95 and 87.82 in control.

Body weights at different ages: Overall average of body weight of mixed sexes at 5 weeks in SML, and control were 1165.49±6.82 g, and 757.4±9.8 g, respectively. The phenotypic and genetic responses to selection for 5-week body weight in SML were 12.91**±2.08 and 10.99*±2.07 g/generation, respectively. The phenotypic response for 5-week body weight in the control population was non-significant (1.90±1.00 g / generation).

Egg quality traits: Egg quality traits viz. egg weight, shape index, albumen height, yolk index, egg shell thickness and Haugh unit at 32, 40 and 52 weeks in CSML were comparable to previous years.

Synthetic Broiler Dam Line

So far, fourteen generations of selection based on 5-week body weight have been completed in coloured (CSFL) and white (SDL) plumaged female parent lines.

***Incubation and Hatchability*:** A total of 4185 and 3008 eggs were sat in CSFL and SDL, respectively out of which 3484 and 2412 good chicks were hatched out in respective line. The fertility percentage was 89.53 and hatchability percentage based on TES and FES were 83.91 and 93.73, respectively in CSFL. Corresponding values in SDL were 91.42, 81.21 and 88.83 percent, respectively.

Body weights at different ages: The overall average of body weight at 5 weeks in SDL was 1152.84±2.44 with phenotypic response as 12.90±2.07** and genetic response as 10.99±2.07**.

Egg weight and shape index in CSFL: In CSFL, the egg quality traits viz. egg weight, shape index, albumen height, yolk index, egg shell thickness and Haugh unit at 32, 40 and 52 weeks of age were comparable to previous years.

Random sample performance test: At 44th RSPPT (Gurgaon) CARIBRO- Vishal secured III rank among 9 entries and first rank among the eateries from public sector. Body weight at 6-weeks and 7-weeks were - 1.588 and 1.886 Kg, respectively. FCR (0-6 wks), mortality % and dressing % were 2.3, 4.6 and 73.56 respectively. Margin of receipt over feed cost at 6-weeks was Rs 1.94 per bird.

Performance of chicks hatched out of fertile eggs procured from surrounding villages: A total of 78 chicks hatched in three hatches from eggs procured from village areas. Incubation of fourth hatch is in progress. The body weights and conformation of these chicks at different ages have been presented below in table-5 and 6:

Table-5: Body weights (g) at different ages in chicks hatched out of eggs collected from villages

Age	N	Mean
0 day	46	32.27±0.62
1st week	46	50.64±1.51
2nd week	44	68.74±1.82
3rd week	43	102.85±3.96
4th week	43	152.17±9.30
5th week	43	216.44±17.24
8week	23	711.24±46.17
12 week	11	746.82±46.52

Table-6: Body Conformation traits at 4th and 8th weeks of ages in chicks hatched out of eggs collected from villages (N=41)

Trait	4 week		8 week		12 week	
	Mean	SE	Mean	SE	Mean	SE
Shank length (cm)	4.01	0.11	5.05	0.58	5.93	0.21
Keel length (cm)	4.4	0.16	6.06	0.31	7.37	0.24
Breast Angle (°)	30.2	1.34	45.50	2.01	42.36	1.66

The chicks after hatching were brooded in battery brooder under quarantined for 4 weeks and health check was carried out (Fig. 5 a & b). Laboratory tests were also performed for diagnosing the disease, if any. The chicks were then transferred to EBF for further rearing on deep litter (Fig. 6 a & b).

Fig. 5 a & b: Chicks in Battery brooder under qurantine

Fig. 6 a & b: Chicks in deep litter in EBF

Other broiler stocks: Other broiler stocks namely IC3, IR3 CARIBRO-Tropicana and Naked Neck coloured (NNC) are also maintained in the Experimental Broiler.

***Incubation and Hatchability*:** The fertility, hatchability (TES) and hatchability (FES) percentages in IC3, IR3 and CARIBRO Tropicana, Naked neck white, Naked neck coloured and control have been presented in Table 7.

Table 7: Reproductive performances in different broiler strains

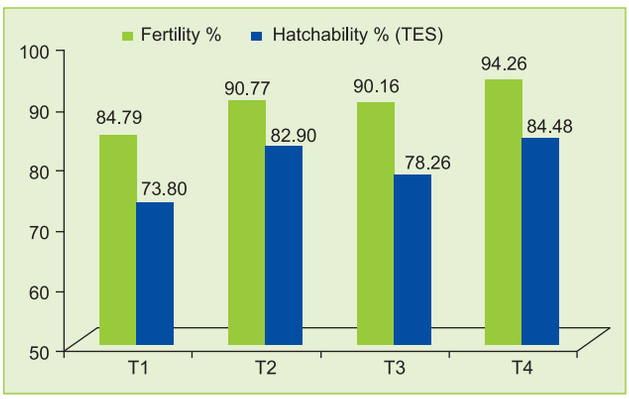
Strain	Egg set	Fertility	Good chicks	H% (TES)	H% (FES)
IR3	702	82.34	487	69.37	84.26
IC3	767	78.36	519	67.66	86.36
NNC	502	76.29	318	63.34	83.029
CARIBRO-Tropicana	431	71.23	222	51.51	72.31

***Body weights*:** The mean body weight at 5-week of age in IR-3, IC-3, CARIBRO-Tropicana and Naked neck coloured were 1155.92±9.05, 952.1±6.77, 1051.30±12.68 and 1164.33± 10.69 g, respectively.

Augmenting Performance of broilers breeder through betaine supplementation

The effect of betaine (methyl donor) supplementation on broiler breeder performance was evaluated by supplementing the broiler breeder ration with betaine at three levels i.e. @ 1, 2 and 3 g/kg for a period of six weeks. In each treatment group 24 hen and 10 cocks were kept and a control group of 34 birds was fed standard breeder ration without supplementing the betaine. Production performance, semen evaluation, hormone, hatchability and fertility parameters were recorded. Production and semen evaluation parameters were recorded three times (2nd, 4th and 6th week post feeding) during the trial. Results indicated that Supplementation of betaine @ 1, 2 and 3g/kg feed did not significantly affected the body weight, feed intake and mean testosterone concentration. Supplementation betaine @ 1g/kg significantly (P<0.01) improved egg production (78 vs 70, 75 and 72%).The semen analysis showed significant difference (P<0.01) among the treatment groups, higher sperm concentration and motility percentage was recorded in 1 and 2 g of supplementation but high level of supplementation (3 g/kg) resulted in decreased concentration and motility. However, fertility and hatchability per cent was higher in 3 g/kg, followed by 1 g, 2 g and control (Fig. 7). Similar trend was observed in early, mid and late embryonic mortality pattern. It could be concluded that supplementation of betaine @ 1 g/kg could improve the broiler breeders egg production and fertility.

Fig. 7. Effect of dietary betaine supplementation on fertility and hatchability in broiler breeders



Conservation of elite layer stock

Pure part-period production strains: Data on various layer economic traits, viz., age of sexual maturity (ASM), body weight at 16 (BW16) and 40 (BW40) weeks of age, egg weight at 28 (EW28) and 40 (EW40) weeks of age and egg number up to 40 weeks of age (EN40) in IWG and IWJ part-period production pure strains were analyzed using least-squares ANOVA. In IWG pure part-period production strain of WLH chicken (n=160), the influence of hatch was significant on ASM and BW16 only; pullets of first hatch revealed lower ASM and higher BW16. The LS means of respective traits were 135.69 ±0.93 days, 982.37 ± 11.55 g, 1494.35 ±17.54 g, 44.98 ±0 .21 g, 50.40±0.31 g and 123.61 ±1.37 eggs, respectively. In IWJ pure part-period production (n=124), the LS ANOVA revealed significant effect of sire on ASM, EW28 and EW40 whereas hatch had significant effect on BW16, BW40, EW28 and EN40. The LS means of ASM, BW16, BW40, EW28, EW40 and EN40 were 139.56±1.32 days, 915.99±14.89g, 1349.00±15.64g, 41.96±0.31g, 46.27±0.31g and 118.98±1.36 eggs, respectively. A total of 460 chicks of IWG and 607 chicks of IWJ strains were hatched for recording of data and regeneration in next year.

Pure annual production strain (IWI and IWH): In IWH pure annual production strain of WLH chicken (n=188), the LS ANOVA revealed significant effects of sire and hatch on all the traits. The LS means of ASM (days), BW16 (g), BW40 (g), EW28 (g), EW40 (g) and EN40 (eggs) were 137.23±1.62, 867.44±10.54, 1347.21±13.58, 46.23±0.41, 51.03±0.54, 123.19±1.51, respectively. In IWI pure annual production strain of WLH chicken (n=229), the effects of sire and hatch were significant on all the traits. The LS means of ASM (days), BW16 (g), BW40 (g), EW28 (g), EW40 (g) and EN40 (eggs) were 137.39±1.33, 879.57±8.96, 1356.93±13.69, 48.05±0.52, 51.88±0.36, 120.00±1.77, respectively. A total of 572 chicks of IWH and 813 chicks of IWI strains were hatched for recording of data and regeneration in next year.

Genetic improvement of Rhode Island Red

***Reproductive Performance of RIR strains*:** The reproductive performance of selected strain of Rhode Island Red (RIR_S), its control population (RIR_C) for 32nd generation has been recorded. Four hatches were taken and a total of 6312 and 2132 eggs were set in RIR_S and RIR_C populations, respectively. Over the hatches fertility % in RIRs and RIRc ranged from 83.6 to 86.9 and 86.0 to 87.8, respectively which was similar to that of previous generation. The hatchability on total eggs set basis ranged from 72.6 to 75.1% and 78.5 to 81.1% in RIRs and RIRc, respectively. The hatchability on fertile eggs transferred basis was 83.6 to 86.9 % and 91.2 to 93.9% in RIRs and RIRc, respectively which was similar to the previous generation.

Comparative performance of RIR pure strain: The RIR population has completed 32nd generation of selection during the period under report and used for development of multicolored strains for rural poultry production. The traits recorded were age at sexual maturity or age at first egg, body weight at at 20th and 40th week of age; egg weight at 28th & 40th week of age, egg number up to 40-week of age and egg colour at 40th week in RIRs and RIR_C pure strains. The least square averages for age at sexual maturity in RIRs and RIRc strains were 138.9±0.40 and 177.75±1.36 days, respectively. The 20th week body weight in RIRs, RIRc strains was 1391.5±5.76 and 1031.4±11.83 g, respectively. The means of 28th week egg weight in RIRs and RIRc were 44.13± 0.11 and 41.77±0.18g, respectively.

The least square averages of the traits like 40th week body weight, egg weight and egg numbers for RIRs and RIRc, were 1831.4±7.98g, 50.62±0.11g, 113.4±0.63nos and 1598.0±16.65g, 48.72±0.24g, 62.06±1.68 nos, respectively (Table 8). The colour of the eggs was compared by assigning numerical values (0-pure white,1-low brown, 2-medium brown, 3-deep brown) and the values for RIRs and RIRc were 1.73±0.020 and 2.75±0.025, respectively.

Table 8: Comparative performance of RIR during 32nd generation (2015-16)

Traits	RIRS	RIRC
B.Wt (g) -20 wk	1391.5±5.76 (1021)	1031.4±11.83 (423)
ASM (d)	138.9±0.40 (988)	177.75±1.36 (368)
E.Wt. (g) - 28 wk	44.13± 0.11 (926)	41.77±0.18(233)
B.Wt (g) - 40 wk	1831.4±7.98 (968)	1598.0±16.65 (387)
E.Wt. (g) - 40 wk	50.62±0.11 (888)	48.72±0.24 (340)
EP up to 40 wk	113.4±0.63 (953)	62.06±1.68 (340)
Egg colour at 40th wk	1.73±0.020 (888)	2.75±0.025 (367)

***Phenotypic and Genetic gain per generation*:** Part period egg number up to 40-wk of age was taken as criteria of selection using a family index (Osborne 1957a,b). Per generation phenotypic gains for ASM, egg number upto 40 week, 40th week egg weight, 20 wk. body weight were -1.054±0.232**, 1.11±0.19nos**, 0.065±0.04g 8.13±2.79g**, respectively; however, 40 wk body weight declined significantly (-8.40±2.15g**).

On genetic scale, the average response per generation for 40 wk egg number was highly significant and positive (1.118±0.118** eggs) (Table-9 & Fig-8). The ASM declined significantly to the tune of -0.765±0.16** day per generation. There has been highly significant positive genetic gain in 40th wk egg weight (Fig-9), 20 and 40 wk body weights to the tune of 0.065±0.045**, 9.036±1.503** and 7.19±1.42**g per generation, respectively. Average regression coefficients for most of the economic traits except that of body weight at 40th week (-15.584±2.32g**) in control population were found to be non-significant indicating its stability in eliminating the environmental trend.

Table-9: Genetic & Phenotypic response in RIR pure strain and control population during S32 generation (2015-16)

Traits	RIRs		RIRc
	Phenotypic response	Genetic response	Phenotypic response
BW at 20thwk (g)	8.134±2.792**	9.036±1.503**	-0.903 ± 2.23
BW at 40thwk (g)	-8.40±2.15**	7.19±1.42**	-15.584±2.32**
ASM (d)	-1.054±0.232**	-0.765±0.16**	-0.290±0.196
EW at 40th wk (g)	0.065±0.04**	0.065±0.045**	-0.014±0.040
EP upto 40th wk (nos)	1.11±0.19**	1.118±0.118**	-0.006±0.141

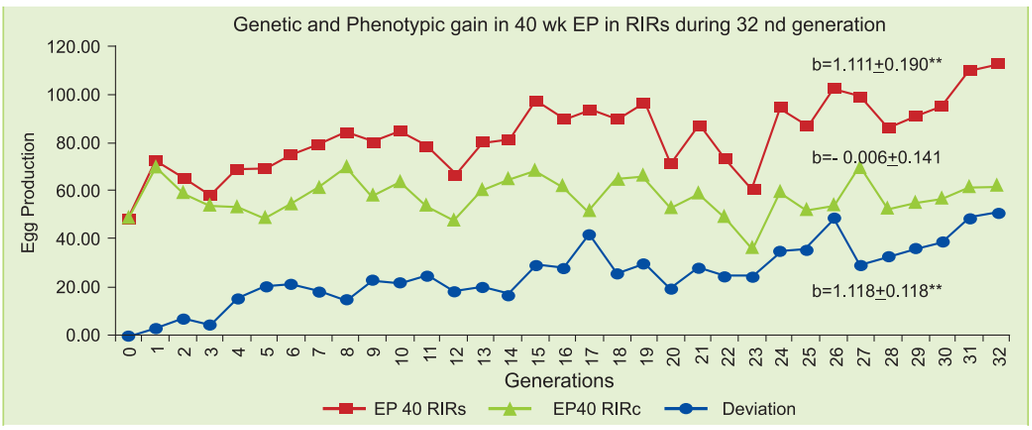


Fig - 8

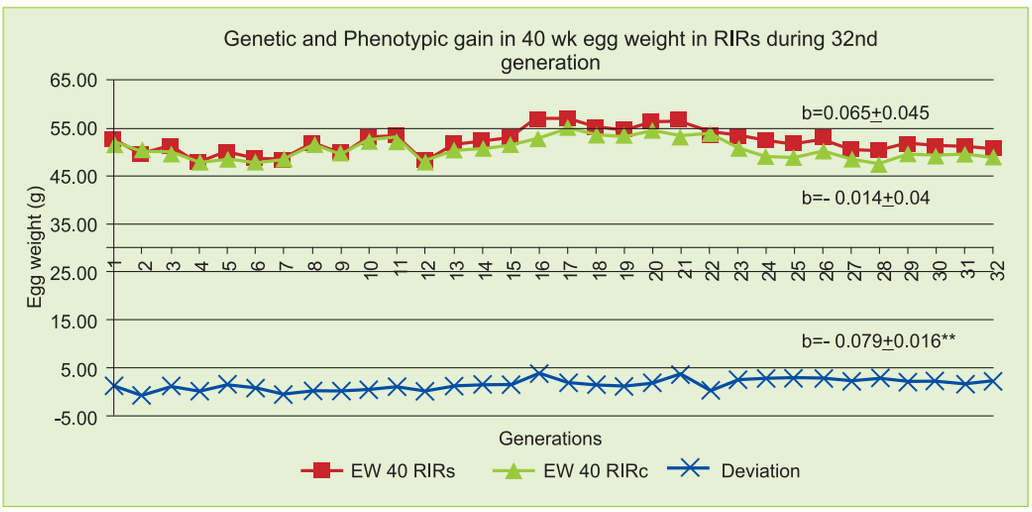


Fig - 9

Immunocompetence and microsatellite profiling in RIR

Mating plan was prepared using ADL176 genotypes owing to their association with higher 40-week egg production (EP40). Total 286 chicks were hatched with average fertility, hatchability on TES and FET as 76.25, 61.44 and 79.85%, respectively. This poullation was used to estimate genetic and phenotypic parameters of growth and layer traits and microsatellite analysis and expression analysis of of CRBP IV gene in various tissues.

Growth and layer economic traits and their inter-relationship in RIR chicken: Body weights at different ages viz. day '0' and at 8, 12, 16, 20, 28, 32 and 40 weeks in pullets were analyzed using least-squares ANOVA. The overall LS means of body weights at respective ages were 34.1±1.0, 532.3±15.5, 953.3±35.1,1339.5±38.4, 1601.8±41.7, 1841.4±50.0, 1835.8± 63.9, 1844.0±54.8g, respectively. The random effect of sire was significant on from BW0

to BW20 and non-significant thereafter. Effect of hatch was significant on BW12 and BW20 only. The data on layer economic traits (n=110) viz., age at sexual maturity (ASM), egg weight at 28 (EW28) and 40 (EW40) weeks of age and egg production up to 28, 32 and 40 weeks of age were analyzed by least square ANOVA. The overall LS means of respective traits were 136.7±1.7 days, 44.0±0.8 g, 49.0±0.7g, 34.8±2.0 eggs, 46.9±2.7 eggs, 84.5±3.4 eggs, respectively.

Profiling of egg production associated microsatellite loci: A total of 40 alleles were observed at these MS loci with average number of alleles being 4.00±0.365 in microsatellite profiling of 114 RIRs pullets using 10 microsatellites *viz*., ADL0023, ADL0158, ADL0176, ADL0273, MCW0044, MCW0069, MCW0103, MCW0110, MCW0145 and MCW0258. The product size (in bp) at ADL0023, ADL0158, ADL0176, ADL0273, MCW0044, MCW0069, MCW0103, MCW0110, MCW0145 and MCW0258 loci ranged from 168-232, 189-247, 187-225, 141-160, 134-144, 158-183, 267-280, 99-119, 203-226 and 147-216, respectively. Out of all the polymorphic loci, five loci viz., ADL0023, ADL0158, ADL0176 and MCW0110 revealed high degree of polymorphism with five alleles. Allelic frequency at 10 MS loci ranged from 0.0225 to 0.8919 with 147 bp allele being the most frequent (89.19%) at ADL0273 locus. The means of population parameters *viz*. Na, Ne, H_o, H_e, PIC value, Shannon's index (I) and Wright's fixation index (FIS) were 4.00±0.37, 2.71±0.26, 0.303±0.062, 0.593±0.050, 0.59±0.05, 1.065±0.104 and 0.513±0.078. The results of χ^2-square and likelihood ratio tests revealed that the population was in H-W disequilibrium.

***Association between genotypic polymorphism at egg production-associated Microsatellite loci and Growth/ layer economic traits*:** Least squares ANOVA was carried out to determine the effect of MS genotypes on growth and layer economic traits. All polymorphic microsatellites were found to have significant effect on growth and/ or layer economic traits. Least squares analysis of variance revealed significant effects of genotypes at ADL0023 on BW32, ADL0158 genotypes on BW8, BW20 and EW28, ADL0176 genotype on BW0, BW28, BW32, BW40, EW40 and EP32, ADL0273 genotype had significant effect on ASM only, MCW0044 genotype on BW32, BW40, EW28 and EP40, MCW0069 genotype on BW0, BW28 and EW28, MCW0103 genotype on BW8, ASM, BW16, BW20 and EP40, MCW0110 MS-genotype on BW16 and EP32, MCW0145 MS-genotype on EW28 and MCW0258 MS-genotype on BW8 traits.

Determination of relative expression of CRBP IV gene in various tissues of RIR chicken qRT-PCR: Relative mRNA expression of CRBP IV gene was studied in kidney, liver and oviduct at different ages viz. 12, 32 and 40 weeks by qRT-PCR and data was analyzed using JMP of SAS (2010). Analysis revealed that the difference between three age groups was significant in kidney (P≤0.05) and oviduct (P≤0.1), and non-significant in liver. The expression was highest at 40 weeks of age in kidney and oviduct. The expression of CRBP IV gene differed significantly among three age groups in kidney (P≤0.05) and oviduct (P≤0.1) in RIR chicken. Fold expressions of CRBP IV gene among different age groups in RIR ($2^{(-\Delta\Delta Ct)}$ method) revealed that the expression was 57.87 folds more at 40 weeks of age in kidney than at 12 weeks. In oviduct, the expression was 5.5 folds more at 40 weeks than at 32 weeks

Association of microsatellite genotype with expression of CRBP IV gene in kidney, liver and oviduct in RIR chicken: Least squares analysis of variance revealed that out of ten polymorphic studied microsatellite ADL0023 and MCW0103 genotypes were found to have significant effects on relative mRNA expression of CRBP IV gene in kidney and ADL0176 genotype had significant (P≤0.05) effect on relative mRNA expression of CRBP IV in oviduct.

***Growth-associated Microsatellites profiling and association studies*:** The pedigreed chicks of RIR were evaluated for growth traits along with their inheritance pattern. Data on body weight at zero day, 2, 4, 6, 8, 10, 12, 16, 20, 24, 28, 32, 36 and 40 weeks of age were analyzed. The means of respective traits in combined sex were 34.4±1.20g,71.36±4.16g, 184.19±5.75g, 361.16±12.64g, 571.34±13.92g, 677.92±16.79g, 457.28±23.37g, 1474.87±35.12g, 1795.35±37.23g, 1938.35±41.95g, 2006.87±63.95g, 2141.99±60.27g, 2204.56±47.05g and 2265.84±51.80g, respectively. Least squares analysis of variance revealed significant (P≤0.01) effect of sire on all body weight except body weight at 10 and 12 week of age. Total 62 males and 52 females, RIRs birds were screened for genetic polymorphism at 10 growth associated microsatellite. Allelic data were

analyzed by POPGENE version 1.32. Microsatellite analysis revealed 1-4 alleles having size ranging from 97 bp at MCW0010 to 349 bp at LEI0071 with varied frequency. There are total 25 alleles with the average number of allele per locus was 2.5000±0.2687. Out of ten microsatellite loci nine microsatellite loci showed polymorphism. The allele frequency at 10 loci range from 0.1140 to 0.7632 and the most frequent allele was 214 bp (76.32%) at LEI0079 locus. The means of Nei's heterozygosity, PIC value, Na, Ne, I and FIS were 0.534±0.038, 0.453±0.042, 2.500±0.849, 2.140±0.714, 0.772±0.364 and 0.168±0.135, respectively. It was found that the mean "H_e" was more than the mean "H_o" which indicated that population was in H-W disequilibrium. The results of χ^2-square and G-square tests also revealed significant differences between "H_o" and "H_e". Out of nine polymorphic microsatellites, five were found to have significant effect on growth traits. LS-ANOVA revealed significant effect of microsatellite-genotypes as ADL0328 on chick weight and body weight at 2 and 28 week of age, LEI0068 on body weight at 28 week of age, LEI0071on chick weight and body weight at 28 week of age, MCW0010 on body weight at 16, 32, 36 and 40 week of age and MCW0058 on body weight at 24 and 28 week of age.

POULTRY WASTE MANAGEMENT

Aerobic composting of poultry excreta: Aerobic composting includes safer biological degradation of organic wastes in to useful manure under presence of oxygen. Poultry excreta has very less C:N ratio (1:9-10) due to which poultry excreta is poorly decomposed by saprotrophic microbes. Correcting the C:N ratio to the tune of 1:25-30 by carbonization and its aerobic composting has very high potential to produce organic manure. Therefore, this technique was standardized during April to July, 2015 using sawdust as carbon source. Four iron-made composting bins (1.2x1.2x1.2 cum) were used (Fig. 10) for composting of cage poultry excreta mixed with sawdust at an initial C/N ratio of 1:15 (T_1); 1:20 (T_2); 1:25 (T_3) and 1:30 (T_4) with equal moisture contents. No sawdust was mixed in the control group (T_0) and initial C/N ratio was 1:10. Composting bin temperature was significantly higher ($P<0.01$) in all treated groups than control both during primary and secondary stage (Table 10). Thermophilic phase was significantly longer ($P<0.01$) in all treated groups than control (Fig. 11). Compost pH during turning and final stage was significantly higher ($P<0.01$) in T_4 than T_0 and other treated groups which were non-significant among themselves. Significantly ($P<0.01$) lower ash and higher volatile solid were estimated in treated groups than Control. There was reduction in ether extract in control group during various stages of composting while it remained almost constant in all treated groups. C/N ratio, N- and P-content was significantly higher in T_3 and T_4 than remaining groups. There was no effect on potassium due to various levels of C:N ratio (Fig. 12). There was non-significant effect of treatment on Total Bacterial Count but *E. coli* were significantly lower ($P<0.01$) in all treated groups over T_0 and *E. coli* was not detected in the finished product of composting in all treated groups (Fig. 13). Germination potential in compost was 94% in T_4 than control (Fig 14). On equivalent fertilizer basis, value-addition to the tune of 2-3 times was estimated from composted poultry organic manure.

Table 10: Composting profile variables due to C:N ratio

Parameters	Phases	Treatments				
		T1 (1:15)	T2(1:20)	T3(1:25)	T4(1:30)	T0(1:10, Control)
Bin Temperature (oC)	Primary	58.75±0.97a	58.84±1.03 a	59.93±0.75a	59.66±0.79a	32.8±0.76b
	Secondary	51.19±0.90 a	51.16±1.04 a	53.13±1.29a	51.98±1.24a	32.57±0.23a
pH	Initial	8.54±0.07	8.78±0.08	8.70±0.08	9.08±0.07	8.77±0.09
	Turning	8.77±0.09 b	8.15±0.08 b	8.83±0.09 b	9.31±0.07 a	7.90±0.11 b
	Final	7.89±0.19 b	8.16±0.15 b	8.28±0.03 b	9.62±0.31 a	7.80±0.01 b
C:N Ratio	Initial	15.50±0.41 d	20.17±0.15 c	25.12±0.06b	30.43±0.75a	10.04±0.21 e
	Turning	13.37±0.12 d	17.37±0.16 c	19.63±0.32ab	20.41±0.01a	18.29±0.67bc
	Final	15.76±1.72	16.32±0.35	18.75±0.21	19.78±0.40	14.92±2.61
Ash (%)	Initial	38.28±1.13 a	26.90±0.20 b	22.93±0.78 c	28.14±0.34b	39.21±1.24 a
	Turning	43.34±0.21 a	35.59±0.60 b	30.15±2.30 c	29.55±0.10c	38.11±1.34 b
	Final	39.73±5.85 b	32.50±0.67bc	28.70±0.80 b	28.59±0.36	60.68±1.05 a

Parameters	Phases	Treatments				
		T1 (1:15)	T2(1:20)	T3(1:25)	T4(1:30)	T0(1:10, Control)
Volatile Solid (%)	Initial	61.72±1.13 a	73.10±0.20 b	77.07±0.78 c	71.86±0.34b	60.79±1.24 a
	Turning	56.66±0.21 a	64.41±0.60 b	69.85±0.30 c	70.45±0.10c	61.89±1.34 b
	Final	60.27±5.85 b	67.50±0.67 bc	71.30±0.80 b	71.41±0.36b	39.32±1.05 a
Ether Extract (%)	Initial	1.92±0.07 c	2.11±0.07 c	2.98±0.02 b	2.11±0.03 c	6.96±0.08 a
	Turning	1.35±0.03 c	2.64±0.13 b	2.60±0.24 b	2.25±0.29 b	4.32±0.28 a
	Final	1.77±0.06 d	2.29±0.12 b	2.79±0.01 a	2.76±0.03 a	2.04±0.02 c
Nitrogen (%)	Initial	2.31±0.10 b	2.10±0.01 b	1.78±0.01 c	1.37±0.02 d	3.51±0.00 a
	Turning	2.46±0.03 a	2.15±0.04 b	2.06±0.03 bc	2.00±0.00 bc	1.96±0.02 c
	Final	2.23±0.04 a	2.40±0.04 a	2.21±0.02 a	2.10±0.05 a	1.66±0.07 b
Phosphorus (%)	Initial	0.79±0.02 b	0.71±0.03 b	0.97±0.02 a	0.77±0.02 b	0.74±0.02 b
	Turning	1.55±0.23 a	1.16±0.19 ab	1.13±0.02 ab	0.96±0.03 b	0.72±0.02 b
	Final	0.68±0.03 b	0.70±0.01 b	0.82±0.02 a	0.81±0.02 a	0.74±0.01 b
Calcium (%)	Initial	2.41±0.09 b	3.53±0.06 ab	4.50±0.09 a	4.69±0.07 a	4.84±0.16 a
	Turning	6.07±0.07 b	6.23±0.08 b	7.55±0.12 ab	8.75±0.64 a	4.78±0.03 c
	Final	6.36±0.08 a	5.32±0.05 b	6.09±0.07 a	6.13±0.11 a	5.45±0.16 b
Total Microbial Count (log10)	Initial	7.85±0.39	7.75±0.40	7.82±0.29	7.95±0.55	7.67±0.23
	Turning	6.36±0.23	6.37±0.20	6.47±0.24	6.73±0.38	6.74±0.11
	Final	6.14±0.25	6.38±0.20	6.12±0.22	6.78±0.22	6.89±0.34

N.B.: Means with different superscript in a row differs significantly

Fig. 10: Aerobic composting of poultry excreta using composting bins

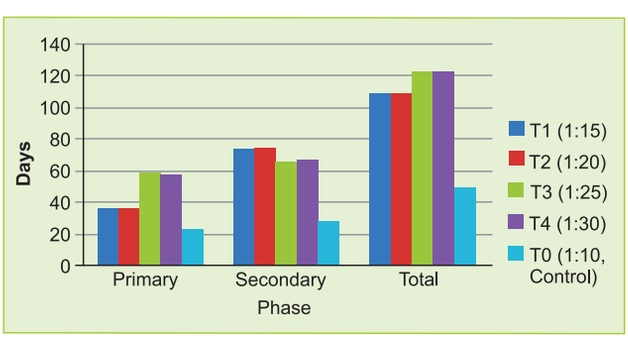


Fig. 11: Thermo-philic Phase profile (Days) in composting bins

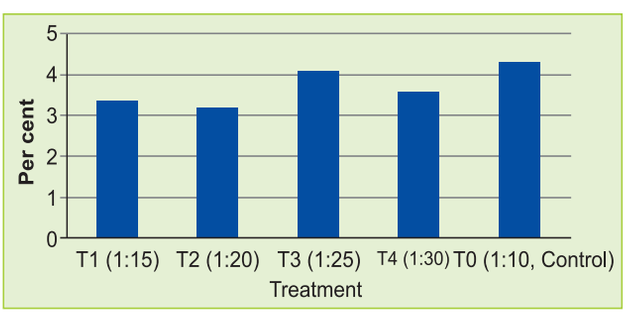


Fig. 12: Potassium (%) profile in organic manure of poultry excreta

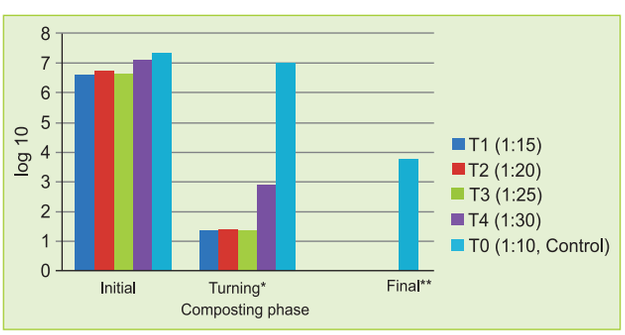


Fig. 13: *E. coli* count (Log10) under different composting bin

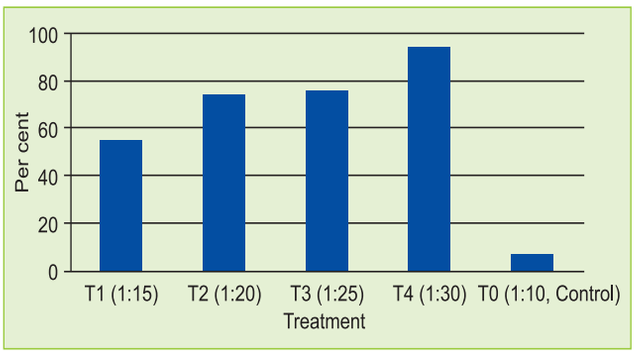


Fig 14: Germination pattern (%) of gram seed in composted manure of poultry excreta

Green energy (biogas) production exclusively from poultry excreta: The *in-vitro* and *in-vivo* conditioning studies were undertaken to overcome the shortcomings of poultry excereta for efficient bio-gas production in all-weather conditions. *In-vitro* standardization for efficient bio-gas production from poultry excreta was done through dilution (D), carbonization (C) and acidification (A) techniques. Best combination of 'D' and 'C' experiments was used for substrate formulation and *in-vivo* bio-gas production using 0.2 cum anaerobic digester and designated as DC (Fig. 15). In DCA, substrate was formulated using combinations of 'D', 'C' and 'A'. Diluted (D) poultry excreta without any other combinations acted as control (T_0). The hydraulic retention time (HRT), bio-gas production, blue flame proportion etc. was significantly better in DCA followed by DC and was lowest in D (Table 11) The ratio of bio-gas production in D:DC:DCA was 1:2:4. The content of methane (%, V/V), carbon-dioxide (%, V/V), oxygen (%, V/V), hydrogen sulphide (ppmv) and balance gases ((%, V/V; N2, VOCs, Moisture etc.) in DC was 58.3, 33.23, 1.33, 22.33 and 7.03, respectively (Table 12). The respective values in DCA were 55.47, 35.5, 0.83, 57.00 and 8.17. It was concluded that conditioning of poultry excreta has better potential for all-weather bio-gas production.

Table 11: Bio-gas production profile under different treatments.

Treatments	HRT (days)	Ammonical N (%)	Bio-gas production PSi	pH	TDS (ppm)
D	97	1.14 ± 0.30b	6.32 ± 0.18b	8.58± 0.52a	13200±465b
DC	42	0.41± 0.06a	11.46 ± 0.39a	7.88± 0.55b	16300±603a
DCA	33	0.28 ± 0.04a	28.38 ± 0.27a	7.13± 0.43b	16850 ±567a
Sig. level	--	P<0.01	P<0.01	P<0.05	P<0.05

Table 12: Bio-gas composition under different treatments.

Treatments	Methane (%, V/V)	Carbon-dioxide (%, V/V)	Oxygen (%, V/V)	Hydrogen sulphide (ppmv)	Balance gases (%, V/V; N2, VOCs, Moisture etc.)
DC	58.3	33.23	1.33	22.33	7.03
DCA	55.47	35.50	0.83	57.00	8.17

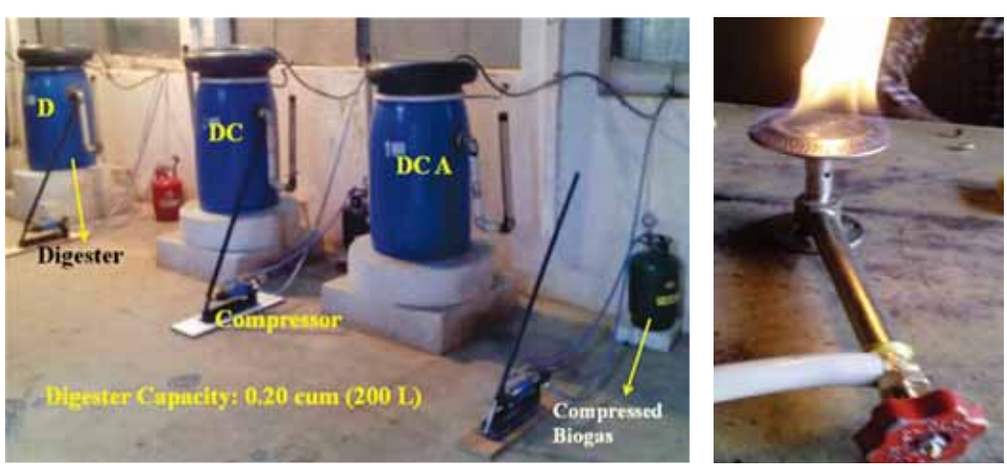


Fig. 15: Bio-gas production from poultry excreta

Nutrient management

Nutrition For Health And Welfare

- Maintenance of natural gut health and gut modulation seems to be the most cost effective, sustainable, farm specific and holistic approach in commercial operation keeping space for animal welfare too. Maintaining a structurally sound gut is only and prime strategy for efficient and hygienic poultry production because it ensures proper digestion and absorption of valuable intrinsic feed factors, provides the best feed conversion ratio, alleviate sub-clinical infections, if any, by promoting body defense, provide resistance against entero-pathogens and can check the mortality and morbidity loses. Feed toxins and toxicants affect the gut integrity if not properly monitored. Insoluble non-starch polysaccharide (NSP) is a major problem leading to soiling of litter. Microbial balance of gut is utmost important for its proper digestion and health. Accordingly, trials were conducted to explore the effect of certain probiotics, prebiotics and mycotoxins on gut health and welfare aspects.
- In growing turkey poults (0-6wk of age) to assess the efficacy of prebiotics (MOS 1%), probiotics (*Bacillus subtilis and Bacillus amyloliquifaciens* 10^6 cfu/g) and synbiotics (combination of prebiotics -MOS 1% and probiotics 10^6 cfu/gm of feed), revealed that synbiotics were more beneficial in improving body weight gain, feed conversion ratio (FCR), immunity, and survivability of poults than either prebiotics or probiotics when included alone. Addition of synbiotics also reduced stress as assessed through corticosterone levels.
- Addition of probiotics in low-energy and low protein feed led to conclude that probiotic (*Lactobacillus acidophilus* @10^6cfu /gm feed) inclusion improved immune response (5.5-21.2%), increased beneficial bacterial concentration (0.2-10.3%), histological structure in ileum (2.4-7.5%) in broiler chickens in comparison to control or antibiotic fed group.
- Moreover, probiotic (*Lactobacillus acidophilus* @10^6cfu /gm feed) inclusion in low energy low protein feed improved the physio-biochemical (0.2-2.3%) characteristics of fresh (0 d) and storage (14 d) meat and reduced the total (12.1-37.8%) and entero-pathogen counts in fresh (0 d) and storage (14 d) meat in broiler chickens.
- The entero-pathogen count was also reduced in different parts of gastro intestinal tract (2.9-16.2%) in broiler chickens.
- Both Ochratoxin A and Aflatoxin B1 affected gut morphometry (villi height, crypt depth and villi height to crypt depth ratio) and immunity (cellular and humoral). Ochratoxin A was more toxic than Aflatoxin B1 assessed through growth performance (body weight gain, feed intake and feed conversion ratio), immunity and gut morphometry. Synergistic relation existed between Ochratoxin A and Aflatoxin B1 in broiler chickens.
- Experimentally induced ochratoxicosis with 200 ppb ochratoxin resulted in reduced production performance, enlargement of liver, regression of bursa, decreased total protein, haemoglobin and increased level of uric acid, creatinine, ALP, SGOT, SGPT and H/L ratio and immuno-suppression.
- Inclusion of *Saccharomyces cerevisiae* at 0.1% level to the 200 ppb ochratoxin contaminated diet ameliorated the ill effects of ochratoxin on production performance, relative weight of liver and bursa, serum protein, uric acid, creatinine, haemoglobin, ALP, SGPT, SGOT, H/L ratio and immune response of broiler chickens during 0-6 weeks of age. A dietary level of 0.1% of *Saccharomyces cerevisiae* in ochratoxin contaminated diet improved the welfare aspects like growth, feed intake, H/L ratio, immunity and health of stressed birds.
- Addition of vitamin E (200 mg/kg) to the ochratoxin contaminated diet improved the production performance, relative weight of liver and bursa, blood biochemical, haematological parameters and immune response during 0-6 week's age of broiler chickens in experimentally induced ochratoxicosis caused by 200 ppb of dietary ochratoxin. Supplementation of 200 mg/kg vitamin E above the requirement of birds during ochratoxicosis resulted in welfare of birds.
- A study on inclusion of turmeric powder (0.025, 0.05 and 0.075%) and oil (0.025, 0.05 and 0.075%) revealed that turmeric powder

(at any level) did not improved weight gain, feed intake and feed conversion ratio of broiler chickens in comparison to control or antibiotic. Application of turmeric powder as well as oil in the diet improved relative weight of bursa and thymus, and immuno-competence of birds, while decreased carcass abdominal fat, serum cholesterol and triglycerides levels. Inclusion of either turmeric powder or oil in diet improved the keeping quality of meat under cold-chain preservation but efficacy of oil was more than that of powder.

Value Addition of Eggs Through Dietary Approaches

- Value addition and designing of poultry eggs and meat akin to customers' demand through dietary means is an important area. Lot of experiments have been conducted on eggs in this institute and it has been feasible to reduce cholesterol and enrich eggs with omega-3 fatty acids and vitamin E. Now experiments are being conducted for value addition of poultry meat through dietary means. Flax seed is unique among oilseeds because it is high in alpha-linolenic acid. Flax is one of the most concentrated sources of polyunsaturated fatty acids, moderate levels of monounsaturated fat, and low levels of saturated fat available in animal feedstuffs for poultry. Flax seed contains 35-45% oil, of which 45-52% is alpha-linolenic acid. Inclusion of flax seed in broiler diets has been shown to increase the omega-3 fatty acid levels in the meat. However, increased unsaturation of broiler meat makes it more prone to oxidative rancidity. Therefore, supplementation of antioxidants in such diets is essential to avoid rancidity which needs to be tested. Accordingly, a 42 day biological experiment was conducted to evaluate the effect of chromium in flax seed based diet on the growth performance, efficiency, carcass characteristics and sensory meat quality of broiler chicken. Supplementation of organic chromium @ 0.5, 1.0 or 1.5 mg /kg in flaxseed (10%) based diet did not influence growth performance, carcass traits & sensory attributes of broiler meat.

Expanding feed resources and improving nutrient extraction from biomass

- The availability and cost of maize and soybean meal, which are major source of energy and protein generally determines feed cost. In the process of reduction of production costs and to buffer the shortage of maize and soybean meal, there is need to identify and evaluate the nutritive value of alternate feedstuffs for use in practical poultry feed. Rice based dried distiller's grains with solubles (DDGS) are available from distillery industries. It is a very good source of protein, available energy and phosphorus besides it contains yeast cells and nucleotides. DDGS is available at a lower price than other protein sources, and therefore, seems to be more attractive to the poultry producer. Hence, there was need to establish its inclusion rate and feeding value in laying hens.
- Rice DDGS contained moisture 8.28%, DM 91.72%, CP 45%, EE 4.49%, CF 4.89%, TA 10.22%, NFE 27.12%, AIA 4.28%, ADF 15.20%, NDF 37.75%, Ca 0.73%, P 0.77% and GE 4097 kcal/kg. The apparent nitrogen-corrected metabolizale energy (AMEn) value of rice based DDGS was evaluated as 2880 kcal/kg diet in adult cockerels. On cock-tail enzyme supplementation the AMEn value of DDGS was improved by 78 kcal/kg. A biological trial of six week duration was conducted to assess the feeding value in layer ration it revealed that rice based dried distiller's grain with solubles (DDGS) can be incorporated at 10% level replacing soybean meal for economical egg production, and better egg quality traits and immuno- competence in laying hens during I & II phase of production.
- Successively, the nutrient composition of another similar product (rice gluten, available from rice starch industry) was evaluated.
- The various feed samples (259) received from the farmers, industries, Institutes, Government farms; NGOs were subjected to analysis for different quality parameters such as protein, fibre, ether extract, total phosphorus, urease activity, glucosinolates and mycotoxins. The data revealed that the quality control, especially in terms of consistency and mycotoxins contamination, needs to be strengthened. The observed data are being compiled for utilization

as required by different agencies including BIS for standardizing specifications of poultry feedstuffs and feed.

Strategic supplementation of macro and micro-nutrients for improving poultry production

- In order to optimize dietary requirements of available phosphorus and vitamin D and to find interaction of these two nutrients with phytase enzyme, two experiments were conducted in broilers and layers.
- The experiment to study the effect of feeding different levels of dietary available phosphorus and vitamin D3 on production performance, egg quality traits and blood biochemical parameters in laying hens, revealed that a dietary concentration of 0.40 % available phosphorus and 1600 IU/kg vitamin D_3 was found adequate to obtain optimum production performance, egg quality traits and blood biochemical parameters in white leghorn layers during 25-36 weeks of age.
- In another experiment to study the interaction effect of feeding different levels of dietary available phosphorus, vitamin D3 and phytase enzyme in broiler chickens revealed that a dietary concentration of 0.35 and 0.25% available phosphorus during starting and finishing phase, respectively and 1500 IU/kg vitamin D3 with supplementation of phytase @ 500FTU/kg diet was found adequate to obtain optimum blood biochemical parameters and retention of calcium and phosphorus.

Physiological intervention for augmentation of reproductive efficiency

Improvement of reproductive efficiency in turkey and chicken

Effect of various storage temperatures on fertilizing ability of chicken spermatozoa using CARI semen diluents : Thirty healthy and adult males from the same hatch of white leg horn (WLH) were taken randomly and maintained in individual cages under uniform husbandry conditions. For the fertility study 60 healthy and adult hensof the same hatch and same breed were also taken randomly and maintained in the similar manner. Good quality pooled semen samples were diluted 1:2(80-100 million sperm/insemination) with CARI semen diluent. Immediately after dilution, samples were divided equally in to three aliquots and stored in 5 ml round bottom glass tube (length=7cm, diameter=1 cm) at different storage temperatures (3±1, 7±1 and 11±1^{0}C) for 24 hrs before insemination of hens. The result of this study indicated that using 24 hrs stored semen, high fertility (88.95±1.76%) was achieved at 7±1°C followed by 11±1°C (51.00±4.00%) and 3±1°C (46.36±3.86%) in WLH chicken during 2-7 days. Overall the pattern of fertility during 2-11 days was also high (79.24±2.12%) in 7±1°C stored semen in comparison to 11±1°C (36.20±3.09%) and 3±1°C (35.01±3.10%). The freshly ejaculated semen revealed 90.05±1.58% fertility. Our studies indicated that chicken semen can be stored for 24hr at 7°C using CARI diluent and expressed good fertility similar to the freshly ejaculated semen. Recently, we have also observed nearly 90 % fertility in 24 hrs stored broiler semen at 7±1°C using CARI semen diluent. It was stated that our CARI semen diluent is equally effective both in layer as well as broiler semen dilution.

The fertilizing ability of CARI semen diluent was compared with BPSE and LAKE's diluent during low temperature storage for 24 hrs. CARI semen diluent was found superior than others.

Role of heat shock protein on the efficiency of digestive system under normal and stressed conditions in poultry

To study the effect of pre-natal thermal conditioning on intestinal structure and digestive enzymes of broiler under post-hatch acute heat stress: Prenatal thermal conditioning reduced the crypt depth in jejunum, while other morphological observations like villi length and villi length to crypt depth ratio remain unaffected. Post hatch acute heat stress exposure poses no significant effect ($P>0.05$) on villi length and ratio of villi length to crypt depth. However, crypt depth of jejunum showed significant ($P<0.05$) reduction. Pepsin and trypsin enzymes activity in jejunum was increased significantly, while amylase showed decreased pattern and lipase activity remains unaffected. Serum glucose levels were significantly increased upon exposure to acute heat stress condition and a linear trend was noticed with the duration. In order to understand the digestive efficiency under acute

heat stress periods, protein synthesis modulator was administered to birds through i/p route. Briefly, birds were injected with two types of modulators namely, enhancer i.e. glutamine @ 0.75 mg/Kg B.W and inhibitor, Quercetin @ 5mg/Kg B.W. In general, HSP-70 enhancer, glutamine showed significant improvement on enzymatic (pepsin, trypsin, lipase and amylase) activity in jejunum. In addition, glutamine reduced the serum triglyceride level.

To elucidate the physiological determinants of broilers with varying body weights exposed to normal and heat stress conditions: On basis of fifth week body weight, broilers were categorized randomly into three treatments (N=24)as high-HBW (>1050 g), medium/control-MBW (900-1050 g) and low-LBW (< 900 g). At six weeks of age, broilers were reared simultaneously under normal and heat stress conditions for a period of 7 days. For thermal exposure trial, broilers were shifted to experimental psychometric chamber (ICAR-Indian Veterinary Research Institute, Izatnagar) and exposed to heat stress @ 39-40 °C and 45±5 % RH for 4 hrs/day i.e., 10:00 hrs to 02:00 hrs in the morning. Recording of physiological responses and sample collection were done at the time period of 0d, 3d and 7d of heat stress exposure. Heat stress exposure indicated increase ($P<0.01$) in heart rate, arterial blood pressure, respiration rate and comb temperature while rectal temperature remained unaffected. Lymphocytes, eosinophils, total red blood cell count, haemoglobin and haematocrit were reduced ($P<0.05$) whereas mean corpuscular volume, mean corpuscular haemoglobin, heterophil count and HL Ratio were increased ($P<0.01$) in response to heat stress. Circulating corticosterone and tri-iodothyronine significantly ($P<0.01$) increased in response to heat stress and body weight respectively. Serum triglycerides remained unaffected till 3rd day exposure but significantly ($P<0.01$) reduced on 7th day with lower content in HBW. Serum ALP and Ca level showed an increased ($P<0.01$) activity in HBW, LBW and MBW on 3rd day. Internal organ (heart, liver, lungs and kidney) morphometry showed significant ($P<0.01$) effects with higher relative weight in LBW broilers. In histological findings, liver was found with significant changes (swelling, severe vacuolar degeneration) on exposure to heat stress with prominent changes in heavier birds. Heat stress also reduced villi length and crypt depth; but VL: CD ratio increased on heat exposure.

Study of physiological responses under normal and stressed conditions in indigenous and improved varieties of poultry

***To study the haematological and biochemical profile in indigenous poultry varieties*:** Blood collection was carried out in native chicken breeds at different age intervals for assessment of the normal hematological and biochemical parameters. Kadakanath at 4 weeks, average body weight of 150.74 g, red blood cell count of 1.95 x10^6/µl, hemoglobin 12.16 g/dl, packed cell volume 35.17% and red blood cell width of 13.72 µm was observed. The heterophil: lymphocyte ratio is 0.15. However, at 8 weeks of age body weight was 539.68 g with RBC 2.10 x10^6/µl, Hb 12.35 g/dl, PCV 35.45%, RBC width 14.07 and H: L ratio 0.18. Aseel Kala had average body weight of 604.84 g at 10 weeks age. The total RBC was 1.46 x10^6 /µl, Hb 10.66g/dl, PCV 31.06 RBC width 12.77 µm and H: L ratio 0.26. Total protein (4.78±0.15g/dl), cholesterol (243.16±15.51mg/dl), triglycerides (142.96±5.47mg/dl) and uric acid (4.89±0.03 mg/dl) did not shown any age or variety difference.

Physiological interventions for addressing reproductive dysfunctions in broiler breeders

To study the association of seminal constituents and plasma testosterone concentration with certain sperm quality attributes in broiler breeders: Fifty adult (35 weeks) healthy broiler breeders of Coloured Synthetic Male Line were chosen randomly and neat semen was collected on individual basis. Sperm motility, concentration, percent livability and functional integrity of sperm plasma membrane were assessed in neat semen as per standard protocols. Trace minerals (Zinc, Copper, Iron and Cobalt) and metabolic constituents (calcium, phosphorus, total protein, cholesterol, triglycerides, alanine aminotransferase-ALT and aspartate aminotransferase-AST) were estimated in seminal plasma by employing atomic absorption spectrophotometry and standard kits respectively. ELISA based plasma testosterone profile was investigated to arrive at hormonal correlation. Results generated from regression analysis indicated that sperm motility (R^2= 0.93) and livability (R^2= 0.89) are positively influenced by concentrations of Zn, Cu, Co, Ca, ALT, testosterone and negatively affected by Fe, P, protein, cholesterol, triglycerides

and AST levels. Similarly, plasma membrane integrity (R^2= 0.81) was in positive correlation with Zn, Cu, Co, Ca, P, triglycerides, ALT and negatively with Fe, protein, cholesterol, AST and testosterone levels. The total sperm concentration (R^2= 0.70) was negatively affected by Fe, triglycerides, ALT and AST enzymes. In conclusion, the sperm quality can be majorly influenced by the varying concentrations of metabolic and trace elemental make up of seminal plasma and circulating levels of testosterone. These findings will allow us to gain new insights on sperm motility and its predicted fate in oviduct. Further, breeder dietary requirements can be redefined to meet quality sperm requirements.

SHELTER MANAGEMENT

Evaluation of Management Practices to Optimize Turkey Production

Effect of floor space, dietary energy and enzyme supplementation on nutrient utilization in turkey poults: Day-old straight-run turkey chicks (n=120) were randomly distributed into twelve experimental groups each having four replicates and reared in experimental battery cages (1.64 ft X 2.30 ft) at two floor spaces (1.25 & 1.90 ft^2/bird) and three dietary energy levels (2400, 2600 and 2800 kcal/kg) with or without supplementation of multi-enzyme (cocktail) from 9^{th} - 16^{th} week of age. All the diets were having similar crude protein (20%) the critical amino acids (lysine 1.2% and methionine 0.37%) as suggested by NRC (1994). Two metabolic trials were conducted at 12 and 16 weeks of age, respectively to assess the nutrients utilization in the growing turkey poults. At 12 weeks of age, dry matter metabolizability (DMM), and nitrogen retention were significantly higher (P<0.05) in the poults provided 1.25 sq. ft floor space than those 1.90 sq. ft. The DMM was significantly higher (P<0.01) in 2800 kcal/kg ME fed poults than 2600 kcal/kg, whereas 2400 kcal/kg ME fed poults showed significantly lower value. However, the DMM and nitrogen retention did not differ due to enzyme supplementation. Interaction of space, energy and enzyme showed significant (P<0.05) difference on nitrogen retention only. Interaction of space and enzyme level showed significant effect on DMM (P<0.01) and nitrogen retention (P<0.05). There was no significant difference in the energy metabolizability (EMM) due to different floor spaces. The EMM was significantly higher (P<0.01) in 2800 kcal/kg than 2600 kcal/kg ME fed poults, whereas 2400 kcal/kg group showed significantly lower value. The EMM was significantly higher (P<0.01) in enzyme supplemented group than the non-supplemented group. The fiber utilization did not show any difference due to floor space, but was higher (P<0.01) in lower energy fed poults (2400 and 2600 kcal/kg). The fiber utilization was also significantly higher (P<0.01) in enzyme supplemented group than non- supplemented group.

At 16 week of age, the DMM and nitrogen retention was significantly higher (P<0.05) in higher floor space (1.90 sq ft), and high energy fed (2800 kcal/kg) poults than their counter parts. The nitrogen retention was significantly higher in enzyme supplemented group than the non- supplemented group. Interaction of energy and enzyme showed significant effect (P<0.01) on DMM. There was no significant difference in EMM due to floor spaces, but it was better (P<0.01) in high energy (2800 kcal/kg) group. The EMM did not differ significantly due to feed enzyme supplementation. Interaction of space, energy and enzyme or space and energy or space and enzyme or energy and enzyme did not show significant difference on EMM. There was no significant difference on fiber utilization due to different space. The fiber utilization was significantly higher (P<0.01) in 2400 kcal/kg than 2600 kcal/kg, whereas 2800 kcal/kg showed significantly lower value. The fiber utilization was significantly higher (P<0.01) in with enzyme supplemented diet group than without enzyme supplemented diet group. Interaction of energy and enzyme showed that fiber utilization differed significantly (P<0.01).

Assessment of performance and welfare of chicken under different housing conditions

Evaluation of performance and welfare of WLH grower and layer birds under two housing systems: Behavioral responses and physical conditions of layers indicate the welfare and degree of adaptation to the production environments. The behavioral inventory of young layers of White Leghorn (CARI-Priya) and their welfare status under different management conditions during winter season was studied. At 18^{th} wk, a total of 450 layer birds from a single hatch were randomly assigned into three treatment groups *viz* floor housing, colony cage and

individual cage. Continuous focal sampling method over a period of 24hrs by using CCTV cameras (marking the hens with different colors) was used to measure the time spent (% of 24hrs) in performing different behaviors (name the behaviors). Feather condition, claw length, foot condition and keel bone deformity was studied in ten birds each selected randomly from housing systems by using suitable scale of measurement at 20th wk.

Results revealed that, during winter, the floor reared layers spent significantly more time in sitting (46.4%), walking (7.2%) and investigating behavior (4.0%) than those reared on colony (38.2, 4.8 and 1.4%) or individual cage (30.9, 1.4 and 1.0%). Whereas, individual cage layers spent more of time in feeding (40.7%) than the colony (26.6%) or floor birds (22.9%). However, time spent for drinking and preening activity was similar in all housing systems. In the colony cages, feather pecking was more frequent, while cage layers pecking appeared stereotyped in many hens, but at a low frequency. There were significant differences ($P<0.05$) in the welfare status regarding feather conditions, claw length, gait scores and tonic immobility of the birds between the managemental conditions, while no significant difference was found in keel bone condition and foot lesions. Significantly higher ($p<0.05$) fearful response and time for first peck (response to novel object test) was observed in individual cage layers than the floor and colony birds

Health Management

Surveillance and monitoring of poultry diseases in poultry farms at CARI

Health management of different diversified poultry species maintained at this institute *viz.* chickens (layer, broiler and desi fowl), quails, turkey, guinea fowl and emu was carried out as a regular and essential activity. This included both prophylactic as well as therapeutic aspect with an objective to prevent the incidence of diseases/infection and to treat the disease in case of any disease/infection. A total of 3,38,900 vaccine doses were employed during April 2015 to March 2016 for the prevention of poultry diseases. Under Avian leucosis virus prevention programme, a total of 1777 broiler breeders were screened for Avian leucosis virus by ELISA. Sero-surveillance, diagnosis of diseases/ infections on the basis of post-mortem examination and detection of causative agent/s were the key factors which were taken into consideration based on which the health programme was devised. With an aim to assess the immunity profile, vaccinal immunity in different poultry species was assessed against important poultry diseases and based on titre of vaccine, vaccination schedule was devised from time to time. Pathogen profiling for *Salmonella*, Avian Leucosis Virus (ALV) and other pathogens was also carried out as an essential component of health monitoring programme. Antibiotic sensitivity was carried out to assess the antibiotic sensitivity pattern and according to sensitivity pattern, antimicrobial agents were used for treatment of the disease/infection so as avoid the problem of development of disease. To boost the immunity of the poultry, vitamins, gut acting acidifiers, probiotics, minerals anti-coccidial drugs, electrolytes, immuno-modulators and water sanitizers were also used in different poultry species both as prophylactic or therapeutic agents. Apart from this, immuno-modulators supplementation either through feed or drinking water were used and these were found very effective for enhancing immunity as well as well beings of poultry birds. Diseases like coccidiosis, colibacillosis, chronic respiratory disease, parasitic infections were detected and these were effectively treated using theraupeutic agents and supportive therapeutics including multivitamins, electrolytes and immnuo-boosters. As a preventive measure from parasitic infections, deworming was carried out regularly in all the poultry species. Incorporation of vitamins, electrolytes and immune-stimulants in drinking water before and after deworming proved effective as stress reliever due to deworming. Microbiological quality of drinking water and poultry feed samples was monitored regularly. Strengthening of bio-security measures in farm premises as well as in all the poultry sheds was carried out regularly with disinfection of poultry sheds, providing foot baths, education of farm workers etc.

Processing, value addition, product safety and quality parameters

Development and shelf-life extension of functional meat product prepared from turkey and spent chicken meat

Shelf-life assessment of functional poultry meat wafers (fpmw) at 37±2 ºc under aerobic packaging condition: After standardization of processing techniques, efforts were made to undertake shelf-life assessment of FPMW during the period under report. For this, two individual samples were prepared in which control sample contained standard formulation as optimized earlier. Treated sample contained additional ingredients oregano powder and Vita-E @ 0.05 and 0.04%, respectively. Results indicated that inclusion of oregano powder and Vita-E in treated sample had additional benefit in improvement of product quality. But moisture contents were increased in both the samples. The lipid stability and antioxidant activity of both the products were increased and decreased respectively with the increase of storage time. The microbial counts for SPC were little affected and indicators as well as pathogens were absent during entire storage period. Sensory scores were drastically declined after 90 days of storage (Fig. 16). So, both the products have shelf-life up to 90 days during storage at 37±2 ºC.

Fig. 16: Poultry meat wafers (After 90 days of storage at 37±2 ºC)

Shelf-life assessment of functional poultry meat finger chips (fpmfc) at 37±2ºc under aerobic packaging condition: Studies were conducted on shelf-life assessment of FPMFC containing standard formulation as optimized previous year. However, an additional sample was prepared with the aim of shelf-life extension of product using 0.05 % oregano powder + 0.04 % Vita-E. Both types of samples were processed, packaged separately in PET jar and finally stored at 37±2 ºC for shelf-life evaluation. It has been observed that addition of oregano powder and Vita-E in the product formulation improved lipid stability, antioxidant activity and microbial quality. However, both these products ingress moisture and values were increased with the increase of storage period. But, the treated sample showed better sensorial quality. Finally, it was concluded that oregano and Vita-E can be used as additional ingredients for functional benefits of FPMFC which shown to had shelf-life up to 8 wks at 37±2 ºC (Fig 17).

Fig. 17: Poultry meat finger chips
(After 8wks of storage at 37±2 ºC)

Shelf-life evaluation of functional chicken meat bites during storage at -18±2ºC under aerobic packaging condition: Chicken meat bites (CMB) offer a potential market at growing fast food outlets. Most acceptable functional CMB processed in the previous year was subjected to shelf-life evaluation during storage at -18 ±2 ºC under aerobic packaging condition (Fig 18). Additional sample was also prepared using 0.05 % oregano powder + 0.04 % Vita-E. Results indicated that TBARS values, pH and moisture loss were affected by the storage condition. Control sample showed higher TBARS values on the day of 15 onwards. Antioxidant activity was decreased with the increase of storage time. In

Fig. 18: Chicken meat bites (Fresh)

Fig. 19: Chicken meat bites
(After 90 Days of storage at – 18±2 ºC)

respect to microbial quality, treated samples showed lower SPC than control; however indicators and pathogens were absent. On sensory evaluation both the products were well accepted by panel members but treated samples scored for all attributes. In general, both the control and treated samples could have shelf-life more than 3 months at -18 ± 1 ºC under aerobic packaging condition (Fig 19).

Development of different value added poultry products for income generation

Development and sale of functional chicken meat bites and sausages to the consumers for popularization and income generation *:* Functional chicken meat bites and sausages, turkey meat bites and quail egg pickles were developed for selling them through institute marketing centre for popularization and income generation. All these products were evaluated for different physical chemical, nutritional and microbiological quality to ensure safety to the consumers. A total 562 packets of chicken meat bites, 66 packets sausages, 45 packets turkey meat bites and 48 packets quail egg pickles were sold through institute marketing centre.

Standardization of processing technology for development of chicken breast fillets (cbf) from spent fowl*:* Processing technology and marinade formulation for development of CBF were standardized for effective utilization of tough breast meat from spent broilers. For processing, breast fillets were subjected to post-mortem ageing at 37 ± 2 ºC for 4 h, marinated into marinade for 40 min, and finally, cooked (grilled) in microwave oven for 40 min. The marinade formulation was standardized using water, mustard seed, black pepper, citric acid, sodium ascorbate, tomato sauce etc. The product was well accepted by the sensory panel members.

Process optimization for development egg rasmalai

Process for development of egg rasmalai was standardized using whole egg liquid (60%), maida (5%), skimmed milk powder (35%), sugar, cardamom powder etc. In processing, standardized milk (4.5% fat) was pasteurized and then continuously heated to condense it after adding cane sugar. Subsequently lumps of emulsion fallen into the milk and simmered for 30 min. Thus, the process developed is very simple, and the product was well accepted by sensory panel members (Fig 20).

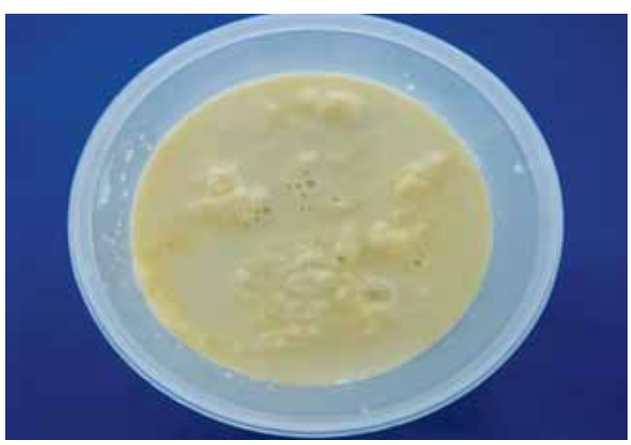


Fig. 20: Egg Rasmalai

Monitoring of poultry products and feed samples for chemical residues from selected markets of Northern India

Residues of few commonly used veterinary drugs like tetracycline oxytetracycline, chlortetracycline, trimethoprim and sulfamethoxazole in poultry meat, eggs and tissues collected from certain locations in northern India were determined. The samples of poultry feed, egg and tissues were collected (n=50/component/location) from farm and market places of Gurgaon and Faridabad areas of northern India. The residue of drugs like tetracycline, oxytetracycline and chlortetracycline in samples of poultry feed, egg, liver and muscle collected from the two locations were found in the range of 0.015-0.25ppm, 0.01-0.02ppm, 0.015-0.025ppm and 0.015-0.025ppm, respectively. In all, the occurrence pattern of, tetracycline, oxytetracycline and chlotetracycline were to the tune of 8%, 10% and 5% among all samples. Higher

drug residues were obtained in samples collected from Faridabad sampling area. The occurrence of residues of trimethoprim and sulfamethoxazole was recorded in samples of poultry feed (0.012-0.023ppm), egg (0.01-0.022ppm), liver (0.015-0.025ppm) and muscle (0.01-0.024ppm) with higher residue levels observed in samples collected from Faridabad. The level of residues determined were within the permissible limit. It was inferred that residues of drugs were found relatively higher levels in liver samples. Among the locations of northern region studied, samples collected from Faridabad contained relatively higher levels of residues than those from other areas. However, all the samples analyzed were found to be within the permissible limit.

Assessment of poultry production as influence by market dynamics

Study on institutional credit support to poultry farming in uttar pradesh

Financial institutions exhibited lack of interest to finance poultry farming ventures. The most important inhibiting factor amongst bankers was perception of high risk involvement in poultry farming primarily due to diseases (particularly AI) followed by moral hazard and lack of availability of insurance for poultry birds. From the poultry entrepreneurs view point, the most limiting factor in availing institutional finance was lack of collateral security or credit worthiness especially for those engaged in small poultry business. Lack of awareness about various schemes run by state Govt. or other Govt. departments to promote poultry farming activities was yet another important constraint in promoting poultry entrepreneurship. It was observed that Institutional finance was more readily available for expanding the pre-existing poultry businesses rather than starting a new poultry venture. The project has been completed and final report is due to be submitted.

HRD and Technology Dissemination

Transfer of proven poultry production technologies and their impact assessment

On-farm demonstrations on CARI Nirbhik: The farmers, motivated using village level exhibition, and on-farm demonstrations were given on- farm demonstration on CARI Nirbhik. Two selected farmers of village panchayat(s) Dandia and Navdia harkisan in Bithari chainpur development block of Bareilly district (UP) were given CARI Nirbhik DOC (improved desi chicken) in the month of June and July,2015 for rearing under semi- scavenging system of backyard poultry.

Field day on CARI Debendra: In order to motivate other farmers of the village for backyard poultry, a field day was organized on 04th September, 2015 at village panchayat Dandia to show the performance of CARI Debendra dual purpose chicken reared by selected farmers of the village. All beneficiary farmers were motivated and ready to adopt backyard poultry farming due to encouraging results in terms of economic gain through selling of eggs and cooks, apart from self consumption of eggs and meat.

Externally funded projects

Biochemical basis for detection of calpains and calpastatin and their role in post-mortem tenderization of meat (DST Sponsored).

Standardization of calpains assisted post-mortem ageing for meat from different species of animals: Calpains (*μ* and *m*) are the key proteolytic enzymes of calpain system that greatly influence the tenderness of meat. So, based on the activity of *μ*-calpain, the post-mortem ageing for meat from different species of animals were standardized.

***Desi breed of chicken*:** Post-mortem ageing of breast muscle from spent male (above one year) of Ankleshwar, Aseel, Kadaknath and Nicobari breeds during holding at 4±1°C was standardized at 24, 24, 24 and 18 h, respectively while that was standardized without holding of thigh muscle from Ankleshwar and Aseel male birds; and at 6 and 24 h, respectively from Kadaknath and Nicobari male.

For female breast muscle, postmortem ageing of Ankleshwar, Aseel, Kadaknath and Nicobari was standardized at 18, 6, 24 and 18 h, respectively while for thigh sample it was standardized at 6, 6, 6 and 18 h, respectively. The μ- and m-calpains in muscle male and females of different breeds (Fig. 21)

Ankleshwar (A) 0 h: Lane-1: Breast muscle (♂); Lane-2: Thigh muscle (♂); Lane-3: Breast muscle (♀); Lane-4: Thigh muscle (♀); Aseel (B) 0 h: Lane-1: Breast

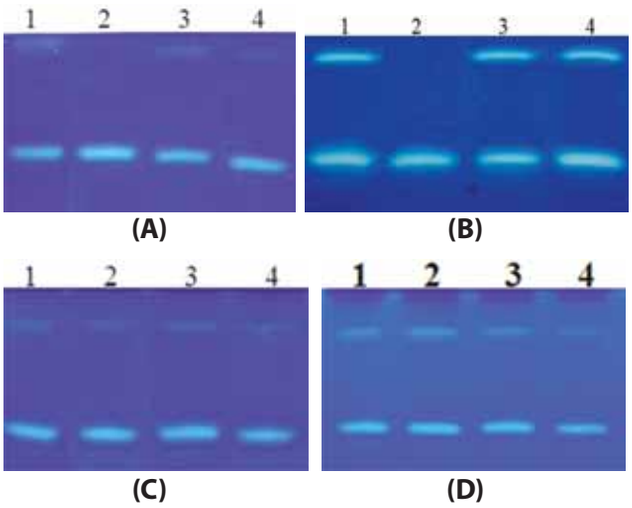


Fig 21: Showing clear bands of µ- and m-calpains on casein gel

muscle (♂); Lane-2: Thigh muscle (♂); Lane-3: Breast muscle (♀); Lane-4: Thigh muscle (♀); Kadaknath (C) 0 h: Lane-1: Breast muscle (♂); Lane-2: Thigh muscle (♂); Lane-3: Breast muscle (♀); Lane-4: Thigh muscle (♀) and Nicobari (D) 0 hr: Lane-1: Breast muscle (♂); Lane-2: Thigh muscle (♂); Lane-3: Breast muscle (♀); Lane-4: Thigh muscle (♀).

***Spent broiler (62 wks age) muscle samples (CARI-BRO Vishal)*:** For spent broiler (female), *µ*-calpain induced post-mortem ageing of breast muscle was observed at room as well as at refrigeration temperature. It has been observed that the *µ*-calpain remained active form upto 24 and 4 h at refrigeration (4 ±1 ºC) and room temperature (27 ±2 ºC), respectively. Thus, this inferred that PM ageing of spent broilers convened for 24 and 4 h at refrigeration (4 ±1 ºC) and room temperature, respectively. Bands of µ- and m-calpains in muscle male and females of broiler breeders (Fig. 22)

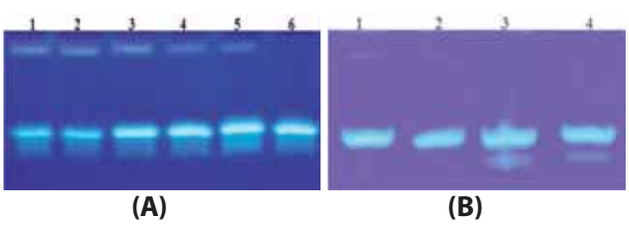


Fig 22: Showing clear bands of µ- and m-calpains on casein gel in broiler breeder muscle samples:

(A) Aging at refrigeration temperature: Lane-1: 0 h breast muscle; Lane-2: 6 h breast muscle; Lane-3: 12 h breast muscle; Lane-4: 18 h breast muscle; Lane-5: 24 h breast muscle; Lane-6: 36 h breast muscle. (B) Aging at room temperature: Lane-1: 0 h breast muscle; Lane-2: 2 h breast muscle; Lane-3: 4 h breast muscle; Lane-4: 6 h breast muscle.

***Buffalo (round) and goat (leg) meat sample*:** During post-mortem (PM) aging at 4±1 °C, the activity of *µ*-calpain was present upto 72 h, however it was completely absent at 96 h. For PM aging at room temperature *µ*-calpain was present upto 6 h, partially autolyzed at 15 h and was completely absent at 24 h. So, PM ageing of buffalo meat was standardized at 72 h and 15h during holding at refrigeration and room temperature. PM aging of goat meat sample was standardized at 4 h during holding at room temperature (Fig. 23 A, B and C).

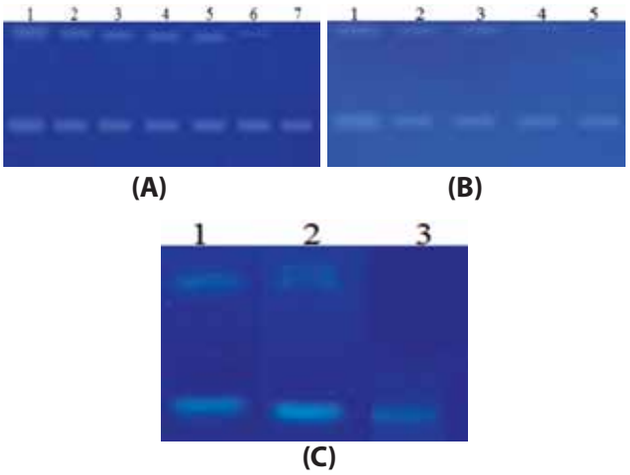


Fig 23: Showing clear bands of µ- and m-calpains on casein gel in buffalo muscle samples:

(A) Buffalo meat ageing at refrigeration temperature: Lane-1: 0 h; Lane-2: 6 h; Lane-3: 18 h; Lane-4: 24 h; Lane-5: 48 h; Lane-6: 72 h; Lane-7: 96 h. (B) Buffalo meat ageing at room temperature: Lane-1: 0 h; Lane-2: 3 h; Lane-3: 6 h; Lane-4: 15 h; Lane-5: 24 h. (C) Goat meat samples (Jamunapari) Lane-1: Jamunapari (0 hr); Lane-2: Jamunapari (4 hr); Lane-3: Jamunapari (6 hr).

Thermotolerance gene expression analysis in Salmonella and development of their thermal death time models applicable to poultry processing (DBT sponsored)

Standardization of protocol for decontamination of hardy Salmonella Typhimurium on dressed chicken in actual processing conditions: The main objective of the project was to standardize a protocol which can be used for inactivation of *Salmonella* Typhimurium on dressed chicken meat without affecting the organoleptic quality and the protocol to be standardized can be easily applied in actual processing of poultry. The D-values and predicted D-values obtained in this study showed

significantly decreasing pattern with increase in temperature or antimicrobial concentration for both models (chicken skin as well as carcass). Similarly, a decreasing trend in D1- and D2-values was also observed with increase and antimicrobial concentration for both models. z-values calculated for dressed chicken skin and broiler carcass model using log D-value, log D1-value and log D2-values also revealed a decreasing trend of z-value from control obtained in this study showed the combined effect of antimicrobial pre-dipping with subsequent thermal treatment for inactivation of *Salmonella* Typhimurium on dressed chicken skin and carcass surface while increasing trend of z-value from control showed the effect of antimicrobial for inactivation of *Salmonella* Typhimurium was not temperature dependent.

Based on the observed D-and z-values of *Salmonella* Typhimurium generated on dressed chicken meat surface for each treatment, experiment was conducted to validate the most effective time-temperature and antimicrobials combination employing a 7D thermal inactivation of *Salmonella* Typhimurium on dressed chicken surface during actual processing in a poultry processing plant. Time required for 7D treatment of dressed chicken carcasses obtained for acidified sodium chlorite (ASC) and carvacrol under which was generated using the observed D-values was too much higher for processing condition. The reason behind the use of lower concentrations of antimicrobials during experiment was to obtain 5 log reductions of survivals which are required for the D, D1 and D2 values calculation as a part of thermal death time modeling. With an idea to make the protocol applicable for poultry processing, higher concentrations of each antimicrobial were used to reduce the time of thermal treatment of carcasses. This data obtained were used for the thermal death time modeling of hardy *Salmonella* Typhimurium on dressed carcass treated with ASC or carvacrol and thermal treatment. The treatments selected for the processing under actual processing in mechanized poultry processing plant were found similarly effective for inactivating the total bacterial count as well as *Salmonella* Typhimurium suitable for ensuring microbial safety of carcasses without any affect on sensory attributes and organoleptic quality of meat.

Identification of Probiotic Strain(s) from Gut Metagenome of Assam Indigenous Chickens (DBT Sponsored under DBT-NER twinning Program)

Lactobacillus genus identification by genus specific primers

DNA was extracted from 52 bacterial culture samples by Phenol-chloroform method. A 203-bp fragment at nucleotides 40 to 243 of 16S ribosomal region were amplified by genus specific primers. The polymerase chain reaction (PCR) was started with heating at 94° C for 3 min followed by 35 cycles of PCR (consisting of 30 s at 92°C, 30 s at 55°C, 60 s at 72°C) and a final cycle 5 min. at 73°C. The PCR products were analyzed on 1.5 % agarose gel (Fig. 24). Out of 52 bacterial samples, 40 samples showed PCR amplification (203 bp), therefore were considered as Lactobacillus genus.

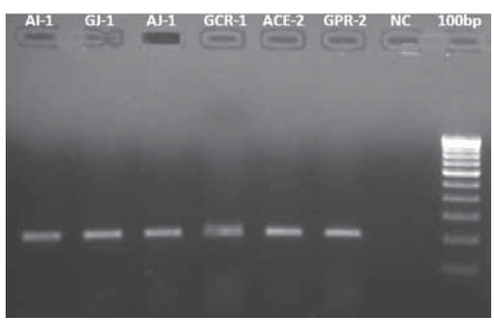


Fig.24 Lane 1-6 : Bacterial DNA samples; NC- Negative template control; 100bp ladder

Sequencing genes in the 16S ribosomal region: For sequencing the genes in the 16S rDNA region, DNA from Lactobacillus genus (40 isolates), bacteria were amplified by universal primers. The PCR was followed by heating at 95°Cfor 2 min and 35 cycles (consisting of 95°C for 45 s, 53°C for 45 sand 72°C for 60 s) and a final cycle 73°C for 3 min. The PCR

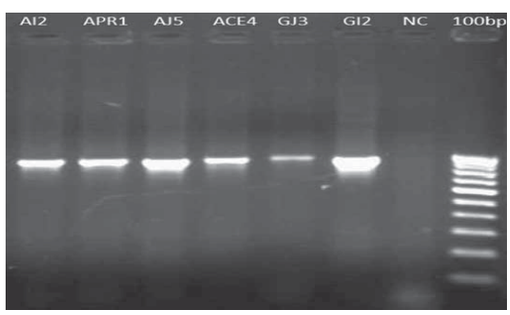


Fig. 25: Lane 1-6 : Bacterial DNA samples; NC- Negative template control; 100bp ladder

products were analyzed on 1.5 % agarose gel (Fig. 25). Out of 40 Lactobacillus genus samples, 30 samples showed PCR amplification (900bp).

The sequencing of these samples were outsourced from M/s Euroffins. The sequencing results revealed that isolates collected from different segments of the gut had high similarity (01-96%) with Lactobacilli strains viz. L. *ruteri*, L. *gasseri etc.* However, few of the isolates viz. AJ-2, AJ-6 (~40%), BCR-3 (65-67%), GJ-3 (56-53), GI-2 and GI-4 had lower similarity with Lactobacilli strains.

Sugar fermentation test using Hi-Carbo kit: The HiMedia-one kit has three parts/strips - A, B and C. Both A and B parts contain 12 sugars each, and part C contains 11 sugars and a control. A total of 35 sugars were used in the test. Out of these 30 isolates, the isolates which exhibited highest scores of sugar fermentation i.e 32/35 sugars and isolate GJ1 showing the score of 31/35 was chosen for further analysis. Isolate GJ1 was chosen since it showed a different pattern of Inositol fermentation.

Assays for evaluating Probiotic strains: The six isolates were evaluated for probiotic properties using different assays viz. pH tolerance test, Bile tolerance test, protease activity assays, Antogonistic assay, Cell surface hydrophobicity % assay and co-aggregation assays were performed. The brief details of these tests have been given above. A score based on different assays was also developed by assigning the coefficient for each parameter according to its merit/ importance (Table-13). Aggregation test being the subjective, was not assigned by any coefficient for developing score rather the isolates securing higher score were further evaluated based on aggregation capability and finally three isolates namely AJ3 (Adult Jejunum), GJ1 (Grower Jejunum) and ACE5 (Adult Cecum) were identified as best probiotic strains.

The three isolates identified as above were used in feeding trial at AAU, Guwahati, to evaluate their probiotic effect *in-vivo*. The feeding trial the isolate AJ3 adjudged to be the best as it improved growth, FCR and humoral immunity in commercial broiler

Culture typing at IMTECH, Chandigarh: Three isolates namely GJ1, ACE5 and AJ3 were sent for typing at IMTECH, Chandigarh. The report from IMTECH (Fig 26) Chandigarh exhibited that isolate GJ has 100 % similarity with Staphylococcus *warneri whereas isolates ACE5 and AJ3 had over 99%* similarity *with* Lactobacillus *reuteri.*

Table-13: Probiotic assays and identification of best probiotic strains

	% survival			mm		%	%	Total score	Aggregation
Sample	**pH 3**	**Bile (0.15)**	**Bile (0.3)**	**Protease**	**Antagonistic test againt E.*coli***	**Cell Hydropbacity**	**Co-Aggregation (E.*coli*)**		
Coefficient	0.25	0.1	0.1	0.05	0.1	0.1	0.3	1.00	
APR1	45.28	20	13.8	12.1	11.54	84.61	3.43	25.95	*
APR5	62.37	28.25	18.38	12.55	9.6	76.8	7.2	31.68	*
AJ 3	**47**	**62**	**33.33**	**13**	**13.15**	**86.8**	3.8	**33.07**	**
AJ6	0	12	4	12	6	47.6	0.2	7.62	*
ACE5	**58**	**73.7**	**63.74**	**13**	**12**	**88**	4.2	**40.15**	***
GJ1	55	**78.26**	**56.52**	**14.31**	**13**	**79.7**	4.2	**38.47**	***

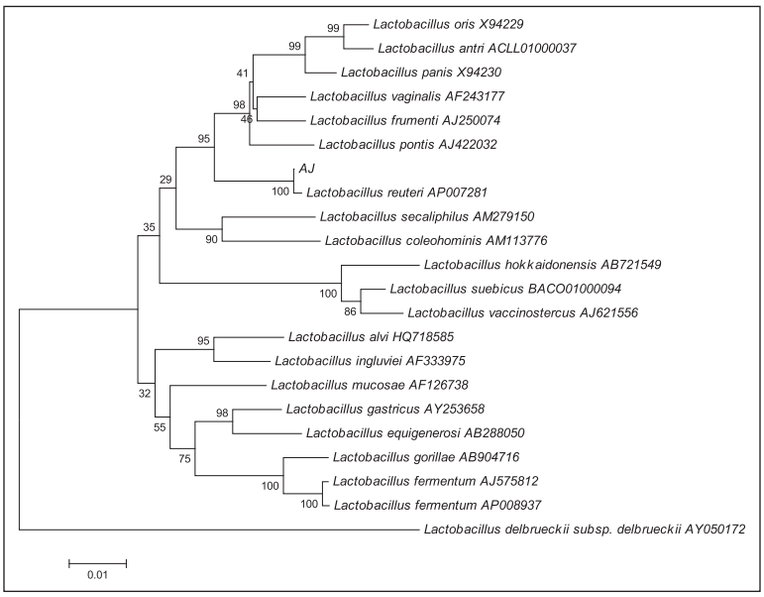


Fig. 26: Evolutionary relationships Strain designated as AJ (results obtained from IMTECH, Chandigraph) NeighborJoining tree based on 16S rRNA gene sequence comparisons showing the phylogenetic relationships among Strain designated as AJ and some of the most closely related species of *Lactobacillus* sp. The *Lactobacillus delbrueckii* subsp.

Assam Indigenous Chicken

REGIONAL CENTRE, BHUBANESWAR

Research achievements:

Maintenance, evaluation and conservation of important breeds of ducks for augmenting duck production in rural and tribal areas.

The average duck day egg production up to 40 week of age (G-2 gen.) were recorded as 71.74, 67.10, 55.88, 13.22, 80.67 & 70.27 eggs for Khaki Campbell, Desi, White Pekin, Moti breeds and DK & PK crossbreds, respectively. The egg production of both the crossbreds was better than their respective breeds. The mean 40th week egg weights for corresponding breeds/ crossbreds were observed as 63.18, 61.18, 65.60, 66.15, 63.41 & 63.96 g. The average age at 50% egg production was observed as 165.66, 164.33, 173.6, 165.00, 160.5 and 187.5 days for respective breeds/ crossbreds

Reproductive and hatchery management strategies for improving fertility and hatchability in duck eggs.

The aim of the project is to standardise the management of hatching duck eggs to produce maximum number of healthy ducklings of different varieties. Thus experiments were conducted to establish the facts associated with hatching of duck eggs.

***Study of weight loss in duck eggs (g) during different days of incubation*:** Fertile duck eggs (200 nos) of Khaki Campbell variety were incubated in the experimental hatchery of RC CARI adopting standard hatchery protocol. In three consecutive hatches, it was found that weight upto 6th day of incubation was not changed, from 6-16th day there was slow reduction of weight. However, weight loss from 16-24 days was significantly ($p<0.05$) higher (Fig.27).

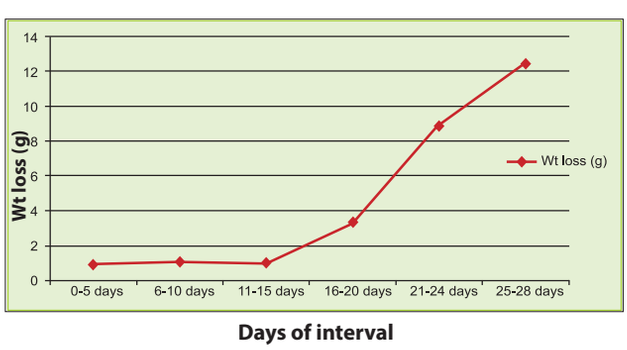


Fig.27: Loss of wt (g) in eggs at different days interval:

***Study on relationship of egg weight on Fertility and Hatchability (%) in ducks*:** A total of 300 eggs (Khaki Campbell) were graded on the basis of their weight i.e. 50-55g, 56-60g, 61-65g and 66-70g. The eggs were incubated in the experimental hatchery and candling was done on 14th day of incubation and fertlity percent was determined. Observation revealed that fertility and hatchability (TES) percent was the highest for the eggs weighing between 56-60g (Fig 28).

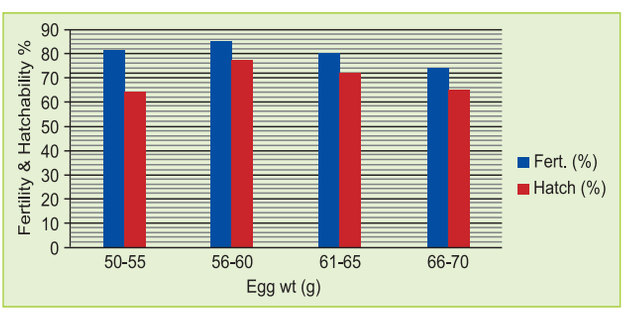


Fig.28: Relationship of egg weight on fertility & hatchability

Study on the effect of storing duration of duck eggs on fertility and hatchability: Fertile eggs collected from farm were stored in the egg cooling chamber. Eggs were transferred to experimental hatchery after being stored for 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 days. For every batch of eggs set the candling was done on 14th day and fertile eggs were transferred to hatcher on 24th day. It was observed that fertility and hatchability (TES & FES) did not vary much for the eggs stored upto 9th day but was drastically reduced by 10 days of storing (Table 14).

Table 14: Effect of storing duration of duck egg on fertility & hatchability

Days of storing	Fertility (%)	Hatchability (%)	
		TES	FES
1	67.64	63.23	93.47
2	61.83	55.72	90.12
3	68.39	57.51	84.09
4	58.09	52.69	90.71
5	63.63	58.18	91.42
6	59.42	51.59	86.82
7	58.71	52.98	90.23
8	64.89	61.42	94.65
9	63.21	58.03	91.80
10	51.39	34.62	67.37

Evaluation of azolla as an alternate feed resource for economic production of duck meat and egg

Production of azolla (*Azolla pinnata*) in silpaulin pit was standardised (Fig. 29). About 4.0 Kg of fresh azolla can be harvested from a pit size of 7m (Length) X 5m (Width) X 0.2m (Depth) daily with optimum temperature of 25-30 ^{0}C and P^H of 6-6.8 (Table 15). The chemical composition revealed that azolla contained DM, 4.86 %; CP, 25.45 %; EE, 3.51 %; CF, 12.66 % and TA, 16.01 % (Table 16).

Performance of crossbred ducks fed azolla (Azolla pinnata): An experiment was conducted in crossbred ducks to see the effect of azolla feeding on egg production performance. Two groups of 12 crossbred ducks (20 weeks old) each were fed control diet (T1), and fresh azolla (T2) @100g/duck. Fresh azolla was fed @ 100g/duck along with concentrate feed (reduced by 25%). The experiment was conducted for a period of 45 days. The egg production, feed intake and egg weight were recorded daily. The feed cost /duck/day was also calculated and savings on feed cost was calculated. It was observed that the average egg production was slightly more (46%) in the ducks fed with azolla compared to the control (44%). The average egg weight was higher (64.38g) in the ducks fed azolla compared to those recorded on control group (60.79g). There was a saving of Rs0.60/day/duck due to feeding of azolla. Ducks fed with azolla had orange colored yolk which might be due to the presence of carotenoid pigments in azolla. The average egg weight was higher (64.38g) in the ducks fed azolla compared to those recorded on control group (60.79g). There was a saving of Rs 0.60/day/duck due to feeding of azolla.

Fig. 29: 10th Day of azolla (Azolla pinnata) growth in silpauline pit

Table 15 : Quantitative production of azolla (*Azolla pinnata*) in pit (2m x 2m x 0.2m)

Months	Production/day/pit (g)			
	Pit-1	Pit-2	Pit-3	Mean±SE
April,2015	695.00	650.00	660.00	668.33±13.64
May,2015	393.50	400.00	438.70	410.73±14.10
June,2015	396.67	403.33	416.67	405.56±5.88
July,2015	408.06	389.35	420.97	406.13±9.18
August,2015	316.13	306.45	341.99	321.52±10.61

Table 16 : Chemical composition of azolla (*Azolla pinnata*)

Proximate constituents	Sample1	Sample2	Sample3	Mean±SE
Dry matter	4.86	4.76	5.08	4.90±0.09
Crude Protein	25.45	24.45	24.65	24.83±0.28
Ether extract	3.51	3.36	3.38	3.48±0.07
Crude fibre	12.66	12.55	13.19	12.80±0.20
Total ash	16.01	15.75	15.68	15.81±0.10

Studies on sperm storage tubules and development of technology for short-term preservation and utilization of male gametes in duck.

A total of 100 day old ducklings (Khaki Campbell) were reared in RC CARI farm with standard management practices. By 12 wk of age the male ducks were separated. From 13th to 24th wk the adult female ducks (4 nos) were sacrificed in every week to measure the growth of reproductive tract and sperm storage tubule (Fig. 30). It was observed that the sperm storage tubule fully developed and functional by 23rd wks of age in Khaki Campbell ducks (Fig. 31).

Fig 30: Development of female reproductive tract of duck (KC) at different week of age

Fig 31: Gross appearance of Sperm Storage Tubule in Khaki Campbell duck

Simultaneously drakes were trained and tried for semen collection. The routine semen evaluations were conducted for neat semen. It was found that the presence of transparent fluid (pre-ejaculatory fluid) affects the motility of spermatozoa in ducks (Fig. 32 a & b).

Surveillance and monitoring of duck diseases and their bio-security measures. (Service project)

A total of 1368 ducks were reported to be died this year with an average mortality as 3.17 %.

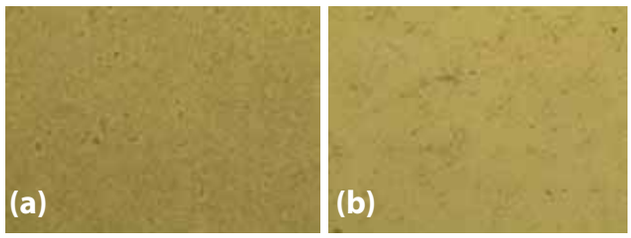


Fig 32: Semen in NS (without Transparent fluid) Semen in NS (with Transparent fluid)

Month wise highest mortality was observed during October ,2015 (10.14%) and minimum in December, 2015 (0.1.31%). Major cause of mortality was found due to Hepatitis (0.78%) which is followed by debility (0.57%), egg bound/egg peritonitis (0.39%), inanition(0.25%), cannibalism (0.23%), septicaemia (0.15%), enteritis (0.12%), pneumonia (0.07%), Gout/nephritis (27, 0.063), hurdling (0.06%), aflatoxicosis (0. 058%), drowning (0.037),omphalitis (0.053%), Hypothermia (0.03%), colibacillosis (0.03%), internal rupture/heamorrhage (0.02%),peritonitis (0.01%), pendulous abdomen (0.01%), Amyloidosis (0.01%), Orchitis (0.005%) and tumor (0.002%). Age wise highest mortality found in adult ducks (2.01%) followed by grower (0.64%) and least in duckling (0.51%). This year more hepatitis death recorded which occured in grower age after five weeks of age. Breed wise highest mortality revealed in white pekin (1.74%) followed by khaki Campbell (0.70%), desi –pati (0.63%) and Muscovy Moti (0.008%) respectively.

Collaborative project

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

Development of rice based farming system for up-land area was tested. Two varieties of upland rice

Fig 33: Rice based farming system

was tried as an integration with duck and tapioca production. Highest gross return of Rs 31,280/- per hactre was recorded.

Further trial on maintenance / refinement of model (Rice-fish-duck-horticulture) for deep water areas was done. Rice (two varieties), horticulture (watermellon, Kukumber), livestock (Duck – (WPxKC); Chicken – (Vanaraja), Fish (Common carp) and tuber crop (Yam – Gajendra variety) was tried in one field as new integrated model. Yeild of each crop was recorded. KC ducks attained 1.6 kg (avg both sex) by 6 months of age through natural grazing and scavenging. Among all the trials Rice-duck- Fish: model found highest remunerative (Rs 80,000 – 1.5 lak per hactre of land) (Fig. 33).

Marketing centre of RC, ICAR-CARI

A total of 248 farmers visited our marketing centre to know about the availability of ducklings and its purchased as well as to know about duck farming. They were advised about the duck farming and also for supply of ducklings. Letters were sent to the farmers indicating the availability of ducklings and rates for the same. During the year marketing centre collected a total revenue of Rs. 14.99 lakhs. The revenue are collected by sale of 3843 live ducks (6225 kg), 237088 numbers of table eggs, 8622 ducklings and miscellaneous items like chick box, egg box, egg tray, banana, raw cashew nut, mangoes, jack fruits etc. Total amount collected from sale of miscellaneous items was Rs39, 277/-. Total advanced received from farmers and other organization for supply of germplasm was Rs. 3, 25, 382/-. Total germplasm supplied during the year form our centre through marketing centre was 26,313 numbers. Besides this total hatching eggs supplied during the year was 642 numbers. Farmers coming to our sale counter for table eggs were interviewed for different attributes or problems of duck eggs and the preparation they made from duck eggs for consumption. It was observed that mostly preferred items from duck eggs are scrambled egg followed by omelets, egg curry and boiled egg (Table 17 & Fig. 34).

Table 17: Study on consumer preference for duck eggs:

Parameters	Average±SE	Range
No of person/day	14±0.66	8-23
Eggs purchased/person (no)	54±1.63	5-210
No of eggs sold/day	781±35	368-1308
Consumer liking for eggs		
Chicken (%)	62.11±2.90	38.40-100
Both (%)	31.72±2.44	0-56
Duck %	5.97±1.09	0-22

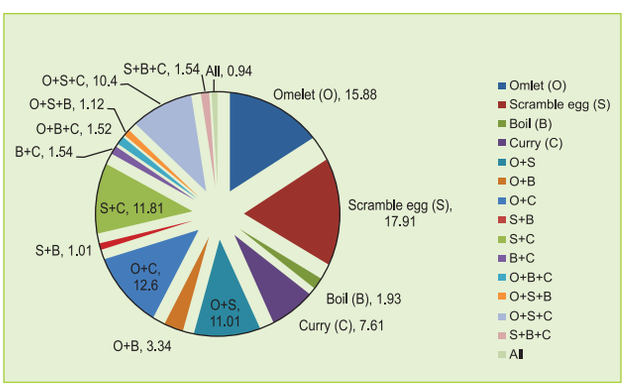


Fig 34: Habit of consumption (preparation) % of respondents

P.G. STUDENTS RESEARCH

Thesis title: *Effect of delay in feed placement and in ovo feeding on post hatch performance, intestinal morphology and gene expression in egg and meat type chickens.*

(Scholar: Dr A.S. Shinde, Roll No. 1538, Advisor: Dr S.K. Bhanja)

The present work was carried out to study the effect of delay in feed placement on the post-hatch performance, intestinal morphology and expression of GIT developmental, nutrient transfer and immune related genes in egg-type (White leghorn) and meat-type (Coloured broiler) chickens. Based on the result, the feed deprival (FD) beyond 24 hr. post hatch showed adverse effects which were ameliorated through *in ovo* feed supplementation (critical nutrients) in another two trials. The experimental design of trial 1 and 2 was a completely randomized design (CRD) with five treatments: immediate access to feed at 0 hr. (Control) and delayed first feed placement at 6, 12, 24, 36 hr. post-hatch (PH), while the experimental design for trial 3 and 4 was factorial design (3x3) with three treatments (*in ovo*, sham and un-injected control) and three fasting periods (0 hr - immediate fed, 24 hr FD and 36 hr FD) as factors. Post-hatch feed deprival for first 24 hr did not affect the growth performance, blood biochemical and organ development, while the yolk utilization and intestinal morphology were affected beyond 12 hr feed deprival in egg and meat type chicken. Feed deprival for first 24 hr improved the *in vivo* immune response in egg and meat type chicken. Feed withdrawal for 24 or 36 hr adversely affected the GIT developmental (Cdx) and nutrient transporter (SGLT) genes expression in egg and meat type chickens. The expression of immune related genes (IL-6 and TLR-2) increased in 24 and 36 hr fasted egg type chicks but only IL-6 expression increased in 12-36 hr fasted meat type chicks. Irrespective of period of fasting *in ovo* supplemented chicks had better growth performance, internal organ development, intestinal morphology and post-hatch immune response than the sham control and un-injected control chicks. In ovo supplemented and 24 hr FD chicks had significantly better performance, while *in ovo* supplemented and 36 hr FD chicks had comparable result with that of un-injected control and immediately fed chicks. Meat type chickens had shown better performance in response to *in ovo* injection than the egg type. It was concluded that *in ovo* supplementation of critical nutrients at 18th day of incubation abate the adverse effects of post-hatch feed deprival for 24 hr or beyond in both egg and meat type chickens.

Thesis title: *Estimation of crossbreeding parameters for production traits under diallel cross of native and exotic breeds of chicken*

(Scholar: Dr S. Ganesan, Roll No. 5343, Advisor: Dr D.P. Singh)

To study the combining ability of native chicken breeds with exotic breed and their performance with respect to growth and egg production traits, a 3×3 complete diallel cross involving two native chicken breeds Aseel Peela (AP) and Kadaknath (KN) along with one exotic breed CARI Red (CR) was undertaken. The progenies belonging to three purebreds and six crossbred genetic groups were compared to growth, conformation, production and egg quality traits. The results revealed significant differences ($P<0.01$) between genetic groups for growth, conformation and production traits. Among purebreds, Aseel and CARI Red weighed significantly ($P<0.05$) higher body weight than Kadaknath at 20 and 40th week of age. CARI Red matured earlier, produced more eggs and had better feed efficiency. The crossbreds were significantly ($P<0.01$) superior over purebreds for all the traits under study. Progenies of Aseel used as male line and CARI Red as female line revealed better growth, body conformation, early maturity and produced more eggs than other crossbreds.

The highest magnitude of positive heterosis found in production traits as compared to growth traits. The complete diallel cross analysis based on two models viz. Griffing's method I under model I and Hayman's model revealed significant (P<0.01) general and specific combining abilities in all the traits studied. However, specific combining ability found non-significance for shape index, shell thickness, albumen index and Haugh unit. Significant (P<0.05) reciprocal effect was observed in body weight, egg weight, shape index, albumen index and Haugh unit. Significant (P<0.05) maternal effect for egg weight, albumen index and Haugh Unit and significant (P<0.05) residual reciprocal (sex linked) effect for body weight were observed under Hayman's model. Additive gene action was more important for inheritance of growth, conformation and various egg quality traits, non-additive gene action was more important for inheritance of age at sexual maturity and both additive and non-additive gene actions were equally important for inheritance of egg production traits. The Griffing's model was adjudged to be better over Hayman's model for estimating the general and specific combining abilities. Gompertz model was adjudged to be the best-fit mathematical function for explaining the pattern of growth and egg production in all the pure and crossbreds. AP×CR was identified as the best crossbred genetic group for development of commercial hybrid native chicken for rural poultry production, because it has better growth and egg production with longer shank bones which helps to escape from predators.

Thesis title: *The study of growth and production traits and their mode of inheritance in four Japanese quail lines*

(Scholar: Dr Sandip Dinkar Bhosale, Roll No. 5059, Advisor: Dr Raj Narayan)

In the present investigation, genetic analyses were conducted to elucidate the mode of inheritance of various growth and production traits and their correlations in four different lines of Japanese quail. Under this study, body weight at 0 day, 1st, 2nd, 3rd, 4th and 5th weeks of age (BW0; BW1; BW3; BW4 and BW5) were measured on individual basis, a total of 423 Chicks of Japanese quail, belonging to four lines viz., CARI-UTTAM (CU); CARI-UJJWAL (CJ); CARI-SWETA (CS) and CARI-PEARL (CP) maintained. Results revealed statistically-significant line differences (P<0.05) for all body-weight traits and feed conversion ratio. Variation due to sex was significant for weekly body weight. CARI-UTTAM (CU) line had better feed efficiency as compared to other three lines under this experiment. The production traits included age at sexual maturity (ASM) and part time egg production at 8, 10, 12 and 15th weeks of age. The age at which first egg was laid recorded highest for the CJ while lowest for the CS. For the egg production at 8, 10, 12 and 15th week difference between various lines were significant. Similarly, the values for egg quality traits like egg weight (EW); egg shape index (ESI); albumen weight (AW); albumen index (AI); Haugh unit (HU); yolk weight (YW); yolk index (YI); yolk colour (YC) and shell thickness (ST) were significantly different for four lines under the study. Analyses of heritability (h^2) for weekly body-weights showed that: estimates were moderate to high in CU, CJ and CP while low to moderate in CJ for all ages of measurement. Low to moderate heritability (h^2) values were realized for the ASM and egg production for CU, CJ and CS whereas slightly higher values for CP. Positive and higher values of genetic (r_g) and phenotypic correlations (r_p) were evident between different body-weight measures for all the four lines of Japanese quail under the investigation. The phenotypic (r_p) among ASM and part time egg production at 8, 10,12 and 15th weeks of age ranged from low to high, across lines. Based on analyses of these results, it can be concluded that quails by possessing moderately-heritable traits, these studied populations can promise satisfactory response to any future selection programme for improving egg production while retaining higher juvenile growth.

Thesis title: *Influence of dietary saccharomyces cerevisiae and vitamin supplementation on ochrotoxicosis in broiler chickens.*

(Scholar: Dr Mohit Singh, Roll No. 5401, Advisor: Dr Ram Singh)

The present study was conducted to study the effect of *Saccharomyces cerevisiae* and vitamin E in ameliorating experimentally induced ochratoxicosis (200 ppb OTA) in broiler. Chickens from 0-6 weeks of age. First experiment included six dietary

treatments (T1-control; T2-T1+ 200 ppb OTA; T3-T1 + 0.05% *S. cerevisiae*; T4-T1+0.1% *S. cerevisiae*, T5-T2 + 0.05% *S. cerevisiae*, T6-T2+ 0.1% *S. cerevisiae*), with 5 replicates of 8 birds each. Addition of OTA at 200 ppb level significantly ($P<0.05$) decreased the body weight gain, feed intake and impaired feed conversion efficiency. Inclusion of *S. cerevisiae* (0.1%) effectively reduced the adverse effect of ochratoxicosis on these production parameters. Feeding 200 ppb of OTA caused increase in the relative weight of liver and decrease in weight of bursa of Fabricius. These effects of OTA were ameliorated by addition of 0.1% *S. cerevisiae*. Addition of ochratoxin in the diet decreased the serum protein and haemoglobin levels and increased uric acid, creatinine, SGPT, SGOT, ALP and H/L ratio values. However, cholesterol values were statistically similar in various dietary treatments. Inclusion of 0.1% *S. cerevisiae* (to the OTA contaminated diet) ameliorated the ill effects on blood biochemical and haematological parameters. OTA contamination in feed significantly reduced the CMI response as well as humoral immunity. Addition of 0.1% *S. cerevisiae* to toxin contaminated diet significantly improved the CMI response as well as humoral immunity. Histopathology of kidney showed significant degeneration of the architecture and cellular organization of the renal parenchyma, cloudy swelling, atropic tubules with degenerated and necrosed epithelium and multifocal aggregates of mononuclear cells in the ochratoxicated birds. The liver samples showed diffuse degenerative changes of hepatocytes with vacuolated cytoplasm, dilated and congested sinusoids, hyperplastic bile ducts, multifocal aggregates of mononuclear cells around bile duct and portal area. Addition of 0.1% *S. cerevisiae* reduced the severity of the nephropathic and hepatic changes associated with ochratoxicosis. In experiment 2, six treatments (T1-control; T2-T1+200 ppb OTA; T3-T1+ 100 mg/kg vitamin E, T4-T1+ 200 mg/kg vitamin E, T5-T2+100 mg/kg vitamin E, and T6-T2+ 200 mg/kg vitamin E) were formulated and each diet was fed to 5 replicated groups of 8 birds each upto 6 weeks of age. Vitamin E (200 mg/kg) level ameliorated the ill effects of ochratoxin on body weight gain, feed consumption and feed conversion efficiency. Addition of 200 mg/kg vitamin E to the OTA contaminated diet ameliorated the ill effects of ochratoxin on relative organ weight, blood biochemical and haematological parameters. Supplementation of 200 mg/kg vitamin E to the OTA contaminated diet significantly improved the CMI response as well as humoral immunity. Supplementation of 200 mg/kg vitamin E also reduced the incidence and severity of histopathological changes in kidney and liver associated with ochratoxicosis. It was concluded that inclusion of 0.1% *Saccharomyces cerevisiae* or 200 mg/kg vitamin E in the diet ameliorated the adverse effects of ochratoxin (200 ppb) in broiler chickens.

Thesis title: *Development and storage quality of functional turkey meat loaf*

(Scholar: Dr Pooja Farshwan, Roll No. 5321, Advisor: Dr C.K. Beura)

Meats have great potential for delivering important nutrients such as fatty acids, minerals, dietary fiber, antioxidants and bioactive peptides into the diet. Turkey meat fits well into it as it contains low calories and high protein as compared to chicken. Because of this reason many turkey meat products are now available in market. But very limited research work has been carried out in our country on suitability of cereal flours and natural preservatives on the comminuted meat products. Therefore, the present study was undertaken to develop turkey meat loaf with the incorporation of different levels of cereal flours (oat and ragi) and natural preservatives (oregano and parsley) as powder and also α-tocopherol acetate. Effect of these non-meat ingredients as extenders, antioxidants, antimicrobial and flavouring agent on the quality of turkey meat loaf during refrigeration storage were also studied. A formulation was standardized in which 3% oat and 3% ragi as cereal flours and 0.25% oregano, 0.5% parsley and 150 ppm α-tocopherol acetate as natural preservatives was selected for storage study. For the preparation of functional turkey meat loaf, emulsion was manually filled in moulds and then cooked in hot air oven for 45-60 minutes. Incorporation of flours increased crude fiber content, whereas oregano helped improved not only the flavour but also the antimicrobial properties of the product and α-tocopherol acetate improved the antioxidant activity. The functional product was found to have

a chemical composition of 24 % crude protein, 13% total fat, 6% ash and 3% crude fiber. In regard to storage studies, the developed product could well be stored for a period of 15 days at refrigeration temperature (4±1°C) without significantly affecting the physico–chemical, microbiological and sensory qualities. Functional turkey meat loaf developed with addition of oat flour, ragi flour, oregano, parsley and α- tocopherol acetate could be a new addition among functional poultry products with a shelf life of 15 days.

Thesis title: *Identification of calpain and calpastatin enzymes from turkey blood and their influence on post-mortem tenderization of skeletal muscles during refrigeration storage.*

(Scholar: Dr Leikhram Kripriyalini, Roll No. 5396, Advisor: Dr Ashim Kumar Biswas)

The study was carried out to standardize a simple and low-cost procedure for extraction, purification and quantification of calpains and calapastatin from turkey blood and muscle samples. For robustness, the standardized method was also applied to turkey breast and thigh muscles for optimization of ì-calpain mediated post-mortem ageing at 4±1°C. Results were further evaluated for various physico-chemical and microbiological parameters. For this, samples were extracted at different pH values of extraction buffer and purified by dialysis followed by anion exchange chromatography. Crude extracts were subjected to casein zymogram and domain's separation was clearly visualized by SDS-PAGE analysis. Activity analysis was performed using spectrophotometric technique. Results of zymogram analysis showed that extraction buffer at pH value of 6.7 had greater extraction efficiency as it showed clear bands of native form of ì-calpain and m-calpain for blood and breast muscle however no presence of ì-calpain was detected for thigh muscle. A 12 kDa MWCO filter and DEAE-Sephacel column for separation and purification was standardized, SDS-PAGE analysis showed minimal presence of calpastatin in blood sample and variable domains of calpains and calpastatin in muscle samples. Concentration of ì-calpain and calpastatin was found to be highest ($P < 0.05$) in breast muscle while m-calpain concentration was greatest ($P<0.05$) in thigh muscles. Further, calpain mediated post-mortem ageing was optimized at 24 hrs for 32 weeks age group of turkey but that was optimized at 48 hrs for 42 weeks age group at 4±1°C. Evaluation of physico-chemical parameters confirmed that post-mortem ageing time optimized has appreciable effect in improvement of turkey meat quality. Finally, it may be concluded that the proposed method optimized is simple, inexpensive and easily performed and has greater potential for application by many countries in the world where large numbers of turkey are processed without proper post-mortem ageing.

Thesis title: *Candidate gene analysis of GnRH receptor and their association with semen quality & fertility of broiler chicken.*

(Scholar: Dr Nirmal Kumar Chelak, Roll No. 5378, Advisor: Dr Jag Mohan)

The aim of this study was to observe the Single Nucleotide Polymorphism (SNPs) in Gonadotropin releasing hormone receptor (GnRHR) gene and their association with semen quality and fertility of broiler chicken. Under this study, adult male broiler chickens (n=418) of three strains (SDL, SML and Control) of CARIBRO VISHAL (white broiler) were taken and evaluated for physical, biochemical and fertility parameters of semen. GnRHR gene was analysed for SNPs in coding region and attempts were also made to associate them with semen quality and fertility traits. For the evaluation of physical, biological and fertility traits, semen was individually collected from each strain of broiler chicken. Semen volume was recorded highest in SML and lowest in SDL strain. The overall mean values of sperm concentration in different strain were found to be $3.81\pm0.07x10^9$ per ml whereas lowest concentration of spermatozoa in SDL strain. The dead spermatozoa counts were higher in SDL followed by control and SML strain. The maximum abnormality of spermatozoa was observed in SDL and minimum in SML broiler chicken. The mean value of GOT activity was found to be higher in SDL than other strains. The overall mean value of ALP profile in seminal plasma was observed to be 15.07±0.53 KA/dl. RRT reflects the metabolic activity of spermatozoa and was observed maximum in SML strain of chicken. No significant difference was noticed in serum testosterone profile among the different strains of broilers

whereas variation was noticed in semen pH. The overall mean values of fertilizing ability of different strains of broiler spermatozoa were observed to be 76.57±1.05% in which highest fertility was observed in SML strain. In other study, attempts have also been made to investigate the SNPs in GnRH receptor gene using the PCR-SSCP technique. A total of 16SNPs were observed in different exons of GnRHR gene. Transition (G⟶A) at 2285bp position (G2285A) changes amino acid glutamine to lysine. So whole population was subjected to screening for this SNP (G2285A) by using allele-specific PCR. AS-PCR analysis resolved two alleles (GH&A) in the whole population with frequency of 0.31 to 0.69 and average genotype frequency ranged from 0.06 to 0.50. Frequency of AA genotype was high in all the strains than BB genotype. Results indicated that homozygotes (AA and BB) expressed lower number of abnormal sperms whereas heterozygote (AB) revealed higher number ($p \leq 0.05$) in SDL, SML and overall population. Similar trend was also followed in control population. From this study it can be concluded that SML strain expressed superior fertility than other broiler strains. Further, it was concluded that G2285A was found to be associated with morphological abnormal spermatozoa.

TECHNOLOGY ASSESSED AND TRANSFERRED

Technology Assessed

- Commercial chicks of CARI Nirbheek, CARIBRODhanraja and CARI Devbendra were assessed for their production performance and were supplied to farmers and different organizations in the country.
- Calpain assisted post-mortem ageing for breast fillets from spent broilers, Desi fowl and goat meat sample has been standardized.
- Processing technology for development of chicken breast fillets from spent broiler was standardized.
- Processing technique for development of Egg Rasmalai has been standardized.
- Method for inactivation of heat tolerant *Salmonella enteritidis* on dressed chicken meat using antimicrobial and thermal treatment was standardized.

Technology Transfer Activities

Kisan Gosthies organized

Two kisan gosthi were conducted during the year. Fist kisan gosthi was organized on 2nd Nov., 2015 on the occasion of 37th Foundation Day of the institute. This event was given wide publicity in and around Bareilly district through farm visits, broadcasting on AIR and telephonic contact. During this kisan gosthi, lectures on commercial broiler farming, preparation of low cost broiler feed, disease management of poultry, desi breeds for backyard poultry, diversified poultry farming, and govt. schemes for poultry farming were delivered by the scientists of the Institute. The major problems enumerated by the poultry farmers were on diseases of poultry, low market price of live chicken, high cost of feed and availability of quality chicks. These were replied in detail by the experts. The second kisan gosthi was organized on 28th Dec., 2015 at village Bhogpur, Baheri of Bareilly district (UP) on the occasion of Jai jawan- Jai kisan week celebration. An exhibition was also organized here to show the elite germplasm of diversified poultry developed by CARI. The poultry farmers were given guidance for successful poultry production and problems raised by them were replied by the experts.

Phone-in Programme on DD Kisan

Dr. J. M. Kataria, Director, ICAR-CARI, Izatnagar participated in live phone –in programme on duck production for rural farmers telecasted on DD Kisan on 9th Dec, 2015. In response to the programme a number of phone calls from interested entrepreneurs and farmers were received by the institute.

(Hello-KISSAN Programme On Duck production by Dr J.M.kataria, Director)

Participation/Organization of Exhibitions

In order to create awareness about production of different poultry species, duck and various value added products, Institute and regional Centre put up stalls in the following regional and national exhibitions.

- Science, Art, Craft and Photography Exhibition organized by BBL Public School on 1st, Nov., 2015 at Bareilly (UP)
- Agricultural Exhibition organized by ICAR, New Delhi from 20-22nd Aug., 2015 at Pipra Kothi, Motihari (Bihar).
- Krishi Unnati Mela– 2016 jointly organised by IARI, New Delhi, and Min. of. Agril.& Farmers Welfare, New Delhi, and CII, Gurgaon from 19-22nd March, 2016 at IARI, New Delhi.
- Dhan Divas Exhibition organized by CRRI, Cuttack on 23rd April, 2015.
- Exhibition organized during farmers meet from 19-22 Feb. 2016 at Baragrah, Odisha
- Exhibition organised by Indian Society of Costal Agricultural Research from January 14-17, 2016 at ICAR-Indian Institute of Water Management, Bhubaneswar.

Sri Devi Prasad Mishra, Minister of Agriculture, Govt. of Odisha & Sri Pravat Biswal, M.L.A. at RC, CARI stall

CARI stall in Agricultural Exhibition at Pipra Kothi, Bihar

CARI stall in Krishi Unnati Mela at IARI, New Delhi, during 19-22nd March, 2016

Exhibition during Farmers meeting at Baragarh district, Odisha: Hon'ble Union Minister of Agriculture and Farmers Welfare, Shri Radha Mohan Singh ji, visited RCCARI stall

Exhibition during Farmers meeting at Baragarh district, Odisha: Hon'ble Minister of State - Independent Charge, Petroleum and Natural Gases, Shri Dharmendra Pradhan ji, visited RCCARI stall

Organization of Exhibition

As a part of Foundation Day celebration and visit of hon'ble Minister of State for Agril. Dr Sanjeev Balyan on 4th Nov., 2015, an exhibition on diversified poultry was organized in the campus, where in all the various species of poultry were exhibited lively. Model- polythene pond for duck rearing was prepared for live show alongwith ducks. Value added poultry products were also displayed in the exhibition

Hon'ble Minister of State for Agriculture and Food Processing, Dr. Sanjeev Balyan ji along with other dignitaries marching towards the poultry exhibition at ICAR-CARI, Izatnagar.

Hon'ble Minister of State for Agriculture and Food Processing, Dr. Sanjeev Balyan ji along with other dignitaries having a view on eggs of diversified poultry species

Awareness Camp-cum- exhibition on poultry farming

An awareness camp-cum-exhibition on poultry farming was organized on 23rd Dec.,2015 at village Deochara, Bareilly (UP) to commemorate the birth anniversary of former prime ministers – hon'ble late Choudhary Charan Singh and Sh. Atal Bihari Bajpai in the form of Jai Kisan Jai Vigyan Week from 23-29 Dec. 2015. The poultry farmers of the area were acquainted about various species of poultry, training facilities available, supply of germplasm etc. by the team of scientists of CARI Izatnagar. Farmers were also motivated to start poultry farming at small scale for income generation.

Duck farming awareness was created through field visits in Cuttak and Sri Kakulem by the scientists of RCCARI, Bhuvaneshwar

Field visits:

Awareness regarding duck rearing was created in villages of Odisha through filed visits by scientists of RCCARI, Bubaneswar

Field vist to Tangi village to sensitize farmers on duck farming

Field vist to KVK, Srikakulam for duck propagation

Foundation Day Celebration

The Institute celebrated its 37th Foundation Day on 2nd Nov, 2015. The function was chaired by Dr J.M.

Kataria, Director of the institute. On this occasion, the participants of the training programme on poultry production management w.e.f. 27 Oct. – 02 Nov.,2015 were awarded certificates for successful completion of training programme.The winners of Swachhta Pakhwara competitions were also given prizes. Kisan gosthi was also held to provide the solution of problems being encountered by poultry farmers. The farmers and poultry entrepreneurs from different villages of UP participated in the gosthi.

Supply of Germplasm: In order to promote diversified poultry production in the country, high yielding germplasms as parent stocks and commercial crosses were supplied to farmers and various agencies in different pockets of the country (Table 20).

Table 18 : Supply of germplasms to farmers and different agencies

Germ plasm supplied	Fertile eggs		Day-old chicks		Growers	Adults	
	Parent line	Commercial	Parent line	Commercial		Parent line	Commercial
Layer	-	4676	5562	27651	-	8	-
Broiler	19449	7230	948	30127	886	-	420
Desi fowl	510	703	1873	9432	-	160	-
Guinea fowl	332	-	0	0	-	880	-
Turkey	-	245	-	2368	-	762	-
Duckling	-	-	-	26313	-	-	-

EDUCATION AND TRAINING

The Post Graduate Education and Training (PGE&T) Section coordinated and monitored the post graduate education programme leading to M.V.Sc., Ph.D. degree in Poultry Science (PSC) discipline and National Diploma in Poultry Husbandry (NDPH) course under the IVRI Deemed University, Izatnagar. The Section also organized the specialized training courses (STC) in various aspects of PSC for different categories of personnel carrying poultry production as a profession in various organization/ institution/ departments etc. Additionally, the Section also co-ordinates PG education leading to M.V.Sc. and Ph.D. degree in Animal Genetics and Breeding/Animal Science/Livestock Production and Management/ Poultry Science under the State Agricultural University/State Veterinary University.

Poultry Science Students on Roll

- M.V.Sc. – 30, Ph.D. – 28
- NDPH – 01

Poultry Science Degree Awarded

- M.V.Sc. – 12 students (Avian Genetics and Breeding-03, Avian Nutrition and Feed Technology-03, Avian Physiology and Reproduction-02, Post Harvest Technology-02, Poultry Housing Management – 1, Avian Medicine 01)
- Ph.D - 04 students (Poultry Housing Management – 1, Avian Nutrition and Feed Technology-02, Post Harvest Technology-1)

Seminars Organized

- ORW Seminar-14, Major Credit Seminar-16, Minor Credit Seminar-05 and Pre-Thesis Submission Seminar-17

Specialized Training Courses

S.No.	Training courses	Duration	Trainee
1.	Specialized training programme on Layer Production	July 13 - 25, 2015	11
2.	Specialized training programme on Poultry Feeding & Quality Control	October 05 - 17 , 2015.	01
3.	Specialized training programme on broiler production	December 9-21, 2015	01

AWARDS AND RECOGNITION

- Dr A.B. Mandal, Principal Scientist was conferred with the Life Time Achievement Award, 2015 from Poultry Federation of India (PFI) for significant contribution towards the welfare of the Poultry Industry.
- Dr A.B. Mandal, Principal Scientist was elected as vice-president of Indian Poultry Science Association and holding the post of Council of World Poultry Science Association (India Branch).
- Dr Ashim Kumar Biswas received NAAS Associate (Fellow) recognition from 2016 for his contribution in Livestock Products Technology. Awarded by National Academy of Agricultural Science, New Delhi.
- Dr V.K. Saxena was nominated as DBT Nominee of IBSC, IVRI, Izatnagar
- Dr Ashim Kumar Biswas received IPSA Fellow 2015 award for his contribution in poultry science in XXXII IPSA conference held on 19-21st Nov., 2015 at Palakkad, Kerala.
- Dr Sanjeev Kumar received "FELLOW of IAAVR" award from Indian Association for Advancement of Veterinary Research at Bhubaneswar on 27th February 2016.
- Dr V.K. Saxena was nominated as Chief Editor of the journal "The Indian Journal of Animal Genetics and Breeding" as well as member of executive committee of "Indian Society of Animal Genetics and Breeding".
- Dr Rokade Jaydip (Under the guidance of Dr A.B. Mandal) received "IPSA Dr D. Choudhury Award for best Ph.D. Thesis 2015" from Indian Poultry Science Association during XXXII IPSACON 2015 at Palakkad, Kerala held during 19-21 Nov., 2015
- Under Dr Simmi Tomar supervision, Dr P.G. Vineetha got IPSA AP Chapter Award for best M.V. Sc. thesis for the year 2014 during XXXII IPSACON 2015 at Palakkad, Kerala held during 19-21 Nov., 2015.
- Dr Rokade Jaydip received "Avitech Young Scientist Award2015" from Indian Poultry Science Association (IPSA) for paper entitled "Evaluation of Mannan-oligosaccharides in broiler chicken during hot-humid summer using zoo technical, molecular and physio-biochemical tools" authored by J.J. Rokade, A.B. Mandal, S.K. Bhanja, Akshat Goel, Manish Mehra and Mukesh Kapgate during Indian Poultry Science Association during XXXII IPSACON 2015 at Palakkad, Kerala held during 19-21 Nov., 2015
- Dr Gautham Kolluri received "Dr P. Kothandaraman Memorial Award", 2015 from Indian Poultry Science Association (IPSA) for paper entitled "Physiological, immunological and production attributes of broilers supplemented with water extracts of spirulina" authored by Gautham Kolluri, Gopi, M., Yadav, A.S. and Rokade, J.J. During XXXII Annual conference of Indian Poultry Science Association & National symposium (IPSACON) 2015 at College of Avian Science and Management, Palakkad, Kerala from 19-21 November 2015.
- Kerala Chapter Award of Indian Poultry Science Association presented at IPSACON-2015, Kerala for the best research paper on poultry nutrition "Effect of in ovo copper and iron supplementation on post-hatch growth and differential expression of growth or immunity related genes in broiler chickens" authored by Goel, A., Bhanja, S.K., Mehra, M. Majumdar, S and Pande, V. Published in Indian Journal of Poultry Science, 48 (3): 279-285.
- Dr Yadav A. S., received best Oral presentation (First prize) award for the research paper Thermal Inactivation of *Salmonella* Typhimurium on dressed chicken skin surface using acidified sodium chlorite by A.S. Yadav, Gaurav Kishor

Saxena, V.K. Saxena, and J.M. Kataria in "6th International Conference on "Emerging Technologies in Food and nutrition for health management" Organized at SRS, ICAR-NDRI, Bengaluru from May 14-15, 2015.

- Dr Chandrahas, received best Oral Presentation (First prize) award during International Conference, ISAPM-2016 on "Innovative Designs, Implements for Global Environment & entrepreneurial Needs Optimizing Utilitarian Sources (INDIGENOUS)" held at COVS, Hyderabad, India, 28-31, January 2016, for paper entitled "Effect of C/N ratio on composting of cage poultry excreta using sawdust" authored by Chandrahas, Raj Narayan, Divya, Simmi Tomar, Sandeep Saran and Hamid Ali.
- Dr J. Mohan, S.K. Sharma, R.P. Singh, R. Agarwal, J.S. Tyagi, G. Kolluri and M. Gopi received best Oral Presentation award for research paper entitled "Production Characteristics and Seasonal Variations in Genital Tract of Female Guinea fowl" at XXXII Annual Conference of Indian Poultry Science Association and National symposium on Clean and Green Poultry Production held at College of Avian Science and Management, Thiruvazhamkunnu, Palakkad, Kerala on 19-21st November 2015.
- Dr Pragya Bhadauria, S.K Bhanja, S. Majumdar, G.Kolluri and S. Saran received best Oral Presentation award for the paper entitled "Comparison of welfare and behaviour of laying hens in different raising systems" authored by in International Livestock Conference "INDIGENOUS" & Expo, 23rd Annual Convention-ISAPM from 28th to 31st January, 2016 at Hyderabad, India.
- Dr S.C. Giri received best Oral Presentation award in the National seminar on "Harmonizing Biodiversity and climate change: Challenges and opportunity" by held at ICAR-Central Island Agricultural Research Institute, Port Blair between 17-19th April, 2015 for the paper entitled "Village duck production for sustainable livelihood and women empowerment in tribal districts of Odisha."
- Dr Mishra, S.K.; Singh, V.K.; Rath, R.; Bais, R.K.S.; Sahoo, S.K. and Mondal, D. awarded best Oral Presentation (Second price) award on the research paper "Investigating a white pekin population, with high egg production for its potential to promote dual purpose commercial ducks" in the XXXII Annual Conference and National Symposium of Indian Poultry Science Association (IPSACON 2015) on "Clean and green poultry production", 19-21 Nov., 2015, College of Avian Sciences and Management, KVASU, Thiruvazhamkunnu, Polakkad (Kerala). DPP-27 (O): 156.
- Dr Biswas, A. K., received best Oral paper Award (3rd Position) for research paper "Simple extraction method for determination of calpain induced post-mortem ageing of breast and thigh muscles during holding at 4±1 °C authored by Biswas, A. K., Tandon, S., Yadav, A.S., Beura, C.K. and Kataria, J.M. (2015) during XXXII Conference of IPSA-2015" held on 19-21st Nov., 2015 at Palakkad, Kerala. Abstract No. PPB-02 (O):221.
- Dr Biswas, A. K., received best oral paper Award (3rd position) for research paper on "Role of different domains of calpain on post-mortem ageing of meat from Jamunapari and Jhakrana breeds of goat reared under conventional management system" authored by Biswas, A. K. and Tandon, S. (2016). International Livestock Conference and Expo and 23rd Annual convention, ISAPM-2016. January 28-31, Hyderabad, India. Abstract No. VPE-53 (O):312 – 313.
- Dr M.K. Padhi, K.V.H. Sastry, S.C. Giri, R.K.S. Bais and S.K. Sahoo received best poster (second) award during XXXIIth Annual Conference and National Symposium of Indian Poultry Science Association (IPSACON-2015) for the article entitled "Consumer perception and habit of consumption of duck eggs" by (IPSACON 2015: 19-21st Nov 2015 at Centre of Advanced Studies in Poultry Science, Faculty of Poultry Science, Kerala Veterinary and Animal Sciences University, Thiruvazhamkunnu, Palakkad, Kerala).
- Dr M. K. Padhi received certificate for registration of PD1 line of chicken registered by BRC of ICAR with the accession number INDIA_CHICKN_001_PD1_13001.

LINKAGES AND COLLABORATION IN INDIA AND ABROAD INCLUDING FUNDED PROJECTS

Sl. No.	Title of the Project	Name of the PI and Associates	Date of Start and Period	Sanctioned Funds (Rs. in lakhs)	Location
AICRP Component					
1.	Development and evaluation of broiler sire line	Dr Simmi Tomar, PI Dr V.K. Saxena, Co-PI Dr. Rokade J.J.	1971	-	Avian Genetics and Breeding Division, ICAR-CARI, Izatnagar
2.	Development and evaluation of broiler dam Line	Dr V.K. Saxena, PI Dr SimmiTomar, Co-PI Dr Avishek Biswas Dr Niranjan Lal Dr. Rokade J.J. (w.e.f. 19.05.2015)	1971	-	Avian Genetics and Breeding Division, ICAR-CARI, Izatnagar
DBT, Govt. of India, New Delhi					
2.	Identification of probiotic strain(s) from gut metagenome of Assam indigenous chickens	Dr V.K. Saxena, PI Dr Simmi Tomar, Co-PI	07.01.2013 (3 years)	25.0	Avian Genetics and Breeding Division, ICAR-CARI, Izatnagar
3.	Thermotolerance gene expression analysis in *Salmonella* Typhimurium and development of their thermal death time models applicable to poultry processing	Dr A.S. Yadav, PI Dr V.K. Saxena, Co-PI Dr J.M. Kataria, Co-PI	19.07.2012 (3 years)	45.1028	Post-Harvest Technology Division, ICAR-CARI, Izatnagar
4.	Evaluating of probiotics, prebiotics and cynbiotics supplementation in low energy and low protein feed for improved nutrient utilization and safe poultry meat production	Dr Avishek Biswas (PI) Dr A.B. Mandal (Co-PI) Dr S.K. Bhanja (Co-PI) Dr A. S. Yadav (Co-PI)	27.03.2015 (3 years)	50.56,962	Avian Nutrition & Feed Technology Division, ICAR-CARI, Izatnagar
DST, Govt. of India, New Delhi					
1.	Biochemical basis for detection of calpains and calpastatin and their role in post-mortem tenderization of meat	Dr Ashim K. Biswas, PI	02.05.2013 (3 years)	21.82	Post-Harvest Technology Division, ICAR-CARI, Izatnagar
Inter-Institutional Collaborative Project					
1.	Identification of RNA transcripts present in chicken sperm and their relation to fertility	Dr Jag Mohan, CCPI Dr R.P. Singh, Sacon	30.07.12	21.0	Avian Physiology and Reproduction Division, ICAR-CARI, Izatnagar
2.	Diversified rice based farming system for livelihood improvement of small and marginal farmers: (Lead centre: ICAR-NRRI, Cuttack)	Dr A.Poonam, PI Dr S. C. Giri (Co-PI)	2012	-	ICAR- RC CARI, Bhubaneswar

LIST OF PUBLICATIONS

Research/Review articles:

Foreign Journal:

Ashutosh Kumar, Rakesh Kumar Majhi, Nirlipta Swain. Giri, S.C., Sujata Kar, Luna Samanta and Chandan Goswami (2016). TRPV4 is endogenously expressed in vertebrate spermatozoa and regulates intracellular calcium in human sperm. *Biochemical and Biophysical Research Communications*, 473:481-488. (NAAS Rating:8.30)

Bhanja, S.K., Hotowy, A., Mehra, M., Sawosz, E., Pineda, L., Vadalasetty, K.P., Kurantowicz, N. and Chwalibog, A. (2015). In ovo administration of silver nanoparticles and/or amino acids influence metabolism and immune gene expression in chicken embryos. *Int. J. Mol. Sci.,* 16: 9484-9503. (NAAS Rating:8.86)

Biswas, A.K., Tandon, S. and Beura, C.K. (2016). Simple extraction method for determination of different domains of calpain and calpastatin from chicken blood and their role in post-mortem ageing of breast and thigh muscles at 4±1 °C. *Food Chemistry*, 200: 315-321. (NAAS Rating:9.39)

Biswas, A.K., Tandon, S. and Divya Sharma. (2016). Identification and characterization of different domains of calpain and their influence on post-mortem ageing of goat meat during holding at 4±1 °C. *LWT-Food Science and Technology*, 71: 60–68. (NAAS Rating:8.42)

Biswas, A.K., Yadav, A.S., Beura, C.K., Kandeepan, G. and Mandal, A.B. (2015). Effect of microwave cooking on cold extruded poultry meat finger chips fortified with herbs. *Fleischwirtschaft-International*, 30(2): 59-66. (NAAS Rating: 6.23)

Das, A.K. Kumar, S., Rahim, A. (2015) Genetics of Body Conformation and Feed Efficiency Characteristics in a Control Line of Rhode Island Red Chicken. *Iranian Journal of Applied Animal Science* 5 (4): 965-973. (NAAS Rating: Not Avialable)

Das, A.K. Kumar, S., Rahim, A., Kokate, L. S. (2015) Genetic Analysis of Body Conformation and Feed Efficiency Characteristics in a Selected Line of Rhode Island Red Chicken. *Asian Journal of Animal Sciences,* 9 (6): 434-440. (NAAS Rating: 2.59)

Das, A.K. Kumar, S., Rahim (2015) Estimating microsatellite based genetic diversity in Rhode Island Red chicken. *Iranian Journal of Veterinary Research*, 16 (3) 52: 274-277. (NAAS Rating: 6.25).

Debnath, J., Kumar, S., Bhanja, S.K., Rahim, A. and Yadav, R. (2015). Factors influencing early layer economic traits in Rhode Island Red chicken. *Journal of Animal Research*, 5(4): 915-919. (NAAS Rating:4.49)

Goel, A., Bhanja, S.K., Mehra, M., Mandal, A.B. and Pande, V. (2016). In ovo trace element supplementation enhances expression of growth genes in embryo and immune genes in post-hatch broiler chickens. *Journal of the Science of Food and Agriculture*, 96(8): 2737-2745. (NAAS Rating: 7.71)

Jag Mohan, Sharma, S.K., Kolluri, G., Tyagi, J.S. and Kataria, J.M. (2015) Selection of diluent for short term preservation of guinea fowl semen. *Asian Journal of Animal and Veterinary Advances*, 10(8): 360-364.

Karuppasamy, K., Ajit S.Yadav and Gaurav Kishore Saxena (2015). Thermal inactivation of Salmonella Enteritidis on Chicken Skin Previously Exposed to Acidified Sodium Chlorite or Tri-Sodium Phosphate. *Journal of Food Science & Technology*. 52(12): 8236–8243. (NAAS Rating: 8.20)

Mohanty, S.R., Sahoo, S.K., Babu, L.K., Pati, P.K. and Joshi, S.K. (2015). Effect of feeding different levels of proteins on carcass characteristics, nutrient utilization and blood biochemical parameters of growing Khaki Campbell ducks. *International Journal of Basic and Applied Agricultural Research,* 13(1): 77-83. (NAAS Rating: Not available)

Padhi, M.K., Chatterjee, R.N., Rajkumar, U., Niranjan, M. and 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(1): 390-394. (NAAS Rating: 6.44).

Sharma, S.K., Mitra, S.K. and Saran, S. (2016). Papaya production in India – History, present status and future prospects. (XXIX IHC – Proc. Int. Symp. on Papaya, Pineapple and Mango. Eds.: R. Drew et al.). *Acta Horticulturae*. 1111: 87-94. (NAAS Rating: Not available).

Shinde A.S., Goel A., Mehra M., Rokade J.J. and Bhadauria P., Bhanja, S.K. and Mandal A.B. (2015). Delayed Post Hatch Feeding Affects Performance, Intestinal Morphology and Expression Pattern of Nutrient Transporter Genes in Egg Type Chickens. *J Nutr Food Sci.,* 5:372. (NAAS Rating: Not Available)

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PARTICIPATION OF SCIENTISTS IN CONFERENCES, SYMPOSIUM, TRAINING'S ETC IN INDIA AND ABROAD

Sl. No.	Name of symposia/seminar/workshop	No. of scientists attended
1.	One month Orientation and three month PAT training under FOCARS module at ICAR-CARI, Izatnagar,April to July,2015.	1
2.	National seminar on *"Harmonizing Biodiversity and climate change: Challenges and opportunity"* held at ICAR-Central Island Agricultural Research Institute, Port Blair between 17-19th April, 2015	1
3.	Workshop/Training on Good Governance from 27th April to 01st May, 2015 at ISTM, New Delhi.	1
4.	UN CC: Lear introductory e-course on 'Climate change' from United Nations Institute for Training and Research (UNITAR) on 5th May, 2015.	1
5.	6thInternational Conference on "Emerging Technologies in Food and nutrition for health management" Organized at SRS, ICAR-NDRI, Bengaluru from May 14-15th, 2015.	1
6.	Training of Public Procurement to be conducted by NIFM, Faridabad from 01 to 06th June, 2015.	2
7.	Brain storming session on "Functional Livestock Products" held at IVRI, Izatnagar on 6thJune, 2015.	1
8.	Participated in National Symposium on Women's land rights and access to agri-resources and services in changing development scenario held at ICAR- CIWA, Bhubaneswar from 19th to 21st August, 2015 organized by ICAR-CIWA, Bhubaneswar and Oxfam India, Bhubaneswar.	1
9.	"Knowledge management and knowledge sharing in organizations" at Indian Institute of Public Administration, New Delhi, from Sept., 07-11th, 2015.	1
10.	Training Knowledge Management and Knowledge Sharing in Organizations to be conducted IIPA, New Delhi from 07 to 11thSept. 2015.	1
11.	Conference on "Utilization of Food Loss and Waste as well as Non-Food Parts as Livestock Feed" held from 1st to 30th October, 2015	1
12.	One day National Workshop on Influenza: Risk factors, Massive impact and Uncertain future on October 19th 2015 at ICAR-Indian Veterinary Research Institute, Izatnagar.	4
13.	2nd International conference and *Indo-Global Summit* and expo on veterinary held on October 26-28th, 2015, in Hyderabad, India.	1
14.	XIV NAVS Convocation–cum–Conference on Antimicrobial Resistance in Livestock Health & Production organized at ICAR-Indian Veterinary Research Institute, Izatnagar on Nov 4th, 2015	9
15.	Workshop on *Identifying, capturing, protecting, managing and commercializing innovations* at NASC, New Delhi during 16th November, 2015.	1
16.	National Workshop on "Current Trend and Future Research Challenges in Vaccines and Adjuvants" Organized by ICAR-Indian Veterinary Research Institute, Izatnagar from Nov. 19-20th, 2015.	3
17.	XXXII Annual Conference of IPSA & National Symposium on "Clean and Green Poultry Production" held on November 19-21st, 2015 at Palakkad, Kerala	17
18.	National Workshop on Nutrigenomics and Metagenomics in Teaching and Research in Animal Nutrition on November 20-21st, 2015 at ICAR-Indian Veterinary Research Institute, Izatnagar, U.P	1

Sl. No.	Name of symposia/seminar/workshop	No. of scientists attended
19.	Workshop organized by Animal Nutrition Association (ANA) at Animal Nutrition Division, ICAR-IVRI, Izatnagar on 14-15th December, 2015.	5
20.	Participated in one day Sensitization programme on Biological Diversity act, 2002 and rules2004 for scientist and Academicians held on 19th December, 2015 at Hotel Suryansh, Bhubaneswar organized by Odisha Biodiversity Board.	1
21.	Training workshop entitled Awareness workshop on usage of "Unified Messaging Solution" in collaboration with ICARI-IVRI, Izatnagar on 22ndDec.2015.	3
22.	Workshop on *National Agriculture Innovation Fund* on Dec. 23rd, 2015 at NASC, New Delhi.	1
23.	11th National Symposium entitled "Innovations in Costal Agriculture- Current status and potential under Changing Environment" organized Indian society of costal Agricultural Research from January 14-17th, 2016 at ICAR-Indian Institute of Water Management, Bhubaneswar.	3
24.	National workshop cum brain storming on innovative strategies of physiological genomic research at CAFT at Physiology and Climatology Division on January 16th, 2016 at ICAR-Indian Veterinary Research Institute, Izatnagar, U.P.	1
25.	4th ICAR Institutes-SAU-State Departments Interface Meet for the year 2015-16; ICAR- NRRI, Cuttack OUAT , Bhubaneswar between 27-28, January, 2016	1
26.	International Livestock Conference and Expo and 23rdAnnual convention, ISAPM-2016 held on January 28-31st, Hyderabad, India.	2
27.	Advanced faculty training on Micronutrients in Animal Nutrition from February 3-23rd, 2016 at CAFT, Animal Nutrition, ICAR-Indian Veterinary Research Institute, Izatnagar, U.P	2
28.	*Global Biotechnology Summit* held at VigyanBhavan, New Delhi organized by Department of Biotechnology (DBT), Ministry of Science and Technology, Govt. of India on February 5-6th, 2016, in Delhi, India.	2
29.	Participation in Brain storming session on Gender issue in agriculture in changing development scenario and scientist and farmers interface on occasion of foundation day on 17th February, 2016 of ICAR-Central Institute for Women in Agriculture.	1
30.	5thTraining Programme on Science, Technology and Emerging Trends in Governance conducted IIPA, New Delhi from 15 to 19thFeb. 2016.	2
31.	*16th Indian Veterinary Congress Silver Jubilee and XXIII Annual Conference of IAAVR and National Symposium on Strengthening of Governance in Animal Health* and Production activities for benefit of farmers and Livestock owners at Odisha Veterinary College, OUAT, Bhubaneswar between 27-28, February, 2016	1
32.	4thU P Agricultural science congress on "Strategic Governance and Technological Advancement for Sustainable Agriculture" Organized by UPCAR, UPAAS and CSA, UAT, Kanpur from 2-4thMarch, 2016 at CSAUAT, Kanpur.	1
33.	Expert group to design the structure and curriculum for 'Post Graduate Diploma in Animal Welfare'. For Indira Gandhi National open University between 3-4thMarch, 2016.	1
34.	Advanced short course on Nutritional Approaches for Gut Health of Animals from March 5-14th, 2016 at Animal Nutrition Division at ICAR-IVRI, Izatnagar.	1
35.	Annual Convention and National Symposium of SVBBI, 2016 organised by Department of Veterinary BiochemistryCollege of Veterinary Science & Animal Husbandry, Bhubaneswar, between 11-12thMarch, 2016	2
36.	National workshop-cum-training programme on Computational approaches in biotechnology for beginnersfrom March 15-19th, 2016 at ICAR-Indian Veterinary Research Institute, Izatnagar.	2
37.	State Level Research-Industry-Farmer-Extension interaction workshop on "Freshwater Aquaculture Development in Odisha" organized by ICAR-CIFA and State Fisheries Department	1
38.	Improving Technical support, extension & demonstration services to the farmers for Eastern Plateau and Hill Agro climatic Region ICAR-CIFA, Bhubaneswar, & ICAR- ATARI, Jabalpur, M.P.	1

CONSULTANCY, PATENTS, COMMERCIALIZATION OF TECHNOLOGY

Consultancy/ Advisory Services

- Provided low-cost feed formulae to about 50 poultry farmers and small feed industries from different states (Uttar Pradesh, Delhi, J&K, Uttaranchal, Haryana, Tripura and Bihar) and solving the problems of farmers from different states through personal contact and telephone call.
- Least cost feed formulation technology is being disseminated through Makefeed Poultry and Dairy software.
- About 1500 farmers/ poultry farmers were provided advisory services on the various aspects of poultry production and value addition through telephone and face to face interaction, postal letters , mobile and email.
- Consultancy granted to Shri Praveen Kumar S/o Ranveer Singh Saharanpur, UP for preparing a bankable project for establishing a Broiler farm of 48000 birds production capacity, annually .
- Consultancy granted to Smt. ShabnamJahan w/o ShriMd.Aslam, Baheri, Bareilly UP for preparing a bankable project for establishing a Broiler farm of 11000 birds production capacity, annually.

Technologies raedy for commercial transfer

- Molecular tools developed to differentiate Japanese quails from the Indian wild quails.
- Standardization of protocol for inactivation of heat tolerant Salmonella *T*yphimurium in actual processing conditions for producing hygienic chicken meat.
- Simple and low-cost casein Zymography technique has been developed for determination of µ- and m-calpain enzymes from variety of tissue samples irrespective of species, breeds, sex and age of animals.
- Standardization of supplementation of rice based distiller's dried grains with solubles (DDGS, protein 45%, AME 2883 kcal/kg) and feed enzyme in layer feed.
- Inclusion of probiotic in low energy low protein feed of broiler chickens for improving performance, immunity and gut health.
- Inclusion of Saccharomyces cerevisiae and Vit E to ameliorated the ill effects of ochratoxin in broiler chickens during 0-6 weeks of age.
- Standardization of process for preparing Chicken breast fillets, Turkey breast fillets and Egg Rasmalai.

MoU/LICENCE SIGNED FOR TECHNOLOGIES (2014-15 to 2015-16)

Sl.	Particulars	Date of Signing MoU	Contracting Party
1.	Supply of Coloured Broiler Parent Lines Fertile Eggs	16..09.2014	M/S The Deputy Director (A.H.) Intensive Poultry Development Project Vadodara, Gujarat- 390 003
2.	Supply of Broiler Parent Lines Fertile Eggs	27.11.2014	M/S The Deputy Director (A.H.) Intensive Poultry Development Project Muvaliya, Dahod, Gujrat-389 151
3.	Poultry Farming	16.05.2015	Chief Veterinary Officer, Udham Singh Nagar UK
4.	Supply of CARI Bro multi Coloured Parent Stock Fertile Eggs	01.10-2015	Deputy Director (A.H.) Intensive poultry Development block, Makarba, Ahemdabad-51, Gujarat-380051

WORKSHOPS, SEMINARS AND TRAININGS ORGANIZED

Date	Event	No. of farmers/beneficiaries
Short term training programmes for farmers		
June 01-06, 2015	Short term training on *"Poultry production management"*	33 (farmers/unemployed youth from UP, MP, HR, Jharkhand, Delhi, Maharashtra, Bihar and Chhatisgarh).
August 17- 22, 2015	Short term training on *"Poultry production management"*	26 (farmers/unemployed youth from Bihar, MP , Delhi, UP and HR).
Oct.,27 – Nov., 02, 2015	Short term training on *"Poultry production management"*	31(farmers/unemployed youth from UP, WB, Bihar and Delhi).
January 04-09, 2016	Short term training on *"Poultry production management"*	25 (farmers/unemployed youth from Bihar, UP, Rajasthan and MP).
Specialized training programmes		
July 13 - 25, 2015	Specialized training programme on *Layer Production*	11 participants
October 05 - 17 , 2015.	Specialized training programme on *Poultry Feeding and Quality Control '*	01 participants
December 9-21, 2015	Specialized training programme *on broiler production*	01 participants

Trainings / Field days organized at Regional Centre Bhubaneswar

Sl No	Date	Place	No farmers	Organiser	Remarks
1	14.05.15	ICAR-CIFA, Kausalyaganga, Bhubaneswar	40	CIFA and ATMA, Khurda dist.	progressive farmers for transfer of technology.
2	27.05.15	KVK, Santpur, Cuttack	20	KVK, Santpur	
3	27.05.15	KVK, Badachana, Jajpur	23	KVK, Jajpur	
4.	20.07.15	KVK, Khurda	300	CIFA	Zilla Krushak sammelan

Sl No	Date	Place	No farmers	Organiser	Remarks
5.	21.08.15	Motihari, Bihar	1000	ICARRC, Patna	Foundation stone of Institute on Integrated farming by Minister Agril Radha Mohan singh
6.	23.09.15	RC CARI	12 VAS (Orissa)	ARD Dept	Dy Director FSB, Cuttack led the VAS for exposure visit
7.	13.10.15	RC CARI	23	KVK Nayagarh & Watershed Mission	Progressive Farmers of 8 districts
8.	19.11.15	RC CARI	22	Dhenkanal and Ganjam	
9.	04.12.15	CIWA	150 (W)	CIWA	Women farmers day
10.	21.12.12	RC CARI	50	ATMA, Sakhigopal	Supervisors
11.	11.03.16	KVK, Kendrapada	50	Watershed Mission	One month programme

DISTINGUISHED VISITORS

Date	*Name*	*Address*
Main Campus, Izatnagar		
April 23, 2015	Prof. B.B. Mallik	Ex. VC , WBUAFS Kolkata-91
April 23, 2015	Dr. Khub Singh	Ex. Director, NIANP Bangalore

SOME VIEWS OF DIGNITARIES

This is an excellent institute, with an efficient Director. I am very happy to visit this institute which is doing high quality research work and creating agriarian economic development .

Prof. B.B. Mallik,
Ex- VC , WBUAFS,
Kolkata-91

It was a pleasure to visit CARI after a long time. The achievements of the institute speaks about work done by the scientists. Present director Dr. Kataria is working hard to have the new campus of the institute. I wish to be best for the Institute.

Dr. Khub Singh,
Ex Director, NIANP,
Bangalore

PERSONNEL

DIRECTOR	**DR J.M. KATARIA**

Heads of Divisions/Sections

Division of Avian Genetics and Breeding	Dr D.P. Singh (upto 30.06.2015) Dr V.K. Saxena (from 01.07.2015)
Division of Avian Nutrition and Feed Technology	Dr A.B. Mandal
Division of Avian Physiology and Reproduction	Dr Jag Mohan
Division of Post-Harvest Technology	Dr A.S. Yadav
Poultry Housing and Management Section	Dr S. Majumdar
Technology Transfer Section	Dr M. P. Sagar
Prioritization, Monitoring and Evaluation Section	Dr Sandeep Saran
Poultry Economics and Agribusiness Research Section	Dr Sandeep Saran
Post-Graduate Education and Training Section	Dr Praveen K. Tyagi
Avian Medicine Section	Dr A.S. Yadav
Incharge, Regional Centre, Bhubaneswar	Dr S.K. Mishra

Administration

Senior Administrative Officer	Shri R.N. Mallik
Assistant Administrative Officer	Shri Irfan Ali Khan
Assistant Administrative Officer	Shri B.S. Bisht
Assistant Finance and Accounts Officer	Shri Kailash Chand

Scientific staff			
1.	Dr J.M. Kataria	Director	Ph.D.
2.	Dr A.B. Mandal	Principal Scientist	Ph.D.
3.	Dr S. Majumdar	Principal Scientist	Ph.D.
4.	Dr D.P. Singh	Principal Scientist (upto 30.06.2015)	Ph.D.
5.	Dr Jag Mohan	Principal Scientist	Ph.D.
6.	Dr V.K. Saxena	Principal Scientist	Ph.D.
7.	Dr Praveen Kumar Tyagi	Principal Scientist	Ph.D.
8.	Dr Jagbir Singh Tyagi	Principal Scientist	Ph.D.

9.	Dr Sanjeev Kumar	Principal Scientist	Ph.D.
10.	Dr Sandeep Saran	Principal Scientist	Ph.D.
11.	Dr C.K. Beura	Principal Scientist	Ph.D.
12.	Dr Raj Narayan	Principal Scientist	Ph.D.
13.	Dr Pramod KumarTyagi	Principal Scientist	Ph.D.
14.	Dr A.S. Yadav	Principal Scientist	Ph.D.
15.	Dr Chandra Deo	Principal Scientist	Ph.D.
16.	Dr S.K. Bhanja	Principal Scientist	Ph.D.
17.	Dr M.P. Sagar	Principal Scientist	Ph.D.
18.	Dr (Mrs.) Simmi Tomar	PrincipalScientist	Ph.D.
19.	Dr Ram Singh	Principal Scientist	Ph.D.
20.	Dr Divya	Principal Scientist	Ph.D.
21.	Dr Asim Kumar Biswas	Senior Scientist	Ph.D.
22.	Dr Avishek Biswas	Senior Scientist	Ph.D.
23.	Dr Chandrahas	Senior Scientist	Ph.D.
24.	Dr Niranjan Lal	Scientist (upto 04.09.2015)	Ph.D.
25.	Dr M. Sirajuddin	Scientist	M.V.Sc.
26.	Dr (Mrs.) Pragya Bhadauria	Scientist (upto 28.11.2015)	Ph.D
27.	Dr Gautham Kulluri	Scientist	M.V.Sc.
28.	Dr Rokade Jaydip Jawant	Scientist	Ph.D.
29.	Dr Gopi M.	Scientist (w.e.f 01.04.2015)	M.V.Sc
30.	Dr S.K. Mishra	Principal Scientist (RC)	Ph.D.
31.	Dr R.K.S. Bais	Principal Scientist (RC)	Ph.D.
32.	Dr D. Mondal	Principal Scientist (RC) (upto 27.02.2016)	Ph.D.
33.	Dr S.K. Sahoo	Principal Scientist (RC)	Ph.D.
34.	Dr B.K. Swain	Principal Scientist (RC)	Ph.D.
35.	Dr K.V.H. Sastri	Principal Scientist (RC)	Ph.D.
36.	Dr M.K. Padhi	Principal Scientist (RC)	Ph.D.
37.	Dr S.C. Giri	Principal Scientist (RC)	Ph.D.
38.	Dr P.K. Naik	Principal Scientist (RC)	Ph.D.
39.	Dr Dhirendra Kumar	Scientist (RC) (w.e.f. 10.08.2015)	M.V.Sc
	Technical Staff		
1.	Dr A. Mishra	T-9 (Medical Officer)	M.B.B.S.
2.	Dr R.D. Sharma	T-9 (Chief Tech. Officer)	Ph.D.
3.	Shri S. Bhatnagar	T-9 (Chief Tech. Officer)	BSc.,MA, B.Lib

4.	Shri B. Arya	T-7-8 (Asst. Chief Tech. Officer)	M.Sc.
5.	Shri R.R. Saxena	T-6 (Sr. Tech. Officer)	M.A.
6.	Shri P.N. Yadav	T-7-8 (Asst. Chief Tech. Officer)	M.A.
7.	Shri Prem Chandra	T-6 (Sr. Tech. Officer) (upto 04.02.2016)	M.Sc.
8.	Shri Shafiq Ahmad	T-6 (Sr. Tech. Officer)	Intermediate, Diploma (Elect. Engg.)
9.	Shri Tasnim Ahmad	T-6 (Sr. Tech. Officer) (upto 14.07.2015)	B.Sc., B.Tech.
10.	Shri Sharad Kumar Johri	T-6 (Sr. Tech. Officer)	M.Sc.
11.	Shri S.R. Meena	T-6 (Sr. Tech. Officer)	M.Sc.
12.	Shri Lalit Kumar Mishra	T-6 (Sr. Tech. Officer)	M.Sc.
13.	Shri Ravi Prakash	T-6 (Sr. Tech. Officer)	M.Sc.
14.	Shri S.P. Singh	T-6 (Sr. Techn. Officer)	MA
15.	Shri M.C. Pathak	T-6 (Sr. Techn. Officer)	BSc

Demise

Shri Tasnim Ahmad Khan, Senior Technical Officer passed away on 15.07.2015

EXPENDITURE STATEMENT AND REVENUE GENERATION

EXPENDITURE STATEMENT (2015-16) *(Rupees in Lakhs)*

Sr. No.	*Heads of Account*	*Plan*		*Non-Plan*	
		Allocation	*Expenditure*	*Allocation*	*Expenditure*
1.	**CAPITAL**				
	Works	493.44	493.23	Nil	Nil
	Other	41.56	41.57	3.00	2.99
2.	**REVENUE**				
	Establishment Expenses	Nil	Nil	1600.00	1554.91
	Pension and Retirement Benefits	Nil	Nil	110.00	110.00
	T.A.	6.41	6.41	3.00	3.00
	Research and Operational Expenses	418.63	418.48	240.00	239.43
	Administrative Expenses	10.60	10.60	220.50	214.34
	Miscellaneous Expenses	4.36	4.35	5.00	3.78
	Total	**975.00**	**974.64**	**2181.50**	**2128.45**
	Loans & Advances	**0.00**	**0.00**	**8.50**	**7.98**

REVENUE GENERATION (2015-16) *(Rupees in Lakh)*

Sr. No.	Items	*Amount*
1.	Disposal of Experimental By-product	110.10
2.	Royalty, Sale of Publications and Advertisement	0.85
3.	Licence Fee	7.36
4.	Leave Salary & Pension contribution	8.10
5.	Analytical and Testing Fee	0.59
6.	Application fee from Candidates	0.42
7.	Interest of Loan and Advances	24.24
8.	Interest on Short Term Deposits	17.48
9.	Internal Resource Generation	17.76
10.	Miscellaneous Receipts	11.09
	Total	**197.99**
	Loan Recoveries	29.52
	Sale of Assets	2.89
	Grand Total	**230.40**

OTHER RELEVANT INFORMATION

Institute Research Committee (IRC) Meeting: The annual Institute Research Committee (IRC) meeting of the Institute was held on September 09, 2015 under the chairmanship of Dr J.M. Kataria, Director ICAR-CARI Izatnagar. Dr V.K. Saxena, Head, AG&B conducted the meeting as acting Secretary, which was attended by the scientists of the Institute. Dr Saxena welcomed the Chairman and all the participants. He presented an overview of the ongoing research programmes continued during the XII Plan.

In the beginning, Dr J.M. Kataria, Director, ICAR-CARI presented his welcome address and appraised the house regarding various reforms to be undertaken for restructuring of research programmes as per the instructions of the Council. He exhorted the scientists to apply for awards, to use the online library facility (CERA) and to make efforts to commercialize the technologies developed by the Institute in collaboration with the Agri-Innovate India Ltd. He also desired to hold a brainstorming workshop on scientific aspects like conservation of indigenous germplasm. He emphasized to submit projects for extramural funding and to be more critical while self-evaluating the work carried out during the period under report.

The Chairman's opening address was followed by presentations by the respective divisions/sections of the Institute. The Action Taken Report (ATR) on the last year IRC general recommendations was presented by the respective HDs and the project-wise recommendations by the concern PIs.

The IRC meeting for the Regional Centre, Bhubaneswar was conducted on 10.10.2015 under the chairmanship of Dr J.M. Kataria. He emphasized that the Centre needs to have one broad based project i.e. "Improvement of duck for egg and meat purpose" under which few sub-projects of different aspects will be included in order to match the mandate of RC and also to cater the requirements of duck farmers of the country.

ISO Certification: The ISO Implementation Committee of the Institute initiated the process for implementation of the ISO in the institute. The records were streamlined/documented as per the advice of the consultants and audited by external ISO certification agency ancompleted the process for implementation of the ISO in the institute. The ISO 9001:2008 was granted to the Institute on 20th Feb. 2016. Dr Sandeep Saran served as Management Representative and Dr V. K. Saxena served as member- secretary of ISO Implementation Committee of the Institute.

Right to Information: Dr Sandeep Saran, Central Public Information Officer (Scientific Matters), ICAR-CARI, Izatnagar received 14 requests pertaining to scientific matters and disposed-off during the year 2015-16.

IRC Meeting at ICAR-CARI, Izatnagar

Result Framework Document: Results Frame-work Document (RFD)-2015-16, ICAR-CARI, Izatnagar, was finalized and submitted to the Council by Dr V.K. Saxena (Nodal Officer) and Dr Sandeep Saran (Co-Nodal Officer). The monthly reports of RFD were also submitted to the Council regularly.

Research Advisory Committee (RAC) Meeting: The 9th Meeting of the Common Research Advisory Committee of ICAR-Central Avian Research Institute (ICAR-CARI), Izatnagar and ICAR-Directorate on Poultry Research (ICAR-DPR), Hyderabad was held on 30th May,2015 at ICAR-CARI, Izatnagar under the Chairmanship of Dr R. Prabakaran, Ex-Vice Chancellor, Tamil Nadu Veterinary and Animal Sciences University, Chennai. The RAC members attended the meeting include Dr J.L. Vegad, Former Dean, Jawaharlal Nehru Agricultural University, Jabalpur (MP); Dr Vivek Vinayak Kulkarni, Director, NRC on Meat, Hyderabad; Dr P.K. Shukla, Professor & Head (Poultry Science)**,** Uttar Pradesh Pandit Deen Dayal Upadhyaya Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go Anusandhan Sansthan, Mathura, Dr J.M. Kataria, Director, ICAR-CARI, Izatnagar; Dr R.N. Chatterjee, Director, ICAR-DPR, Hyderabad; Dr A.B. Mandal, Principal Scientist and Head, Avian Nutrition & Feed Technology Division, ICAR-CARI, Izatnagar (Member Secretary) and Dr S.V. Ramarao, Principal Scientist, ICAR-DPR, Hyderabad (Nodal Officer). The scientists from CARI and PDP participated in the meeting and presented the research progress in different disciplines. The following recommendations were emerged out.

1. Further strengthening of mycotoxins analysis facilities in both the institutes.
2. For selection of Aseel, body weight and shank length at 100 days may be considered as reproductive organs start growing by 16 weeks and influences body weight.
3. Research should be concentrated on more and more alternative raw materials to replace the traditional feed resources in poultry diet in both the institutes.
4. Improving immuno-competence in birds by nutritional and genomics approach, dietary manipulation for ameliorating stress and gut health in both the institutes.
5. Take up research on 'Food safety', sustainability of environment and welfare issues.
6. Developing institute-industry linkages for contractual research.
7. Avian Nutrition and Post Harvest Technology divisions of CARI should interact with commercial (corporate) poultry sector, while DPR on rural poultry.
8. Since dedicated scientific manpower had been put into and huge financial investment has been made by the Council during the last forty years, and CARI has had been nerve centre for developing and propagation of improved varieties of Japanese quails throughout the country from 1974, therefore, the research and breeding on Japanese Quails should continue at CARI, Izatnagar.

RAC Meeting at ICAR-CARI, Izatnagar

Institute Management Committee (IMC) Meeting: The 43rd Institute Management Committee meeting was held on July 7, 2015 under the Chairmanship of Dr J.M. Kataria, Director CARI, Izatnagar consisting of Shri R.N. Mallik Member Secretary, Dr Pankaj Kumar Nominee of Additional Director - Animal Husbandry, Bareilly, Shri Rabindra Kumar, F&AO, IVRI, Izatnagar Dr Jagmohan, Dr B.P. Mishra, Dr P.K.Raut, and Shri Kailash Chand.

The Committee was satisfied with the research activities and achievements made by this Institute. Research Projects for the year 2015-16 were brought to the notice of all the members and were approved by IMC.

Adhar Enabled Biometric Attendance System (AEBAS): Adhar Enabled Biometric Attendance System (AEBAS) has been installed, under the supervision of Dr Chandrahas, Nodal Officer, both at CARI, Izatnagar and at its regional centre, Bhubaneswar w.e.f. 05.12.2015 and 20.06.2016,

respectively. The attendance marked on this system has link with Central Attendance Portal (http://attendance.gov.in) of NIC. Employee can verify their past Attendance Register on http://cariicar.attendance.gov.in/.

Implementation of MIS & FMS: An ERP solution for ICAR, developed at IASRI, New Delhi, for Management Information System (MIS) including Financial Management System (FMS) has been implemented as ICAR-CARI, Izatnagar under the supervision of Dr Chandrahas, Nodal Officer. Various modules like Financial Management, Project Management, Material Management, Human Resource Management & Payroll is working smoothly at the Institute.

Institute Animal Ethics Committee(IAEC): The Institute Animal Ethics Committee (IAEC) was reconstituted as per the instructions received from the CPCSEA, New Delhi vide F. No. 25/39/2008-AWD, dated:26.10.2015. The new IAEC comprises Dr J.M. Kataria, Director as Chairman, Drs Gautam Kolluri, Subrat Kumar Bhanja, Pramod Kr. Tyagi as members and Dr Chandrahas as member-secretary. A meeting of newly constitute IAEC members, along with CPCSEA nominee members, was held on 08.02.2016. During this meeting, proposals for conducting experimentations involving poultry birds etc. in various projects during the current year submitted by scientists of this institute were examined and approved.

Institutional Bio-safety Committee (IBSC): Two meetings of IBSC were held which were chaired by Dr J.M. Kataria, Director ICAR-CARI and Chairman, IBSC during which the all research proposals (both ongoing and newly submitted) received by Dr Ajit Singh Yadav, Secretary, IBSC were discussed from bio-safety point of view. IBSC cleared all the research projects and suggested the measures to be taken as per the guidelines issued by DBT (Govt. of India). The reports of IBSC were submitted to DBT from time to time.

Institute Technology Management Unit (ITMU): The following MoUs were prepared and finalized for transfer of technologies between the Institute and various clients (Table 19 and 20).

Table 20 : Details of MoU signed

Name of Technology	Signed with	Date of signing	Revenue generated (Rs.)
Poultry Farming	Chief Veterinary Officer, Udham Singh Nagar, UK	16.05.2015	105600
Supply of Fertile Eggs of CARI-Bro multi-coloured Parent Stock	Deputy Director (A.H.) Intensive poultry Development block, Makarba, Ahemdabad-Gujarat-380051	01.10.2015	231000

Table 19 : Bankable project report were prepared from April 2015 to March 2016

Applicant	Type of unit	Capacity	Date	Amount Charged (Rs.)
Sh. Praveen Kumar S/o Ranveer Singh, Saharanpur, UP	Broiler Farm	48000 broilers in a cycle of 1000 broilers every fortnight in deep litter system	06.07.2015	7980
Smt. ShabnamJahan w/o Shri Md. Aslam, Baheri, Bareilly UP	Broiler Farm	11000 broilers in a cycle of 500 broilers every fortnight in deep litter system	04.02.2016	3000

Apart from above, ITMU held a meeting on 03-02-2016 to discuss the proposal of Trademarks registration of various poultry germplasm.

Hatchery Operations: With incubation/ hatching capacity of about 80,000 eggs at a time, the major responsibilities of the Experimental Hatchery Section are to hatch out the required number of replacement stock of different pure line/ pedigreed flocks pertaining to different strains of various germplasm *viz.*, chicken, quails, turkey, guinea fowl, etc. being maintained at ICAR-CARI , to hatch out required commercial / parent stock broilers, layers and Desi breeds of CARI for supplying to various government / private poultry farms, supply of embryonated eggs and day-old chicks to IVRI and CARI for preparation of vaccines and conducting experiments to serve their academic and other mandates, to teach courses PSC-503 , PSC-504,603 and 604/ NPH 409, 410. as well as to provide necessary support for teaching & conducting practical for other post graduate courses on incubation and hatching , to conduct specialized training course on "Incubation and Hatchery Management" with the collaboration of PGE&T section for the poultry entrepreneurs and government/ private personnel. In addition to this, hatching of 15182 commercial stocks of CARI for supplying to various government/ private poultry farms was performed. Also, for preparation of vaccines and conducting experimental trials, embryonated eggs were supplied to other institutions (mainly IVRI) to serve their academic and other mandates. Consultancies pertaining to establishing poultry hatchery and/or sorting out specific problem to government/ private personnel were also provided.

On the whole the average hatchability in various germplasm on fertile egg set (FES) basis was recorded 85.04 percent during 2015-16. At occasion the highest hatchability (FES) 96.54% was obtained in broiler chicken (Table 21). Reproductive records of stocks at RCCARI, are presented in Table 22.

Table 21: Hatching performance of various germplasm of the year 2015-2016

Type of birds	Total eggs set	Fertile eggs (%)	Hatchability on total egg set (%)	Hatchability on fertile egg set (%)	Number of good chicks hatched
Layer	83381	64.91 (37.91-83.76)	55.55 (34.06-76.45)	85.59 (66.15-93.75)	46319
Broiler	45993	74.08 (43.81-90.67)	65.26 (35.42-85.08)	88.09 (80.86-96.54)	30014
Quail	36833	72.71 (61.92-80.08)	55.26 (43.48-65.49)	75.998 (65.05-89.94)	20353
Guinea fowl	9365	55.94 (11.15-64.43)	46.65 (7.64-53.02)	83.39 (68.57-87.03)	4369
Turkey	8072	71.952 (31.73-82.98)	62.104 (28.39-71.05)	86.312 (76.32-93.00)	5013
Desi fowl	18555	71.68 (38.17-83.60)	60.47 (21.80-72.70)	84.36 (53.21-92.59)	11220
Commercial (TT section)	20917	79.29 (63.49-87.97)	72.58 (55.51-78.13)	91.54 (84.60-94.81)	15182

Figure in parenthesis denotes minimum and maximum range.

Table 22: The overall activities of experimental hatchery of RC CARI, Bhubaneswar

Duck breed	Total no of set eggs	Total no of fertile eggs	Total no. of duckling hatch out	Fertility percentage	Hatchability percentage	
					TES	FES
Khaki	40877	22287	15117	54.52	36.98	67.82
Desi	25001	15827	9004	63.30	36.01	56.89
WP	26682	12798	6397	47.96	47.96	49.98
Moti	160	60	18	37.50	11.25	30.00
Total	**92720**	**50972**	**30536**	**54.97**	**32.93**	**59.90**

Feed Storage and Processing Unit: The main activity of the section includes procurement and storage of different feed ingredients, feed formulation, quality control and ensuring balance feeds for valuable germ plasm of layers, broilers, guinea fowls, quails and turkeys maintained under different Divisions/Sections of the Institute as well as research projects involving poultry at IVRI. During the period under report, the feed unit has manufactured and supplied 9713.15 qtls. of different types of poultry feed (Table 23). Detailed break up of feed supplied to different projects is shown below:

Table: 23 Feed supplied to different projects/ divisions (2015-16)

Project/Division	Total Quantity (Qtls)
Broiler project	2703.4
Layer project	2440
Desi fowl unit	1381.9
Quail farm	785
Guinea fowl unit	565
Turkey unit	784.15
AN&FT	75.1
P&R Div.	145
PHM	228
IVRI	71.35
TT Section	497
Hatchery section	22.25
SAU Mathrua	10
HAPP Mukteswar	5
Total	**9713.15**

Marketing of Poultry Products: The detailed break-up of eggs and poultry meat disposed off and the net revenue generated through Marketing Centre of the Institute during the period April 2015 to March 2016 is given in Table 24 and revenue in Table 25.

Table 24 : Quantity of experimental by-products disposed off

Month	Eggs (Nos)		Processed poultry meat (kg)				
	Chicken	Quail	Chicken	Guinea fowl	Kadaknath	Quail	Turkey
April, 2015	109920	22300	2830.5	5.0	180.25	---	---
May, 2015	67069	21645	3360.25	---	101.0	----	12.5
June, 2015	62082	35300	1108.5	1.75	33.0	----	4.0
July, 2015	53119	55900	218.0	151.25	---	---	5.0
August, 2015	42525	64100	101.0	2.5	---	----	34.5
September, 2015	60786	63400	949.5	---	---	60.0	11.5
October, 2015	99123	66350	1113.0	147.75	---	34.0	4.75
November, 2015	83561	54200	1941.5	78.75	10.0	66.5	1.0
December, 2015	82683	53150	2337.0	415.0	8.0	134.0	61.0
January, 2016	80570	44600	1866.75	188.5	5.0	64.5	74.5
February, 2016	71575	29800	1984.25	4.0	48.0	39.5	7.0
March, 2016	81816	28350	1228.0	150.0	---	78.0	53.75
Total	**8,94,829**	**5,39,095**	**19,038.25**	**1144.5**	**385.25**	**476.5**	**269.5**

Table 25: Net revenue generated from the disposal of poultry eggs, poultry meat and poultry products

Commodity	Revenue (`)
Chicken eggs	32,35,940
Quail eggs	6,19,395
Chicken meat	16,54,795
Guinea fowl meat	91,560
Kadaknath meat	30,820
Quail meat	2,38,250
Turkey meat	26,840
Poultry products	42,410
Total	**59,40,010**

The marketing centre of RC, ICAR-CARI, also generated a total revenue of `. 14.99 lakhs during the year 2015-16 by sale of 3843 live ducks (6225 kg), 237088 numbers of table eggs, 8622 ducklings and miscellaneous items like chick box, egg box, egg tray, banana, raw cashew nut, mangoes, jack fruits etc.

Agriculture Knowledge Management Unit (AKMU): Agricultural Knowledge Management Unit (AKMU) is instrumental in establishment and management of Local Area Network (LAN) for providing internet and intranet services to the scientists, officers/ staff and students in the Institute.

The main activities of AKMU are maintenance and providing the Internet, maintenance of Institute Website and other computer related works including LAN, systems management, processing of pay bills for the employees of the institute, research data analysis, research data management in the institute and also updating of institute website.

The internet and intranet services were provided round the clock (24X7) for the employees of the Institute. Presently, 85 functional nodes are being used for providing Internet and Internet services in the institute. The Wi-Fi connectivity is also being provided for the scientists and students in the Library and other places in the institute.

The Institute website provides overall research activities, achievements, other valuable information of the institute and its regional Centre. The contents of the institute website are being updated regularly. The information related to training programmes, recruitments of staff, tender notices and other circulars/news items of the institute are also being periodically uploading on the Institute Website.

For smooth functioning of ICAR MIS-FMS system, different modules are also being run with the help of AKMU. Internet connectivity and its management are being provided to Bio-Metric Attendance Systems installed in the institute.

As per the ICAR guidelines of Research Data Management (RDM) Project of ICAR is being carried out for its implementation in the institute

Library and Information Services: During the period under report 85 new publications were added in the Library collection. This brings the total number of books, bound volumes of journals and theses etc. in the library from 5882 to 5966. ICAR-CARI Library subscribed 23 journals, out of which 12 were reputed foreign scientific journals/ magazines (in print) and one journal subscribed Online only. In addition of these, a number of National and International Serial Publications, Annual Reports and News letters were received on gratis.

The following library activities have been updated / automated:

- The data of all newly added/purchased Books, Theses, Bound Journals, and current issues of Periodicals, with complete bibliographic information were updated, using LIBSYS database/software.
- Online catalogue, OPAC (Online Public Access Catalogue) services accessible to the library users.
- Library membership has been Computerized and, Circulation of books and other publications were also done through LIBSYS-7 software.
- Renewal of Journals for the year 2016 were also updated in the LIBSYS software/database

Wi-Fi facility is made available in the library, so that, library users may use their own Laptop and other electronic gadgets to access internet. ICAR-CARI, Library, being a member of Consortium for e-Resources in Agriculture (CeRA), is getting access to more than 2000 online full text journals. Document Delivery Request (DDR) services are also being exchanged among the members library under CeRA. The library also provides Internet, E-mail,

Information retrieval through CD-ROM database and Xerox services to the Scientists and Students.

Hindi Cell: The meetings of Official Language Implementation Committee were held time to time for review of progressive use of Hindi in the Institute. Quarterly Reports of Official Language have been sent to ICAR as well as Department of Official Language, Govt. of India. Data regarding working knowledge in Hindi and proficiency of Hindi of the officials have been updated and individual orders/ instructions were issued for doing official work in Hindi.

Hindi workshops were organized during the year for the administrative staff to increase use of Hindi in the Institute. Acquainted staff with Official Language Act and Rules and trained 77 Officers and 77 employees in the Hindi workshops organized in

Hindi Pakhwara at ICAR-CARI, Izatnagar

four terms e.g. 17 April, 2015, 24 August, 2015 and 30 December, 2015 during the period under report. Beside this, circulars and instructions were issued for compliance of Official Language Act and Rules in the Institute. Scientific, Technical and Administrative materials were translated and typed the same received from Divisions, Sections and Units of the Institute.

Hindi Pakhwara was organized during 14-28 Sept., 2015 in the Institute. On this occasion, Dr J.M. Kataria, Director, ICAR-CARI, Izatnagar addressing the staff said that use of Hindi is not only in administrative works, as also in new technological achievements of the Institute is spreading out to the end users in Hindi through research papers written in Hindi and lectures delivered by the Scientists, trainings for the farmers and publications in Hindi. Various competitions such as essay writing in Hindi, debate, typing in Hindi on computer, noting/drafting, general knowledge, translation and shabdawali parichaya were conducted in the Hindi Pakhwara. Research papers writing in Hindi competitions are being organized for last eleven years in the Institute. Research papers in Hindi competition was also organized during the reviewing period and total four research papers were received in Hindi and three of them were awarded as First, Second and Third prizes, and one consolation prize in the form of cash. Dr J.M. Kataria, Director of the Institute distributed prizes and momentous to winners.

Benchmark Survey of Sansad Gram: The benchmark survey of the Sansad Gram – RahpuraJagir under the block Fatehganj, district Bareilly (UP) adopted by hon'ble Sh. Santosh Kumar Gangwar, MP was conducted on 26/08/2015 by Technology Transfer Section of the Institute to chalk out future plan for the development of the village through poultry technologies interventions. The survey reveals that the village population is about 5000 persons and dominated by hindu religion. Majority of families are involved in agriculture. There were 10 poultry farms in the village but presently only one broiler farm of 600 capacity is in operation since 2012.

Swachh Bharat Mission at Regional Centre : The staff of the regional Centre performed cleaniness activities at its campus and contributed in *Swachh Bharat Abiyan*. Special Swachhta Pakhwara was also performed from 26th Sept. to 11th Oct., 2015 . During this pakhwara, special drive was launched to clean the surrounding by employees of the Centre.

Swachh Bharat Abhiyan at Institute: On the direction of Prime Minister of India Hon'ble Shri Narendra Modi and under the leadership and guidance of Dr J.M. Kataria, Director, ICAR-CARI,

Izatnagar, Swachh Bharat Abhiyan activities were performed twice a week during the year 2015-16.

Special Swachh Bharat Abhiyan was also performed from 26th Sept. to 11th Oct., 2015. During this special drive, various activities like lecture on personal hygiene, essay writing, debate, and slogan writing competitions were conducted in addition to regular planned cleanliness activities. The winners of these competitions were also given prizes.

Staff Personalia:

Posting/Appointment

- Dr Gopi M., Scientist joined on 01.04.2015 at CARI, Izatnagar.

Transfer from other Institute

- Dr Dhirendra Kumar, Scientist joined CARI Regional Centre, Bhubnewar on 10.08.2015 after transfer from IVRI, Izatnagar.

Transfer to other Institutes

- Dr Niranjan Lal, Scientist transferred to ICAR Research Complex for NEH Region, Umiam, Meghalaya, on 04.09.2015 consequent upon selection to the post -Programme Coordinator, KVK, Churachandpur,Manipur.
- Dr Pragya Bhadauria, Scientist, transferred to ICAR-Agricultural Technology Application Research Institute, Zone-I, Ludhiana, on 28.11.2015
- Shri Prem Chandra,T-6 Sr. Technical Officer, transferred to ICAR-National Bureau of Fish Genetic Resources, Lucknow, on 04.02.2016
- Dr D. Mondal, Principal Scientist transferred to ICAR-IVRI ERS, Kolkata on 27.02.2016

List of Officials promoted during 2015-2016

Sl. No.	Name of Official	Promoted		w.e.f.
		From	To	
1.	Dr. S.C. Giri	Sr. Scientist	Pr. Scientist	30.12.2014
2.	Dr. P.K.Naik	Sr. Scientist	Pr. Scientist	15.07.2014
3.	Shri Arun Kumar Singh	T-5	T-6	1.07.2011
4.	Shri Mohd. Womiq Raza	T-5	T-6	1.07.2011
5.	Shri K.K.Das	T-4	T-5	1.01.2015
6.	Shri Arun Kumar	T-3	T-4	27.07.2014
7.	Shri Arvind Kumar	T-2	T-3	4-10-2014
8.	Shri M.C.Pathak	T-5	T-6	1.01.2015
9.	Shri Jaideep Arora	T-3	T-4	24.10.2015

Retirements

- Dr D.P. Singh, Principal Scientist retired on 30.06.2015
- Shri Ram Chandra, Skilled Supporting Staff retired on 30.06.2015.
- Shri Sewa Ram, Skilled Supporting Staff retired on 30.06.2015.
- Shri Kedar Dutt, Skilled Supporting Staff retired on 29.02.2016.
- Shri Hori Lal, Skilled Supporting Staff retired on 31.03.2016.
- Smt. Devki Devi, Skilled Supporting Staff retired on 31.03.2016.

LIST OF RESEARCH PROJECTS (2015-2016)

Total Institute Projects – 28 Institute + 2 AICRP + 5 Externally + 3 Service (Total 38 Projects)

Sl.	Project Code No.	Project Title	Principal Investigator	Co-Investigator
PROGRAMME-1: PRODUCTIVITY ENHANCEMENT OF SELECTED POULTRY SPECIES (20)				
Sub Programme - (i) Enhancement of productivity, reproductive efficiency and immune-competence of selected diversified poultry species along with development of improved package of practices. (18)				
1.	P-1/2012/1-IAV/L30/6600 DOS: 17.10.2012 DOC: 16.10.2015	Improving reproductive performance and immune-competence in turkey through nutritional intervention.	Dr. Avishek Biswas	Dr. (Mrs.) Divya Dr. S. Majumdar
2	P-1/2010/1-IAV/ L50/6400/6100 DOS: 01.6.2010 DOC: 31.5.2015	Evaluation and improvement of reproductive efficiency in guinea fowl and chicken.	Dr. Jag Mohan	Dr. Jagbir Singh Tyagi
3.	P-1/2015/1-IAV/L50/6100-6600 DOS: 09.09.2015 DOC: 08.09.2018	Improvement of reproductive efficiency of Turkey and Chicken	Dr. Jag Mohan	Dr. S. Majumdar Dr. J.S. Tyagi Dr. Gautham Kolluri Dr. Gopi, M.
4.	P-1/85/95/1-IAV/ L10/6100/9705 (Component-AICRP-PB, Hyderabad) DOS: 01.4.1985 DOC: 31.3.9999	Development and evaluation of synthetic broiler sire line.	Dr. (Mrs.) Simmi Tomar	Dr. V.K. Saxena Dr. Jaydip J. Rokade (w.e.f. 19.5.2015)
5.	P-1/85/95/2-IAV/ L10/6100/9705 (Component-AICRP-PB, Hyderabad) DOS: 01.4.1985 DOC: 31.3.9999	Development and evaluation of synthetic broiler dam line.	Dr. V.K. Saxena	Dr. (Mrs) SimmiTomar Dr. Avishek Biswas Dr. Niranjan Lal (till 04.09.2015) Dr. Jaydip J. Rokade (w.e.f. 19.5.2015)
6.	P-1/2015/1-IAV/L30/6000 DOS: 01.4.2015 DOC: 31.3.2018	Augmenting gut health and welfare of poultry through dietary approaches	Dr. A.B. Mandal	Dr. S.K. Bhanja Dr. A.S. Yadav Dr. Ram Singh Dr. Avishek Biswas
7.	P-1/2012/1-IAV/L30/3700-3755 DOS: 01.07.2012 DOC: 30.06.2016	Establishing dietary requirement of critical minerals and vitamins for poultry.	Dr. Chandra Deo	Dr. A.B. Mandal Dr. Praveen K. Tyagi

Sl.	Project Code No.	Project Title	Principal Investigator	Co-Investigator
8.	P-1/2012/1-IAV/L30/6100 DOS: 18.10.2012 DOC: 17.10.2016	Efficacy of herbs containing essential oils on performance and immunity in broiler chickens.	Dr. (Mrs.) Divya	Dr. A. Biswas Dr. Ashim K. Biswas
9.	*P-1/2014/1-IAV/6000/3745* DOS: 1.8.2014 DOC: 31.7.2017	Ochratoxicosis in poultry	Dr Ram Singh	-
10.	P-1/2015/L30/6100 DOS: 01.10.2015 DOC: 30.09.2018	Augmenting Performance of broilers through betaine supplementation	Dr. Rokade J.J.	Dr. Gopi M. Dr. V.K. Saxena Dr. S.K. Bhanja Dr. Gautham Kolluri
11.	P-1/2015/1-IAV/L50/6100 DOS: 01.10.2015 DOC: 30.09.2017	Physiological interventions for addressing reproductive dysfunctions in broiler breeders	Dr. Gautham Kolluri	Dr. Jag Mohan Dr. J.S. Tyagi Dr. Gopi, M. Dr. Rokade, J.J. Dr. Pragya Bhadauria (upto 28.11.2015)
12.	P-1/2015/1-IAV/L10/6400 DOS: 10.09.2015 DOC: 09.09.2018	Improving Pearl variety of Guinea fowl for low input climate resilient alternate to chicken	Dr Simmi Tomar	Dr. Gautham Kolluri
13.	P-1/2015/1-IAV/L05/6200 DOS: 01.01.2015 DOC: 31.12.2017	Reproductive and hatchery management strategies for improving fertility and hatchability in duck eggs	Dr S.C. Giri	Dr K.V.H. Sastry Dr S.K. Sahoo
14.	P-1/2015/1-IAV/L50/6200 DOS: 01.01.2015 DOC: 31.12.2017	Studies on sperm storage tubules and development of technology for short term preservation and utilization of male gametes in ducks	Dr K.V.H. Sastry	Dr S.C. Giri Dr R.K.S. Bais Dr S.K. Sahoo
15.	P-1/2014/1-IAV/L30/6200 DOS: 01.10.2014 DOC: 30.09.2017	Evaluation of azolla as an alternative feed resource for economic production of duck meat and egg.	Dr B.K. Swain	Dr S.K. Sahoo Dr P.K. Naik Dr R.K.S. Bais Dr S.K. Mishra
16.	*Service Project*	Monitoring of poultry diseases and implementation of bio-security measures including vaccination for achieving better survivability and productivity in CARI birds.	Dr. A.S. Yadav	Dr. Gautham Kolluri
17.	*Service project*	Quality assessment of feed stuffs and poultry feed	Dr. A.B. Mandal	--

Sl.	Project Code No.	Project Title	Principal Investigator	Co-Investigator
18.	*Service project*	Development of different value added poultry products for income generation	Dr. A.K. Biswas	Dr. A.B. Mandal Dr. A.S. Yadav Dr. C.K. Beura
Sub Programme - (ii) Development of package of practices for rural poultry production system (5)				
1.	P-1/2011/1-IAV/ L10/6100/9705/ RIR DOS: 01.06.2011 DOC: 31.05.2016	Improvement of Rhode Island Red for development of multicolored strains for rural poultry production.	Dr. S.K. Bhanja	Dr. Sanjeev Kumar Dr. Raj Narayan
2.	P-1/2012/1-IAV/E15/6600 DOS: 01.06.2012 DOC: 31.05.2017	Evaluation of management practices to optimize turkey production	Dr. S. Majumdar	Dr. S.K. Bhanja Dr. Jagmohan Dr. (Mrs) Pragya Bhadauria (till 28.11.2015)
3.	P-1/2013/1-IAV/L10/6100 DOS: 01.04.2013 DOC: 31.03.2018	Conservation of Elite layer stock*	Dr. Sanjeev Kumar	Dr. Niranjan Lal (till 04.09.2015) Dr S.K. Bhanja
4.	P-1/2015/1-IAV/L10/6510 DOS: 10.09.2015 DOC: 09.09.2020	Preservation of elite germplasm of Japanese quails	Dr Raj Narayan	Dr Chandrahas
5.	P-1/2015/1-IAV/L10/6100 DOS: 10.09.2015 DOC: 09.09.2020	Maintenance and Evaluation of native chicken and their utilization for family poultry production	Dr Chandrahas	Dr Raj Narayan Dr V.K. Saxena
PROGRAMME 2: CLIMATE RESILIENT POULTRY PRODUCTION SYSTEM AND WASTE MANAGEMENT (5) ***Sub Programme – Impact assessment, adaptation evaluation and amelioration strategies to combat extremes of climate through genetic / molecular, nutritional, physiological, shelter management and evolving efficient technologies for utilization of poultry waste.***				
1.	P-1/2012/1-IAV/L32/3790 DOS: 01.07.2012 DOC: 30.06.2016	Utilization of alternate feed resources and wastes in poultry feed.	Dr Pramod K. Tyagi	Dr Ram Singh Dr (Mrs.) Divya Dr. Avishek Biswas
2	P-1/2010/1-IAV/ L50/6000/3730 DOS: 01.07.2010 DOC: 30.06.2015	Role of heat shock protein on the efficiency of digestive system under normal and stressed conditions in poultry.	Dr Jagbir Singh Tyagi	Dr. Jag Mohan Dr. Gautham Kolluri
3.	P-1/2014/1-IAV/ T00/6000/9790 DOS: 01.10.2014 DOC: 30.09.2017	Utilization of poultry waste for green energy and organic fertilizer generation	Dr Chandrahas	Dr.(Mrs.) Simmi Tomar Dr. Raj Narayan Dr.(Mrs.) Divya Dr. Sandeep Saran
4.	P-1/2014/1-IAV/L05/6100 DOS: 1.9.2014 DOC: 31.8.2017	Assessment and performance and welfare of chicken under different housing conditions	Dr (Mrs) Pragya Bhadauria (upto 28.11.2015) Dr S. Majumdar (w.e.f. 29.11.2015)	Dr Sandeep Saran Dr. Gautham Kolluri

Sl.	Project Code No.	Project Title	Principal Investigator	Co-Investigator
5.	P-1/2015/1-IAV/L50/6000 DOS: 1.10.2015 DOC: 30.09.2018	Study of physiological responses under normal and stressed conditions in indigenous and improved varieties of poultry	Dr Jagbir Singh Tyagi	Dr. Jag Mohan Dr. Gautham Kolluri Dr. Gopi M Dr. Chandrahas
PROGRAMME 3: VALUE ADDITION, FOOD SAFETY, QUALITY ASSURANCE AND PRODUCT DEVELOPMENT (3)				
Sub Programme – Development of value added poultry feed and poultry products with functional attributes and quality assurance including product development.				
1.	P-1/2014/1-IAV/L34/8954 DOS: 01.09.2014 DOC: 31.08.2017	Monitoring of poultry products and feed samples for chemical residues from selected markets of northern India	Dr C.K. Beura	--
2	P-1/2015/1-IAV/L30/9705 DOS: 10.09.2015 DOC: 09.09.2019	Value addition of poultry meat through dietary means	Dr Praveen K. Tyagi	Dr.Pramod K. Tyagi Dr. Chandra Deo Dr.(Mrs) Divya Dr. Asim K. Biswas Dr. Avishek Biswas
3.	P-1/2012/1-IAV/ Q10/9705-6600 DOS: 01.11.2012 DOC: 31.10.2015	Development and shelf-life extension of functional meat products prepared from turkey and spent chicken meat	Dr Ashim K. Biswas	Dr. C.K. Beura
PROGRAMME 4: HRD, MARKET INTELLIGENCE AND TECHNOLOGY DISSEMINATION (2)				
Sub Programme – (i) Market intelligence, contingency planning and economic implications of emerging issues in poultry value chain.(1)				
1.	P-1/2012/1-IAV/E10/6000 DOS: 01.7.2012 DOC: 30.6.2016	Study on institutional credit support to poultry farming in Uttar Pradesh	Dr. Sandeep Saran	-
Sub Programme – (ii) Skill development, capacity building for different stakeholders and transfer of technology. (1)				
1.	P-1/2011/1-IAV/C00/6000 DOS: 01.09.2011 DOC: 02.03.2016	Transfer of Proven Poultry Production technologies and their impact assessment.	Dr. M.P. Sagar	Dr. Niranjan Lal (till 04.09.2015)

EXTERNALLY FUNDED PROJECTS – (04)

Sl.	Sanction order No.	Title of the project	Name of PI	Name of Co-PI
1.	BT/PR12887/ AGR/36/622/2009 dated 21.5.2010 (DBT Project) DOS: 21.5.2010 DOC: 20.5.2015	Application of RNAi technology for augmenting broiler production.	Dr V.K. Saxena	Dr K.V.H. Sastry
2.	BT/PR4326/ AAQ/1/496/2012 dated 16.7.2012 (DBT Project) DOS: 19-7-2012 DOC:18-7-2015	Thermotolerance gene expression analysis *Salmonella Typhimurium* and development of their thermal death time models applicable to poultry processing	Dr A.S. Yadav	Dr V.K. Saxena Dr J.M. Kataria

Sl.	Sanction order No.	Title of the project	Name of PI	Name of Co-PI
3.	BT/374/NE/TBP/2012 dtd. 07.01.2013 DOS: 07.01.2013 DOC: 06.01.2016	Identification of probiotic strain(s) from gut metagenome of Assam indigenous chicken.	Dr V.K. Saxena	Dr(Mrs.) SimmiTomar
4.	SB/FT/LS-283/2012 dtd. 02.5.2013 DOS: 02.5.2013 DOC: 01.5.2016 (DST Project)	Biochemical basis for detection of calpains and calpastatin and their role in post mortem tenderization of meat.	Dr Ashim K. Biswas	-

INTER-INSTITUTIONAL COLLABORATIVE PROJECT (1)

1.	SR/FT/LS-147/2011 DOS : NA DOC : NA	Identification RNA transcripts present in chicken sperm and their relation to fertility	Dr Jag Mohan (CCPI)	Dr R.P. Singh (SACON)
2.	DOS : April 2012 DOC : May 2017	Diversified rice based farming system for livelihood improvement of small and marginal farmers	Dr (Mrs) A. Poonam (PI)	Co.PI. : Dr P. K. Nayak; Dr M. Nedunchezhian (RC CTCRI, Bhubaneswar); **Dr S.C.Giri (RC CARI, Bhubaneswar);** Dr S.M.Prasad, Dr Md. Shahid, Mr N.N.Jambhulkar, Dr Sanjay Saha, Ms mayabini Jena and G.A.K.Kumar (All NRRI, Cuttack)

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CERTIFICATE OF REGISTRATION

Registered

QUALITY MANAGEMENT SYSTEM

This is to certify that

ICAR-CENTRAL AVIAN RESEARCH INSTITUTE

IZATNAGAR–243 122, BAREILLY
UTTAR PRADESH, INDIA

Hereby granted the Certificate Number: **BN14750/14743:0216**

Subsequent to the Registration Assessment conducted on 17-Feb-2016 and the organization has been found to be operating a Quality Management System which complies with the requirements of

ISO 9001:2008

For the following scope:

Research and Development for Diversified Poultry Production Including Extension, Education and Training

Originally Registered: 20-Feb-2016 **Latest issue:** 20-Feb-2016 **Expiry Date:** 15-Sep-2018

For BSCIC CERTIFICATIONS PVT.LTD.

Sanjay Seth
Managing Director

BSCIC NABCB QM 030
ISO 9001 REGISTERED

Validity of this Certificate is subject to Annual Surveillance Audits to be done Successfully on or before 17-Feb-2017 and 17-Feb-2018 resp.

(In case if Surveillance Audit is not allowed to be conducted; this Certificate shall be Suspended/Withdrawn).

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BSCIC Headquarters: IInd Floor, SCO 150, Sector - 21 C, Faridabad 121001 Haryana, India.

ICAR-Central Avian Research Institute

(Indian Council of Agricultural Research)
Izatnagar, Bareily-243 122 (UP) India
EPABX: +91-581-2300204, 2301220, 2303223; Fax: +91-581-2301321
E-mail : director.cari@icar.gov.in; Website: www.icar.org.in/cari/index.html

Regional Centre

Jokalunda, Infront of Kalinga Studio, Bhubaneswar-751 003 (Odisha)
Phone: +91-674-2386870, 2386251; Fax: +91-674-2564950