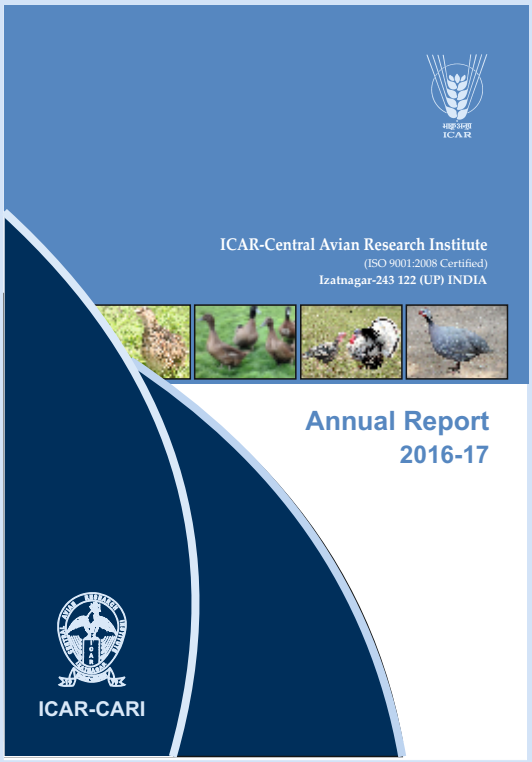
Annual Report
2016-17

भाकृअनुप
ICAR

ICAR-Central Avian Research Institute
(ISO 9001:2008 Certified)
Izatnagar-243 122 (UP) INDIA



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

Editors:
Dr V.K. Saxena
Dr M.P. Sagar
Dr S.K. Bhanja
Dr J.J. Rokade

Cover page design: **Dr V.K. Saxena** and **Dr M. Gopi**

Design and Layout: **Dr V.K. Saxena**, **Dr M.P. Sagar** and **Shri S.R. Meena**

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(M) 94127 338797; sandybly@gmail.com

Preface

*With enormous elasticity in dimensions of production, poultry occupy a unique place in animal production system. On one end it serves as a tool for livelihood generation for a poor man while on the other end it exhibits potential for high-end business for corporate sector. As a result, poultry has emerged as one of the fastest growing segments of the agricultural sector in India. Poultry therefore has enormous potential to serve the mankind not only to alleviate mal-nutrition and protein deficiency but also to provide socio-economic security to the weaker sections of society. It is worthwhile to mention that Hon'ble Prime Minister of India while addressing a farmers' rally in Bareilly, Uttar Pradesh, on 28th February, 2016 urged for "**Doubling the Farmers' Income (DFI)**" by the time the nation celebrates its 75 years of independence in the year 2022. Poultry has great potential to help in fulfilling the dream of Hon'ble Prime Minister. Marching in line with the call of Hon'ble prime minister, the Central Avian Research Institute is devoting itself to help farmers in doubling their 'REAL INCOME' and not just the 'NOMINAL INCOME', through poultry farming.*

Since its establishment on November 2, 1979, this institute is significantly contributing 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 institute is also focusing on integrating poultry (duck) with paddy and fish farming besides offering the technology for duck production in Polythene Pond which is suitable in the areas where water bodies are not available. Further, to give impetus to genetic improvement of ducks through pedigreed breeding and selection, the institute is advancing in developing artificial insemination technology for ducks which is first of its kind in the country. Consistent with the urge of Hon'ble PM to conserve the indigenous Germplasm, we are pro-actively promoting the indigenous chicken and the backyard poultry production which not only have immense potentiality to increase farmers' income but also to minimize the problems of waste and pollution associated with intensive poultry production system. The multicoloured turkey variety and two desi crosses are in last phases of evaluation and will be soon joining the inventory of germplasm developed at CARI, Izatnagar. The recent 'DAC' technology for utilization of poultry waste in generation of biogas and organic manure has shown promising results. The research works carried out in cutting edge areas like molecular and reproductive biology, nutrigenomics, metagenomics etc. have also helped in developing some newer technologies like universal semen diluents for poultry species, newer probiotic strains like L. plantarum (Japanese quail origin) and L. reuteri (indigenous chicken origin). Number of alternate feed resources like DDGS, de-oiled cotton seed meal, roasted guar korma, enzymes, medicinal and aromatic plants have been evaluated and standardized for augmenting production with cheaper feed cost. The institute has also 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 capacity building and entrepreneurial developing training programs organized at the institute have helped the educated youth and marginal farmers to setup their own business especially under Start Up scheme of Govt of India. The institute made significant strides in supply of germplasm with about1.5 lakh units of diverse poultry species supplied throughout the country with increased supply of rural chicken germplasm.

I extend my sincere gratitude to Dr T. Mohapatra, 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 Dr Prabhakar Rao, Chairman RAC for their comments and inspiring views. I am extremely happy to present the Annual Report and 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 as ever this institute will rise to newer heights and will ever be an instrument of nation building

(J.M. Kataria)

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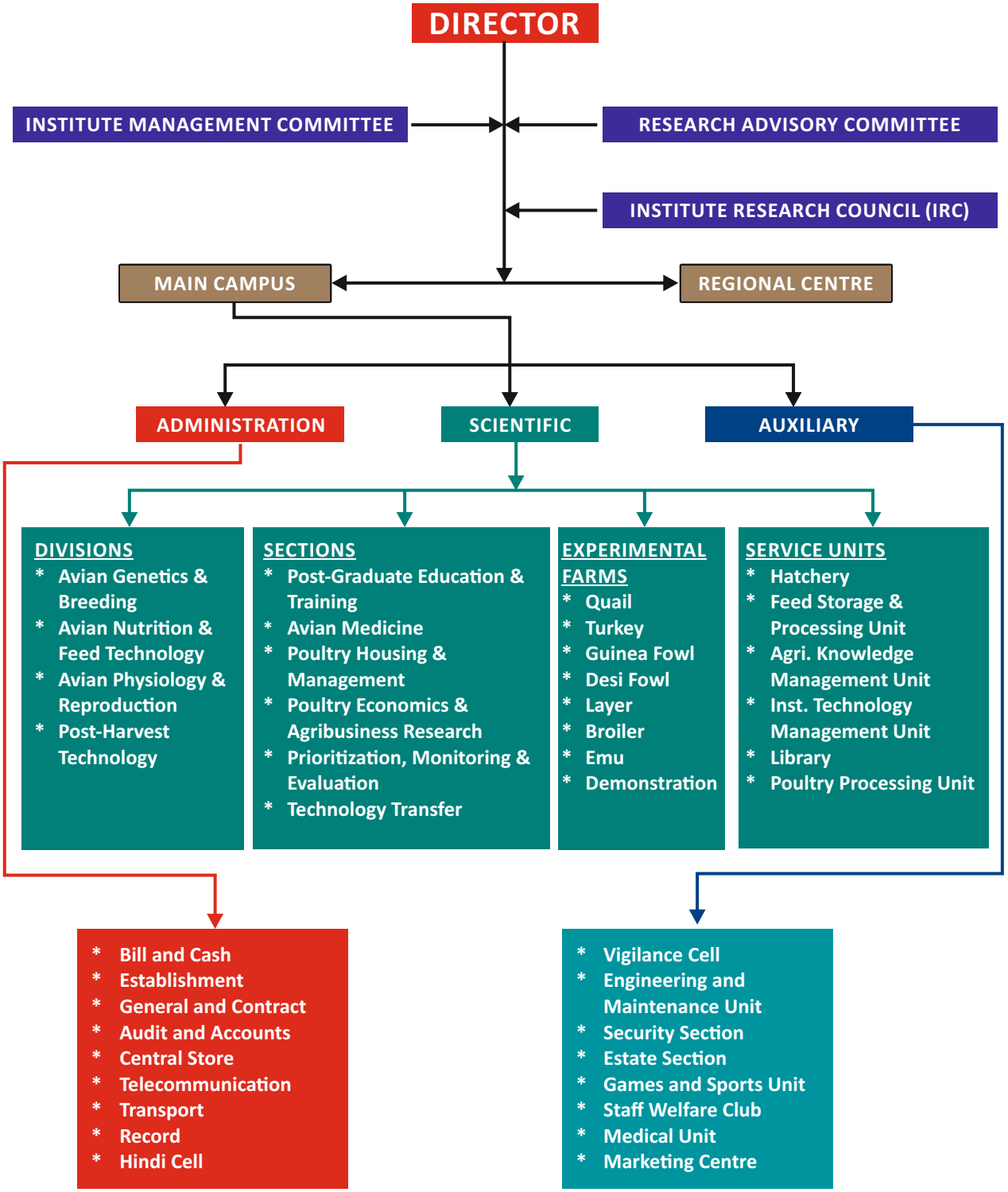
ORGANOGRAM


DIRECTOR
INSTITUTE MANAGEMENT COMMITTEE
RESEARCH ADVISORY COMMITTEE
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MAIN CAMPUS
REGIONAL CENTRE
ADMINISTRATION
SCIENTIFIC
AUXILIARY
DIVISIONS
* Avian Genetics & Breeding
* Avian Nutrition & Feed Technology
* Avian Physiology & Reproduction
* Post-Harvest Technology
SECTIONS
* Post-Graduate Education & Training
* Avian Medicine
* Poultry Housing & Management
* Poultry Economics & Agribusiness Research
* Prioritization, Monitoring & Evaluation
* Technology Transfer
EXPERIMENTAL FARMS
* Quail
* Turkey
* Guinea Fowl
* Desi Fowl
* Layer
* Broiler
* Emu
* Demonstration
SERVICE UNITS
* Hatchery
* Feed Storage & Processing Unit
* Agri. Knowledge Management Unit
* Inst. Technology Management Unit
* Library
* Poultry Processing Unit
* Bill and Cash
* Establishment
* General and Contract
* Audit and Accounts
* Central Store
* Telecommunication
* Transport
* Record
* Hindi Cell
* Vigilance Cell
* Engineering and Maintenance Unit
* Security Section
* Estate Section
* Games and Sports Unit
* Staff Welfare Club
* Medical Unit
* Marketing Centre

INTRODUCTION

Envisaging the role of poultry in fighting poverty and malnutrition, the Central Avian Research Institute (CARI), the oldest and only research institute of its kind under the aegis of the ICAR came into existence on 2nd November 1979. Since its inception, the institute is wholly dedicated to poultry science research and have contributed significantly towards the evolution and transformation of backyard/free range small scale subsistence poultry into fully developed intensive commercial farming in the country. The main campus located at Izatnagar, Bareilly (U.P.) is devoting to promote RandD and extension on diversified poultry species whereas its regional centre at Bhubaneswar (Odisha) is aiming to improve ducks. Besides, the institute also imparting post graduation education in Poultry Science and National Diploma on Poultry Husbandry as a constituent division of IVRI Deemed University. The continued efforts and contributions of CARI in terms of germplasm, technology and process development as well as HRD support to IPS, the subsistence backyard poultry rearing has been transformed into a vibrant and aggressive agro-industry with its domestic market currently estimated at over Rs 60,000 crore. The institute is firmly progressing for developing the newer improved germplasm of diversified poultry for rural poultry production as well household convenience. The multicolored turkey variety and two desi crosses are in last phases of evaluation and will be soon joining the inventory of germplasm developed at CARI, Izatnagar. The integrated farming model with duck, paddy and fish was popularized. The Polythene Pond technology developed by this institute is suitable in the areas where water bodies are not available.. The institute is advancing in developing artificial insemination technology for ducks which is first of its kind in the country.

The institute has also made significant contributions towards evaluation and standardization of alternate and newer feed resources to help in lowering down the feed cost besides developing feed formulae for computing low cost ration under different climate and regions of the country. The improvement in feed efficiency has also been brought through increasing the nutrient availability. Institute has developed the protocols for about two dozen value added processed products utilizing poultry egg, meat and byproducts and development of methods for their shelf-life extension. The universal semen extender for different poultry species was developed which can maintain the fertility till 24 h. Besides, the institute has also contributed significantly in frontier research like molecular genetics and biotechnology, nutrigeno-mics, metagenomics. Institute's HRD program has been providing trained manpower for manning large commercial poultry houses in the country.

The continued and dedicated efforts of the instated has resulted into an overall growth of @about 8-10% per annum of Indian Poultry Sector and contributing 0.7% in National GDP. The of IPS has been several challenges like increasing cost of feed ingredients, deceased 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, the scientists, and researchers have always found way through these challenges to make poultry an economically viable enterprise and a vibrant component of Indian agriculture system.

Mandate

- Basic and applied research on productivity enhancement for sustainable production in diverse avian species.
- Human resource development and capacity building.

Major R&D Activities

- Presently, total 34 projects (29 institute funded projects and 05 externally funded) are running in the Institute.
- Genetic improvement, characterizationand 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 energy
- Conducting research on basic and applied aspects of avian nutrition and rendering diagnostic and 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, awareness creation about

poultry production technologies through participation in national and regional exhibitions, Radio and TV talks, technology assessment and transfer through on-farm trials, germplasm supply and publication of books/bulletins, etc.

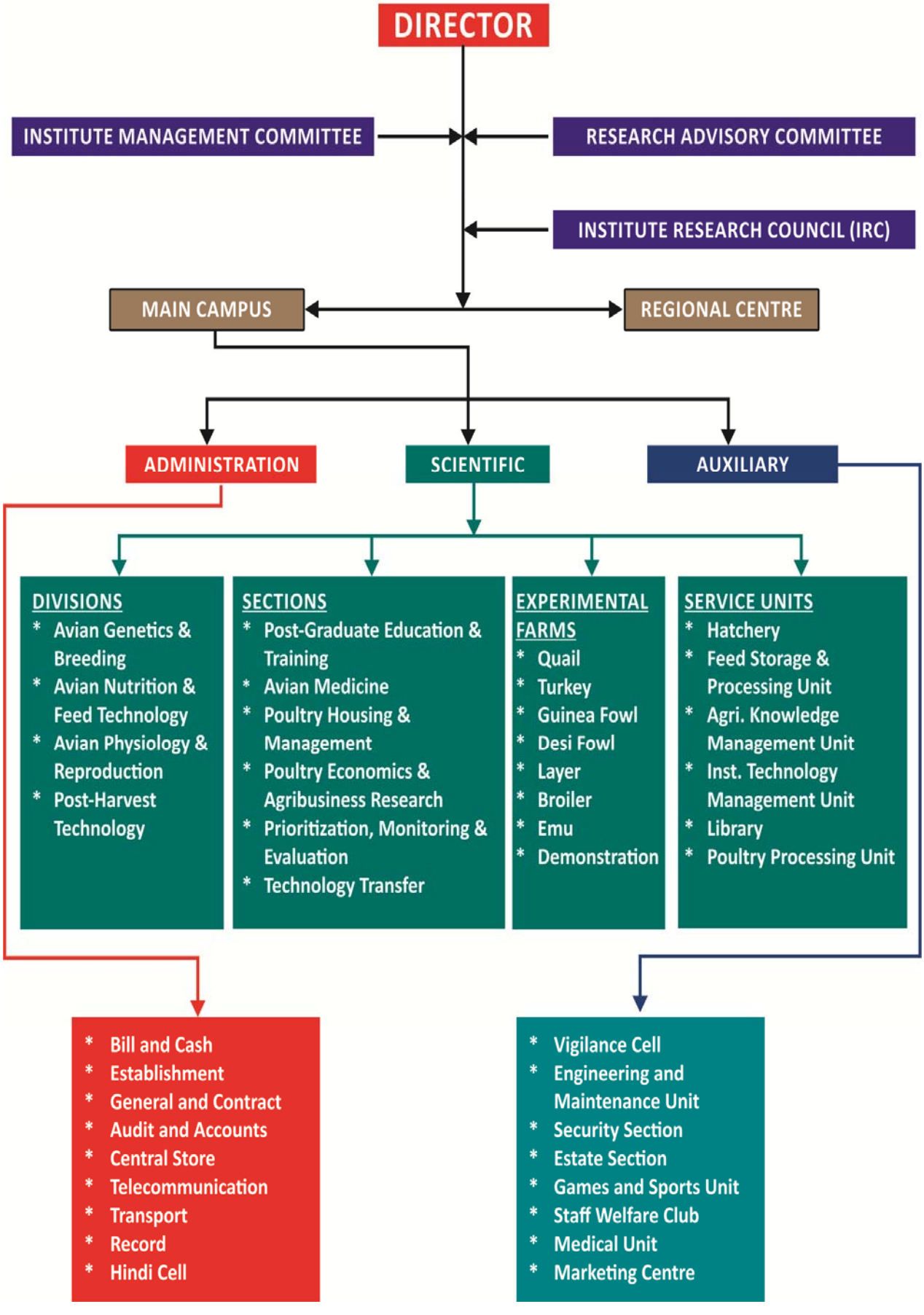
CARI Regional Centre, Bhubaneswar is dedicated for research on genetic improvement of ducks and development of location specific germplasm for catering the needs of Eastern and North-Eastern parts of the country.

STAFF POSITION

(As on 31.03.2017)

Sr. No.	***Category***	***Sanctioned Strength***	***In-Position***	***Vacant***
1.	Scientific	40+1	33+1	07
2.	Technical	61	34	27
3.	Administrative	31	26	05
4.	Skilled Support Staff	137	96	41

ORGANOGRAM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* Estate Section
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EXECUTIVE SUMMARY

Productivity Enhancement of Selected Poultry Species

- As per the ICAR letter No. AS/11/1/2013/ASR-II dated 27 Feb 2015, regarding preservation of elite germplasm of Japanese Quail at CARI, Izatnagar, the population of Japanese quail parent stocks at Experimental Quail Farm was 12991 as on 31 March 2017 which comprised of five different plumage colours, one egg colour, one cross line and one control line of Japanese quails.
- A total of 4990 keets were hatched from 14247 eggs set with a fertility of 60.99% and hatchability on fertile eggs set as 57.42%. In Pearl variety, in IV generation of selection the body weights at 4, 8 and 12 weeks were 162.64±1.5, 566.03±2.6 and 913±2.5g, respectively whereas in control the corresponding averages were 178.25±1.6, 504.72±3.2 and 856.72±3.9 g. Mean FCR during 0-4, 5-8 and 9-12 wk of age were 3.6±0.29, 3.81±0.43 and 4.89±0.27. Two levels of photoperiod (16 and18 hrs light) and three levels (16, 18 and 20%) of dietary protein in pearl Guinea fowl were attempted to break the seasonality in egg production. Photoperiod (18h) and 20% dietary protein showed best results.
- A total of 1950 Aseel Peela, 1049 Aseel kagar, 1654 CARI Red, 663 Nicobari, 1881 Kadakanath, 1060 Ankaleshwar, 496 coloured Frizzle, 549 coloured Naked Neck and 1831 gene pool line chicks were hatched, maintained in pure form and were utilized for production of 15610 parent and commercial chicks for family poultry production.
- 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 general and specific combining ability, heterosis, reciprocal effect, maternal effects on growth (body weight), body conformation, age at sexual maturity, annual egg production and egg quality traits.
- Crosses of Nicobari (male line) and CARI Red (female line) was adjudged as best cross combination for rural poultry production adjudged on the basis of phenotypic and genotypic traits.
- The combining ability analysis revealed significant GCA and SCA variances for body weight, body conformation and egg production traits. Significance of variance for GCA, SCA, reciprocal and sex-linked /maternal effects were recorded for growth and egg quality traits.
- Additive gene action was more important for inheritance of growth, body conformation and various egg quality traits. Non-additive gene action was more important for inheritance of age at sexual maturity and yolk index in egg quality traits. For inheritance of egg production traits, both additive and non-additive gene actions were important.
- Among different diallel models, Griffing's model was better over Hayman's model. Gompertz model was found to be the best fit mathematical function for production curve for explaining the pattern of egg production in pure and crossbred genetic groups of native chickens.
- The average fertility per cent in RIRs and RIRc during 33rd generation of mating was 83.2 to 91.2 %, respectively. The hatchability on total eggs set and fertile eggs transferred basis in RIRs and RIRc was 69.98, 83.2 % and 84.1 and 91.2%, respectively.
- The body weights at 20th and 40th week in RIRs and RIRc strains during 33rd generation were 1391.5±5.76g, 1831.4±7.98g and 1031.4± 11.84g, 1598.0±16.65g, respectively.
- The RIRs females recorded significantly higher 40th week egg production (by 40.83 nos) and 40th week egg weight (by 2.27 g), but lower age at the first egg, AFE (by 36.4d) as compared to that of control population (RIRc). On genetic scale, the AFE declined to the tune of -0.803**±0.15 day per generation. The average response per generation for 40 week egg number and egg weight were 1.10**±0.111 eggs, 0.077**±0.015g, respectively. Average regression coefficients for most of the economic traits in control population were found to be non-significant indicating its stability in eliminating the environmental trend.
- The RIR commercial crosses (CARI Debendra, CD and CARI Sonali, HR) showed 59.2 and 81.6% fertility, 88.6 and 88.5% hatchability on fertile egg set basis, respectively.
- The 40th week egg weight and egg number in CD and HR were 56.6±1.22, 51.8±1.40g and 96.4±3.03, 99.8±3.54 nos, respectively. Correspondingly the 72th week egg weight and egg number in CD and HR was 64.6±1.90, 59.1±1.58g and 207.5±7.74, 222.7±9.33 Nos, respectively
- Fertility percentages were 85.56 and 83.69 in CSML and SML, respectively. Hatchability

percentage on TES and FES were 77.26 and 90.30, respectively in CSML and 76.45 and 91.34 respectively in SML. Fertility percent in control was 84.92 and hatchability percent based on TES and FES were obtained as 74.72 and 87.26, respectively.

- Overall average body weight of mixed sexes at 5 weeks in CSML, SML and control were 1222.63±4.65, 1177.59±5.95 and 756.67±7.45 g, respectively. Phenotypic and genetic responses in CSML were 16.45**±0.08 and 14.73**±1.08 g/generation, respectively. Corresponding values in SML were 14.60**±1.49 and 12.69*±0.84 g/generation, respectively. The phenotypic response for 5-week body weight in the control population was non-significant (2.32±1.33 g / generation).
- The Least Squares means of ASM, BW16 and BW40, EW28, EW40 and EN40 in IWG, IWJ, IWH and IWI strain of WLH ranged from 136.4±1.4 to 146.8±1.2d, 823.4±7.9 to 1064.2 ±13.1g, 1209.9±12.4 to 1628.2±19.3g, 43.6±0.2 to 47.1 ±0.3 g, 48.24±0.28 to 50.2 ±0.4g and 103.4±1.5 to 109.3±1.8 eggs, respectively.
- The body weights at different ages viz., 0 day, 2, 4, 6, 8, 10, 12, 16, 20, 20, 24, 28, 32, 36 and 40 weeks in RIR chicken (286) was analyzed by ANOVA taking sire as random and sex and hatch as fixed effects. Least squares analysis of variance revealed significant effects of sire, sex and hatch on various body weights. Overall least-squares means of body weight at corresponding ages were 34.4±1.20, 71.36±4.16, 184.19±5.75, 361.16±12.64, 571.34±13.92, 677.92±16.79, 457.28±23.37, 1474.87±35.12, 1795.35±37.23, 1938.35±41.95, 2006.87±63.95, 2141.99±60.27, 2204.56±47.05, 2265.84±51.89, respectively.
- Relative mRNA expression of IGF-1 gene in liver and breast muscle tissues of RIR^S chicken. Analysis revealed that in liver, differences were significant ($P \leq 0.05$) in the relative mRNA expression of IGF-1 gene between two hatches. Second hatch exhibiting higher expression. In breast muscle, the relative mRNA expression of IGF-1 gene differed significantly ($P \leq 0.1$) between two sexes. Males demonstrated higher expression of IGF-1 gene as compared to females.
- Association analysis between genotypes at nine polymorphic microsatellite loci and mRNA expression of IGF-1 gene revealed that genotypes at microsatellites LEI0071 locus only differed significantly ($P \leq 0.11$) in expression of IGF-1 gene in breast muscle of RIR^S chicken.With genotype BD and AD exhibiting minimum and maximum fold expression.
- Betaine supplementation trial in four treatment groups viz. T1 (control), T2 (0.5 g/kg), T3 (1g/kg) and T4 (1.5g/kg) for a period of six week confirmed that supplementation of betaine @ 1g/kg could significantly improve performance, physiobiochemical indicators, welfare as well as immunity in heat stressed broiler chickens.
- The best C:N ratio for aerobic composting of poultry excreta during winter season was 30:1, which resulted in organic manure having NPK value (%) of 2.15, 2.05 and 3.91, respectively, with very less TBC and *E. coli* count, about 70-72% germination potential and value-addition to the tune of 2.25 times based on fertilizer value.
- A novel 'DAC' technology was developed for all-weather biogas production exclusively from poultry excreta. The poultry biogas burnt like LPG with blue flame. The composition of poultry biogas revealed that the methane (%, V/V) was 60.02 and was equal to or better than biogas production from other methods and substrate.

Nutrition Management

- The AME_n value of rice gluten meal was 3030 kcal/kg on dry matter basis and on enzyme supplementation (protease and cocktail) the AME_N value of rice gluten meal increased to 3068 and 3066 kcal/kg on dry matter basis, respectively.
- The effective level of inclusion of high-protein rice gluten meal in broiler diet was 15% replacing soybean meal.
- High-energy (2800 kcal ME/kg) and high protein (18% CP) diet was beneficial for egg type starting chicks (CARI Sonali) during dry summer (April-May, 28.0±0.12°C to 35.25±0.37°C, Rh, %: 68.95±0.90 to 79.15±0.61), and inclusion of mannan-oligosaccharides (MOS) @ 0.2% in such diet gave further advantage in improving performance and welfare as evidenced through zoo-technical indices and blood bio-chemicals.
- Dietary concentration of 0.40% available phosphorus and 1600 IU/kg vitamin D_3 was adequate to obtain optimum production performance, egg quality traits and blood biochemical parameters in white leghorn layers during winter season.
- A dietary calcium to available phosphorus ratio of 10.0 (3.50% Ca and 0.35% AP) with 2000 IU/kg vitamin D_3 was found adequate to obtain optimum production performance, egg quality traits and blood biochemical parameters in white leghorn layers.
- Efficacy of synbiotics (mixture of probiotics

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 (MOS@) 1%) or probiotics (*Bacillus subtilis* and *Bacillus amyloliquifaciens* @ 10^6 cfu/gm) alone in growing turkey poults (0-6wk of age).

- High energy (2800 kcal ME/kg) and high protein (18% CP) diet along with inclusion of symbiotics (MOS and probiotics- *Bacillus subtillis*, *Bacillus amyloliquefaciens*) was beneficial for improving performance, gut health and immuno-responsiveness of egg type starter chicks during dry summer.
- Combination of 0.3% MOS and 500 mg/kg Na-butyrate in diet was more effective in counteracting the ill effects of dietary induced aflatoxin B1 (300 ppb AFB1) and ochratoxin A (250 ppb OTA) toxicity rather than using MOS or NaB alone in broiler chickens.
- Inclusion of MOS at 0.2% in low energy low protein diet improved production performance, immune response, gut health, physio-biochemical characteristics of fresh and storage (14 d) meat, increased beneficial bacterial concentration in gut of broiler chickens and reduced microbiological counts in fresh and stored meat of broiler chickens.
- Inclusion of *Kappaphycus alvarezii* and red sea weed based formulations (AF-KWP) at 1.25% or 1.50% level in broiler diet improved performance, immuno-responsiveness, gut health (both microbial and structural), breast yield, physio-biochemical characteristics and reduction of microbiological counts in fresh and storage (14 d) meat was also obsereved.
- Ochratoxin contamination at the rate of 150 ppb in the feed impaired the production performance assessed through body weight gain, feed intake, feed utilization efficiency, survivability, relative weight organs (liver, bursa, thymus), blood biochemicals, cell mediated and humoral immunity and histopathological changes during 0-6 weeks of age in broiler chickens.
- Inclusion of *Saccharomyces cerevisiae* at 0.1% level along with 100 mg vitamin E/kg diet or *S. cerevisiae* at 0.075% level along with 200 mg vitamin E/kg diet to the ochratoxin (150 ppb) contaminated feed ameliorated the adverse effects of ochratoxicosis during 0-6 weeks of age in broiler chickens. The feed-cost per unit gain reduced on supplementation of *S. cerevisiae* at 0.1% level along with 100 mg vitamin E/kg ochratoxins contaminated diet but could not compensate the additional cost of additives.
- Inclusion of 100 mg vitamin C per kg diet to the ochratoxin (150 ppb) contaminated feed partially ameliorated the adverse effects of ochratoxicosis on production performance, relative organ weights and biochemical parameters of broiler chickens.
- Incorporation of HSCAS to the ochratoxin (150 ppb) contaminated feed could not ameliorate the adverse effects of ochratoxicosis, however, HSCAS at 0.50% level partially alleviated the ill effects of ochratoxicosis on organ weights and total serum protein in broiler chickens.
- A dietary combination of 10% flaxseed and 1.5 mg Cr/kg diet was optimum for desirable meat quality, oxidative stability and serum biochemical profile of broiler chicken.
- A diet with 10% flaxseed can be used for value addition of broiler meat along with 125% BIS recommended lysine without any adverse effect on broiler performance, efficiency, carcass traits and serum biochemical profile.
- Inclusion of 0.2% hempseed and 0.1% dill seed in diet was beneficial for improved growth and welfare of broiler chickens.

Physiological Interventions for Augmentation of Reproductive Efficiency

- Effect of various dilution rates (i.e. 1:1, 1:2, 1:3, 1:4, and 1:5) on fertilizing ability of chicken spermatozoa using CARI semen diluent was investigated. During the entire fertile period (1-10 days) dilution rate 1: 2 expresses high fertility (78.25±2.89%) than others.
- Effect of semen to air ratio using various sizes of glass tubes(5, 10, and 25 ml) on fertilizing ability of chicken spermatozoa during 24 hr storage in CARI semen diluent was examined. During 1-5 days of fertile period higher fertility was exhibited by semen stored in 5 ml capacity glass vial (88.63±2.02%) than 10 (78.00±1.44%) and 25 ml (73.57±2.41%) glass vial.
- Administration of GnRH analogue (200 µg) significantly ($P<0.05$) improved breeder hen housed egg production and ovarian health with enhanced rate of lay. This also reduced incidence of double yolk eggs.
- Haematological values get affected by the interaction of breed, sex, age and season in Aseel and Kadaknath breeds. Kadaknath male had significantly ($P<0.01$) higher RBC and Hb than Aseel in hot-humid season.

Poultry Products Technology

- Health oriented meat products viz. *functional poultry meat wafers, meat finger chips and chicken meat bites* showed positive impact on serum biochemical profiles (triglycerides, total cholesterol, HDL and LDL cholesterol, AST, ALT, total proteins) and other quality parameters.
- Morphometric and histochemical parameters revealed normal condition of different vital organs of mice due to feeding of control (corn-based diet) and functional meat products.
- Process for development of egg sausage was standardized.
- Standardized micro-calpain assisted post-mortem ageing of meat from diversified animal species during holding at 27±2°C.
- *Lactobacillus plantarum* exerted antimicrobial action against *E. coli* and *Salmonella* Typhimurium in tryptic soy broth at temperatures of 18, 20 and 22°C.
- Chicken meat sausages prepared from minced chicken meat fermented with *Lactobacillus plantarum* supplemented with malted oat flour was found to have better antioxidant and antimicrobial properties as well as higher fiber contents as compared to control group.
- Residue of drugs like tetracycline, oxytetracycline, and chlortetracycline in samples of poultry feed, egg, liver and muscle collected from Ludhiana and Barbala areas of northern India were found in the range of 0.012 to 0.025ppm. The occurrence pattern of, tetracycline, oxytetracycline and chlotetracycline were to the tune of 5%, 8% and 5% among all samples. Similarly the occurrence of residues of trimethoprim and sulfamethoxazole was recorded in samples of poultry feed, egg, liver and muscle ranged from 0.01 to 0.025ppm. Higher residue levels were observed in samples collected from Barbala. The levels of residues determined were within the permissible limit.

Poultry Shelter Management

- The combination of prebiotic with probiotic as synbiotic supplementation in feed was found to be more beneficial in improving growth performance, immune-competence, blood biochemical profiles, gut health and welfare of turkey poults than used these individually.
- The overall growth performance was better in poults fed synbiotic and reared in cages than on deep litter birds.
- Synbiotic proved to be more beneficial for poults reared on deep litter in terms of microbial and gut health, and alleviating stress (immunity and corticosterone level) than those reared in cage.
- The layer birds housed in individual cage laid significantly ($P<0.05$) more egg than their counter parts in colony cage or floor during early summer months.
- The colony housed birds produced more egg during summer months than the floor or individually caged birds.
- Supplementation of Nanoparticles on 18th embryonic day at broad end of egg using 24 gauge 25 mm needle provides the best hatchability related parameters.
- *In ovo* injection of 25 to 50 µg/egg silver NP did not affect growth but improved the immune organ weight (bursa and spleen), SRBC response and expression of TLR-2 and TLR-4 gene in broilers.
- *In ovo* supplementation of gold NP at either 25 or 50 µg/egg had almost 35-40gm higher body weight at the marketable age (42nd day post hatch) and increased the spleen weight and response to PHA-P ($P< 0.01$).

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- In Khaki Campbell, Desi, White Pekin, and Moti, the pooled mean body weights at 6 weeks of age were 810.75, 427.99, 1119.13 and 567.01 g. Corresponding weights at 8 weeks of age were 1049.09, 747.14, 1513.08 and 919.91 g and at 10 weeks the average body weights were 1202.97, 1055.47, 1808.57and 1342.80 g.
- The average age at first egg in the flock was recorded as 128.77, 118.33, 125.4 and 190 days for Khaki Campbell, Desi, White Pekin and Moti (Muscovy), respectively. The average 16 week body weights were recorded as 1338.7, 1322.2, 2030.03 and 1588.47 g and at 20 week the body weights were 1389.46, 1394.96, 2175.02 and 1805.13 g for corresponding breeds. The average duck day egg production up to 40 week of age in G-3 were 64.84, 50.67, 52.64 and 19.56 eggs for Khaki Campbell, Desi, White Pekin and Moti, respectively. The mean 28^{th} week egg weights for respective breeds were 54.32, 55.61, 63.08 and 54.69 g; at 40^{th} week the corresponding means were 58.37, 55.33, 66.98 and 53.79 g.
- Hatchability was found to improve by cleaning eggs with 60 % ethyl alcohol in Khaki Campbell and 40 percent in Desi ducks whereas cleaning showed no effect in white pekin duck eggs.
- Fertility and hatchability (TES and FES) improved significantly in Khaki Campbell (45 week old) inseminated artificially inseminated with semen added with 10mcg PGF_2 alfa/ml.

- The methodology was standardized for harvesting 6Kg Azolla/day from 10th day onwards from pit (7Mx5Mx0.2 M) lined with silpauline sheet and added with fertile soil, cow dung and super phosphate.
- Feeding of fresh azolla @ 200g/duck/day in White Pekin Laying ducks was beneficial in terms of improved FCR & performance. There was a saving of Rs 0.55/day/duck on feed cost due to feeding of fresh azolla (*Azolla pinnata*).
- The physical parameters viz., volume, spermatozoa concentration of semen collected with and without PEF were examined. Poor fertility (18.9%) was noticed when the semen collected without PEF was inseminated. However the role of pre ejaculatory fluid on fertility of spermatozoa during cold storage is being investigated.
- The diet containing 23% CP was optimum during starter stage (0-8 weeks) and diet containing 18% CP was optimum for White Pekin ducks during grower stage.
- Integrated model of Rice-fish-duck is in the process of refining for better out-put in farmers field. A specific native variety of duck collected from Rairangapur sub-division of Mayurbhanj district were introduced in the model operated at NRRI, Cuttack. The performance of ducks observed in this model was highly encouraging. Mortality was least in comparison to other varieties tried in previous years. Further work is in progress.
- The acceptability of duck meat and egg was analysed by collecting data on 1662 consumers visiting RC marketing centre for purchase of duck eggs. All the consumers are consuming the eggs in different dish forms with a maximum of boiled and curry form (~28%). Only 32.65 % consumer gives their preference for duck eggs over chicken egg. All the consumers reported to consuming the duck meat for its good taste and dark meat. Hatchability in fertile egg set basis was upto 98 % in Desi and 94% in Khaki Campbell and White Pekin.

P.G. Education

- During the period under report, 58 students (28 MVSc and 30 PhD) were on roll in Poultry Science discipline under Deemed University, Indian Veterinary Research Institute, Izatnagar.
- Five PhD and 06 MVSc students submitted their theses and received degrees in Poultry Science discipline under Deemed University, Indian Veterinary Research Institute, Izatnagar.

Extension and Transfer of Technology

- Four regular short term training programmes on poultry production management were organized.
- Five specialized short-term training courses in different areas of Poultry Science were organized and trained 34 youths.
- CARI and its regional Centre participated in ten national/regional exhibitions and kisan melas.
- CARI organized Poultry Exhibition-2016 at its campus on 5th Nov., 2016.
- A workshop on Kukkut Vitya Vyavastha: Vartman Sthiti, Samasyai avam Samadhan was organized on 1st March, 2017 under the Agribusiness Incubation Project.
- A kisan goshthi was organized to address the problems of poultry farmers in different aspects of poultry farming at its campus.
- Swachhata Pakhwaras were organized from 16th - 31th May and 16th to 31th Oct., 2016.
- A rally on swachhta was held on 24th May, 2016 at village panchayat Navdia harkisan of Bareilly district (UP).
- Swachhta awareness programme was conducted on 30th May, 2016 at the village Dandia of Bareilly district.
- World Egg Day was organized on 14th Oct., 2016 at Primary and Junior Schools, IVRI, Izatnagar.
- World Soil Day was organized on 5th Dec., 2016 jointly at village Dandia of Bithri chainpur development block, district Bareilly (UP).
- Krishi Education Day was organized on 3rd Dec., 2016 at CARI, Izatnagar.

RESEARCH ACHIEVEMENTS

Productivity Enhancement of Selected Poultry Species

Preservation of elite germplasm of Japanese quails

As per the ICAR letter No. AS/11/1/2013/ASR-II dated 27 Feb 2015, regarding preservation of elite germplasm of Japanese Quail at CARI, Izatnagar, the population of Japanese quail parent stock at Experimental Quail Farm was 12991 as on 31 March 2017 which comprised of five different plumage colours, one egg colour, one cross line and one control lines of Japanese quail.

Pedigreed hatching of different plumage colour varieties of Japanese quail was undertaken with the available germplasm viz CARI-Uttam, CARI-Ujjawal, CARI-Pearl, CARI-Sweta, CARI-Suneheri, CARI-Brown, Cross Line and Control Line. Details of reproductive traits in different line is presented in table 1.

Table 1: Details of reproductive traits of different pure breeds/lines

Varieties of J. quails	No. of Egg set	Infertile Egg	Transfer Egg	Good Chicks	Hatchability Percentage
CARI-Uttam	5355	21	5334	3544	66.44
CARI- Ujjawal	2070	10	2062	1484	71.99
CARI- Pearl	1514	15	1499	992	66.17
CARI- Sweta	2001	07	1994	1375	68.96
CARI -Sunehari	2738	16	2722	1388	50.99
CARI- Brown	3136	19	3117	1618	51.90
CROSS	2292	15	2377	1350	56.79
Control	2268	10	2258	1240	54.91

Genetic Improvement of Guinea Fowl Germplasm

Improving Pearl variety of Guinea fowl as low input climate resilient alternate to chicken

In IV generation of selection for body weight at 12 week, the body weights at 4, 8 and 12 week of age in Pear variety were 162.64±1.5, 566.03±2.6and 913±2.5g, respectively, whereas in control the corresponding averages were 178.25±1.6, 504.72± 3.2 and 856.72±3.9 g. Corresponding body weights in Lavender were 188.4±1.65, 543.7±4.15 and 988.8±7.0g whereas, in white perl variety were 126.0±7.02, 459.8±7.51 and 725.8±7.25g respectively. FCR in perl variety during 0-4, 5-8 and 9-12 wk of age were 3.6±0.29, 3.81±0.43 and 4.89±0.27 respectively. Out of total 14247 eggs 4990 keets were hatched with fertility of 60.99% and hatchability fertile eggs set as 57.42%. At peak egg production egg quality traits such as: egg weight, egg shell thickness, yolk colour, egg shape index, albumin index, yolk index and haugh unit were 44.12±0.22g, 69.13±0.48mm, 7.98±0.11, 79.45±0.42, 77.79±1.11%, 40.10±0.21% and 93.18±0.44 respectively.

An investigation was carried out to break seasonality of laying in Guinea fowl through dietary and photoperiod interventions. The experiment was planned during October to February with 144 Pearl Guinea fowl of 15-35 week age divided in 6 treatment groups (24/treatment) comprising of 3 levels of dietary protein (16,18 and 20%) and two levels of photoperiod (16 and18 hrs light). The best results were obtained at 18hrs photoperiod and 20% dietary protein. Photoperiod appeared to be the primary factor influencing reproductive traits in Guinea fowl comparing to dietary protein as egg production was better under 18 hrs light regime in all three protein levels.

Conservation and Utilization of Indigenous Chicken

Maintenance and evaluation of native chicken and their utilization for family poultry production

Multiplication and reproduction performance of the various breeds: A total of 1950 Aseel Peela, 1049 Aseel kagar, 1654 CARI Red, 663 Nicobari, 1881 Kadakanath, 1060 Ankaleshwar, 496 coloured Frizzle, 549 coloured Naked Neck and 1831 gene pool line chicks were hatched, maintained in pure form and were utilized for production of 15610 parent and commercial chicks for family poultry production. Detailed reproductive traits of different pure breeds/lines have been presented in Table 2. Highest fertility of 87.33% was observed in Ankaleshwar followed by Nicobari (86.81%) and coloured necked neck (80.73%). Ankaleshwar, Nicobari and Ankaleshwar, Aseel Peela had shown best hatchability on TES and FES basis.

Table 2: Details of reproductive traits of different pure breeds/lines

Breed	No. of Egg Set	Killed Chicks	Chicks Hatched	Good Chicks	Fertility (%)	Hatchability (%,TES)	Hatchability (%, FES)
CARI Red	3014	15	1669	1654	70.33	55.37	78.72
Aseel Peela	3008	10	1960	1950	75.53	65.15	86.26
Kadaknath	3530	11	1892	1881	66.65	53.59	80.4
Aseel Kagar	1556	9	1058	1049	80.59	67.99	84.37
Coloured Necked Neck	898	9	558	549	80.73	62.13	76.96
Coloured Frizzle	803	9	505	496	76.71	62.88	81.98
Ankaleshwar	1390	8	1068	1060	87.33	76.83	87.97
Nicobari	910	2	665	663	86.81	73.07	84.17
Gene Pool line	1831	12	1242	1230	78.86	67.83	86.01
Total	**16940**	**85**	**10617**	**10532**	**75.49**	**62.67**	**83.02**

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 performed to evaluate and measure general and specific combining ability (additive and non-additive gene action), heterosis, reciprocal effect, maternal / sex linked effect on growth (body weight), body conformation (shank, keel length and breast angle), age at sexual maturity, annual egg production and egg quality traits. A total nine genetic groups viz. three pure breds Ankleshwar, Nicobari and CARI Red (Fig. 1, 2,3), three crossbreds Ankleshwar x Nicobari, Ankleshwar x CARI-Red, Nicobari x CARI-Red (Fig. 4, 5, 6) and three reciprocals Nicobari x Ankleshwar, CARI-Red x Ankleshwar, CARI-Red x Nicobari (Fig. 7, 8, 9) were resulted. In mating plan 32 sires and 150 dams in Ankleshwar, 18 sires and 108 dams in CARI-Red and 20 sires and 121 dams in Nicobari were used for this experiment. The egg production rate of genetic groups compared with nonlinear optimization technique by using five models viz. Exponential, Gompertz, Monomolecular, Logistic and Modified logistic to find out best-fitted mathematical models for egg production.

Fig. 1: *Females of AN x AN*

Fig 2: *Females of NC x NC*

Fig 3: *Females of CR x CR*

Fig. 4: *Females of AN x NC*

Fig. 5: *Females of AN x CR*

Fig. 6: *Females of NC x CR*

Fig 7: *Females of NC x AN*

Fig. 8: *Females of CR x AN*

Fig 9: *Females of CR x NC*

A) Body weight and Conformation traits: The results revealed that crossbreds were superior over purebreds for various growth, body conformation, egg production and feed efficiency traits. Among purebreds, CR weighed significantly (P<0.05) heavier than Ankleshwer and Nicobari at 20th, 40th and 72nd week of age (Table 3) The lowest body weight was observed in Ankleshwer at all the ages. Crossbreds weighed heavier than its corresponding purebreds at all the ages. Among six crossbred groups, the cross NC×CR recorded highest body weight from 20th to 72nd week of age. The mean shank length of Ankleshwer were significantly (P<0.05) higher from 20th to 72nd weeks of age. Average keel length of CARI Red was recorded significantly (P<0.05) higher at 20th, 40th and 72nd week of age. In general, the shank, keel length and breast angle of all the crossbreds were significantly (P<0.01) more than the purebreds.

B) Reproductive and Productive traits: Crossbreds were earlier to achieve sexual maturity (by 8 days) as compared to the purebreds. Among purebreds, genotype CR was first to achieve sexual maturity (177.83±5.92 days) followed by Nicobari and Ankleshwer. Among crosses, NC×CR pullets (175.29±3.28 days) attained earlier sexual maturity. Crossbreds (198.64±5.17 eggs) exhibited significantly higher mean egg production (by 25 more eggs) than the purebreds (173.38±5.42 eggs). All the genetic groups exhibited highly significant difference (P<0.01) for mean egg production (21-72 weeks). Among purebreds, CR achieved the highest mean egg production (191.00±9.72 eggs) than the other purebreds during 72 weeks production period.

Table 3: Mean±SE of B.Wt (g) influenced by mating systems and genetic groups

Groups	N	Body weight (g)		
		20 week	40 week	72 week
Pure bred				
AN x AN	30	1160.94±36.16^{a}	1222.24±32.99^{a}	1533.48±50.86^{ab}
NC x NC	30	1257.64±53.16^{b}	1462.45±42.55^{bc}	1614.29±64.15^{bcd}
CR x CR	32	1429.28±38.61^{d}	1568.92±43.93^{cd}	1735.38±44.15^{cde}
Crosses				
AN x NC	32	1178.36±36.52^{a}	1426.09±43.35^{b}	1569.61±45.09^{a}
AN x CR	33	1350.08±33.91^{c}	1606.46±33.42^{cd}	1773.97±44.37^{e}
NC x CR	34	1427.54±38.95^{d}	1723.66±37.59^{d}	1875.69±50.01^{fg}
Reciprocal				
NC x AN	33	1322.92±43.09^{bc}	1399.91±36.61^{b}	1465.21±47.39^{a}
CR x AN	35	1273.92±43.09^{b}	1555.70±36.95^{bc}	1732.86±46.34^{cde}
CR x NC	33	1370.59±35.14^{c}	1586.96±22.29^{cd}	1823.29±38.14^{ef}

Among crosses NC×CR (223.96±9.25) had highest mean egg production and AN×CR (191.87±9.29) had the lowest. The reciprocal cross CR×NC had highest annual egg production of (213.32±21.88) while NC×AN had the lowest; showing heterotic effect in egg production with indication of improving the laying performance of native chicken by crossing with CARI Red as male parent. Various egg quality traits differed significantly among all nine genetic groups at 40th and 72nd weeks. Among purebreds, CARI red exhibited the highest egg weight and egg quality traits 40 at week of age except the shape index which was highest (76.03±0.91) in CARI Red. At 72nd week of age, purebreds had significantly higher egg weight (52.84g) than crossbreds whereas egg quality traits were higher in crossbreds. Among purebreds, feed consumption per kg eggs mass and per day feed consumption was highest in CARI Red whereas among crossbred NC×CR was found best. Highest and positive heterosis at of measurement was recorded in NC×CR followed by its reciprocal CR×NC. The magnitude of heterosis was higher in NC×CR followed by AN×CR for egg weight and other egg quality traits.

C) ***General and Specific combining ability for egg production traits***: Significant (P<0.01) variance due to GCA and SCA were observed for all the traits studied. However, reciprocal and sex-linked /maternal effects were found to be significant only for body weight, egg weight and egg number at 40th and 72nd weeks of age. The CR breed recorded the highest (positive) and significant (P<0.01) GCA effect for body weight at all ages of measurement. The best SCA effect was found in NC×CR followed by CR×NC for body weight. Similarly, the reciprocal effects were positive and significant for body weight at all the ages in all the crosses. ANOVA in model B revealed that SCA variance for body weight had significant unidirectional dominance and asymmetry of gene distribution. Maternal effects for body weight were significant in these crosses. Reciprocal differences other than maternal effects for body weight were found significant. It indicated that GCA, SCA and reciprocal effects were important for growth traits.

The highest and positive GCA effect in shank length was revealed by AN. For keel length NC was found to have high and positive values at all ages. The CR genotypes had shown the highest and positive GCA effect in keel length at all ages of measurement. The reciprocal effects, residual reciprocal effects and maternal effects on body conformation traits at all ages. It is inferred that the additive and non additive effects were non significant of genes were important for body conformation traits. At 40th week of age, least square estimates of GCA revealed the highest (positive) significant value for egg weight, yolk index, albumen index, Haugh unit and albumen weight in NC; shape index, shell weight and yolk weight in CR and shell thickness in NC. At 72nd week of age, least square estimates of GCA effect revealed the highest (positive) significant effect for egg weight, Haugh unit score, albumen weight and yolk weight in NC; shape index in AN; shell weight and yolk index in CR. In case of annual egg production, CR recorded the highest (positive) value of GCA effect as compared to NC and CR.

Significant differences were observed for

reciprocal effects in different crosses for body growth, measurement, egg production and egg quality traits. For inheritance of egg production traits, both additive and non-additive gene actions were important, however, the non-additive gene action was found more important for ASM and yolk index.

D) Best fitted model for egg production curve: The egg production data were analysed using two models *viz.* Model A: Griffing (1956) and Model B: Hayman (1954). Model A (Griffing, 1956) provided the best information with respect to GCA, SCA and reciprocal effects simultaneously. Model B (Hayman) suffered adversely from the power to test the variance component. The crossbreeding genetic parameters were determined using model A. The measures of goodness of fit for Gompertz model gave minimum value for MSE, MAE and AIC and higher adjusted R^2. Based on this study, crosses of Nicobari (male line) and CARI Red (female line) was adjudged as best cross combination for rural poultry production.

Genetic Improvement of Synthetic Broiler Lines

Development and evaluation of synthetic broiler sire lines

So far, 15th 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 2030, 5000 and 946 eggs were set in SML, CSML and control out of which 1535, 3815 and 696 good chicks were produced in respective lines. Corresponding fertility percentages were 83.69, 85.56 and 84.92. Hatchability percentages on TES and FES were 76.45 and 91.34 respectively in SML, 77.26 and 90.30, respectively in CSML and 74.72 and 87.26 in control.

Body weights at different ages: Overall average of body weight of mixed sexes at 5 weeks in CSML, SML and control were 1222.63±4.65, 1177.59±5.95 and 756.67±7.45 g, respectively. The phenotypic and genetic responses to selection for 5-week body weight in SML were 14.60**±1.49 and 12.69*±0.84 g/generation. Corresponding values in CSML were 17.56**±1.26 and 15.23**±1.64 g/generation. The phenotypic response for 5-week body weight in the control population was non-significant (2.46±1.32 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.

Development and evaluation of synthetic broiler dam lines

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

Incubation and hatchability: A total of 5287 and 3722 eggs were in CSFL and SDL, respectively, out of which 4282 and 2758 good chicks were hatched out in respective line. The fertility percentage was 88.99 and hatchability percentage based on TES and FES were 80.99 and 91.01, respectively in CSFL. Corresponding values in SDL were 84.09, 74.91 and 89.07 percent, respectively.

Body weights at different ages: The overall average of body weight at 5 weeks in CSFL and SDL were 1175.09±3.51 and 1115.05±3.44 g. The phenotypic and genetic responses to selection for 5-week body weight in SDL were observed as 13.00±2.81** and 10.67±2.80** g/generation. Corresponding values for CSFL were 18.61**±1.37 and 16.27**±1.73.

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.

Other broiler stocks: The frizzle stock was crossed with naked neck for production of a stock having both naked neck and frizzle genes. The stock was given the name CARIBRO-Tropicana. Besides two other commercial stocks namely IC3 and IR3 are also maintained in the Experimental Broiler Farm.

Incubation and hatchability: The fertility, hatchability (TES) and hatchability (FES) percentages in IC3, IR3 and CARIBRO Tropicana, Naked neck white, naked neck colored and control have been presented in table 4.

Table 4: Reproductive performances in different broiler strains

Genetic gp	Egg set	Killed	Good chicks	Total Chicks	Fertility %	H% TES	H% FES
IR3	1070	17	823	840	93.36	78.50	84.08
IC3	1193	21	839	860	84.58	72.09	85.23
NNC	862	13	589	602	86.66	69.84	80.59
Trop.	498	5	379	384	89.56	77.11	79.01
NNW	170	1	132	133	89.41	78.23	87.5

Body weights: The mean body weight at 5-week of age in IR-3, IC-3, CARIBRO-Tropicana, Naked

neck colored and naked neck white were 1156.69±7.85, 934.08±5.52, 1039.13±9.43, 1265.63±8.75 and 1207.15±13.94 g, respectively.

Augmenting Performance of Broilers Breeder Through Betaine Supplementation

In order to evaluate role of betaine (methyl donor) as heat ameliorating agent in broiler chicken, experiment was conducted with betaine dietary levels @ 0.5, 1 and 2 g/kg for a period of six week.

Each treatment group had 48 birds with four replicate of 12 birds per replicate. Production performance, immunity, gut morphology, physiobiochemical and stress parameters were recorded. Supplementation of betaine @ 1g/kg significantly improve production performance as well as breast meat yield ($P<0.05$). Supplementation of betaine also significant ($P<0.01$) improved humoral as well as cellular immunity with best result in 1gm/kg dose level. Supplementation of betaine shows significant ($P<0.01$) improvement in gut morphology with increase in villus length. Betaine supplemented groups showed significant ($P<0.01$) improvement in Hemoglobin, serum protein and immune organ weight. Addition of betaine @ 1gm/kg to basal diet significantly ($P<0.01$) reduce serum corticosteron, H:L ratio, ALT, AST and serum cholesterol. It was concluded that betaine supplementation could improve performance, welfare as well as immunity in heat stressed birds, with best result in 1g/kg dose.

Conservation of Elite Layer Stock

Pure annual production strains: Data on layer traits, viz., age of sexual maturity (ASM), body weight at 16 (BW16) and 40 (BW40) and weeks of age, egg weight at 28 (EW28) and 40 (EW40) weeks of age and egg number up to 40 (EP40) weeks of age in IWH and IWI was analyzed LSML-ANOVA. Effect of sire was significant on ASM and EP40 traits only in IWH, and IWI strain. The LS means of respective traits in IWH were 146.7±1.6 days, 823.4±7.9 g, 1209.9±12.4 g, 43.6±0.2 g, 49.4±0.3 g, 103.4±1.5 eggs, respectively. Corresponding means in IWI were 146.8±1.2 days, 856.9±9.5 g, 1256.3±12.3 g, 45.05±0.34 g, 50.11±0.36 g, 105.08±1.12 eggs.

Pure part-period production strains: Data on above mentioned traits was analysed using LS-ANOVA in IWG and IWJ strains. LS means of respective traits in IWG were 136.4±1.4 days, 1064.2±13.1 g, 1628.2±19.3g, 47.1±0.3g, 50.2±0.4g and 109.3±1.4 eggs. Corresponding means in IWJ were 142.4±2.0 days, 997.9±14.8g, 1531.1±21.1g, 45.52±0.36g, 48.24±0.28g and 109.2±1.8 eggs,

Genetic Improvement of Rhode Island Red

Improvement of Rhode Island Red for development of multicolored strains for rural poultry production

Reproductive performance of RIR strains: The reproductive performance of selected strain of Rhode Island Red (RIR_S) and its control population (RIR_C) for 33_{rd} generation has been recorded. Five hatches were taken and a total of 6408 and 2090 eggs were set in RIR_S and RIR_C populations, respectively. The average fertility per cent in RIRs and RIRc were 83.2 to 91.2 %, respectively. The hatchability percentage on total eggs set and fertile eggs transferred basis in RIRs and RIRc were 69.98, 83.2 % and 84.1 and 91.2%, respectively.

Comparative performance of RIR pure strain*: E*valuation for the economic traits like age at sexual maturity (ASM) or age at first egg (AFE), body weight at 20th and 40th week of age; egg weight at 28th and 40th week of age and egg number up to 40-week of age in RIR selected (RIRs) and control population (RIR_C) was performed. The least square average of ASM in RIRs and RIRc strains was 144.9±0.41 and 181.3±0.96 days, respectively. The 20th week body weight in RIRs, RIRc strains was 1367.5±4.16 and 1153.5±7.77g, respectively. The 28th week egg weight in RIRs and RIRc was 45.15±0.08 and 42.90±0.13g, respectively.

The average 40th week body weight, egg weight and egg numbers, were 1735.5±5.95g, 50.17±0.08g, 105.13±0.48 nos for RIRs and 1618.9±11.08g, 47.90±0.16g, 64.3±0.80 nos, respectively (Table 5).

Table 5: Comparative performance of RIR during S32 generation (2015-16)

Traits	RIRS	RIRC
B.Wt (g) -20 wk	1367.5±4.16 (1743)	1153.5±7.77 (579)
ASM (d)	144.9±0.41 (1744)	181.30±0.96 (579)
E.Wt. (g) - 28 wk	45.15±0.08 (1679)	42.90±0.13 (336)
B.Wt (g) - 40 wk	1735.3±5.95 (1639)	1618.9±11.08 (563)
E.Wt. (g) - 40 wk	50.17±0.08 (1521)	47.90±0.16 (507)
EP up to 40 wk	105.13±0.48 (1720)	64.30±0. 80 (579)

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). On Phenotypic scale, the ASM declined significantly to the tune of -1.051±0.22**day per generation. There was a significant positive gain in 40th wk egg weight (0.05±0.04g) and 20th wk. body weight (7.19±2.28g**), while 40 wk body weight (-8.48±2.02g**) declined significantly. The Egg number up to 40th wk of age improved to the tune of 1.13±0.18nos**.

On genetic scale, the average response per generation for 40th wk egg number was highly significant and positive with the estimates of 1.10±0.111** eggs (Table-5 and Fig -10). The ASM declined significantly by -0.803±0.15** day per generation. There was significant positive genetic gain in 40th wk egg weight (Fig-11), 20th and 40th wk body weights to the tune of 0.077±0.015**, 8.13±1.51** and 6.24±1.45**g per generation, respectively. Average regression coefficients for most of the economic traits in control population were found to be non-significant indicating its stability in eliminating the environmental trend.

Table 6: Genetic and Phenotypic response in RIR pure strain and control population during S33 generation

Traits	RIRs	
	Phenotypic response	Genetic response
BW AT 20thwk (g)	7.19±2.68**	8.13±1.51**
BW AT 40thwk (g)	-8.48±2.02**	6.24±1.45**
ASM (d)	-1.051±0.22**	-0.803±0.152**
EW AT 40th wk (g)	0.05±0.043**	0.077±0.015**
EP At TO 40th wk (nos)	1.13±0.18**	1.10±0.111**

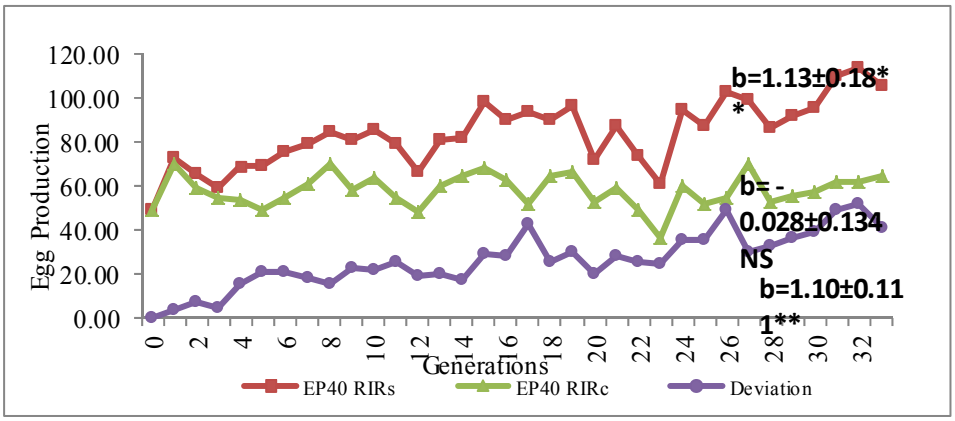


Fig. 10: Genetic and Phenotypic gain in 40 wk EP in RIRs during 33nd generation

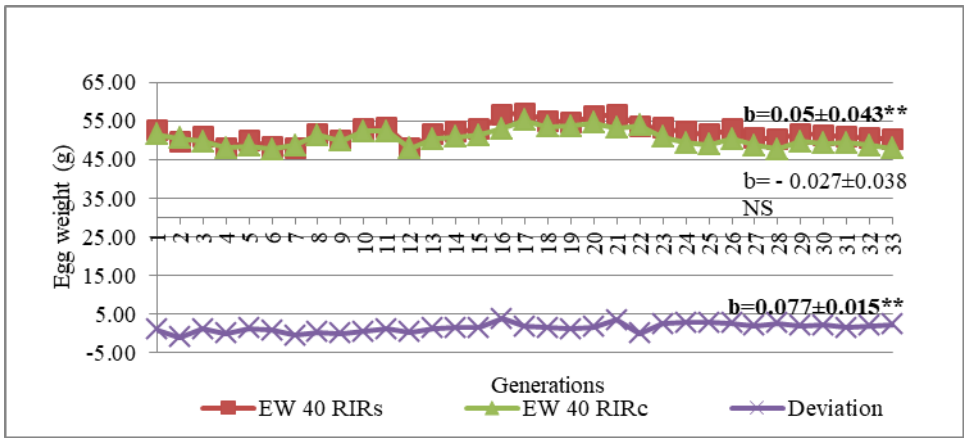


Fig. 11: Genetic and Phenotypic gain in 40 wk egg weight in RIRs during 33nd generation

Performance of RIR crosses: The fertility, hatchability % on total eggs set basis and hatchability % on fertile eggs basis in RIR crosses like CARI Debendra (CD) and CARI Sonali (HR) was 59.2, 52.4, 88.6% and 81.6, 72.2, 88.5%, respectively. The ASM, 20th wk, 40th wk and 72th

wk body weight of CD and HR were 142.5±2.93 d, 2101.3 ±41.85 g, 2708.5 ±70.0g and 3190.7 ±89.4g and 140.5 ±1.90d, 1361.7 ±30.20g, 1693.0±38.3g and 1918.5±46.3g, respectively. The egg production up to 40th and 72th wk, egg weight at 28th, 40th and 72 wk of CD and HR were 96.4±3.03 nos, 207.5±7.74 nos, 51.3±0.18, 56.6±1.22 and 64.6±1.90 and 112.7±2.514, 267.7±4.40, 49.7±0.77, 51.8±1.40 and 59.1±1.58, respectively.

Immunocompetence, Microsatellite and candidate gene expression profiling of RIR chicken and association of microsatellite alleles/ IC profile with egg production traits

***A) Growth and layer economic traits and their inter-relationship in RIR chicken*:** Data on RIRs chicken (286) on body weights at various ages viz 0 day, 2, 4, 6, 8, 10, 12, 16, 20, 24, 28, 32, 36 and 40 weeks of age were analyzed by LS ANOVA taking sire as random and sex and hatch as fixed effects. The effects were significant for sire on body weights at almost all the ages and that of hatch on BW4, BW6, BW8, BW20 and BW24.The overall LS means of these body weight traits were 34.4±1.20, 71.36±4.16, 184.19±5.75, 361.16±12.64, 571.34±13.92, 677.92±16.79, 457.28±23.37, 1474.87±35.12, 1795.35±37.23, 1938.35±41.95, 2006.87±63.95, 2141.99±60.27, 2204.56±47.05 and 2265.84±51.80 g, respectively.

B) Profiling of growth associated microsatellite loci: Total 114 RIRs chicks were genotyped using 10 growth associated microsatellite loci belonging to chromosome 1. The allelic and genotypic data were analyzed using POPGENE® software. The influences of microsatellites' genotype on growth traits were analyzed using JMP 9.0.0 software package. The the molecular sizes of products ranged from 97 to 349 bp among MS loci. A total of 26 alleles were observed at ten MS loci with average number of alleles being 2.60±0.26. The number of alleles at various loci ranged from 1 to 4. The most frequent allele (76.32%) at LEI0079 locus was 214 bp size.

C) Population structure: The mean±SE of Nei's heterozygosity and PIC value were 0.5598±0.0381 and 0.4809±0.0414 and 0.2961 (LEI0079) to 0.6716, respectively. N_a and N_e, I and F_{IS} were 2.6000±0.8433, 2.2583±0.7401, 0.8190±0.3725 and 0.2178±0.1225. The mean±SE of observed and expected heterozygosity were 0.597±0.2354 and 0.501±0.2063, respectively. Chi-square test and likelihood ratio tests revealed that the studied population was in H-W disequilibrium at almost all MS loci.

D) Association between genotypic polymorphism at growth-associated Microsatellite loci and Growth traits: Out of the 10 microsatellites studied, 9 microsatellites revealed polymorphism. Least squares analysis of variance was carried out to determine the effect of microsatellites genotypes on growth traits taking sire as random and microsatellites genotype sex and hatch as fixed effects. five out of 9 MS found to have significant effect on growth traits. ADL0010 microsatellite-genotypes had significant effect (P≤0.05) on BW16, BW32, BW36 and BW40. with AA genotype pullets showing highest body weight at 16 weeks of age (1605.22±132.53g). Pullets with AA genotype at MCW0010 locus revealed highest BW32 (2438.26±181.68 g), BW36 (2465.85±172.82g) and BW40 (2529.79±207.45g). Genotype BC had lowest BW40 (1915.75±179.55 g).

MCW0058 microsatellite-genotypes had significant (P≤0.05) effect on BW24 and BW28. Pullets having CC genotype revealed highest BW24 (2127.35±89.59 g) and BW28 (2111.49±122.95 g) whereas the pullets with AC genotypes revealed lowest BW24 and BW28. Bird having BC genotype at MCW0068 loci revealed highest BW28 with 2172.60±106.27 g.

Genotypes at MCW0328 microsatellite locus differed significantly (P≤0.05) for chick weight and body weight at 2 and 28 week of ages. The pullets with BB genotype showed highest chick weight (35.74±2.16 g) which was significantly different than pullets having AA (32.74±3.03 g) and AB (33.06±2.14 g) genotypes. At BW2, BB genotype demonstrated highest body weight (87.93±4.08). The AA genotype chicks revealed lowest BW2 (79.89±8.16g).

LEI0071 microsatellite- genotypes had significant effect (P≤0.05) on chick weight and BW28. The pullets having AB genotype showed highest chick weight (38.20±2.49 g). Birds having CC genotype revealed highest BW28 (2165.16± 128.79 g).

E) Relative expression of IGF-1 gene in various tissues of RIR chicken: Relative mRNA expression of IGF-1 gene in liver and breast muscle tissues of RIRs chicken exhibited significant (P≤0.05) differences in liver between two hatches. The 40-ΔC_t values were 32.58±0.792 and 35.86±1.120 in first and second hatches, respectively. In breast muscle, the relative mRNA expression of IGF-1 gene differed significantly (P≤0.1) between two sexes with males having higher 40-ΔC_t values (34.270±0.256) than females (33.577±0.256).

Poultry Waste Management

Utilization of poultry waste for green energy and organic fertilizer generation

Aerobic composting of poultry excreta: In order to develop safer disposal and handling technique of poultry excreta for health and environment safeguards under Indian conditions, this study was planned to standardize the aerobic composting of poultry excreta during winter season through different C/N ratio using sawdust as carbon source.

Meshed iron wire made composting bins measuring 1.2m length x 1.2m width and 1.2m height were fabricated by the use of discarded poultry cages. The poultry excreta were mixed with the calculated amount of sawdust to attain the C:N ratio of 15:1 (T_1); 20:1 (T_2); 25:1 (T_3) and 30:1 (T_4). No sawdust was mixed in the control group (T_0) and the initial C/N ratio was 10:1. Composting was carried out by sequential layering of saw dust and poultry excreta. Measured quantity of water was also added during filling to maintain constant moisture (45-50%) in all treatments except control. The turning of composting bins was undertaken after completion of primary phase. It was supposed that secondary phase, which also includes curing of composting product, gets completed when temperature again reached to its initial filling level.

The average bin temperature was significantly ($P<0.01$) higher in all the treatments than control group and T_1 (Table 7) both during primary and secondary phases of composting. Similar trend was observed for peak temperature. The composting period was very less in control than T_3 and T_4 groups. The initial moisture content was significantly higher in control than other four treatment groups during initial ($P<0.01$) and final ($P<0.05$) stage of composting (Table 7).

Volume and weight reduction (%) was numerically lower in control than other treatment groups in order of T_4, T_3, T_2 and T_1. There were non-significant differences for initial pH among various groups. The pH during turning and final stage of composting was significantly ($P<0.01$) higher in control than treatment groups. The TOM and TOC were significantly higher in T2, T3 and T4 groups than control and T_1 groups during initial ($P<0.01$), turning ($P<0.05$) and final ($P<0.05$) stages of study. The C:N ratio was significantly ($P<0.05$) higher in T_3 and T_4 than control and other two treatment groups during initial and final stages of composting. The total bacterial count (TBC) and *E. coli* count (log10) was non-significant during at initial and turning stages but at final stage both were significantly ($P<0.01$) lower in different treatment groups than control.

Among various plant nutrients (Table 8) total nitrogen, during initial stage, was significantly ($P<0.01$) higher in control than treatment groups in declining order of T_2, T_1, T_3 and T_4. At turning and at the final stage the difference was non-significant in all the groups. The calcium at initial and turning stage was non-significant among different treatment and control groups. However, difference was significant ($P<0.05$) at final stage. Similarly, P and K were non-significant at various stages of composting. Maximum value addition was calculated in T_1 followed by T_2, T_3 and T_4 groups. Since best germination was observed in T_4 and T_3 group, about 2.0-2.5 time value addition can easily be expected from aerobic composting of poultry excreta during winter season.

Table 7: Temperature and duration of poultry composting

Parameters	Stage	T_1 (15:1)	T_2(20:1)	T_3(25:1)	T_4(30:1)	T_0(10:1, Control)
Average Temp. (°C)	P	44.84±0.83^b	48.77±0.74^a	51.24±0.96^a	51.11±0.89^a	36.12±1.50^c
	S	31.30±0.82^c	45.59±1.31^b	45.23±0.77^b	51.96±1.04^a	24.11±1.14^d
Peak Temp. (°C	P	56.72	73.10	73.85	74.05	49.35
	S	41.10	60.80	62.68	69.48	39.00
Average composting duration (days)	P	58	86	86	87	42
	S	21	48	85	86	34
	Total	79	134	171	173	76

P:Primary phase, S:Secondary phase; Means with different superscript in a row differs significantly at P<0.01

Besides, generating the financial gains to the poultry farmer, this technology has enormous positive impact on environment by drastically reducing pollutants, bad odour and flies thereby also helping in accomplishing the Sawachch Bharata Mission.

Table 8: Physical, chemical and microbial properties of poultry compost at different stages of composting

Parameters	Stage	T_1 (15:1)	T_2(20:1)	T_3(25:1)	T_4(30:1)	T_0(10:1, Control)
Moisture (%)	I	45.80±0.16^{b}	45.80±0.18^{b}	46.50±0.54^{b}	45.60±0.90^{b}	70.06±1.32^{a}
	T	50.70±0.52	51.60±0.67	53.90±0.39	51.20±0.48	58.58±0.67
	F	36.35±0.94^{B}	38.20±0.15^{B}	32.18±0.45^{C}	32.13±0.63^{C}	45.00±0.72^{A}
C:N Ratio	I	16.54±0.35^{d}	20.27±0.88^{c}	25.01±0.12^{b}	30.01±0.25^{a}	10.09±0.09^{e}
	T	14.58±0.38^{C}	16.40±0.18^{AB}	18.60±0.08^{A}	19.45±0.29^{A}	16.90±1.41^{AB}
	F	14.84±1.79^{AB}	16.11±1.30^{AB}	19.03±0.82^{A}	18.72±0.44^{A}	12.33±1.16^{C}
TBC (log10)	I	8.31±0.01	8.55±0.01	8.09±0.01	8.30±0.01	8.87±0.01
	T	7.61±0.01	7.34±0.01	7.43±0.01	7.66±0.01	8.72±0.01
	F	6.63±0.21^{b}	7.12±0.09^{b}	6.85±0.16^{b}	6.76±0.20^{b}	8.58±0.05^{a}
E. coli	I	5.71±0.01	5.09±0.01	5.46±0.01	5.43±0.01	5.40±0.01
	T	5.05±0.01	4.97±0.01	5.07±0.01	5.52±0.01	5.25±0.01
	F	0.96±0.55^{b}	1.03±0.59^{b}	0.83±0.49^{b}	0.83±0.49^{b}	5.13±0.02^{a}

I:Initial, T:Turning, F:Final ; Means with different superscript in a row differs significantly (Upper case, P<0.05; Lower case, P<0.01)

Table 9: Plant nutrient content and germination potential of poultry compost

Parameters	Stage	T_1 (15:1)	T_2(20:1)	T_3(25:1)	T_4(30:1)	T_0(10:1, Control)
Nitrogen (%)	I	2.16±0.05^{b}	2.11±0.10^{b}	1.76±0.09^{c}	1.39±0.01^{d}	3.56±0.05^{a}
	T	2.26±0.03	2.25±0.04	2.16±0.03	2.10±0.01	2.11±0.08
	F	2.30±0.08	2.25±0.07	2.12±0.07	2.15±0.05	2.17±0.05
Phosphorus (%)	I	1.43±0.16	1.40±0.16	1.66±0.01	1.42±0.16	1.58±0.17
	T	1.84±0.09	1.89±0.11	1.71±0.01	1.99±0.01	1.74±0.01
	F	1.94±0.11	1.97±0.09	1.71±0.24	2.05±0.31	2.43±0.13
Potassium (%)	F	3.38±0.08	3.47±0.11	3.51±0.09	3.91±0.11	3.83±0.09
Germination Potential (%) (Black-eyed beans)	Crude Compost	8.00	32.00	50.00	70.00	0.00

I:Initial, T:Turning, F:Final ; Means with different superscript in a row differs significantly (Upper case, P<0.05; Lower case, P<0.01)

Table 10: Value-addition of poultry excreta due to aerobic composting

Components	T_1 (15:1)	T_2(20:1)	T_3(25:1)	T_4(30:1)
Quantity of poultry compost (kg)	100	100	100	100
Input cost (@Rs 2.50/kg saw dust)	33.48	71.50	116.88	160.05
Urea equivalent (Rs.) @Rs. 5.52/kg	27.60	27.00	25.44	25.80
Potash equivalent (Rs.) @Rs. 17.44/kg	98.25	100.86	102.02	113.65
SSP equivalent (Rs) @ Rs. 7.44/kg	90.21	91.61	79.52	95.33
Limestone equivalent (Rs.) @ Rs.4.0/kg	63.60	53.20	60.92	61.56
Total Output (Rs.)	256.66	261.47	237.98	272.48
Net income (Rs.): Output-Input cost	223.18	189.97	121.10	112.43
Per kg net income (Rs.)	2.23	1.90	1.21	1.12
Cost of fresh poultry excreta (Rs.)	0.50	0.50	0.50	0.50
Value Addition (times)	4.46	3.80	2.42	2.25

- Soil health (porosity) + Environmental + Health issues: Many times more
- Suitable for organic crop production

Standardization of 'DAC Technology' For Biogas Production Exclusively from Poultry Excreta: Industrialization and intensification of poultry farming has led to generation of poultry wastes to the tune of 28-30 million metric tonnes per annum. These wastes are posing many environmental and health threats due to lack of proper utilization technologies/ disposal methods. Therefore, scientists of ICAR-Central Avian Research Institute, Izatnagar, Bareilly (UP)-243122 had developed a novel 'DAC' technology for all-weather biogas production exclusively from poultry excreta. This technology was tested on a pilot biogas plant comprising of anaerobic digester (200 lit) with various common components like inlet pipe, outlet pipe, gas collector, bio-gas compressor, gas cylinders etc.The poultry biogas burns like LPG with blue flame. The composition of poultry biogas revealed that the methane (%, V/V) was 60.02 which is equal to or better than biogas available from other methods and substrate.

The signifying point of this technology is that only poultry excreta are required for biogas production. There is no need to add cow dung which is commonly being mixed for biogas production from poultry excreta in other methods. This technology also helps in conservation of water as used slurry of digester is reutilized again and again as dilutor for poultry excreta. Round the year i.e. both during summer and winter biogas production is possible from this technology. It is pertinent that, in India, most of the biogas plants become non-functional during winter season due to lower ambient temperature. In our technology, about 12-13 to 19-20 kg poultry excreta is required for production of about one cubic meter of biogas during summer and winter seasons, respectively. This quantity of biogas is sufficient for cooking 3-times meals of an average family comprising 4-5 members. This can also be used as heat source at poultry farm. Spent slurry of poultry biogas has good manure value and germination potential and can be easily applied in agricultural fields for organic crop production without burning effect on plants which is a common problem with crude poultry excreta.

This technology may be helpful in self sustainability of rural poultry farmers in terms of their energy demand. The excreta of 5000 layers birds has capacity to produce approximately 4100 kg biogas per annum whose market value will be around Rs. 1.31 lakh, if cost of biogas is considered at the rate is considered Rs. 32.00 per kg. There is potential to produce around 128 tonnes of manure from spent slurry. The value of this manure will stand around Rs. 2.56 lakhs on urea, phosphate, potash and micronutrient equivalence basis. Therefore, this technology has great potential of value addition to the tune of 5-6 times from invaluable poultry excreta. Besides, generating the financial gains to the poultry farmer, this technology has enormous positive impact on environment by drastically reducing pollutants, bad odour and flies thereby also helping in accomplishing the Sawachch Bharata Mission.

Nutrients Management

Nutrition for Health and Welfare

- Body weight at the age of sexual maturity is an important criterion for maximum and sustainable egg production in commercial layers. However, problems (threat to health, growth performance and immunity) remain for summer hatched chicks as feed intake is reduced due to thermal stress and thus it becomes difficult to attain optimum body weight at the point of lay resulting in delayed egg production. Therefore, a study was conducted to evaluate the effects of dietary inclusion of mannan-oligosaccharides (MOS) at different energy and protein level on performance of brown shelled egg-type chicks (CARI Sonali, n=200) from 3 to 9 weeks of age during hot-dry summer (April-May, 28.0±0.12°C to 35.25± 0.37°C, Rh,%: 68.95±0.90 to 79.15±0.61). After feeding a standard diet from 0-21d of age, the chicks were randomly distributed into four dietary treatment groups viz., T1 with high energy 2800 kcal ME/kg and high protein 18.00 % (HEHP), T2 with HEHP diet and MOS @ 0.2% (HEHP+MOS), T3 with low energy 2700 kcal ME/kg low protein 17.34 % (LELP) and T4 with LELP diet and MOS @ 0.2% (LELP+MOS). Feed intake and FCR improved significantly ($P<0.05$) in HEHP as well as MOS incorporated group. H: L ratio significantly ($P<0.05$) reduced in MOS supplemented group at

42nd as well as 63rd day of age. Immune organs like thymus, spleen and bursa had significantly (P<0.05) higher weight in MOS supplemented group. Total protein (P<0.001), SGOT (P<0.001), SGPT (P<0.001), creatinine (P<0.05) were significantly improved while cholesterol, uric acid and ALP was significantly (P<0.001) reduced in MOS supplemented diets. Villus height and crypt depth improved significantly (P<0.001) in MOS supplemented group at 42nd as well as 63rd day of age. Thus it was concluded that high-energy (2800 kcal ME/kg) and high protein (18% CP) diet was beneficial for egg type starting chicks during dry summer. Moreover, the inclusion of MOS @0.2% gave further advantage to improve performance and reduce thermal stress as evidenced through zoo-technical indices and blood bio-chemicals.

- Maintaining a structurally sound gut is a prime strategy for efficient and hygienic poultry production as it ensures proper digestion and absorption of valuable intrinsic feed factors, alleviate sub-clinical infections, if any, by promoting body defense, provide resistance against entero-pathogens and thus reducing losses due to mortality and morbidity. Accordingly, a study was conducted to evaluate the effect of synbiotic on performance parameters, blood characteristics and carcass yields of turkey poults fed diets containing probiotic, prebiotic and synbiotics (Probiotic + prebiotic). In a factorial design, 160-day-old healthy turkey poults were randomly allocated into four groups with four replicates each of 10 chicks. A basal diet was formulated, the rest three diets were prepared by adding MOS at 0.1% as T2, Bacillus subtilis (10^6cfu/g of feed) as T3 and combination of both (0.1% MOS and Bacillus subtilis at 10^6cfu/g of feed) as T4 with basal diet. Production performance in terms of body weight (g) and feed conversion ratio (FCR) improved in increasing order in T2, T3 and T4 compared to control group. Feed intake (FI) were significantly (P<0.01) less in synbiotic group compared to groups fed other dietary treatments. Serum protein and albumin level, serum enzymes (AST, ALP and ALT), total glucose and total cholesterol concentration were influenced by probiotic or MOS alone or in combination compared to control groups. Villus height at 35d of age were highest in T_4 treated group followed by T_3 and T_2, lowest height was recorded in T_1 (control) group and the results were highly significant (P<0.001). Similar pattern was observed in villus width also, and highest villus width was recorded in T_4 group, lowest was recorded in T_1 (control) group, the results were highly significant (P<0.001). The crypt depth was also recorded highest in T_4, the results were significant (P<0.05). Microbial population was also improved on addition of any of these additives but maximum improvement was observed in synbiotic group. The results of the present study showed that synbiotic provide additive benefits in growth performance; feed conversion ratio, serum biochemical parameters, and structural as well as microbial gut health than that of individual use of prebiotics or probiotics.
- Similarly an experiment was conducted to evaluate the effects of dietary inclusion of symbiotic (mannan-oligosaccharides and probiotics- *Bacillus subtillis*, *Bacillus amyloliquefaciens*) at different energy and protein level on performance of egg-type starting chicks (22-63d of age) during hot-dry summer (April-May, temperature- 28.0±0.12°C to 35.25±0.37°C, RH, %: 68.95±0.90 to 79.15± 0.61). After feeding a standard diet from 0-21d of age, the chicks were randomly distributed into four dietary treatment groups viz., T_1 with high energy 2800 kcal ME/kg and high protein 18% (HEHP), T_2 with HEHP diet with symbiotic (MOS @ 0.2% + Protimix @ 0.025 %), T_3 with low energy 2700 kcal ME/kg low protein 17.34% (LELP) and T_4 with LELP diet with symbiotic (MOS @0.2% + Protimix @0.025 %). Each treatment had fifty birds divided in five replicates of ten each. Parameters like production performance, immune organ weight, blood biochemical and intestinal histo-morphometry were measured at 42nd and 63rd day post hatch. Feed intake and FCR improved (P<0.05) in HEHP+symbiotic group. H: L ratio reduced (P<0.05) in symbiotic fed group. The relative yields of immune organs like thymus, spleen and bursa were higher (P<0.05) in symbiotic supplemented group. Total protein (P<0.001), SGOT (P<0.001), SGPT (P<0.001), creatinine (P<0.05) were significantly improved while cholesterol, uric acid and ALP were significantly (P<0.001) reduced in symbiotic supplemented diets. Villus height and crypt depth improved significantly (P<0.001) in symbiotic supplemented group. Thus it was concluded that high energy (2800 kcal ME/kg) and high protein (18% CP) diet along with inclusion of symbiotic was beneficial for egg type starting chicks during dry summer.
- Feed mycotoxins (aflatoxins and ochratoxins) also affect the gut integrity and welfare aspects. Accordingly an experiment was conducted to assess the comparative efficacy of MOS (0.15%

and 0.3%) and Na-butyrate salt (500 and 1000 mg/kg) and their combinations for amelioration of toxicity of dietary induced Aflatoxin B1 (300 ppb) and Ochratoxin A (250 ppb) in broiler chickens. The body weight gain (0-6 wk) of broilers in control group was 1682 g but was significantly ($P<0.05$) lower gain (1370 g) in artificially toxin (300 ppb AFB1+250 ppb OTA) induced diet fed group (T1). The overall gain in 0.3% MOS along with 500 mg/kg Na butyrate salt incorporated diet was statistically similar to that of control. Feed intake in control group was higher ($P<0.05$) than mycotoxin (300 ppb AFB1+250 ppb OTA) fed group. MOS at levels (0.15% and 0.3%), 0.15% along with 500 and 1000mg/kg NaB salt and 0.3% MOS along with 500 mg/kg NaB salt improved feed consumption in broiler chickens. The FCR in toxin alone fed group was poor but improved in 0.3% MOS+500 mg/kg NaB fed group. Shrinkage loss and less dressing yield were more in mycotoxins alone fed group. Supplementation of MOS and NaB salt had partial ameliorative effect on these parameters. The increased relative weight of liver, heart, gizzard, spleen and kidney in toxin alone fed group was significantly ameliorated by dietary supplementation of 0.3% MOS with 500 mg/kg NaB. Supplementation of 0.3% MOS with 500mg/kg NaB also reduced the toxic effect of mycotoxins on the relative weight of bursa. Decreased cellular and humoral immunity of broilers due to mycotoxin feeding was significantly ($P<0.05$) improved on 0.3% MOS + 500 mg/kg NaB salt supplemented group. Feeding mycotoxin (300 ppb AFB1+250 ppb OTA) showed congested sinusoids with diffused degenerated hepatocytes and focal aggregates of mononuclear cells in liver parenchyma, loss in villus architecture due to severe degeneration and increased in number of crypts cell in jejunum tissue and acute degeneration, necrosis in renal tubules and fatty vaculation in many section of renal tubules. Supplementation of 0.3% MOS alone or along with 500 mg/kg NaB salt to the mycotoxin contaminated diet ameliorated the adverse effects of mycotoxin and showed nearly normal appearing liver parenchyma. 0.15% MOS alone and along with 500 and 1000 mg/kg NaB salt; 0.3% MOS along with 500 mg/kg NaB salt decreased the severity of toxicity of mycotoxin in intestinal tissue, whereas only 0.3% MOS along with 500 mg/kg NaB salt improved mycotoxin induced damage of renal parenchyma. The villus length/ crypt depth ratio in other treatment groups was higher than that of control group (T0) and lower to that of toxin fed group (T1). There was gradual increase in villus length to crypt depth ratio from 2nd week (4.33 µm) to 6th week (5.10 µm) of age and significantly ($P<0.05$) highest value of villus length to crypt depth ratio was seen in 4th and 6th week of age. There was progressive improvement in genes linked with growth (IGF) and antioxidant property (GST) but inflammation related genes (IL-10 and TLR-2) were not stimulated due to dietary supplementation of MOS. The study lead to conclusion that combination of 0.3% mannan-oligosachharides (MOS) and 500 mg/kg Na-butyrate in diet was more effective in counteracting the ill effects of dietary induced aflatoxin B1 (300 ppb AFB1) and ochratoxin A (250 ppb OTA) toxicity rather than using MOS or NaB alone in broiler chickens.

- Similarly in another study, associated efficiency of *Saccharomyces cerevisiae* and vitamin E in ameliorating adverse effects of ochratoxin in broiler chickens (0-6 weeks of age, n=320) was studied. Each of eight dietary treatments (T_1- control/basal diet); T_2- T_1+ 150 ppb OTA; T_3-T_2 +0.05% SC+100 mg vitamin E-VE; T_4- T_2+ 0.075% SC+100 mg VE; T_5- T_2+ 0.1%SC+100 mg VE; T_6- T_2+ 0.05% SC+200 mg VE; T_7- T_2+ 0.075% SC+200 mg VE; T_8- T_2+ 0.1% SC+200 mg VE per kg diet) was fed to 5 replicated groups of 8 birds from 0 to 42 days of age. During overall growth period (0–6 weeks), the body weight gain (BWG) of birds fed ochratoxin contaminated diet (T_2) was lower than that of control group (T_1).The BWG of group T_5, T_7 and T_8 was higher ($P\leq 0.05$) than T_2 but statistically similar to that of control. During overall growth period, the FI in control group was statistically similar to other treatment groups. The FI in groups T_7 and T_8 was higher ($P\leq0.05$) than that of group received basal diet with toxin (T_2). The overall FCR in control group (T_1) was lower ($P\leq0.05$) than that of T_2. The FCR in groups T_3, T_4 and T_6 was higher ($P\leq0.05$) than the control, but lower than that of T_2. The FCR in groups T_5, T_7 and T_8 was lower than T_2 and statistically similar to that of control (T_1).The overall livability percentage in control group (T_1) was higher ($P\leq0.05$) than that of ochratoxin fed group (T_2). The liveability percentage in group T_3 was lower ($P\leq0.05$) than control and similar to that of T_2. The livability percentage in groups T_4 to T_8 was statistically similar to that of control. Ochratoxin contamination in diet caused significant reduction in body weight gain, feed consumption, feed efficiency and livability percentage. There was no significant ($p<0.05$) difference among various dietary treatments with

regard to shrinkage loss, dressing yield and eviscerated yield, and cut-up parts of birds. The relative weight of liver (percent of live body weight) in control group (T_1) was significantly ($p<0.05$) lower than that of ochratoxin alone fed group (T_2).The relative weight of liver in T_5, T_7 and T_8 was significantly ($p<0.05$) lower than toxin fed group (T_2) and statistically similar to that of control. The relative weight of thymus and bursa of Fabricius in control group (T_1) was significantly ($p<0.05$) higher than that ofochratoxin alone fed group (T_2). The relative weight of thymus and bursa in groups T_5, T_7 and T_8 was higher ($p<0.05$) than the toxin fed group (T_2) and statistically similar to that of control (T_1), suggesting that addition of *S. cerevisiae* along with vitamin E at any level in these groups alleviated the ill effects of ochratoxin on relative weight of thymus and bursa in broiler chickens. The total serum protein, cholesterol and haemoglobin content of control group (T_1) was higher ($p<0.05$) than that of ochratoxin fed group (T_2).The serum protein, cholesterol and haemoglobin value in groups T_5, T_7 and T_8 was higher($p<0.05$) than ochratoxin fed group (T_2) and statistically similar to that of control.The serum uric acid, creatinine, ALP, SGOT, SGPT and H/L ratio value in control group (T_1) was lower ($p<0.05$) than that of ochratoxin fed group (T_2).The uric acid, creatinine, ALP, SGOT, SGPT and H/L ratio value in T_5, T_7 and T_8 was lower($p<0.05$) than the ochratoxin fed group (T_2) and statistically similar to that of control. The CMI and HA titre value of control group (T_1) was higher ($p<0.05$) than that of ochratoxin fed group (T_2).The CMIand HA titre value in T_5, T_7 and T_8 was higher ($p<0.05$) than that of toxin fed group (T_2) and statistically similar to that of control.It was concluded that inclusion of *S. cerevisiae* at 0.1% level along with 100 mg vitamin E/kg diet or *S. cerevisiae* at 0.075% level along with 200 mg vitamin E per kg diet to the ochratoxin (150 ppb) contaminated feed ameliorated the adverse effects of ochratoxicosis on production performance of broiler chickens. Feeding of 150 ppb ochratoxin contaminated feed resulted in hypertrophy of liver and atrophy of thymus and bursa of Fabricius, however, there was no effect on carcass traits. Addition of *S. cerevisiae* (0.1%) along with vit.E (100mg/kg) or *S. cerevisiae* (0.075%) along with vit. E (200 mg/kg) to the 150ppb ochratoxin contaminated feed ameliorated the adverse effects of ochratoxicosis on relative weight of organs in broiler chickens. Ochratoxin contamination at the rate of 150 ppb in the feed resulted in decreased ($p<0.05$) total serum protein, cholesterol and haemoglobin content and increased ($p<0.05$) serum uric acid, creatinine, ALP, SGOT, SGPT and H/L ratio value. Inclusion of *S. cerevisiae* at 0.1% level along with 100 mg vitamin E or *S. cerevisiae* at 0.075% level along with 200 mg vitamin E per kg diet to the ochratoxin (150 ppb) contaminated feed ameliorated the adverse effects of ochratoxicosis on biochemical profile and immune response in broiler chickens.

- Efficacy of vitamin C in ameliorating ochratoxicosis in broiler chickens was also assessed in broiler chickens. Accordingly, day-old broiler chicks (n=240) were divided into 6 treatment groups (T_1- control (Basal diet); T_2- T_1+150 ppb OTA; T_3-T_1 + 100 mg vitamin C-VC; T_4- T_1+200 mg VC; T_5- T_2+ 100 mg VC; T_6- T_2+ 200 mg VC per kg diet). Each diet was fed to 5 replicated groups of 8 birds each from 0 to 42 days of age. During overall growth period (0-6 weeks), the BWG of control group (T_1) was higher ($P<0.05$) than that of toxin fed group (T_2). The BWG in T_5 and T_6 was higher ($P<0.05$) than that of toxin fed group (T_2) but lower ($P<0.05$) than that of control, indicating that addition of vitamin C at any level to the ochratoxin contaminated diet partially ameliorated the adverse effects of ochratoxicosis on body weight gain. The feed intake did not vary significantly among various treatment groups. The FCR in control group (T_1) was lower ($P<0.05$) than that of T_2. The FCR in other treatment groups (T_3 to T_6) was statistically similar to that of control. The relative weight of liver and kidney in control group (T_1) was lower ($P<0.05$) than that of ochratoxin fed group (T_2). The relative weight of bursa of Fabricius in control group (T_1) was higher ($P<0.05$) than that of T_2. The total serum protein and cholesterol content of control group (T_1) was higher ($P<0.05$) than that of T_2. The uric acid and alkaline phosphatase value of control group (T_1) was lower ($P<0.05$) than that of T_2. Inclusion of vitamin C at any level to the ochratoxin contaminated diet partially ameliorated the adverse effects of ochratoxicosis on relative organ weights and biochemical profile. It was concluded that inclusion of 100 mg vitamin C per kg diet to the ochratoxin (150 ppb) contaminated feed partially ameliorated the adverse effects of ochratoxicosis on production performance, relative organ weights and biochemical parameters of broiler chickens.
- Efficacy of mycotoxin binder (hydrated sodium calcium aluminosilicate -HSCAS) was assessed to ameliorate ochratoxicosis in broiler chickens (0-6 weeks of age, n=240), divided into 6

treatment groups (T_1, control; T_2, T_1+ 150 ppb OTA; T_3, T_1+ 0.25% HSCAS; T_4, T_1+ 0.50% HSCAS; T_5, T_2+ 0.25% HSCAS; T_6, T_2+ 0.50% HSCAS). Each diet was fed to 5 replicated groups of 8 birds each from 0 to 42 days of age. During overall growth period (0-6 weeks), the BWG of birds in control group (T_1) was higher ($P<0.05$) than that of ochratoxin fed group (T_2). The BWG in T_5 and T_6 was statistically similar to that of toxin fed group (T_2) and lower ($P<0.05$) than that of control, indicating that addition of HSCAS at any level to the ochratoxin contaminated diet did not ameliorate the adverse effects of ochratoxicosis on body weight gain. The FI in control group (T_1) was higher ($P<0.05$) than that of toxin fed group (T_2). The FI in T_5 and T_6 was statistically similar to that of toxin fed group (T_2) and lower ($P<0.05$) than that of control. The FCR in control group (T_1) was lower ($P<0.05$) than that of toxin fed group (T_2). The FCR in T_5 and T_6 was statistically similar to that of toxin fed group (T_2) and higher ($P<0.05$) than that of control. The relative weight of liver and kidney in control group (T_1) was lower ($P<0.05$) than that of ochratoxin fed group (T_2). The relative weight of bursa of Fabricius in control group (T_1) was higher ($P<0.05$) than that of T_2. The total serumprotein and cholesterol content of control group (T_1) was higher ($P<0.05$) than that of T_2.The uric acid and alkaline phosphatase valueof control group (T_1) was lower ($P<0.05$) than that of T_2. Addition of HSCAS at 0.50% level to the ochratoxin contaminated diet partially ameliorated the adverse effects of ochratoxicosis on relative organ weights and total serum protein. It was concluded that ochratoxin contamination of feed at the rate of 150 ppb impaired the production performance and altered relative organ weights and blood biochemistry. Incorporation of HSCAS to the ochratoxin (150 ppb) contaminated feed could not ameliorate the adverse effects of ochratoxicosis, however, 0.50 percent level of HSCAS partially alleviated the ill effects of ochratoxicosis on relative organ weights and total serum protein in broiler chickens.

Value Addition of Eggs through Dietary Approaches

- Value addition and designing of poultry meat akin to customers' demand through dietary means is an important area. Accordingly an experiment was conducted to assess the effect of organic chromium in flax seed meal based diet on growth performance, meat quality, serum biochemicals and sensory attributes of broiler chickens. The results on meat quality and serum bio-chemicals revealed that flaxseed feeding caused a marked rise in the percentage of unsaturated fatty acids, including MUFA, PUFA, n3, n6 fatty acids and n3:n6 and PUFA:SFR ratios, whereas, marked decline was seen in saturated fatty acids and no effect of Cr was observed on fatty acid profiles of broiler chicken. Flaxseed feeding reduced the meat and serum cholesterol and fat (%) of meat, whereas, progressive reduction was observed with increasing Cr levels. The combination of 10% flaxseed with 1.0 mg chromium/kg diet increased the final pH of broiler meat. The addition of flaxseed caused significant reduction of water holding capacity, extract release volume and antioxidant potential of broiler meat, whereas, increasing chromium supplementation progressively increased them. Flaxseed feeding significantly increased drip loss and lipid oxidation of broiler meat, activity of serum antioxidant enzymes and serum malonaldehyde concentration, whereas, chromium supplementation decreased the levels of these parameters. It was concluded that dietary combination of 10% flaxseed and 1.5 mg Cr/kg diet is optimum for desirable meat quality, oxidative stability and serum biochemical profile of broiler chicken.
- The effect of dietary lysine in flax seed meal based diet on the growth performance, carcass traits, meat quality and sensory attributes of broiler chickens was also assessed in a 42-day feeding trial with completely randomized design. A total of 240 day-old broiler chicks of uniform body weight were distributed randomly in 30 groups of 8 chicks in each. Five dietary treatments were formulated with no flaxseed in first one and 10% in other four; and 100% BIS lysine in first two and 105%, 115% and 125% BIS lysine in third, fourth and fifth treatment respectively. Each treatment was allocated 6 replicates at random. Diet with 10% flaxseed was found to have negative effects on growth and efficiency of broilers, whereas, lysine supplementation on such diet improved growth and efficiency of birds. No significant effect of lysine and flaxseed feeding was found on various carcass traits except for the better percentages of eviscerated weight, dressed weight and breast yield; and better meat to bone ratios of breast and thigh due to lysine supplementation, whereas, flaxseed feeding reduced meat to bone ratios of breast and thigh. Different dietary treatments had no significant effect on mortality pattern of birds and sensory evaluation of broiler meat. Significant reduction of serum cholesterol was observed due to flaxseed and lysine in broiler

chicken. The serum antioxidant enzyme activities and malonaldehyde concentration were significantly increased by flaxseed feeding and progressively decreased by lysine supplementation. From the present study it was concluded that 10% flaxseed can be used for value addition of broiler meat along with 125% BIS recommended lysine without any adverse effect on broiler performance, efficiency, carcass traits and serum biochemical profile.

- A study was conducted o assess the effect of hemp seeds and dill seeds in combination and alone in diet on production performance, biochemical, immune response and meat quality on broiler chicks. Hemp and Dill seed are known for their medicinal properties and nutritional value. Hemp is a good source of protein, fatty acid, poly unsaturated fatty acids, vitamin and minerals. Dill powder known as antioxidant, anti-diabetic and hypo-cholesterolaemic. In this experiment a total of 352 broiler birds were divided into eleven treatment groups with four replicates in each group (*n*=8 birds/replicate). There were eleven dietary, one control group with basal diet, second to tenth different level of dill and hemp seed and eleventh group was antibiotic (0.02% BMD). The growth of birds was influenced by the addition of hemp and dill seeds. The broilers fed diet containing 0.2% hempseed and 0.1% dill seed had higher body weight gain as compared to other treatments. Feed conversion ratio and carcass yields were not influenced by the dietary treatments. However, the meat yield was significantly higher in diet containing 0.3% hemp seed and 0.3% dil seed. SGOT values were lower in the treatments having hemp seed alone than in combination of both at any level. There is no significant difference observed in SGPT level, however, in combination it has shown decreasing trend than in hemp seed alone. Triglycerides differ significantly and shown decreasing values in treatments with low to moderate level of hemp and dill seed, or hemp seed alone. At higher inclusion levels however, the TGA levels have also increased. No effect was observed on reduction on *E. coli* count at any level of treatment but increase in Lactobacillus count in treatments having combination of both seeds was observed. The humeral immunity increased in all treatments and better titers were observed in the birds fed with both the seeds at any level of inclusion. It was concluded that inclusion of 0.2% hempseed and 0.1% dill seed in diet was beneficial for improved growth and welfare of broiler chickens

Expanding Feed Resources and Improving Nutrient Extraction from Biomass

- The availability and cost of soybean meal, a major source of dietary protein is a major constraint in practical feed formulations. In the process of reduction of production costs and to buffer the shortage of soybean meal, there is need to identify and evaluate the nutritive value of alternate protein feedstuffs for use in practical poultry feed. Rice gluten is available from starch industry, which is a very good source of protein, available energy and methionine. Hence, there was need to establish its inclusion rate and feeding value in laying hens.
- To ascertain the available energy and nutrients (protein digestibility, available carbohydrates and phosphorus) from rice gluten meal, with and without feed enzyme supplementation, an experiment was conducted following 3 x 3 factorial CRD where in rice gluten meal without and with two enzyme (protease and cocktail) fed to cockerels at two substitution levels (20 and 40%) of reference diet following practical diet replacement method. .All the cockerels were distributed randomly into nine dietary groups (D1 to D9). Each diet was replicated nine times having one cockerel per replicate. The experiment was conducted for 14 (10+4) days. The data obtained for various parameters were subjected to statistical analysis as per 3 x 3 factorial CRD design. The rice gluten meal employed in this study was analysed to contain-dry matter 91.99, crude protein 49.94, ether extract 5.79, total ash 3.31, acid insoluble ash 0.89, calcium 0.84, and phosphorous 0.98%. The AME_n value of rice gluten meal diets were 3034 and 3027 kcal /kg at 20 and 40% replacement levels with a mean value of 3030 kcal/kg on dry matter basis. On enzyme supplementation (protease and cocktail) the AME_N value of rice gluten meal were 3067, 3069 and 3076, 3055 kcal/kg respectively at 20 and 40% replacement respectively with a mean value of 3068 and 3066 kcal/kg on dry matter basis, respectively.
- In order to find out the effective inclusion level of inclusion of rice gluten meal in diet of broiler chicken, a biological trial of six weeks duration was conducted to assess the feeding value of rice gluten meal in broiler chickens. Six experimental diets adequate in all nutrients, were prepared, consisting of maize-soya control and five levels of rice gluten meal (5, 7.5, 10, 12.5 and 15%). Each diet was assigned to five replicated groups of 8 (CARIBRO Vishal) broiler chicks each for 0-2 (pre-starter), 2-4 (starter) and 4-6 wk (finisher) growth phases. The results indicated

that the body weight gain, feed intake, feed conversion ratio, protein and energy efficiencies did not differ statistically ($P > 0.05$). The humoral and cellular immune response, carcass traits, cut up parts and yields of digestive and immune organs weights also remained statistically similar due to various dietary treatments. However, the cost of per unit meat production was significantly lowered as RGM was increased in the diet. It is evident from the results that high-protein rice gluten meal can safely and economically be added in broiler diet upto 15%.

- The various feed samples (302) 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 D3, an experiment was conducted to evaluate the effect of feeding different levels of dietary phosphorus and vitamin D3 on production performance, egg quality traits and blood biochemical parameters in laying hens. A feeding trial of 12 weeks (40-51wk) duration was conducted involving two levels of available phosphorus (0.40 and 0.30 %) each with four levels of vitamin D_3 (1200, 1600, 2000 and 2400 IU/kg) in a 2×4 factorial experiment. Results revealed that a dietary concentration of 0.40 %available phosphorus and 1600 IU/kg vitamin D_3 was adequate to obtain optimum production performance, egg quality traits and blood biochemical parameters in white leghorn layers during winter season.
- Another experiment was undertaken to evaluate the response of feeding different levels dietary calcium to phosphorus ratio, and levels of vitamin D3 on production performance, egg quality traits and blood biochemical parameters in laying hens. A 10 weeks (30-39wks) feeding trial was conducted involving four levels of calcium to phosphorus ratio (8.12, 10.0, 12.5 and 16.0) each with two levels of vitamin D_3 (1600 and 2000 IU/kg) in a 4×2 factorial experiment. Results revealed that a dietary calcium to phosphorus ratio of 10.0 (3.50% Ca and 0.35%AP) with 2000 IU/kg vitamin D_3 was found adequate to obtain optimum production performance, egg quality traits and blood biochemical parameters in white leghorn layers.

Physiological Interventions for Augmentation of Reproductive Efficiency

Improvement of Reproductive Efficiency in Turkey and Chicken

Effect of various dilution rates on fertilizing ability of chicken spermatozoa using CARI semen diluent

In order to find out the best dilution rate chicken semen was diluted in CARI poultry semen diluent and examined the fertility after 0 and 24 hr. Thirty healthy adult males and ninety healthy adult females from the same hatch of white leg horn (WLH) chicken were taken randomly and maintained in individual cages under uniform husbandry conditions. Good quality of semen samples were collected from chickens by Burrows and Quinn, (1937) method. Subsequently, pooled semen was taken in 5 glass tubes of 5 ml capacity round bottom (length=7 cm, diameter=1 cm). All the tubes containing constant semen volume (3ml) diluted with CARI diluent at a rate of 1:1, 1:2, 1:3, 1:4, and 1:5. Immediately after dilution, the sperm concentration was examined in each tube with the help of haemocytometer. All the tubes were kept at 8°C for 24 hr before insemination to the hens .A.I. was carried out by intravaginal insemination by using A.I. gun (IMV, France) in 5 different groups containing 18 hens in each. Next day of A.I. was skipped and subsequently fertile eggs were collected from 1-10 days. Obtained data was analysed as per the standard method of Snedecor and Cochran (1989).

Results on identification of the best dilution rate for 24 hrs stored semen in CARI poultry semen diluent are given in Table 11. Different dilution rates i.e.1:1, 1:2, 1:3, 1:4, and 1:5 were used in this study for 24 hrs stored semen. Superior fertility (91.07±1.91%) was expressed by dilution rate 1:2 whereas inferior fertility (49.40±2.54%) by dilution rate 1:5. However, no significant difference was found in fertility between 1:1 and 1:3 dilution rates during the fertile period 1-5 days. During the entire fertile period (1-10 days) dilution rate 1:2 expresses high fertility (78.25±2.89%) than others.

Table 11: Effect of various dilution rates on fertilizing ability of chicken (WLH) spermatozoa during 24 hrs storage at 7±1ºC using CARI poultry semen diluent (Mean±SEM, n=20)

Day	Dilution rate				
	1:1	**1:2**	**1:3**	**1:4**	**1:5**
Day1	69.83±3.08	79.83±3.37	74.50±3.62	58.33±8.89	55.67±4.84
Day2	83.33±4.14	99.00±1.02	75.17±3.13	79.17±6.88	53.83±9.98
Day3	82.00±5.98	91.33±2.24	77.17±2.38	69.17±11.38	51.67±3.21
Day4	70.00±4.68	92.50±4.81	59.17±8.24	61.33±8.63	44.50±2.58
Day5	79.50±6.72	92.67±5.35	70.83±5.15	42.17±4.69	43.33±5.03
Average	**76.93±2.39^{B1}**	**91.07±1.91^{A1}**	**71.37±2.42^{B1}**	**62.13±4.11^{C1}**	**49.40±2.54^{D1}**
Day6	76.17±6.78	84.00±5.99	51.50±6.03	41.33±4.94	38.67±6.32
Day7	68.50±8.45	70.67±9.00	45.83±5.71	33.67±3.56	30.88±5.68
Day8	48.33±6.60	70.33±10.09	55.83±6.39	45.17±5.54	32.00±3.73
Day9	46.67±7.18	55.50±11.28	39.67±2.44	32.50±3.15	32.33±2.97
Day10	31.33±5.89	46.67±5.02	28.17±4.33	28.00±3.12	20.33±3.67
Average	**54.20±4.29^{B2}**	**65.43±4.28^{A2}**	**44.20±2.88^{C2}**	**36.13±2.03^{CD2}**	**30.83±2.28^{D2}**
Total	**65.57±2.80^{B3}**	**78.25±2.89^{A3}**	**57.78±2.58^{C3}**	**49.13±2.89^{D3}**	**40.12±2.02^{E3}**

Mean values bearing different super script in rows (A, B, C, D) differs significantly (P≤0.05). Mean values bearing different super script in columns (1, 2, 3) differs significantly (P≤0.05).

Effect of semen to air ratio in glass tubes on fertilizing ability of chicken spermatozoa during 24 hr storage in CARI semen diluent

Thirty healthy adult males and ninety healthy adult females from the same hatch of white leg horn (WLH) chicken were taken randomly and maintained in individual cages under uniform husbandry conditions. Good quality semen samples were collected from chickens by Burrows and Quinn, (1937) method. All the samples were pooled and diluted 1:2 with CARI poultry semen diluent. Immediately after dilution, semen was poured at the rate of 3ml/tube into three sizes of glass vials such as 5ml (length 7cm, diameter 1cm), 10 ml (length 10cm, diameter 1.40cm) and 25ml (length 15cm, diameter 1.60cm) capacity round bottom. All the samples were stored at 8±1°C for 24 hr before insemination. A.I. was carried out by intravaginal insemination (80-100 million sperm /hen) by using A.I. gun (IMV, France) in three different groups having 30 hens each. Next day of A.I. was skipped and subsequently, fertile eggs were collected from 1-10 days. Glass vials of various sizes/capacity were used in this study for storing (24 hr) chicken semen

Table 12: Effect of semen to air ratio in storage vessels on fertilizing ability of chicken (WLH) spermatozoa during 24 hr storage at **7**±1°C using CARI poultry semen diluent (Mean±SEM, n= 20)

Day	Volume		
	5 ml	**10 ml**	**25 ml**
Day1	78.84±2.72	71.67±1.25	81.67±6.31
Day2	94.17±2.90	83.67±2.15	74.67±3.67
Day3	89.00±5.76	79.70±3.33	73.67±6.59
Day4	90.83±4.69	78.17±3.97	70.33±6.15
Day5	90.33±4.49	77.50±2.84	67.50±3.95
Average	**88.63±2.02^{A1}**	**78.00±1.44^{B1}**	**73.57±2.41^{B1}**
Day6	87.67±6.43	69.83±6.54	64.33±6.16
Day7	74.83±7.52	55.67±8.68	57.00±6.90
Day8	71.17±4.29	55.17±1.82	45.17±3.22
Day9	68.67±5.01	57.67±4.58	41.83±4.25
Day10	54.00±3.98	41.50±3.78	30.83±3.35
Average	**71.27±3.00^{A2}**	**55.97±2.90^{B2}**	**47.83±2.99^{B2}**
Total	**79.95±2.06^{A3}**	**66.98±2.15^{B3}**	**60.70±2.57^{B3}**

Mean values bearing different super script in rows (A, B) differs significantly (p≤0.05). Mean values bearing different super script in columns (1, 2, 3) differs significantly (P≤0.05).

in CARI semen diluent. Results on these aspects are shown in Table 12. During 1-5 days of fertile period higher fertility was exhibited by semen stored in 5 ml capacity glass vial (88.63±2.02%) than 10 (78.00±1.44%) and 25 ml (73.57±2.41%) glass vial. No significant difference was obtained in fertility between 10 and 25 ml glass vials, however numerically higher mean values of fertility was noticed in semen stored in 10 ml capacity glass vial. Similar trend was revealed by all the sizes of glass vials when the fertility recorded during 6-10 days of the study period.

Study of physiological Responses under Normal and Stressed Conditions in Indigenous and Improved Varieties of Poultry

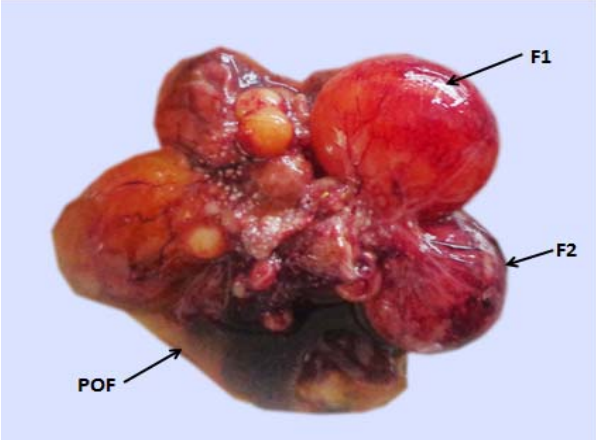
To evaluate the effect of age, sex, breed and season on haematological parameters in Aseel and Kadaknath birds

A total of 400 hatched chicks in each breeds were vent sexed at day old and reared under hot-humid and winter seasons. All the birds were maintained under uniform feeding and managemental conditions for 12 weeks. The blood samples were collected (n=25) from jugular vein in each sex, breed, season at 3 weeks interval. The haematological parameters viz., total RBC, Hb, PCV, MCV, MCH, MCHC and WBC using haematology analyser and DLC manually. The results were subjected to factorial analysis at two phases (0-6 weeks and 7-12 weeks of age) to assess the interaction as well as individual (age, sex, season, breeds) effects. At six weeks of age, Kadaknath male had significantly ($P<0.01$) higher (2.24×10^6/µl; 16.93 g/dl) RBC and Hb, respectively than Aseel (1.53×10^6/µl; 10.18 g/dl), in hot-humid season. At 3 weeks, Aseel males had higher ($P<0.01$) MCH (90.94 fg), MCHC (89.07 g/dl), and WBC (28.22×10^6/ µl) values than other breed-sex-age-season interactions. Fluctuating response was observed with PCV and MCV content among the treatment groups. On direct effects, increase in age from 3 to 6 weeks significantly ($P<0.01$) reduced the Hb, MCV, MCH, MCHC values. The RBC, WBC and PCV did not show any age variations. Kadaknath had higher haematological values than Aseel except MCHC and WBC. Birds had higher ($P<0.01$) haematological values (Hb, MCV, MCH, MCHC) in hot-humid season than winter season. Influence of sex was not observed ($P>0.05$) among the parameters studied. Similar trend was observed with respect to interaction as well as season, breed and sex influence on haematological parameters at 7-12 weeks of age. During this age group the effect of age is limited to MCV only. Whereas breed effect was restricted to MCV and MCH with Aseel birds recording higher values in the former and Kadaknath in the later. Season followed the same trend as that of 0-6 weeks for all the parameters except MCV in winter. Significant interaction effect ($P<0.01$) was in differential leukocyte count and HL ratio except eosinophil. Higher HL ratio was recorded by Kadaknath male (0.37) in hot-humid season during 6th week. Season × Breed × Sex × Age interaction effect was highly significant ($P<0.01$) for all parameters except eosinophil. Higher HL ratio was observed in winter when compared to hot–humid season. Winter reared birds had higher HL ratio irrespective of breed, sex and rearing system. Season had significant ($P<0.05$) effect on basophils, monocyte and lymphocyte for 9 and 12 weeks period. Age had significant ($P<0.01$) effect on basophil, monocyte and heterophils. It may be concluded that haematological values gets affected by the interaction of breed, sex, age and season in Aseel and Kadaknath breeds.

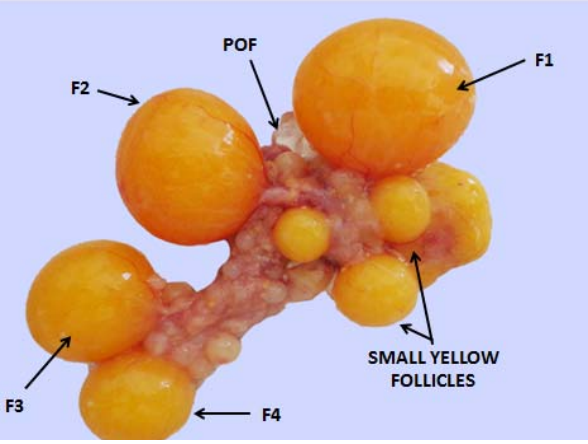
Physiological Interventions for Addressing Reproductive Dysfunctions in Broiler Breeders

To ascertain the influence of GnRH analogue administration in broiler breeders

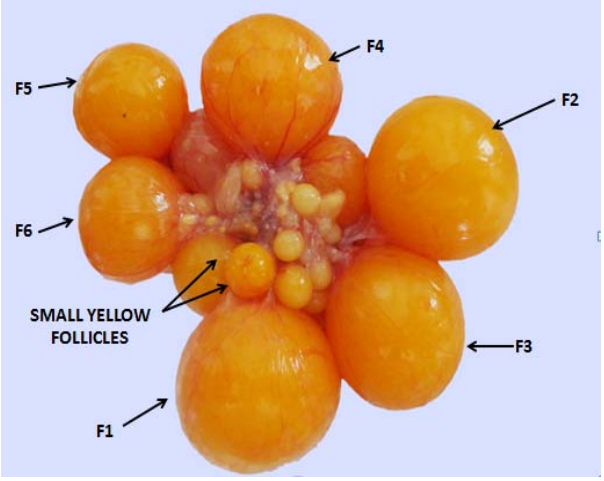
Seventeen weeks old broiler breeders were randomly divided into three groups (n=10) and injected with GnRH analogue-Buserelin acetate (Receptal^{TM}) @ and 400 µg-0.4 ml (T2) and 200 µg-0.2 ml (T_3) intramuscularly on weekly basis. Control (T_1) birds were injected with distilled water. Egg size, rate of lay and external egg quality traits were estimated. No significant difference was obtained for shell colour and egg weight among treatment groups. However, results indicated numerically higher values for T_3 group than T_1 and T_2. Values for shape index was ranged from 74.39±1.046 to 76.15±1.56 (T_1); 76.54 ±3.42 to 78.50±0.73 (T_2); 75.18b±0.87 to 78.80±1.04 (T_3). Hen housed egg production was significantly higher in low dose treated group (22.3%) than high dose treated (15.33) and control (18.33) groups. Incidence of double yolk eggs was found to be 6.45%, 3.59% and 10.66% for T_2, T_3 and T_1 groups, respectively. Similarly, higher blood spot incidence was found in control (5.36%) followed by T_2 (4.30%) and T_3 (4.93%). Ovary with ovarian follicles weighed 44.65 g, 72.36 g and 41.1 g respectively for treated and control groups. Low dose (T_3) treated birds also showed higher liver weight of 57.13 g than higher dose (37.06 g) and control groups (41.4g). As far as ovarian morphology is concerned, higher number of pre ovulatory follicles were observed with regards to low dose treated groups than others (Fig. 12). In conclusion, lower dose (200 µg) of GnRH analogue significantly ($P<0.05$) improves breeder hen housed egg production and ovarian health with enhanced rate of lay. This also reduced incidence of double yolk eggs and blood spots.

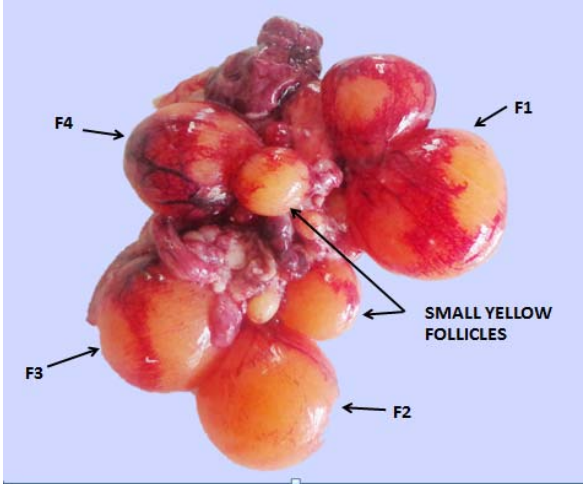


T_1 (Control, injected with distilled water)



T_2 (injected with 400 µg Buserelin acetate)





T_3 (injected with 200 µg of Buserelin acetate)

Fig. 12: Morphology of ovarian follicles as revealed in broiler breeders injected with GnRH analogue

To study interaction effect of cereals with polyphenols on alleviation of heat stress in broilers

The present study was carried out to assess the impact of polyphenols and diet composition on the performance of heat stressed broilers. Polyphenols were extracted from pomegranate peels (PPE). A total of two hundred and forty-day old coloured broiler chicks were randomly divided into six groups, 1: fed corn soybean meal diet without PPE supplementation, 2: fed corn-soybean meal supplemented with 50 ppm PPE, 3: fed corn-soybean meal supplemented with 100 ppm PPE, 4: fed rice-sorghum-soybean meal based diet without PPE, 5: fed rice-sorghum-soybean meal based diet with 50 ppm PPE and 6: fed rice-sorghum-soybean meal based diet with 100 ppm PPE. The body weight gain was significantly ($P < 0.05$) higher in rice-sorghum based diet than the corn diet. Supplementation of polyphenols significantly increased body weight gain than un-supplemented group with more prominent results with rice-sorghum based diets. CMI response was significantly ($P<0.05$) higher in T5 and T6 than the other groups. Higher osmotic fragility was observed with rice-sorghum cereal based diet than the corn diet. The HL ratio was significantly ($P<0.01$) lower in rice-sorghum (0.09) based diet than the corn (0.12) based. Incorporation of polyphenol extracts @ 50 ppm improved the overall welfare status of the broilers. Supplementation of 50 ppm PPE improved broiler's performance in rice-sorghum-soybean meal based diet under hot-humid environment conditions.

Shelter Management in Turkey and Chicken

Evaluation of Management Practices to Optimize Turkey Production

Effects of dietary supplementation of synbiotics (Bacillus subtilis and Bacillus amyloliquifaciens with MOS) on growth performance, immunity and gut health of turkey poults

A biological feeding trial of ten wks (0-10 wk) duration was conducted to study the effects of dietary supplementation of synbiotics (Bacillus subtilis and Bacillus amyloliquifaciens with MOS) on growth performance, immunity and gut health of turkey poults. The dietary treatments included one

control (T1- commercial standard diet-0 levels of additives), prebiotics (0.1% MOS/kg of diet), probiotics (mixed bacillus culture @ 106 cfu/g feed) and synbiotics (mixed bacillus culture @ 106 cfu/g feed plus 0.1% MOS/kg of diet).

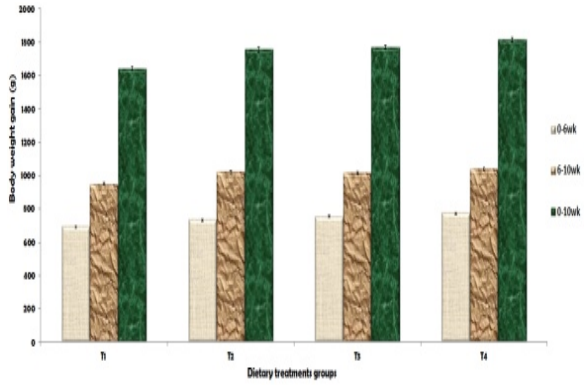
Straits run day-old turkey poults (n=256) were randomly divided into 4 dietary treatment groups in battery brooder and deep litter systems. The cage system had 4 replicates of 6 birds (4×4×6) each and the deep litter system had 2 replicates of 20 birds (4×2×20) each in all dietary treatments. The experimental diets were offered ad lib. Growth performance parameters like body weight gain (BWG), feed intake (FI) were recorded and feed conversion ratio (FCR) was calculated. Blood samples were collected at the end of the experiment for analysis of different serum and blood biochemical parameters. Poults were slaughtered at 70d of age to study carcass traits. Caecal and faecal materials were collected at day 35 and 70 for analysis of intestinal microbial load.

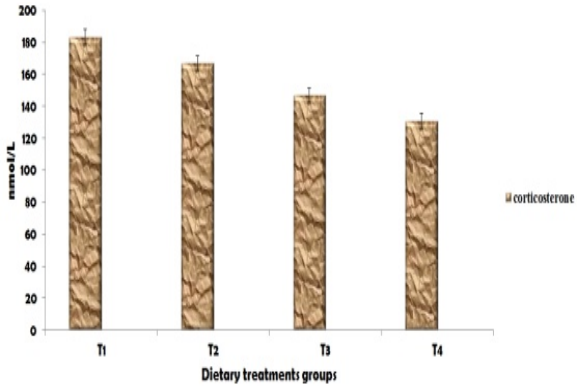
The results of the study revealed that body weight of turkey poults during 2^{nd} to 10^{th} wk significantly ($p<0.001$) improved in treatment groups as compared to control. Higher body weight was recorded in T4 (synbiotics) compared to other. Caged reared poults recorded better BW compared to deep litter reared poults. Lower feed consumption was recorded in T4, T3 and T2 than control. Cage reared poults consumed more feed in 0-6 week duration but less feed during 6-10 week as compared to deep litter system. The overall feed conversion ratio (FCR) was significantly better ($P<0.001$) during 0-6 or 6-10 or 0-10 wk of age in MOS and bacillus supplemented group. Cage reared poults had improved FCR in second ($P<0.001$) and tenth ($P<0.05$) week compare to deep litter reared poults. There was no significant difference in mortality pattern of turkey poults due to different dietary treatment groups.

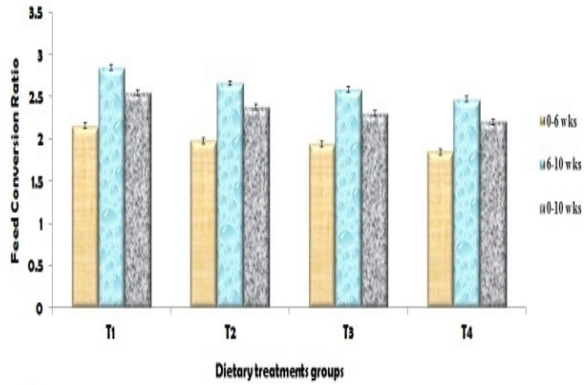
No significant difference was observed in total protein and albumin values among the control and dietary treated groups. Serum enzymes like, alanine amino transferase (ALT) significantly ($P<0.001$) decreased in T4, T3 and T2 groups. Commercial diet with synbiotics (B. subtilis and B. amyloliquifaciens with MOS) played an important role in decreasing the ALT enzyme activity. On the other hand, there was significant ($p<0.001$) increase in serum AST value in test groups compared to control. Significant ($P<0.01$) decrease in the total cholesterol level was recorded in test diets compared to control group. Serum glucose level decreased significantly ($P<0.01$) in probiotic, prebiotic and synbiotic groups compared with the control one. The corticosterone level significantly ($P<0.001$) reduced in dietary treatment groups compared to control group. Lowest value was observed in T4 (synbiotic) and highest one in T1 (control). Deep litter poults recorded lower corticosterone values compared to their counterparts in cages and values were significant ($P<0.05$). The heterophil lymphocyte ratio significantly ($P<0.001$) reduced in dietary treatment groups compared to control group. Lowest value was observed in T4 (synbiotic) and highest one in T1 (control). Deep litter poults of all the treatment groups including control recorded lower value compared to their counterparts in cages and values were significant ($P<0.01$).

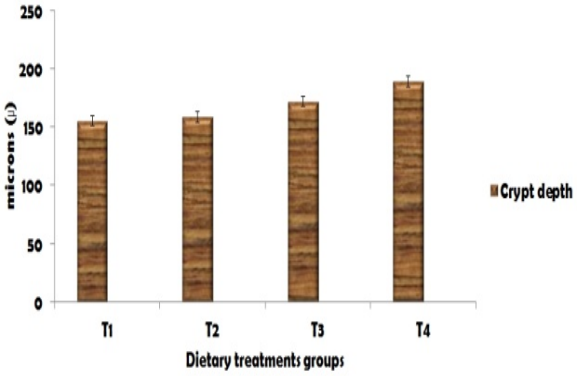
Significant difference ($P<0.001$) was observed in villus height and villus width in dietary treatment group, highest value observed in T4 and lowest in T1. Higher Crypt depth was recorded ($P<0.05$) in treatment groups. Deep litter reared poults had shown significant ($P<0.001$) increase in villus height compared to caged ones in all treatment groups including control. In microbial load, significant differences ($P<0.05$) were observed in coliform and lactobacillus count in caecal digesta (35 and 70d) and excreta (35 and 70d). Total plate count (TPC) significantly reduced in T4, T3 and T2 groups compared to control group. The cage poults of all the dietary treatment groups showed significant ($P<0.01$) reduction in coliform and total plate count (35 and 70d) than their counterparts in deep litter.

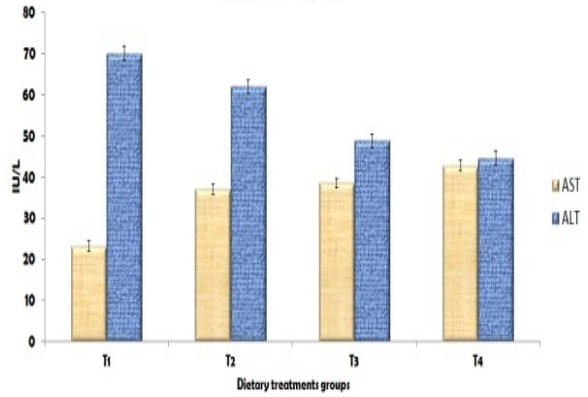
Humoral immune response i.e., (HA titre) was significantly ($P<0.001$) higher in T4, T3, T2 groups compared to control group. Similarly, cell mediated immune response (CMI) i.e., foot pad index was higher ($P<0.001$) in T4 and T3 groups compared to control group. CMI increased significantly ($P<0.05$) in deep litter reared poults of dietary treatment groups compared to cage reared poults.

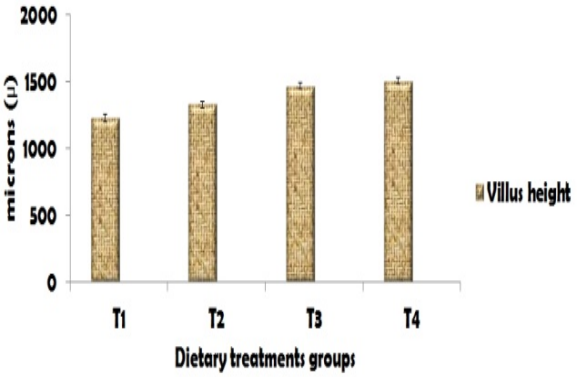












Assessment of Performance and Welfare of Chicken under Different Housing Conditions

Evaluation of production performance and welfare of WLH layer birds under different housing systems

The production performance and behavioral inventory of White Leghorn (CARI-Priya) layers under different management conditions during summer season was studied. At 18th wk, a total of 450 layer birds from a single hatch were randomly assigned into three treatment groups viz colony cage, individual cage and floor housing. The Hen day egg production during 20-36 week of age was recorded. 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.

Results revealed that, during early summer (Feb-March), there was no difference in the hen day egg production in the birds reared under different housing systems i.e colony or floor reared birds but individually caged layers had significantly ($P<0.05$) more egg production than their other two counter parts. During 28-32 weeks of age individually caged layers had significantly higher hen day egg production ($P<0.05$) than the colony or floor reared layers. However, during 32-36 weeks of age (peak summer) the colony reared layer had more hen day egg production ($P<0.01$) than the colony or floor reared layers and floor reared birds recorded less egg production than the individually reared birds.

Table 13: Hen day egg production of CARI Priya under different housing condition during summer months

Housing type	20-24 wks	24-28 wks	28-32 wks	32-36 wks
Colony cage	66.0±2.02	76.8±2.22[a]	78.2±1.90[a]	82.0±1.87[c]
Individual cage	64.3±2.06	86.4±1.38[b]	87.0±1.21[b]	71.3±1.60[b]
Floor	52.7±1.84	84.9±2.20[ab]	81.1±1.83[ab]	56.9±1.15[a]

Mean bearing different superscripts in column differ significantly (P<0.05)

Health Management

Surveillance and Monitoring of Poultry Diseases in Poultry Farms at CARI

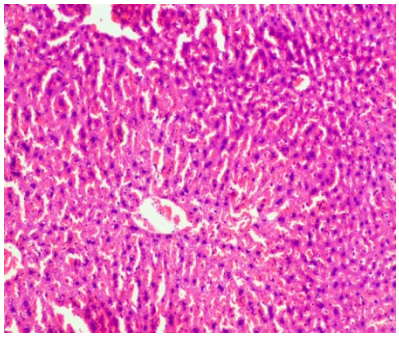
Prevention of poultry disease, early detection and effective treatment of poultry disease are important components of poultry health management**.** Healthcare of different poultry species viz chickens (layer, broiler and desi fowl), quails, turkey, guinea fowl and emu maintained at the institute included both preventive as well as therapeutic aspects. The strategies for health care were devised based on sero-surveillance, diagnosis of diseases/infections on the basis of post-mortem examination and detection of causative agent/s. Vaccination was carried out regularly in different poultry species. Which constituted important segment of preventive health care strategy. Various does of vaccines used included Ranikhet disease(RD): 1,66,000 doses, Marek's disease (MD); 70,500 doses; infectious bursal disease (IBD): 88,500 doses; R2B strain of RD;40,000 doses, IBD killed 2029 doses; RD killed; 10,000 doses with a total doses of 4, 14, 029 doses. Sero-monitoring was carried out regularly and based on the level of antibody titre, the vaccination programme was devised from time to time in different poultry species. *Salmonella* and Avian Leucosis Virus(ALV) screening was part of pathogen profiling programme. As antibiotic resistance is now days having global importance. Hence, use of antibiotics was done very judiciously and in case of infection, antibiotic sensitivity was carried out. Use of gut acting acidifiers, probiotics, vitamins, minerals supplements, electrolytes and immune-modulators was part of health management programme in different poultry species. Main diseases encountered in the flocks included chronic respiratory disease, colibacillosis, coccidiosis, etc. and these were effectively controlled suitable therapeutic agents. The main gate of the experimental farm as well as different poultry farms were provided with foot dips and bio-security measures were further strengthened with regular disinfection of poultry sheds, providing foot water baths, education of farm workers and restricted entry for visitors. Since waste disposal is important from hygienic point of view, thus, the waste generated from hatchery, processing plant and dead birds was disposed off hygienically taking all measures.

Processing, Value Addition, Product Safety and Quality Parameters

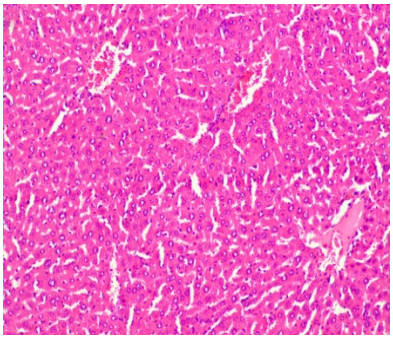
Development and Shelf-life Extension of Functional Meat Product Prepared from Turkey and Spent Chicken Meat

Assessment of functional activity of poultry meat wafers using laboratory animal trails

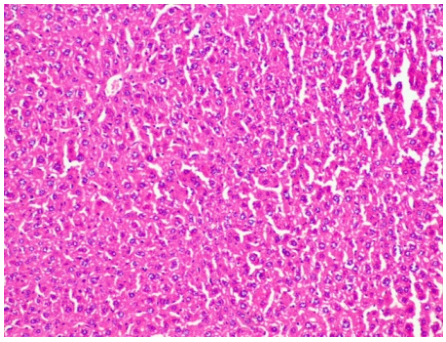
After standardization of processing technique for functional poultry meat wafers (PMW), efforts were made for better understand the functional activity of PMW using laboratory animal (mice) trails. For this, three individual samples were prepared in which control sample contained corn based diet (CBD) (maize, wheat, milk and salt) while treated samples contained meat based diet *viz*. (i) control wafers (WC) and (ii) treated (functional) wafers (WT), and that were standardized previously. The results on serum biochemical profiles revealed that feeding of functional wafers significantly (P<0.01) influenced total proteins, triglycerides, total cholesterol, LDL contents, AST, ALT etc. Triglycerides, total cholesterol, LDL cholesterol, AST, ALT were significantly lower for mice fed with functional wafers. The HDL contents and Glycemic Index (GI) were also higher for same group of mice but differed non-significantly. Feeding of control wafers increased values for triglycerides and total serum protein contents while functional wafers subsides these effects. The percent body weight gain though was greater for mice fed with corn-based diet differed non-significantly. From this study it was also observed that the changes in serum biochemical profiles were depended on length of feeding time since values for most of the parameters were first increased then decreased and again increased. The morphometric and histochemical parameters of different vital organs (heart, liver, lungs, kidney, small intestine and spleen) of mice fed with corn based diets and control and functional PMW however were normal at the end of the study.



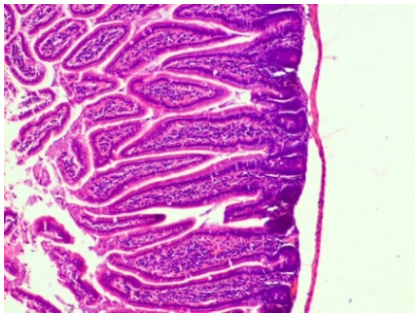
CBD (Liver Cross Section, 10x)



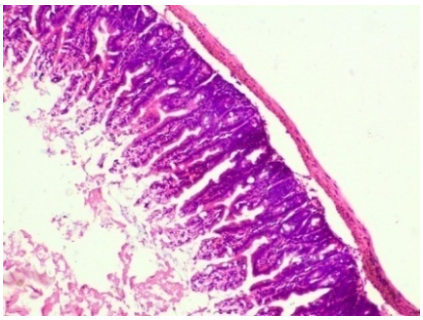
WC (Liver Cross Section, 10x)



WT (Liver Cross Section, 10x)

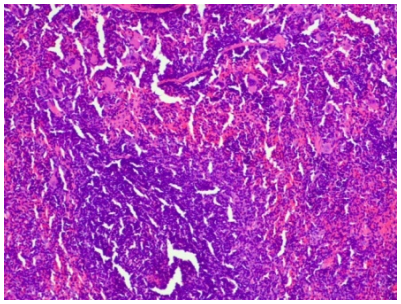


Corn based diet (S.I Cross section, 10x)

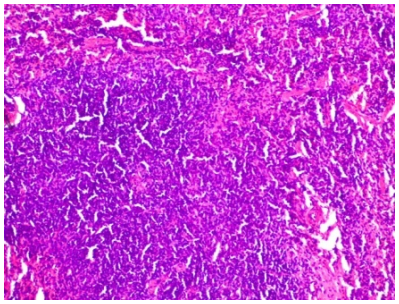


WC (S.I Cross section, 10x)

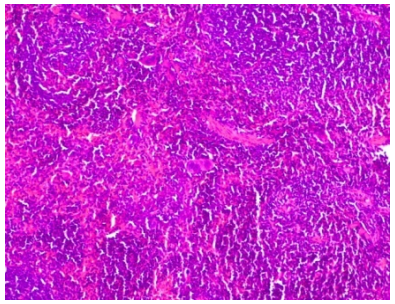
WT (S.I Cross section, 10x)



Corn based diet (Spleen Cross section, 10x)



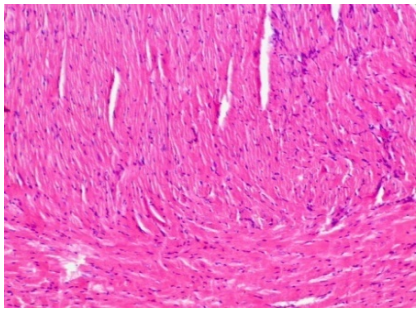
WC (Spleen Cross-section, 10x)



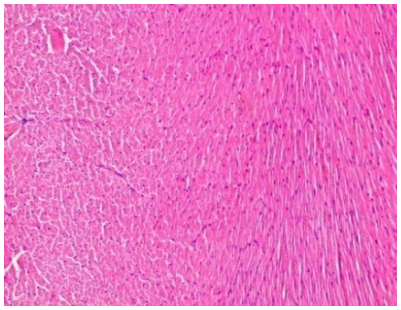
WT (Spleen Cross-section, 10x)

Assessment of functional activity of poultry meat finger chips using lab animal trail

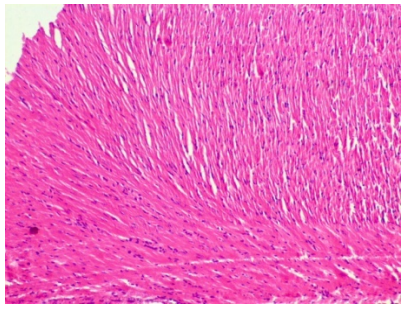
Studies were conducted on functional activity assessment of standard (control; FC) and functional (treated; FT) poultry meat finger chips (FPMFC) in *in-vivo* animal trials (mice). A formulation containing corn-based diet (maize, wheat, milk and salt) was provided to one group of mice for comparison. Results indicated that feeding of FC or FT sample improved total serum protein turn-over but decreased percent body weight gain of the mice. Mice fed with functional finger chips significantly decreased serum triglycerides contents but increased AST and glycemic index than either corn based or control finger chips fed groups. Other serum biochemical parameters like HDL and LDL, total cholesterol and ALT though increased and deceased respectively for FT fed group but did not differ significantly from corn-based diet fed mice. As expected, serum from FT fed mice showed better lipid stability and antioxidant activity. Morphometric and histochemical parameters of heart, liver, lungs, kidney, small intestine and spleen, however differed non-significantly amongst mice fed with corn based diet, FC and FT samples.



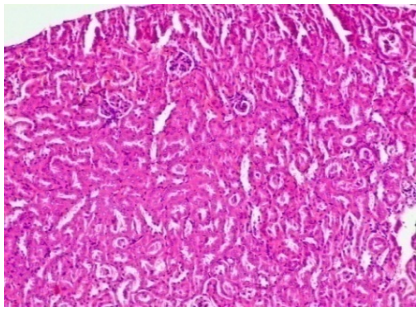
Corn based diet (Heart Cross Section, 10x)



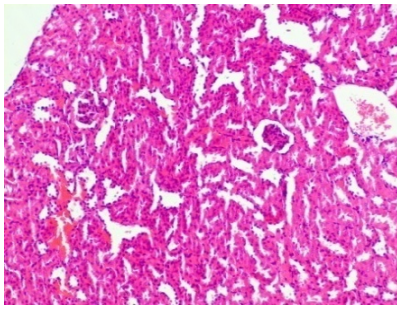
FC (Heart Cross Section, 10x)



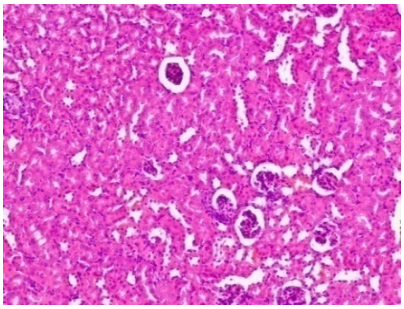
FT (Heart Cross Section, 10x)



Corn based diet (Kidney Cross Section, 10x)



FC (Kidney Cross Section, 10x)

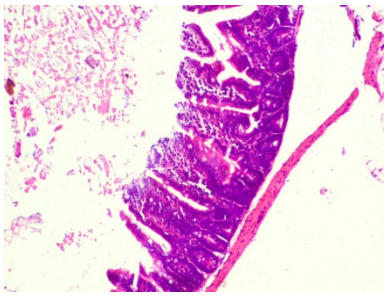


FT (Kidney Cross Section, 10x)

Evaluation of functional activity of chicken meat bites in laboratory mice model study

Standard and function chicken meat bites developed earlier were elucidated for functional activity in *in-vivo* mice trials. A corn based diet (without meat ingredients) was also formulated to supplement the mice as per standard method and that was considered as control. Results indicated that functional chicken meat bites (BT) fed mice showed better serum total protein turn-over, higher HDL but lower LDL contents. This sample also showed lower serum cholesterol content but did not differ from corn-fed or control bites (BC) fed mice. Other serum biochemical profiles *viz*. AST level was lowest but ALT was moderate level. Glycemic Index did not vary significantly from corn based diet fed mice. Though percent body weight gain was nearly similar for all groups of mice but BC fed mice showed belly fat deposition. All the biochemical parameters also greatly influenced due to length of feeding time, irrespective types of diets provided with them. Histological and other morphometric parameter were normal amongst the different mice groups since there was no variation/change observed in the any vital organs (heart, liver, kidney, lungs, spleen and small intestine).

BC (S.I. Cross Section, 10x)



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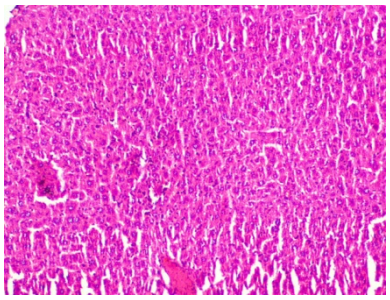

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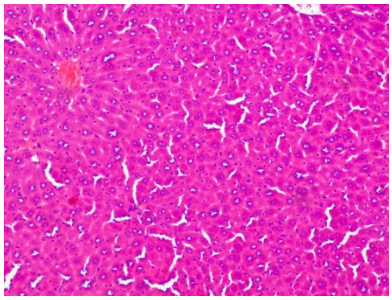

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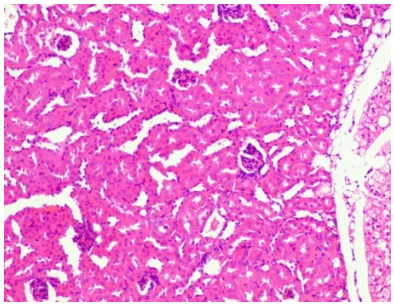
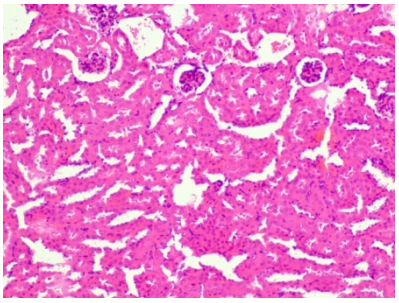


BC (Kidney Cross Section, 10x)



BT (Kidney Cross Section, 10x)

Development of Different Value Added Poultry Products for Income Generation

Functional chicken meat bites, sausages 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 physico-chemical, nutritional and microbiological quality to ensure safety to the consumers. A total 239 packets of chicken meat bites, 42 packets sausages and 108 packets quail egg pickles were sold through institute marketing centre and in different agriculture fair.

Assessment of *lactobacillus plantarum* as Probiotic Bacteria in Development of Fermented Chicken Sausages

Standardization of in-vitro growth conditions of *Lactobacillus plantarum* and evaluation of its antimicrobial potential against *E. coli* and *Salmonella Typhmurium*

Lactobacillus plantarum, one of the most resourceful probiotic bacteria which have been known for its antioxidant and antimicrobial property. Thus, the aim of this study was to assess antimicrobial properties of *L. plantarum* against

artificially inoculated standard strains of *Salmonella* and *E.. coli* in tryptic soya broth (TSB) with their pre-determined concentrations. The results indicated that both *E. coli* and *Salmonella* Typhimurium were inhibited by *L. plantarum* at all selected incubation temperatures i.e. 18, 20 and 22°C up to 96 hr of experiment under static conditions. *E. coli* and *Salmonella* Typhimurium, however, these were not completely eliminated at these temperatures. Results of assessment of survivability *L. plantarum* incubated at a temperature of 45, 55 and 60°C for 0, 30, 60 and 90 min in phosphate buffer saline (pH-7.4) supplemented with different concentrations of dextrose and starch either singly or in combinations at incubation temperatures of 45, 55 and 60°C resulted in significantly ($P<0.05$) higher survivability of *L. plantarum* at incubation temperature of 45 and 55°C. The combination of both sugars namely, dextrose and starch at 1 % (w/v) level of each sugar exerted better survivability than using sugars alone.

Development of chicken meat sausages prepared from minced chicken meat fermented with *Lactobacillus plantarum* and malted oat flour

The study was carried out to standardize fermentation conditions and to assess the probiotic attributes of *Lactobacillus plantarum* in chicken sausages prepared after fermentation of minced chicken meat from culled hens. Further, antioxidant and antimicrobial properties of *L. plantarum* with the use of different levels (0, 1, 2, 3, 4 % ;w/w) of malted oat flour as a substrate in chicken sausages prepared before and after fermentation of minced chicken meat with *L. plantarum*. Results indicated that chicken sausages prepared after fermentation of chicken meat (without spices) with *L. plantarum* caused increase in antioxidant scavenging activity against hydroxyl (ABTS) and superoxide anion (SASA free radicals as compared to the chicken sausages prepared from minced chicken meat without fermentation, however, their activity was significantly ($P<.05$) higher in chicken sausages prepared from minced chicken meat supplemented with different levels of malted oat flour. Similarly, the minced chicken meat supplemented with malted oat flour subjected to fermentation with *L. plantarum* also showed lower lipid oxidation, lower pH value, higher fiber content and better scores for sensory as well as lower microbial counts as compared to sausages prepared from fermented minced chicken meat without oat flour. The results of storage study under refrigeration (4±1°C) and frozen (-18°C) temperatures of chicken sausages prepared after fermentation of minced chicken meat with *L. plantarum* and supplemented with 2% (w/w) malted oat flour indicated that the product was acceptable up to 9th day at refrigeration and up to 6o days frozen storage under aerobic package.

Standardization of processing technology for development of chicken egg sausages

Processing technology for development of CES was standardized for effective utilization of surplus eggs for profitable income by the farmers. For this, egg yolk was placed at the centre and albumen was kept around so that product may remain attractive by the consumers. Egg contents were encased in casing manually, and cooked by water cooking until hard boiling. The egg sausage contained 100 % natural ingredients and taste is delicious as rated by some sensory panel members.

Egg sausages (pieces)

Monitoring of Poultry Products and Feed Samples for Chemical Residues

Detection of antibiotic residues in poultry meat, eggs and feed samples

Harmful bio- and phyto contaminants including veterinary drugs exert harmful effect in human and animal food chain and cause a serious concern since quite some time. With an aim to provide a safe food to human population, food safety guidelines are to be followed in all food products. Since drugs are being administered to livestock and poultry at different phases of rearing to maintain proper health status, residues are likely to occur in body. Therefore, possible source of entry such as feed along with the food products like egg and tissues (muscle) to be monitored for detection and quantification of residue of the drugs so as to create a database in this regard. 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=40/component/ location) from farm and market places of Ludhiana and Barbala areas of northern India.

As revealed from results, residue of drugs like tetracycline, oxytetracycline, and chlortetracycline in samples of poultry feed, egg, liver and muscle collected from all four areas were found in the range of 0.015-0.25ppm, 0.012-0.02ppm, 0.015-0.023ppm and 0.015-0.025ppm, respectively. In all, the occurrence pattern of, tetracycline, oxytetracycline and chlotetracycline were to the tune of 5%, 8% and 5% among all samples. Higher drug residues were obtained in samples collected from Barbala sampling areas. The occurrence of residues of trimethoprim and sulfamethoxazole was recorded in samples of poultry feed (0.015-0.025ppm), egg (0.01-0.02ppm), liver (0.015-0.023ppm) and muscle (0.01-0.02ppm) with higher residue levels observed in samples collected from Barbala area. The level of residues determined was within the permissible limit.

It was inferred that residues of drugs were found relatively higher levels in feed samples. Among the locations of northern region studied, samples collected from Barbala contained relatively higher levels of residues than those from other areas. All the samples analyzed, however, were within the permissible limit.

HRD and Technology Dissemination

Poultry Entrepreneurship Development

Establishment of agri-business incubator: For establishing ABI in the institute, 4 rooms were earmarked for renovation and as per the cost estimates received from the CPWD, the money was deposited with CPWD on March 30, 2016. The work is still in progress and is expected to be completed in by July, 2017. Moreover, few equipment/ appliance / furniture etc. have been purchased in the project. One Business Manager, one Business Executive and one Office Assistant cum Computer Operator were appointed in the project for the period 2.1.2017 to 31.3.2017.

During 2016-17, a workshop entitled "*Financing poultry: Status, constraints and way-forward*" was organized on March 1, 2017, It was attended by about 160 participants including farmers, bankers, representatives of insurance sector and state animal husbandry department and scientists/technocrats. The issues of poor credit flow to the poultry sector and non-availability of insurance facilities to the poultry farmers/ entrepreneurs were deliberated at length in the farmers-bankers-insurers-scientists interactive meet. Shri V.K. Sachan, Joint Director, Poultry Development Cell, Govt of Uttar Pradesh was invited as Chief Guest of the function. Besides, Shri Mahendra Kumar, Deputy Zonal Head, Bareilly Zone, Bank of Baroda and Shri S.K. Wadera, Deputy General Manager, Zonal Office, SBI, Bareilly were invited as Guests of Honour representing the banking sector. The insurance sector was represented by Shri Ajay Bharti, Sr. Divisional Manager, Oriental Insurance Co. Ltd, Bareilly and Shri Parveen Bhatia, Divisional Manager, National Insurance Co. Ltd., Bareilly as Guests of Honour.

Externally Funded Projects

Kappaphycus alvarezii and Red Sea Weed Based Formulations for Improving Productivity and Health of Broiler Chickens and Laying Hens *(CSIR Sponsored Project.)*

Algae are a large and diverse group of plant like organisms ranging from unicellular to multicellular forms. The largest and most complex marine algae are called seaweeds. *Kappaphycus alvarezii*, red algae is consumed by coastal people. Fresh and dried seaweeds are utilized as human food. The sea weeds have recently received significant attention as source of soluble polysaccharides and natural antioxidants (carotenoids, tocopherols and polyphenols), which may be beneficial for improving digestibility of nutrients and suppression of free radical generation. Accordingly one experiment was conducted using sea weed based formulation in commercial broiler chickens (n= 280) during extreme winter months (Dec. 2016 to Jan, 2017). Seven diets with various

levels of seaweed formulation (0, 0.25, 0.50, 0.75, 1.0, 1.25 and 1.50% AF-KWP) were formulated and each diet was fed to 5 replicated groups of 8 birds each. Significant improvement ($P<0.05$) were observed on body weight gain and feed intake in diets with 1.25% and 1.50% AF-KWP groups compared with others AF-KWP or control groups. Feed conversion ratio (FCR feed: gain ratio) did not differ statistically but apparently lower FCR was observed in treatments with 1.25% or 1.50% AF-KWP compared to control diet. HA titre (humoral immune response) and foot pad index (cell mediated immune response) increased progressively in groups fed diet containing of *Kappaphycus alvarezii* and red sea weed based formulations (AF-KWP) but the values were significantly higher in 1.25% and T_7 1.50% levels compared to control diet. Significant improvements in breast and thigh yields (percentage of live weight) were observed in the AF-KWP @ 1.25 or 1.50% treated group. Serum enzymes, ALT, total cholesterol and uric acid concentrations were decreased, whereas, serum enzymes AST, creatinine and serum minerals (Ca and P) were increased in 1.25 or 1.50 % AF-KWP treated group. Inclusion of AF-KWP @ 1.25 or 1.50% decreased the enteropathogen and increased the *lactobacillus* count in crop and caecal, and improved the villi height and width in ileum in broiler chickens. Improvement in physio-biochemical characteristics and reduction of microbiological counts in fresh and cold-chain stored (14 d) meat was also observed on inclusion of 1.25 or 1.50% AF-KWP in basal diet. It was concluded that *Kappaphycus alvarezii* and red sea weed based formulations (AF-KWP) can be incorporated at 1.25% or 1.50% level in broiler diet for improved performance, immuno-responsiveness, gut health (both microbial and structural), breast yield, physio-biochemical characteristics and reduction of microbiological counts in fresh and storage (14 d) meat.

Evaluating of Probiotics, Prebiotics and Cynbiotics Supplementation in Low Energy and Low Protein Feed for Improved Nutrient Utilization and Safe Poultry Meat Production *(DBT Sponsored Project.)*

Prebiotics are being established as promising alternate to antibiotics growth promoter for gut health and safe poultry meat production. A feeding trial was conducted to compare the production performance, immunity and gut microbiota in broiler chicks on feeding prebiotics included low energy or low protein diet. A total number of 240, day-old broiler chicks were randomly assigned to 6 dietary treatments from 0-6 weeks of age. The dietary treatments were basal diet (T_1), basal diet + BMD@ 20 mg/kg diet (T_2), basal diet + mannan-oligosaccharides (MOS) @ 0.1 and 0.2% (T_3 and T_4), basal diet + fructo-oligosaccharide (FOS) @ 0.1 and 0.2% (T_5 and T_6) respectively. The results of the present study led to conclude that mannan oligosaccharides (MOS) at 0.2% inclusion level in low energy low protein diet improved production performance and immune response, gut health and increased beneficial bacterial concentration in gut of broiler chickens. Prebiotic (MOS @ 0.2%) inclusion in low energy low protein feed also improved the physio-biochemical characteristics of in fresh and storage (14 d) meat and reduced microbiological counts in fresh and stored frozen (14 d) meat in broiler birds. The entero-pathogen count in different parts of gastro intestinal tract was decreased in broiler chickens. Results indicated that MOS could be an alternative to antibiotic growth promoters (AGP) for broiler chickens for safe and clean meat production.

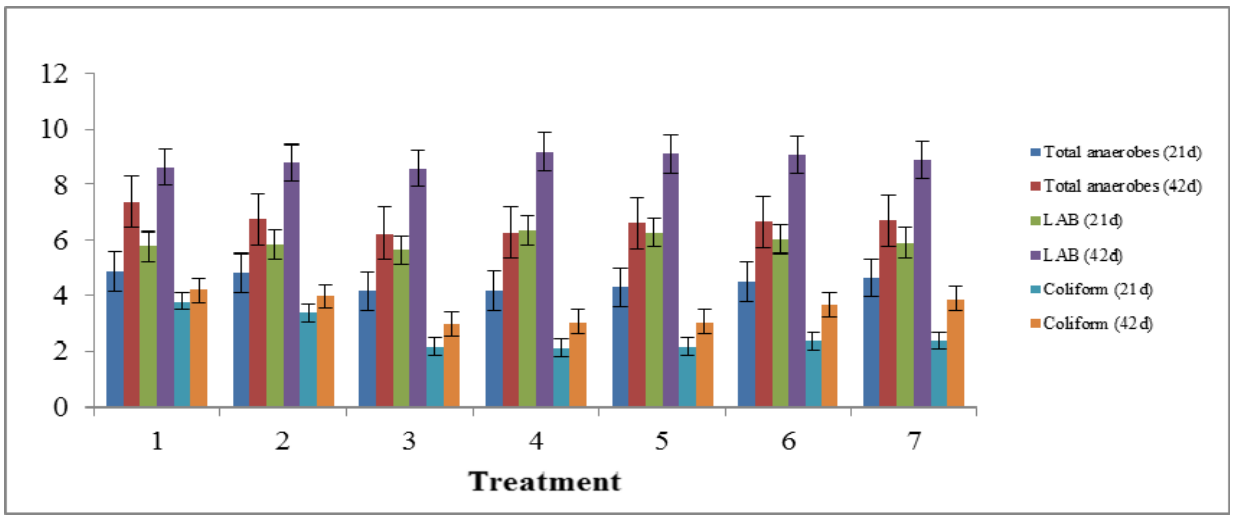


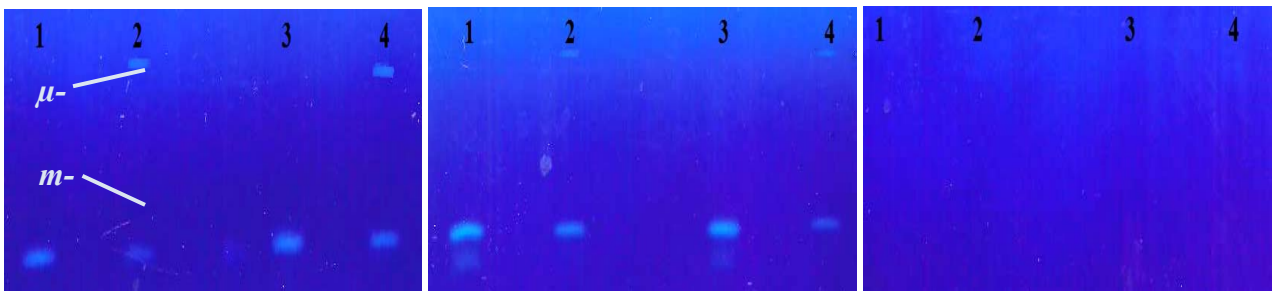
Fig. 13: *Effects of dietary supplementation of prebiotics with low energy and low protein diet on microbial load in faecal sample of broiler bird*

Biochemical basis for Detection of Calpains and Calpastatin and Their Role in Post-mortem Tenderization of Meat (DST Sponsored)

Standardization of micro-calpain assisted post-mortem ageing of meat from diversified animal species

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 was standardized.

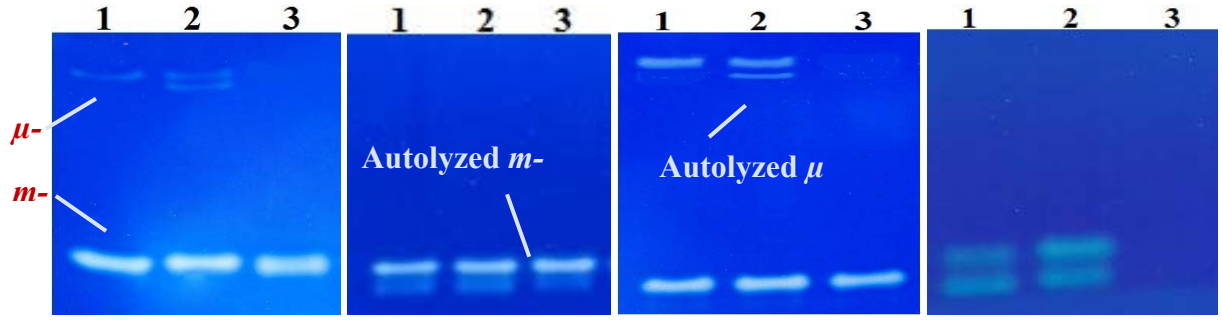
***Rhode Island Red (RIR)*:** For Rhode Island Red (RIR) chicken, μ-calpain induced post-mortem ageing of breast and thigh muscles was observed at room temperature. In breast muscle substantial amount of μ-calpain was found during initial hours of holding but μ-calpain activity was absent in thigh muscle. For breast muscle, μ-calpain mediated PM ageing was optimized at 3 h during holding at 27±2°C.



(A) **(B)** **(C)**

Fig.14: Showing clear bands of μ- and m-calpains on casein gel in RIR samples: Muscle samples-
(A) 0 h: Lane-1: Thigh (♀); Lane-2: Breast (♀); Lane-3: Thigh (♂); Lane-4: Breast (♂).
(B) 3 h: Lane-1: Thigh (♀); Lane-2: Breast (♀); Lane-3: Thigh (♂); Lane-4: Breast (♂).
(C) 6 h: Lane-1: Thigh (♀); Lane-2: Breast (♀); Lane-3: Thigh (♂); Lane-4: Breast (♂).

***Turkey*:** For turkey, optimal presence of μ-calpain was observed up to 3 h in breast muscle however m-calpain remained stable up to 6 h from both male and female birds during post-mortem ageing. The μ-calpain, m-calpain and calpastatin concentrations were also decreased significantly. For thigh muscle activity of μ-calpain was absent even immediately after slaughter. Thus it was concluded that μ-calpain assisted post-mortem ageing time for breast muscle from both male and female birds was 3 h at room temperature.



(A) **(B)** **(C)** **(D)**

Fig.15: Showing clear bands of μ- and m-calpains on casein gel in Turkey samples (32 weeks age group):
(A) Lane-1: 0 h Breast (♂); Lane-2: 3 h Breast (♂); Lane-3: 6 h Breast (♂).
(B) Lane-1: 0 h Thigh (♂); Lane-2: 3 h Thigh (♂); Lane-3: 6 h Thigh (♂).
(C) Lane-1: 0 h Breast (♀); Lane-2: 3 h Breast (♀); Lane-3: 6 h Breast (♀).
(D) Lane-1: 0 h Thigh (♀); Lane-2: 3 h Thigh (♀); Lane-3: 6 h Thigh (♀).

***Guinea fowl (Swetambari and Pearl)*:** PM ageing time at 27±2°C for guinea fowl (Swetambari and Pearl) was optimized at 2 h for breast muscle since μ-calpain rapidly autolyzed at 2 h for both the species, and was completely absent at 4 h, and for thigh muscle, it was completely autolyzed at 2 h for both the species.

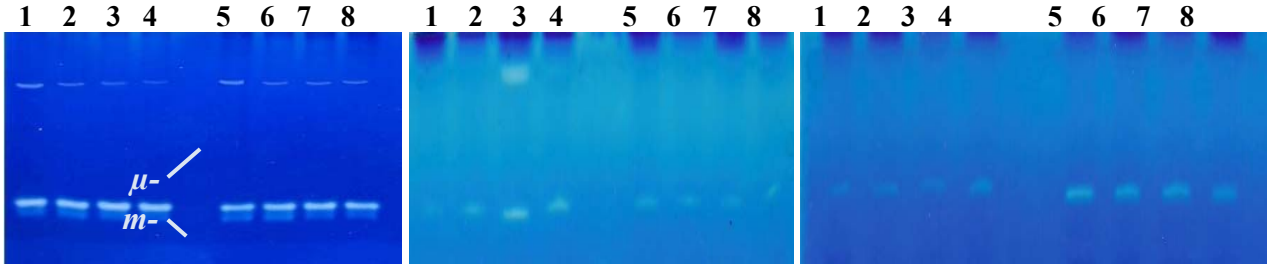


Fig. 16: Showing clear bands of μ- and m-calpains on casein gel in Guinea Fowl samples:
(A) 0 h: Lane-1: Swetambari Breast (♂); Lane-2: Swetambari Breast (♀); Lane-3: Pearl Breast (♂); Lane-4: Pearl Breast (♀); Lane-5: Swetambari Thigh (♂); Lane-6: Swetambari Thigh (♀); Lane-7: Pearl Thigh (♂); Lane-8: Pearl Thigh (♀).
(B) 2 h: Lane-1: Swetambari Breast (♂); Lane-2: Swetambari Breast (♀); Lane-3: Pearl Breast (♂); Lane-4: Pearl Breast (♀); Lane-5: Swetambari Thigh (♂); Lane-6: Swetambari Thigh (♀); Lane-7: Pearl Thigh (♂); Lane-8: Pearl Thigh (♀).
(C) 4 h: Lane-1: Swetambari Breast (♂); Lane-2: Swetambari Breast (♀); Lane-3: Pearl Breast (♂); Lane-4: Pearl Breast (♀); Lane-5: Swetambari Thigh (♂); Lane-6: Swetambari Thigh (♀); Lane-7: Pearl Thigh (♂); Lane-8: Pearl Thigh (♀).

Goat (Jamunapari): For goat micro-calpain assisted PM ageing time to 4 h during post-mortem ageing at room (27±2 ºC) temperature, after that a second polypeptide was detected which presumably is the autolyzed form of μ-calpain.

REGIONAL CENTRE, BHUBANESWAR

Maintenance, Evaluation and Conservation of Important Breeds of Ducks for Augmenting Duck Production in Rural and Tribal Areas

The ducklings, grower and adult stocks of four duck breeds (*viz*. Khaki Campbell, Desi, White Pekin and Moti) of G-3 generation were maintained during the period under report and their juvenile growth and egg production traits *viz*. body weights at day old, 4, 6, 8 and 10 weeks; age at first egg, age at 50% egg production, body weights at 16, 20 and 40 weeks, egg production up to 40 weeks and egg weights at 28 and 40th weeks of age were recorded. The Moti, basically a Muscovy breed of duck (very poor egg producer) has been maintained for conservation. The body weights of replacement stocks of different duck breeds were recorded at 0, 4, 6, 8 and 10 weeks of age. The body weights were recorded for both the sexes from day old to 10 weeks of age. The average body weights of both sexes and all hatches are presented for all the age groups of all the breeds up to 10 weeks of age. The pooled average body weights at day old age were recorded as 37.45, 34.83, 40.01 and 41.28 g, respectively for Khaki Campbell, Desi, White Pekin, and Moti. The pooled mean body weights for corresponding breeds at 4th week of age were observed as 506.42, 232.27, 654 and 364.88 g, respectively. The average body weights at 8 weeks of age were 1049.09, 747.14, 1513.08 and 919.91 g respectively. Ten weeks body weights were 1202.97, 1055.47, 1808.57 and 1342.80 g for respective breeds. Consistently lower body weights of Desi from day old to 8 weeks of age was observed.

The average age at first egg in the flocks were recorded as 128.77, 118.33, 125.4 and 190 days for Khaki Campbell, Desi, White Pekin and Moti (Muscovy), respectively. The average age at 50% egg production was observed as 169, 185.33, 171.33 and 209.5 days for respective breeds. The average 20th week body weights were observed as 1389.46, 1394.96, 2175.02 and 1805.13 g for corresponding breeds. The mean 40th week body weights for respective breeds were recorded as 1381.99, 1506.34, 2175.88 and 1853.30 g. The average duck day egg productionup to 40 weeksof age recorded for G-3 generation (2016-17) were 64.84, 50.67, 52.64 and 19.56 eggs for Khaki Campbell, Desi, White Pekin and Moti, respectively. The mean 28th week egg weights for respective breeds were recorded as 54.32, 55.61, 63.08 and 54.69 g. Similarly, the mean 40th week egg weights for corresponding breeds were observed as 58.37, 55.33, 66.98 and 53.79 g.

Reproductive and Hatchery Management Strategies for Improving Fertility and Hatchability in Duck Eggs

Effect of cleaning eggs during collection on hatchability in three varieties of ducks

Duck eggs (Khaki, Deshi and White pekin) collected in the morning from the duck house were subjected for gentle cleaning with soft cotton dipped in 40, 60 and 80 percent ethyl alcohol regularly. They were stored in cooling chamber and transferred to incubator for the purpose of hatching. Seven hatches were taken for three breeds of duck. Observation revealed that hatchability is improved by cleaning eggs with 60 percent ethyl alcohol in Khaki Campbell and 40 percent in Desi ducks whereas cleaning imparted no effect in white pekin duck eggs.

Effect of one semen additive on Fertility and Hatchability in ducks

Khaki Campbell laying ducks (30 nos) of 45 weeks of age were randomly divided into three groups. Semen collected from drakes of same breed for artificial insemination was divided into three aliquots. PGF2α (10 µg /ml and 20 µg /ml) were added to two aliquots separately where as other aliquot remain as control. AI was done with standard practice with 0.1ml semen per bird at 3 days interval for a period of one month. Eggs collected between every five days were incubated. It was observed that fertility and hatchability (TES and FES) per cent were highly significant for the group inseminated with semen added with 10µg PGF2α /ml.

Evaluation of Azolla as an Alternate Feed Resource for Economic Production of Duck Meat and Egg.

Performance of White Pekin layer ducks fed azolla (Azolla pinnata)

Production of Azolla (Azolla pinnata): A pit (dimension: 7M x 5M x 0.2M) was maintained. A Silpauline sheet (30ft x 24ft) was lined the entire pit and the projections from all sides were covered with a line of bricks from all sides to keep it in proper position. Fertile soil (90 kgs), cow dung (16 Kg) and 240 g superphosphate mixed in 90 litres of water were added to the pit. Water level was maintained at 10 cm depth throughout the pit. 4000 gram of azolla (*Azolla pinnata*) culture was spreading in the pit uniformly. On every week 8 kg of cow dung and 120 gm of superphosphate was added to maintain the nutrient level in the pit. About 25 % of water was replaced with fresh water on every 10th day. From 10th day onwards 6kg of azolla was harvested from the pit everyday regularly.

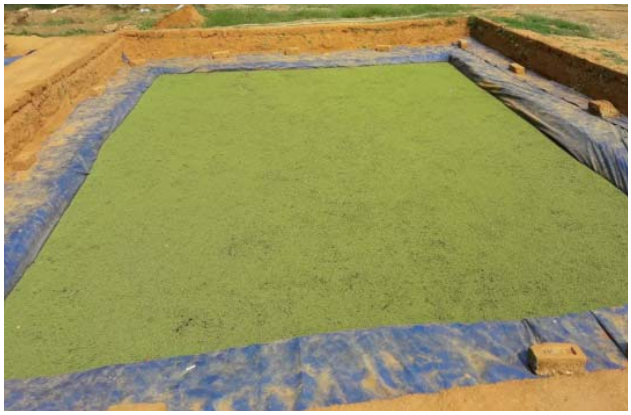


Fig. 17 . 10th day growth of Azollapinnata

Table 14: Chemical composition (%) of Azolla (*Azollapinnata*)

Proximate constituents	Sample 1	Sample 2	Sample 3	Mean ±SE
Dry matter	4.72	4.82	4.68	4.74±0.04
Crude Protein	28.71	29.42	30.63	29.59±0.56
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	14.27	14.45	13.98	14.23±0.12

An experiment was conducted to study the effect of feeding Azolla (*Azolla pinnata*) on the performance of White Pekin ducks. Sixty White Pekin laying ducks (62 weeks) were divided into two groups (each group has five replicates with six laying ducks per replicate) and were randomly fed two diets i.e. control diet (Standard duck layer diet) and experimental diet (standard duck layer diet reduced by 20% + fresh azolla @ 200g/duck/day). The body weight, egg production and egg weight were similar for the control and the azolla fed ducks. The feed intake, DM intake and CP intake were significantly ($P<0.01$) higher for control group compared to azolla fed group. The feed conversion efficiency, performance efficiency index and shape index of eggs were significantly ($P<0.01$) better for the azolla fed ducks. The egg quality characteristics *viz.,* haugh unit score, albumen index, yolk index and shell thickness without shell membrane (mm) were similar for both control and azolla fed ducks. The yolk colour of ducks fed azolla was deep orange compared to the light yellow yolk of control group. It can be concluded that feeding of fresh azolla @ 200g/duck/day in White Pekin Laying ducks was beneficial in terms of improved FCR and performance. The cost of feeding got reduced by Rs. 0.55/day/duck due to incorporation of fresh azolla.

Studies on Sperm Storage Tubules and Development of Technology for Short-term Preservation and Utilization of Male Gametes in Duck

Effect of Pre-ejaculatory fluid on fertilizing ability of spermatozoa

Semen collection was done with and without pre-ejaculatory fluid (PEF) to examine the affect of pre-ejaculatory fluid on the fertilizing ability of spermatozoa. The physical parameters *viz*., volume, spermatozoa concentration of semen collected with and without PEF were examined. The semen thus collected was inseminated into the mature laying ducks. Eggs were collected and incubated in the hatchery. The Eggs were examined on tenth day for the development of embryo. Around 41.6 per cent of the eggs of the bird's inseminated semen along with PEF were fertile. However, poor fertility (18.9%) was noticed when the semen collected without PEF was inseminated. The role of pre-ejaculatory fluid on fertility of spermatozoa during cold storage is being investigated.

Table 15: Physical characteristics of semen collected with and without pre ejaculatory fluid

S. No.	Particulars	Semen Volume (µl)	Colour	Sperm concentration
1.	With PEF	943.75	Creamy White	1.4×10^9/ml
2.	Without PEF	581.25	Creamy White	6.1×10^9/ml

Table 16: Percent fertility of semen collected along with Pre Ejaculatory Fluid

S. No.	Particulars	Total no. of eggs set	Total no. of fertile eggs	Fertility (%)
1.	With PEF	89	37	41.57
2.	Without PEF	74	14	18.91

Nutrient Requirement of White Pekin Ducks

Performance White Pekin ducks on different levels of protein during starter stage

An experiment was conducted to study the optimum level of dietary protein requirement of White Pekin ducks during starter stage. 225 day old ducklings are randomly divided into three groups having three replicates in each group with 25 ducklings in each replicates. Three experimental diets namely T_1, T_2 and T_3 containing 19, 21 and 23% CP, respectively were offered to the birds from 0-8 weeks of age. Care was taken to prepare iso-caloric diet. The level of essential amino acids like L-Lysine and DL-Methionine was balanced by adding their synthetic form available. All the birds were reared in the deep litter system in similar managemental condition except different dietary treatment. Daily feed intake and weekly body weight were recorded. A metabolism trial was conducted after 8^{th} weeks of age to study the nutrient availability of the ducks. No significant differences among the treatment group were observed with respect to their final body weight, DM, OM and EE metabolizability. From this experiment it was concluded that the diet containing 23% CP was optimum for White Pekin ducks during starter stage.

Optimum level of protein requirement for White Pekin ducks during grower stage

One hundred eighty nine ducks of 9^{th} weeks of age are randomly divided into three groups i.e. T_1, T_2 and T_3

having three replicates in each groups. Three experimental diets containing 14, 16 and 18% CP were offered to T_1, T_2 and T_3, respectively. All the birds were reared in intensive system of rearing. The birds were offered feed twice daily as wet mash. Daily feed intake and weekly body weight were recorded upto 16th week. After 16th week a metabolism trial of six days duration was conducted. The dried feed, faeces and residue were analyzed for their nutrient content. The significant difference in body weight at 16th week of age (1784.28±27.63, 1823.16±29.05 and 1915.47±81.42 g in T_1, T_2 and T_3, respectively) was observed. The DM, OM and CF metabolizability showed no significant differences between the groups. From this experiment it was concluded that the diet containing 18% CP was optimum for White Pekin ducks during grower stage.

Diversified Rice Based Farming System for Livelihood Improvement of Small and Marginal Farmers (*Lead Centre: ICAR-NRRI, Cuttack*)

Native variety of duck collected from Rairangapur sub-division of Mayurbhanj district were introduced in the model operated at NRRI, Cuttack. A small population of collected variety of duck is being maintained separately in RC-CARI for evaluation under intensive method of rearing. The performance of ducks observed in this model was highly encouraging. Mortality was least in comparison to other varieties tried in previous years. Foraging ability was highly satisfactory as less amount of supplementary feed was provided.

Ducks in Rice field

Ducks coming out of house for grazing

Study on acceptability of duck meat and egg along with its marketing in Odisha

A total 1,662 consumers visited the marketing centre for purchase of various duck products. On an average 7.35 persons visited our centre for purchase of table duck eggs. Preparations (dish) they made from the duck eggs for consumption were omelet (O), scrambled egg (S), boil (B) and curry (C). The per cent of consumers consuming different forms were presented in Fig.18. Maximum consumers using duck eggs for preparation of B+C followed by O+S, O+S+C, S+B, S+C, S+B+C, O+S+B, O+B, O+S+B, O+C and O+S+B+C. About 32.65 % consumers preferred duck eggs over chicken eggs. About 552 ducklings supplied during this year.

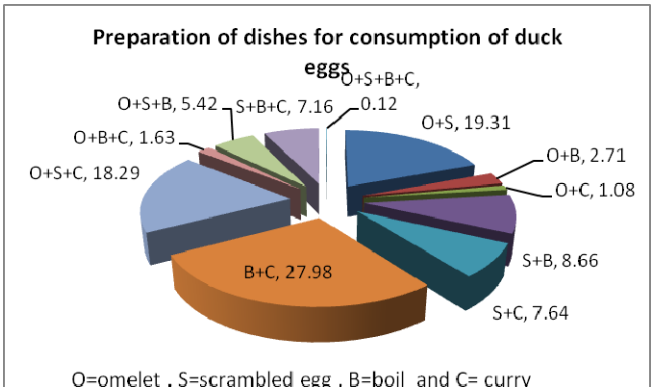


Fig. 18: Consumption of duck eggs in different combination

PG STUDENTS' RESEARCH AND EDUCATION

The MVSc and PhD students carried out research for the partial fulfillment of degree in Poultry Science (PSC) discipline at ICAR-CARI, Izatnagar under the IVRI Deemed University, Izatnagar. Additionally, PG educations leading to MVSc and PhD degree in Animal Genetics and Breeding/Animal Science/ Livestock Production and Management are also carried out under the auspices of IVRI Deemed University. During the period under report, 28 MVSc and 30 PhD students in Poultry Science were on roll. Six MVSc and five PhD students were awarded degree in Poultry Science discipline.

Research Highlights

Value addition of broiler meat through dietary means (*Dr Nasir Akbar Mir, Ph D, Advisor: Dr Praveen K Tyagi*)

A series of biological trials as per completely randomized design (CRD) were conducted to investigate the influence of adding organic chromium, lysine, broken rice and DDGS in flaxseed meal based diet on the growth performance, carcass and meat quality traits, serum biochemical parameters and sensory attributes of broiler chickens. A total of 240 broiler chicks of same hatch with uniform weight were used in the experiment I and II, whereas, 288 chicks were used in experiment III. The diets were formulated as per the recommendations of BIS (1992) and flaxseed meal was used to replace 10% of soybean in basal diet. In experiment I five dietary treatments (T1, T2, T3, T4 and T5) were formulated with no flaxseed in T1 and 10% in other four. No Cr was supplemented inT1 and T2, whereas, 0.5 mg, 1.0 mg and 1.5 mg/kg diet were supplemented in T3, T4 and T5, respectively. In experiment II five dietary treatments (T1, T2, T3, T4 and T5) were formulated with no flaxseed in T1 and 10% in other four. BIS recommended lysine level (1.3%) was supplemented in T1 and T2, whereas, 105%, 115% and 125% BIS recommended lysine levels were supplemented inT3, T4 and T5 respectively. In experiment III six dietary treatments (T1, T2, T3, T4, T5 and T6) were formulated with no flaxseed in T1 and 10% in other five. Broken rice was used as replacement of maize in T3 (20%) and T4 (40%), whereas, 5% and 10% DDGS were used as replacement of soybean in T5 and T6, respectively. Each treatment was allocated 6 replicates of 8 birds each based on similar initial body weight. The first two feeding trial were conducted for six weeks and third one for seven weeks. The feed as well as drinking water were provided *ad libitum* to the birds during the entire experimental periods.

The results revealed that feeding of 10% flaxseed exerted negative effects, whereas, Cr and lysine supplementation had positive effects on the weekly body weight, body weight gain, FCR, production efficiency factor, protein and energy efficiency ratios and lysine efficiency, but no effect on mortality. No significant effects were seen in feeding of broken rice and 5% DDGS to broilers. The feeding of flaxseed, broken rice, DDGS; and Cr and lysine supplementation revealed no effects on carcass traits. However, increasing Cr supplementation resulted in a progressive decline of abdominal fat (%), and increase of eviscerated yield, liver weight, dressed yield, breast yield, meat:bone ratio of both breast and thigh. Similarly, combination of 10% flaxseed and 40% broken rice yielded highest meat:bone ratio. The flaxseed feeding caused a marked rise in the percentage of unsaturated fatty acids, including MUFA, PUFA, n3, n6 fatty acids and n3:n6 and PUFA:SFR ratios, whereas, a decline was seen in saturated fatty acids, which was furthered by addition of 5% as well as 10% DDGS in diet. There was no effect of Cr, lysine and broken rice supplementation on fatty acid profiles of broiler chicken. Flaxseed feeding reduces the meat cholesterol and fat (%), whereas, progressive reduction was observed with increasing Cr and lysine levels. The combination of 10% flaxseed with 1.0 mg Cr/kg diet or 5% DDGS or increasing lysine levels increased the final pH of broiler meat. Though, flaxseed feeding along with Cr and lysine revealed significant differences in tintometer colour values of broiler meat, but no regular trend was observed in the results. No significant dietary effects of broken rice and DDGS with 10% flaxseed were observed on broiler meat colour values. The addition of 10% flaxseed caused significant reduction of WHC and ERV of broiler meat which is further reduced by addition of 5% or 10% DDGS in broiler diets, whereas, increasing Cr and lysine supplementation progressively increased WHC and ERV of broiler meat. However, the effects of 10% flaxseed, DDGS, Cr and lysine on drip loss were reverse of WHC and ERV. The feeding of broken rice had no effect on WHC, ERV and drip loss of broiler meat. 10% flaxseed reduces the DPPH and ABTS values of broiler meat which are further reduced by addition of 5% or 10% DDGS, whereas, Cr and lysine supplementation increased them. However, no effect of broken rice was observed on these parameters. 10% flaxseed feeding causes significant increase of lipid

oxidation (free fatty acid, peroxide and TBARS values) of broiler meat which is further increased by addition of 10% DDGS in broiler diets, whereas, Cr and lysine supplementation decreases it. However, 5% DDGS and broken rice feeding had no effect on it. 10% flaxseed and 40% broken rice feeding decrease serum triglyceride and cholesterol concentrations, whereas, increasing Cr and lysine supplementation resulted in to their progressive decline; and DDGS and 20% broken rice addition exert no such effects. However, no effect of flaxseed, Cr, lysine, broken rice and DDGS were observed on serum glucose. 10% flaxseed feeding increases the activity of antioxidant enzymes like superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GSH-Px) and glutathione reductase (GR) and MDA concentration in serum, which are further increase by addition of 5% or 10% DDGS in broiler diet, whereas, Cr and lysine feeding decreases them. However, no significant effect of feeding broken rice was found. The feeding of 10% flaxseed, broken rice, DDGS and supplementation of Cr and lysine did not exert any significant effects on the sensory attributes of raw as well as cooked broiler meat.

Evaluation of growth performance, immune response and gut health status in turkey poults fed diet supplemented with synbiotics *(Dr Uttam Garain, MVSc, Advisor: Dr S. Majumdar)*

The effects of dietary inclusion of synbiotics i.e., mixed *bacillus* culture and mannan-oligosaccharide (MOS) on growth performance, immune response and gut health status of turkey poults were evaluated on 256 day-old straight-run turkey chicks reared in different housing system. A commercial basal diet (control; T1) was formulated, the rest three diets were prepared by adding 0.1% MOS (T2), *Bacillus subtilis* + *Bacillus amyloliquifaciens @ 106 cfu/g feed* (T3) ;combination of *Bacillus subtilis* + *Bacillus amyloliquifaciens @ 106 cfu/g* and 0.1% MOS (T4) with basal diet. Production performancein terms of body weight gain (g) and feed conversion ratio (FCR) improved in T2, T3 and T4 compared to control. Feed intake (FI) was significantly ($P<0.01$) lower in synbiotic group compared to other dietary treatments. Also less mortality occurred in synbiotic group. The prebiotic or synbiotic supplementation caused significant ($P<0.001$) increase inthe erythrocyte count, hemoglobin concentration and hematocrit values compared to control values. Serum protein and albumin level, serum enzymes (AST, ALP and ALT), totalglucose and total cholesterol concentrations were influenced by probiotic or MOS alone or incombination compared to control group. No significant differences were recorded inpercentage of cut up parts yields. HA titres were significantly ($P<0.001$) higher in T3 and T4 compared to control andMOS. Cell mediated immunity improved significantly ($P<0.001$) when probiotic (T3) and synbiotic (T4) were supplemented with basal diet compared to control or MOS treated groups. Significant ($P<0.001$) reduction was observed in coliform and total plate count in caecal digesta (35 and 70 d) and excreta (35 and 70 d) in synbiotic treated groups however, lactobacillus count significantly increased in T3 and T4 compared to control and MOS treated groups. Villi height, villi width and crypt depth were increased ($P<0.001$) in synbiotic supplemented groups at 35 and 70 d post hatch. The results of the present study showed that synbiotic provided additive benefits in growth performance, immune response, biochemical profile and gut health of the poults than when used prebiotics or probiotics individually.

Estimation of crossbreeding parameters for production traits in complete diallel crosses involving two native and one exotic chicken breeds *(Dr Vijay Singh, PhD, Advisor: Dr Raj Narayan)*

Diallel crossing is the one of the best method of testing the combining ability and selection of best male and female lines for maximizing the growth and production potentials. To study the combining ability of native chicken breeds with exotic breed with respect to growth and egg production traits, a 3×3 complete diallel cross involving two native chicken breeds *viz* Ankleshwar and Nicobari (NC) along with one exotic breed CARI Red (CR) was undertaken. The progenies belonging to three purebreds and six crossbred genetic groups were compared with growth, body conformation, and production and egg quality traits at 40^{th} and 72^{nd} week of age. The crossbreds revealed superiority over purebreds for various growth, body conformation, feed efficiency and production traits. The results revealed significant differences ($P<0.01$) between genetic groups for growth, body conformation, some egg quality traits and production traits. Among purebreds CARI Red weighed significantly ($P\leq0.05$) heavier than Ankleshwer and Nicobari at 20^{th}, 40^{th} and 72^{nd} week of age. Study of body conformation traits *viz*. Shank length, keel length and breast angle indicated significant difference ($P\leq0.01$) between genetic groups at all the ages of measurements. In general, the shank, keel length and breast angle of all the crossbreds were significantly ($P\leq0.01$) higher than the purebreds. Progenies of Nicobari used as male line and CARI Red as female line revealed better growth, body

conformation, feed efficiency early maturity and also produced more eggs than other crossbreds. The highest estimate of heterosis was 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. Significant (P<0.01) reciprocal effect was observed in body weight, egg weight, shape index, albumen index and Haugh Unit. Significant (P<0.01) maternal effect for egg weight, albumen index and Haugh Unit and significant (P<0.01) residual reciprocal (sex linked) effect for body weight were observed under Hayman's model. Additive gene action was more important for inheritance of growth, body conformation and various egg quality traits, whereas non- additive gene action was more important for inheritance of age at sexual maturity and both additive and non-additive gene action 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 egg production in all the pure and crossbreds. NC x CR was identified as the best crossbred genetic group for development of commercial hybrid native chicken for rural poultry production, because it had higher growth rate, better feed efficiency and egg production with longer shank length which helps to escape from predators.

Identification of calcium dependent endogenous enzymes in meat from desi breeds of chicken and their influence on ageing during refrigeration storage *(Dr Irshad Ahmad Khoja, MVSc, Advisor: Dr Ashim Kumar Biswas)*

The study was carried out to identify and quantify calpains and calpastatin from from muscle samples of different Desi breeds of chicken and to find out their role in post-mortem ageing. A standardized method was applied to breast and thigh muscles for optimization of μ-calpain mediated post-mortem ageing at 4±1°C. 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 zymography and domain separation was visualized by SDS-PAGE analysis. Activity analysis was performed spectrophotometrically. Activity analysis showed that extraction buffer at pH value of 8.3 had greater extraction efficiency as it showed better results for μ-calpain and *m*-calpain concentrations in breast and thigh muscles. A 12 kDa molecular weight cut-off (MWCO) filter and DEAE-Sephacel column were used for separation and purification. SDS-PAGE analysis showed variable domains of calpains and calpastatin in muscle samples. Concentration of μ-calpain, *m*-calpain and calpastatin was found to be highest ($P < 0.05$) in breast muscle than in thigh muscles. Further various physico-chemical and microbiological parameters were evaluated and calpain mediated post-mortem ageing at 4±1 ºC was optimized at 18, 24, 18 and 24 hrs for male breast muscle of Nicobari, Kadaknath, Aseel and Ankleshwar, while that for male thigh muscle at 24, 6, and 0.5 hrs, respectively. For female breast muscle, PM ageing of Nicobari, Kadaknath, Aseel and Ankleshwar was standardized at 24,18, and 6 hrs, respectively while for female thigh sample it was standardized at 18, 6and0.5 hrs, respectively. Evaluation of physico-chemical parameters confirmed that post-mortem ageing time optimized has appreciable effect in improvement of chicken meat quality. Finally, it may be concluded that post-mortem ageing period for different breeds of chicken has ample influence on the improvement of meat tenderness without appreciably affecting the other quality parameters during holding at 4±1ºC.

Effect of dietary protein and photoperiod levels on performance in Guinea Fowl *(Dr T. Tamilmani, MVSc, Advisor: Dr Simmi Tomar)*

The seasonality of reproduction in Guinea fowl is characterized by a delay in sexual maturity and the overall length of laying cycle, affected by the temperature, light, protein and energy content of the diet. In India, the laying season of these seasonal breeders are restricted to March to September (increasing day length) with no laying during October to February months (decreasing day length). The present study was designed to investigate the effects of dietary proteins and photoperiod levels on the seasonal variations in productive and reproductive traits and its manipulation to break the seasonality in reproduction in Pearl variety of Guinea fowl. During the trial parameters such as body weight, body weight gain, feed intake, FCR, egg production (HDEP%), livability, internal and external egg quality, age at sexual maturity (ASM), fertility and hatchability data were collected and analysed. Completely Randomized Design (CRD) was planned and in 2×3 factorial design two levels of photoperiods (16 hrs and 18 hrs) three levels of dietary protein (16%, 18%, and 20%). Each treatment had 36 birds and individual birds were considered as replicates. The experimental trial was conducted for 20 weeks during winter months (Oct-

2015 to Feb-2016).The birds were housed in individual cages fitted with watering, feeding and egg collection facilities with standard mangemental conditions. During the trial period three dietary protein and two photoperiod levels were given to the birds. The body weight of individual bird in every treatment was recorded at fortnight interval to observe the change in body weight. Similarly, body weight gain and average feed intake was also calculated. FCR was calculated 15-20th (based on BWG) week and 21-34th (Based on per dozen of egg production) week period. Livability was calculated for entire experimental period. Ten eggs per treatment groups were collected at 24th, 28th, 32nd week of experiment and analyses various egg quality traits (internal and external).At the end of the experiment birds were mated (1:4) within the dietary treatments and their eggs kept for fertility and hatchability evaluation. The results revealed that T3, 16 and 20% dietary protein had significant effect on body weight. Photoperiod had no effect on body weight. Similarly, for body weight gain T3, T4 and T6, 16% and 20% protein and 18hrs photoperiod had significant effect. Significantly, higher feed intake was found in T3, T4, T5 and T6 and 16% and 20% protein and 18hrs photoperiod. Better FCR found in T3 and T6 at 20th and 34th week respectively. Livability was 100% in T5 and T6 at 20th and 34th week. ASM was early in T6 (132 days) and late in T2 (140 days). Control group birds were not laid during the whole experimental period. HDEP was higher in T6 (24.91%) and lower in T2 (6.62%). Dietary protein and photoperiod interaction had significant ($P<0.05$) effect on egg weight and egg volume (T6), egg shell thickness (T1), Albumen index (T2 and T6), albumen height (T2 and T4), Yolk height, yolk depth and yolk colour (T2). Dietary protein had significant effect on egg weight, egg volume and shape index (20% protein), albumen height, yolk depth and Haugh unit (18 and 20% protein). Photoperiod had significant ($P<0.05$) effect on albumen index, yolk depth, albumen height and yolk height in 16 hrs photoperiod and yolk colour in 18hrs photoperiods. Rest of the parameters had no significant ($P>0.05$) effect. Fertility and hatchability was calculated, numerically higher fertility was found in T4 (70.83), and lower in T1 (21.05%). Similarly, numerically higher hatchability was found in T1 (100%), and lower in T5 (21.05%).

Genetic analysis of residual feed intake and its molecular pathways in colored broiler chicken *(Dr Anand Prakash, Ph D, Advisor: Dr VKSaxena)*

The present study was under taken to estimate residual feed intake (RFI) and feed conversion ratio (FCR) at each week up to 35 days and various genetic factors influencing these traits and their correlations with other growth traits. Also transcriptome analysis was performed in liver and duodenum of high and low RFI chicks for finding out differentially expressing genes and molecular pathways for RFI in colored broiler chicken. The heritability of residual feed intake (RFI) at each week up to 5 weeks period was 0.43±0.16, 0.26±0.13, 0.04±0.09, 0.29±0.19 and 0.49±0.25, respectively. Besides at 3rd week of ageat which heritability of RFI was close to zero, all the heritability estimates were low to moderate.For 1st week the genetic correlations between RFI and body weight gain (BWG) was close to zero and formetabolic body weight (MBW), FI it was non-significant. For 2nd week the genetic correlations between RFI and BWG was moderate but with high SE and for MBW it was high and for FI it was non-significant. For3rd week the genetic correlations between RFI and BWG was non-significant and for MBWmoderate but with high SE and for FI it was high. The same estimates at these periods were not reported earlier. The negative genetic correlation associated with higher standard error between RFI and BWG (-0.99±0.40) at days 28-35 indicated that birds having low values of RFI may grow more than other birds in the flock having higher RFI values. There was low negative genetic correlation associated with higher standard error between RFI and BWG atdays 21-28 (-0.26±0.41). The expression of genes influencing low and high feed efficiency and the pathways of these genes was found out to know the basic molecular mechanism influencing feed efficiency. After microarray analysis liver showed 2798 differentially expressed genes. Out of total DEGs, 913 genes were down regulated and 1885 were up regulated. Thefold change varies from 552.94 to -475.17. Duodenum showed 1030 differentially expressed genes after analysis. Out of total DEGs, 461 genes were down regulated and 569 were upregulated. The fold change varies from 1549.28 to -162.6. After this gene ontology (GO) studies of differentially expressed genes in both liver and duodenum were done. In liver, 72 biological processes, 37 cellular components and 33 molecular functions were identified. In duodenum, 89 biological processes, 30 cellular components and 29 molecular functions were identified. The differentially expressed highly connected (DEHC) gene network of liver and duodenum showed up regulation of genes responsible for anorexia, satiety effect, growthmaintenance, and down regulation of genes responsible for oxidative stress, obesity, appetite.

Evaluation of Functional Attributes of Chicken Sausages Fermented with Lactobacillus Plantarum *(Dr Geeta, MVSc, Advisor: Dr AS Yadav)*

Studies were undertaken to assess the survivability of *L. plantarum* (10^{10}CFU/ml) at different incubation temperatures of 45, 55 and 60°C with 0, 30, 60 and 90 min of exposure and further evaluation of functional attributes of chicken sausages fermented with *L. plantarum* was done. For this two sugar substrates namely, dextrose and starch were provided to each ofeight treatment groups in different concentration for checking the survivability of this probioticbacteria in presence of sugar substrates and it was found that treatment group having 1% each of dextrose and starch in combination provided best protection during incubation temperatures of 45, 55 and 60 ^{0}C with each incubation time as compared to the use of sugar substrates individually, however, all the sugar supplemented groups were found better in survivability of *L. plantarum* as compared to control group without sugar substrates. In further study, evaluationof antioxidant potential was done for each of the control and treatment groups. The antioxidant potential against ABTS + radical cation, DPPH and superoxide anion was found higher in thosegroups, in which different concentration of additional sugar substrates namely, dextrose andstarch were supplemented at the time of adding *L. plantarum* (10^8cells/gm) in minced meat foreach group. The antioxidant potential of *Lp*control was found higher than that of control group without *Lp*, however, its radical scavenging activity was comparatively less than each of thetreatment groups in which sugar substrates were added. After fermentation, total plate countand coliform count of raw minced meat declined in *Lp* control without sugar substrates andeach of the treatment groups with additional sugar substrates at the time of adding starterculture in minced meat groups. All the groups, in which sugar substrates were supplemented at the time of adding *L. plantarum* in minced meat groups, achieved higher scores for each of thesensory parameters as compared to *Lp* control group and control group without *Lp,* which were not having sugar substrates, however, *Lp* control group was found better in its sensory attributesas compared to that of control group without *Lp*. Groups, in which both sugar substrates namely, Dextrose and starch were used in combination came forth as the best groups from sensory point of view. During refrigerated (4±1°C) and frozen storage (-20±1°C), higher antioxidant potential was maintained throughout the storage period by sausages of treatment group with 1% each of dextrose and starch as compared to *Lp* control group. Based on the physicochemical, antioxidant, microbiological and sensory parameters, fermented chicken sausages for both groups were found safe upto12 days of refrigerated storage (4±1°C) and till 60 days of frozen storage (-20±1°C).

Studies on interaction of dietary aflatoxin and ochratoxin and their amelioration by dietary modulation in broiler chickens *(Dr Mamta Sharma, PhD, Advisor: Dr AB Mandal)*

The present study was conducted to evaluate the impact of aflatoxin (AFB1), ochratoxin (OTA) and their interaction as well as their dietary amelioration by mannan-oligosaccharides (MOS) and Na-butyrate (NaB) salt in terms of genes expression, gut health, patho-physiology and growth performance of broiler chickens. Accordingly, two feeding trials following CRD design was conducted on broiler chickens from 0 - 42 days of age. First experiment included nine dietary treatments including two level AFB1 (150 and 300 ppb) and OTA (150 and 250 ppb) and their four combination, whereas second phase of experiment included total ten dietary treatments including MOS (0.15% and 0.3%) and Na-butyrate salt (500 and1000 mg/kg) and their different combinations along with toxin level chosen from first experimenti.e. 300 ppb Aflatoxin B1 +250 ppb Ochratoxin A. An additional replicate of eight birds in each treatment was taken for collection of biological samples at different growth phases (at 2nd, 4th and 6th wk of age). The response criteria included were growth performance (BWG, FI and FCR), immune responsiveness (CMI and humoral immunity), gene expression studies (EH, OD, IGF, GST, IL-10 and TLR 2), blood biochemical profile (total protein, uric acid, cholesterol, AST, ALT and ALP), gut morphomerty, histopathology (liver, intestine and kidney tissue), carcass traits (eviscerated weight, blood loss, cut-up part yields) and yield of various organs (liver, heart,gizzard, bursa, spleen and kidney) in both the experiments. Addition of both mycotoxin (AFB1 and OTA) and their combinations significantly ($P<0.05$) decreased the body weight gain, feed intake, and impaired feed conversion ratio. OTA was more deleterious than AFB1 in reducing the growth performance of broiler chickens, indicating that OTA was almost two times more toxic than AFB1. Feed contaminated with both AFB1 (300 ppb) and OTA (250 ppb) caused severe depression in BWG, which led to the synergistic toxicity on growth performance in broiler chickens. There was no difference ($P<0.05$) among various dietary treatments with regard to shrinkage loss, dressing

yield, eviscerated yield and cut-up parts yields. The relative weight of liver (percent of body weight) in 300 ppb AFB1 + 150 ppb OTA and 300 ppb AFB1 +250 ppb OTA group was significantly higher than that of control. The relative weight of gizzard, heart, spleen and kidney in 300 ppb AFB1 + 150 ppb OTA treatment group was significantly ($p<0.05$) higher than that of control, whereas the relative weight of bursa was significantly ($p<0.05$) reduced in 300 ppb AFB1 + 150 ppb OTA fed group. Activities of AST, ALT and ALP increased ($P<0.05$) and total protein, uric acid and cholesterol decreased in alltoxin fed group compared to control and maximum deleterious effect was seen in 300 ppb AFB1+ 150 ppb OTA fed group. The CMI and humoral immune was significantly ($P<0.05$) higher in control group and gradually decreased in other treatment group. The expression profiles of genes OD, IL-10 and TLR-2 was upregulated and EH, GST and IGF were down regulated in aflatoxins fed group compared to control. The combined feeding of AFB1 and OTA showed additive effect on CMI response and HA titre value of broiler chickens. The cellular organization of liver parenchyma, intestine and kidney was normal in control group. The liver, intestine and kidney samples in mycotoxin fed group showed moderate to degenerative and necrotic changes, inflammation with infiltration of heterophils, section of lymphoid aggregates detachatment of villus and increased number of goblet cells (in intestine) widened bowman capsule and denuded tubular epithelium (in renal parenchyma). Severity of all pathological lesions was progressive towards higher combination of both toxins. The mean villus length to crypt depth ratio of control group was highest and it significantly ($P<0.05$) decreased in all other treatment groups. Significantly ($P<0.05$) lowest villi length to crypt depth ratio was observed in 300 ppb AFB1 +250 ppb OTA fed group than that of control. The reduced growth performance (BWG, FI and FCR) in mycotoxin fed group was improved on 0.3% MOS along with 500mg/kg Na butyrate salt supplementation. Supplementation of MOS and NaB salt had partial ameliorative effect on slaughter traits. Dietary supplementation of 0.15% MOS +500mg/kg Na butyrate salt to the mycotoxin contaminated feed significantly improved the relative thigh percentage. The increased relative weight of liver, gizzard, heart and kidney; activity of AST, ALT and ALP and decreased relative weight of bursa; value of total protein, uric acid and cholesterol in toxin alone fed group was significantly ameliorated by dietary supplementation of both MOS and NaB salt and their different combination except 1000 mg/kg NaB salt alone and along with 0.3% MOS combination.The expression profiles of genes OD IL-10 and TLR-2 was downregulated and EH, GST and IGF were down regulated in 0.3% MOS, 1000 mg/kg and 0.15% MOS+1000mg/kg Na butyrate supplemented group. Supplementation of 0.3% MOS alone and along with 500 mg/kg NaB salt to the mycotoxin contaminated diet ameliorated the adverse effects of mycotoxin on histopathology of liver, intestine and kidney and showed statistically similar villi length to crypt depth value to that of control. There was gradual increase in villus length to crypt depth ratio from 2nd wk (4.33 µm) to 6th wk (5.10 µm) of age. Accordingly, it was concluded that combination of 0.3%MOS+500 mg/kg NaB in diet was beneficial to counteract the ill effects of both aflatoxin B1 and ochratoxin A (300 ppb AFB1+250 ppb OTA) contaminated feed rather using MOS or NaB alone in broiler chickens.

Effect of feeding probiotics on growth performance and meat quality traits in broiler chickens *(Dr Junaid, N, M.V.Sc, Advisor: Dr Avishek Biswas)*

The effects of dietary supplementation of probiotics i.e., *Lactobaccilus acidophilus* and *Bifidobacterium bifidi* on growth performance, immune response, expression of genes related to growth immunity and meat quality traits were evaluated on day-old straight-run broiler chicks (n=352). A commercial basal diet (control-1; T_1) and a low energy low protein diet (LELP) diet (control-2; T_2) was formulated, the rest nine test diets were prepared by adding Bacitracin Methylene Di-Salycilate (BMD) @ 20 mg/kg diet (T_3), T_2+*L. acidophilus @ 10^{6}cfu/g feed*(T_4), T_2+*L. acidophilus @ 10^{7}cfu/g feed* (T_5), T_2+*B. bifidi@ 10^{6}cfu/g feed* (T_6), T_2+*B. bifidi@ 10^{7}cfu/g feed* (T_7), T_1+*L. acidophilus @ 10^{6}cfu/g feed* (T_8), T_1+*L. acidophilus @ 10^{7}cfu/g feed* (T_9), T_1+*B.bifidi@ 10^{6}cfu/g feed* (T_{10}) and T_1+*B.bifidi@ 10^{7}cfu/g feed* (T_{11}). Production performance in terms of body weight gain (g), feed intake (g), feed conversion ratio (FCR) and mortality (%) did not differ ($P>0.05$) on feeding of diets containing different levels of probiotics. Haem-agglutination (HA) titre significantly increased ($P<0.05$) in commercial and LELP diets with probiotics supplementation, whereas cell mediated immunity (CMI) significantly improved only in LELP diet with probiotic supplemented groups as compared to commercial diet supplemented with probiotics, control and antibiotic treated group. No significant ($P>0.05$) difference was observed in protein concentration and ALP activity in any of the dietary probiotic treatment group but serum albumin, serum enzymes (AST and ALT), kidney function

test (creatinine, uric acid), serum minerals (Ca and P) and total cholesterol concentration increased or decreased significantly ($P<0.05$) in commercial as well as LELP diet with probiotic in comparison to antibiotic and control group. Fold expression of growth and immunity related genes i.e., IGF-2,TGF-β, and IL-6 were up regulated in LELP diet with probiotic supplemented group, whereas, down regulated in commercial diet with probiotic supplemented group at 42 d of age. No significant difference was recorded in yields of carcass traits, cut up parts and organs. In physico-biochemical parameters of meat (fresh and frozen), no significant differences were recorded in pH, drip loss and lovibond tintometer colour (except b* value) but water holding capacity (WHC), cholesterol, fat and extract release volume (ERV) found significantly ($P<0.05$) increased/decreased in probiotic supplemented group but better result were noticed in *Lactobacillus* supplemented group. In lipid oxidation parameters (TBARS, free fatty acid and peroxide values) and anti-oxidant parameters i.e., ABTS+ and DPPH of fresh and frozen (14d) meat were significantly ($P<0.05$) increased /decreased in commercial and LELP diet with probiotic supplemented group compared with control and antibiotic treated group. Microbial load i.e., standard plate count (SPC), *coliforms* and *staphylococcus* were significantly ($P<0.05$) decreased in fresh (0) and frozen meat (14 d), whereas yeast and mould was not detected in any of the dietary probiotics supplemented and control group. From present study it can be concluded that both the probiotic *i.e Lactobacillus acidophilus* and *Bifidobacterium bifidi (*10^6 and 10^7cfu /g feed) inclusion in commercial as well as LELP diet had improved immune response and meat qualities but *Lactobacillus acidophillus@* 10^6cfu /g feed was found better alternate to antibiotic growth promoter.

Studies on micro-calpain mediated ageing on quality of precooked breast fillets prepared from broiler breeders *(Dr Anil Kumar Giri, Ph. D, Advisor: Dr Ashim Kumar Biswas)*

Chicken breast fillet is a versatile meat product consumed throughout the world. But toughness of fillets is the main problem for its acceptability. The toughness of meat can be greatly decreased by efficient handling and processing during post-mortem ageing. It is well accepted that calpains are the key proteolytic enzymes which play a major role in post-mortem (PM) ageing and thereby meat tenderness. However, there is very little information on the effect of calpain mediated post-mortem ageing on the quality of precooked breast fillets from spent/ breeder broilers is available. So, keeping in view of these points, efforts were made to efficiently utilize the breast fillets from breeder broilers by optimizing post-mortem aging period, standardization of marinade and marination time adopting different cooking techniques. The storability study and production cost for pilot scale processing of breast fillets were also carried out to evaluate the feasibility and commercial viability of the products with a view of transferring the technology to small entrepreneurs. For standardization of PM ageing of breast fillets at room and refrigeration temperature, samples were drawn at an interval of 0.5, 2, 4, 6 and 8 and 0.5, 3, 6, 12, 18, 24 and 36 h, respectively. The activity of both these enzymes along with their potential inhibitor calpastatin was determined by casein zymography, SDS-PAGE and biochemical assay. Other parameters like Warner-Bratzler shear force values (WBSFV), myofibrillar fragmentation index (MFI), protein extractability, changes in pH, Lovibond tintometer colour, free fatty acid, peroxide value, TBARS and microbial quality were also evaluated. It was observed that optimum PM ageing periods for the breast fillets were 4 and 24 h during holding at room and refrigeration temperature, respectively. Marination time of 45 min was selected as best for cooking the breast fillets. Among cooking methods, MW grilling was found to be most suitable for preparation of better quality chicken breast fillets followed by HAO, SSF cooking and lastly MW cooking. Storability study during refrigeration storage under aerobically packaging conditions indicated that room temperature ageing and refrigeration ageing of breast fillets showed significantly lower WBSF value than control (without ageing). TBARS value, PV and FFA values showed linear increasing trend but sensory attributes showed linear decreasing trend during refrigerated storage. SPC and PPC increased with the increase of storage days. Amongst all the samples, refrigeration ageing of breast fillets had lower overall SPC. Total Coliforms, *Staphylococcus* spp. and *Salmonella* spp. count not be found at any storage interval, however, yeast and mould growth was detected only after 15 days of storage period. So, precooked breast fillets can well be stored up to 15 days at refrigeration temperature under aerobic packaging condition without appreciably affecting product quality and sensory acceptability and the economics of production of broiler breast fillets from spent fowl indicated its viability in favour of small scale entrepreneurs.

TECHNOLOGY ASSESSED AND TRANSFERRED

Technology Assessed

- Commercial chicks of CARI Nirbheek, CARIBRO Dhanraja and CARI Devbendra were assessed for their production performance and were supplied to farmers and different organizations in the country.
- Micro-calpain assisted post-mortem ageing for breast and thigh muscles from RIR, Turkey, Guinea fowl (Swetambariand Pearl) and Goat (Jamunapari) meat sample has been standardized.
- Processing technology for development of chicken egg sausage was standardized.
- Technology for development of fermented chicken sausages using *Lactobacillus plantarum* and malted oat flour was standardized.
- "Duck rearing in polythene ponds"; an innovative technology for rural farmers.
- "CARI-Model of Duck rearing" for sustainable income generation by small and marginal farmers.

Technology Transfer Activities

Kisan Goshthi Organized

A kisan goshthi was organized on 2nd Nov. 2016 on the occasion of 38th Foundation Day of the institute. During this kisan goshthi, lectures on commercial broiler farming, preparation of low cost broiler feed, disease management of poultry, desibreeds 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 replied in detail by the experts.

Question-answer session during kisan goshthi

Participation/Organization of Exhibitions

In order to create awareness about production of different poultry species and various value added products, Institute's stall was put up in the following regional and national exhibitions.

i) Kisan Sammelan and Agricultural Exhibition organized by KVK-IVRI, Izatnagar on 16th April, 2016.
ii) Science and Art exhibition at B.B.L. public school, Bareilly from 27th to 28th August, 2016.
iii) Agricultural Exhibition organized by DUVASU, Mathura from 26-29th Sept., 2016 at Pandit Deen Dayal Upadhyay Dham, Nagla Chandrabhan, Mathura.
iv) Poultry India- 2016 from 22nd- 25th November, 2016 held at Hitex International Exhibition Center, Hyderabad, Telangana, India..
v) Northern Agricultural Fair organized by IIFSR, Modipuram, Meerut from 28-30 Nov., 2016 at Muzaffarnagar (UP)
vi) Krishi Unnati Mela-2017 organised by IARI, New Delhi, from 15-17th March, 2017 at IARI, New Delhi.
vii) Dhan Divas Exhibition organized by NRRI, Cuttack on 23rd April, 2016.
viii) Farmers Exhibition organized by NRRI, Cuttack on 9th May, 2016.
ix) Exhibition organized by Orissa Krishak Samaj on 16th Oct 2016
x) Farmers meet cum Exhibition organized by CIWA, Bhubaneswar on 17th Feb, 2017

ICAR-CARI stall in Poultry India 2016

Hon'ble Minister of State for Ministry of Agriculture and Farmers Welfare Sh. Sudarshan Bhagat, visiting CARI stall in Agricultural Exhibition at Deen Dayal Dham, Mathura

Live display of poultry species in Krishi Unnati Mela-2017at New Delhi

Dr A.K. Singh, DDG (Extn) and Dr J. K. Jena, DDG (Fishery Sci) ICAR in RC CARI stall

Dr Trilochan Mohapatra,Hon'ble Director General, ICAR and Secy. DARE, Govt of India visiting RC, CARI stall

Students and their parents inquiring about poultry at ICAR CARI stall in BBL school, Bareilly(UP)

Organization of Exhibition

On the occasion of visit of Hon'ble DG, ICAR and Secy. DARE, Govt of India, Dr Trilochan Mohapatra on 5/11/2016, an exhibition on diversified poultry was organized in the campus, where in all the species of poultry were exhibited lively. Other than poultry germ plasm, value added poultry products were also displayed in the exhibition.

Sh. Santosh Kumar Gangwar, MoS for Finance, Govt of India and Sh Dharmendra Kashyap Hon'ble Member Of Parliament visiting CAR stall during Agriculture Exhibition at IVRI, Izatnagar

Visits

The visits of students, scientist trainees, farmers, and poultry owners were conducted at the institute and its Regional Centre to acquaint them with the poultry production technologies.

A visit of farmers from Badaun district of UP sponsored by Regional Rural Development Institute, Asafpur was conducted on 5-08-2016. These farmers were also trained in backyard poultry farming by a team of scientist from CARI at Regional Rural Development Institute, Asafpur under three days off-campus training programme.

Trainee farmer from Badaun Distt. visiting Demonstration Farm of the institute

A group of progressive farmers and farm women from KVKs- Churachandpur and Tamenglong of Manipur, and Longling of Nagaland states visited CARI, Izatnagar on 18-03-2017. They were acquainted with poultry production technologies developed by the Institute.

Group of farmers KVKs of Nagaland andManipur at CARI Museum

Visit of farmers from Chhatisgarh on 21-07-2016

Visit of Agril. Dev. Officers from different states on 21.09.2016

Visit of farmers from Dhenkanal, Odisha on 07.06.16

Live Telecaste on Electronic Media

Dr J.M. Kataria, Director, ICAR-CARI participated in live programme-Hello Kissan on Duck production for rural farmers telecasted by Door Darshan, New Delhi on April 2016.

Hello-KISSAN Programme on Duck production by Dr J.M. Kataria, Director

Dr A.S. Yadav, Pincipal Scientist, ICAR-CARI participated in live programme-Hello Kissan on **Murgi Palan** telecasted by Door Darshan, New Delhi on 23rd February, 2017

Dr V.K. Saxena (2016) Pincipal Scientist, ICAR-CARI participated in live programme-Hello Kissan on DD-KISSAN Channel on the subject-**Vaigyanik Kukkut Palan** telecasted by Door Darshan, New Delhi on 17th Nov., 2016

Dr S.C. Giri, Pincipal Scientist, RC-ICAR-CARI participated in live programme– Hello Kissan on DD-KISSAN Channel on the subject-**Duck Farming and Pscisculture** telecasted by Door Darshan, New Delhi on 27th Oct., 2016

Dr S.C. Giri, Pincipal Scientist, RC- ICAR-CARI participated in live programme- Hello Kissan on DD-KISSAN Channel on the subject-**Duck Farming and Pearl Culture** telecasted by Door Darshan, New Delhi on 23rd March, 2017.

Dr M.P. Sagar, Pincipal Scientist, ICAR-CARI participated in live programme on different

diversified poultry breeds on electronic media ETV Rajasthan for Jai Kisan Programme during Krishi Unnati Mela at IARI, New Delhi from 15-17 March, 2017

Dr Avishek Biswas, Senior Scientist, ICAR-CARI participated in live programme on different poultry breeds for poultry farming on On-line Krishi Channel, Punjab during Krishi Unnati Mela at IARI, New Delhi from 15-17 March, 2017

Supply of germplasm

In order tocater the demand of quality germplasm of diversified poultry species, The Institute and its Regional Centre has supplied germplasm of layer, broiler, desi fowl, guinea fowl, turkey and duck to poultry farmers, private hatcheries and Govt. Institutions during the 2016-17 (Table 17).

Table 17: Supply of germplasm from ICAR-CARI, Izatnagar and its RC, Bhubaneswar

Germ plasm supplied	*Fertile eggs*		*Day-old chicks*		*Growers*	*Adults*		*Total*
	Parent line	*Commer-cial*	*Parent line*	*Commer-cial*		*Parent line*	*Commer-cial*	
Layer	14,624	-	12,535	-	809	117	-	28,085
Broiler	24,356	1,600	8,093	25130	1,243	98	216	60,736
Desi fowl	4,764	-	9,157	-	592	1,102	-	15,615
Guinea fowl	400	-	-	-		449	-	849
Turkey	1,988		5,444		-	1,122		7,432
Duck	1,080	16,684	-	-	-	-	-	17,764
Total	**47,212**	**18,284**	**35,229**	**25130**	**2,644**	**2,888**	**216**	**1,30,481**

AWARDS AND RECOGNITIONS

- **Dr Sanjeev Kumar and Dr V.K. Saxena** were awarded with **FELLOWSHIP** of NATIONAL ACADEMY OF VETERINARY SCIENCE (I), during XV NAVS Convocation-cum-conference on 22.10.2016 at Amritsar.
- **Dr A.B. Mandal and Dr Sanjeev Kumar** were elected as **Member, Governing Council, National Academy of Veterinary Sciences (I)** (2017-2019).
- **Dr A.B. Mandal was elected as Vise-President of IPSA** and holding the post of Councilor of World Poultry Science Association (India Branch).
- **Dr S. Saran** served as **Alternate Representative on Agricultural Systems and Management Sectional Committee (FAD-22)** of Bureau of Indian Standards (BIS).
- **Dr Rokade J.J.** received "**Travel Grant Award from SERB, DST**", GOI for attending "World Poultry Congress 2016" held in Beijing, China from 5th -9th September, 2016 and subsequent SERB's commitment letter for attending the same.
- **Dr Pragya Bhadauria, Dr S.K Bhanja, Dr S. Majumdar and Dr G. Kolluri were awarded WPSA Young Scientist Grant-2016** for the research paper entitled "Behavioural inventory and welfare status of young layers under different managemental conditions during winter season during XXV World Poultry Congress held at Beijing, China during 05-09th September, 2016.
- **Dr Rokade J.J. received "World's Poultry Science Association Travel Grant"** to attend "XXV World's Poultry Congress" held from 5th -9th September 2016 in Beijing, China
- **Dr M. Gopi received Travel Grant Award** from **World's Poultry Science Association**, The Netherlands in November 2016.
- **Dr Gautham Kolluri received Travel Grant Award** from British Poultry Science Co. Ltd. Scotland, United Kingdom in June 2016.
- **Dr Gautham Kolluri received Travel Grant Award** from Centre for International Co-operation in Science, Chennai, Tamil Nadu in July 2016.
- **IPSA Dr D. Choudhury Award for best Ph.D. Thesis** was conferred on **Dr Shinde Tamboli Anil Suryakant**, Ph D thesis under the supervision of **Dr S.K. Bhanja**, PS, ICAR-CARI, Izatnagar, during XXXIII IPSACON held at AAU, Khanapara. Guwahati, Assam during 3-5 November, 2016.
- **Ayurvet Research Awrad** for research paper- Amelioration of alfatosicosis by methionine supplementation in broiler chickens (2014). 49: 1-6 authored by Sharma, Mamta, **Singh Ram, Mandal A.B.** and Kurade, N.P. was conferred during IPSACON 2016, held at AAU,Khanapara, Assam.
- **"IPSA-Prof. P.K. Pani award"** for the research paper entitle, Development of PCR-RFLP technique for differentiating diversified poultry species using mitochondrial 12s ribosomal RNA (12S rRNA) authored by Ilaya Bharathi D., **V.K. Saxena, Raj Narayan** and Avinash Pange at IPSACON 2016 held at AAU, Guwahati, Assam
- **"IPSA Young Scientist Award"** during IPSACON 2016 held at Guwahati, Assam for paper entitled "Augmenting Broiler Breeder Performance Through Betaine Supplementation" authored by **J.J. Rokade**, **M. Gopi, S.K. Bhanja, K. Gautham**, **Chandrhas and V.K. Saxena.** Pp 343
- **Dr Avishek Biswas** was elected as Executive **body member of Animal Nutrition Association** (ANA), Izatnagar.
- **Dr Dukare S.P.** was awarded **IPSA Young Scientist Award** for oral presentation of research paper entitled "Evaluation of symbiotic (MOS plus mixed bacillus culture) in egg type (CARI-Sonali) Authored by Dukare S.P., **Rokade, J.J.,** Sajad and **Mandal, A.B.** under supervision of Mandal, A.B., during IPSACON 2016, held at Khanapara, Assam.
- **Dr M.K. Padhi** was nominated as Member in the committee constituted by DDG Animal Science, to document technologies and to develop a compressive road map and state specific recommendations for the eastern region on 19th December, 2016.
- **Dr Sanjeev Kumar** was elected as Joint Secretary, Society for Conservation of Domestic Animal Biodiversity (SOCDAB) (2017-2019).
- **Dr Sanjeev Kumar** was elected as Member, Executive Committee, The Indian Association for the Advancement of Veterinary Research, Izatnagar (2016-18).
- **Dr Sanjeev Kumar** was elected as Member, Executive Committee, The Indian Society of Animal Genetics and Breeding, Delhi (2017-19).
- **Dr Chandrahas** was received "Reviewer Excellent Award from Journal of Animal Research and Asian Journal of Dairy and Food Research from ARCC, Karnal.
- **Dr. Geeta received Best oral paper prize (First position)** for research paper on "Assessment of antimicrobial potential of *Lactobacillus plantarum* in fermented chicken sausage" by Dr. Geeta, Yadav, A.S., Biswas, A.K. and Gautham Kolluri. 2016 under the guidance of Dr. **A.S**. **Yadav** at *International Congress on Post-Harvest Technologies of Agricultural Produce for Sustainable Food and Nutritional Security* held on Nov. 10-12, 2016 at Integral University, Lucknow.

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 J.J. Rokade, Co-PI	1971	-	Avian Genetics and Breeding Division, ICAR-CARI, Izatnagar
2.	Development and evaluation of broiler dam Line	Dr V.K. Saxena, PI Dr Simmi Tomar, Co-PI Dr J.J. Rokade, Co-PI	1971	-	Avian Genetics and Breeding Division, ICAR-CARI, Izatnagar
DBT, Govt. of India, New Delhi					
3.	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	Avian Nutrition and Feed Technology Division, ICAR-CARI, Izatnagar
DST, Govt. of India, New Delhi					
4.	Biochemical basis for detection of calpains and calpastatin and their role in post-mortem tenderization of meat	Dr Ashim K. Biswas, PI	16.07.2013 (3 years)	21.82	Post-Harvest Technology Division, ICAR-CARI, Izatnagar
5.	Enhancing gut health and immunological functions in broilers through convergence of biotechnological and nutritional interventions	Dr Gopi M. (PI) Dr.Jaydip J. Rokade (Co-PI)	24.03.2017 (3 years)	42.35	Division of Avian Physiology and Reproduction, ICAR-CARI, Izatnagar
CSIR Project					
6.	Kappaphycus alvarezii and red seaweed based formulations for improving productivity and health of dairy and poultry animals	Dr A.B. Mandal (PI) Dr Praveen K. Tyagi (Co-PI) Dr S.K. Bhanja (Co-PI) Dr Ashim K. Biswas (Co-PI) Dr Avishek Biswas (Co-PI)	30.03.2016 (2 years)	19.63	Avian Nutrition and Feed Technology Division, ICAR-CARI, Izatnagar
ICAR Project					
7.	Poultry entrepreneurship development initiative-The Agri Business Incubator	Dr Sandeep Saran (PI) Dr Chandrahas (Co-PI) Dr M.P. Sagar (Co-PI)	01.01.2016 (15months)	22.50	Poultry Economics and Agribusiness Research Section, ICAR-CARI, Izatnagar

RESEARCH PUBLICATION

Research Papers/ Review Articles

International

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: 781-788.

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Kripriyalini, L., Biswas, A.K., Tandon, S., Beura, C.K. and Yadav, A.S. (2016). Comparison of levels of calpains and calpastatin in blood and their distribution in skeletal muscle of turkey. *International Journal of Meat Science*, 7(1): 1–6.

Mahapatra, P.S., Singh, R., Kumar, K., Sahoo, N.R., Agarwal, P., Mili, B., Das, K., Sarkar, M., Bhanja, S.K., Das, B.C., Dhara, S.K. and Bag, S. (2016). Valproic acid assisted reprogramming of fibroblasts for generation of pluripotent stem cellsin buffalo (Bubalus bubalis). *The International Journal of Developmental Biology*, doi: 10.1387/ijdb. 160006sb.

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College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-781022 pp: 23-31.

Bhanja, S.K. and Kataria, J.M. (2016). Health and welfare of laying chicken under different housing systems. *In the proceedings of III Association of Avian Health Professionals (AAHP) Convention and National Symposium on Poultry Health and Welfare riding the wave for the future* organized by ICAR-Central Coastal Agricultural Research Institute, Ela, Goa-403402 during 20-21 October, 2016. pp: 114-122.

Biswas, A.K. (2016). Micro-calpain assisted post-mortem ageing of meat and its influence on quality.In the proceeding of *International Symposium and 7th Conference of Indian Meat Science Association* held from 10-12th November,2016 at GADVASU, Ludhiana.[Invited Paper 2, pp. 299-303.]

Mandal, A.B. (2016). Poultry feed industry-Challenges. *In the Proceeding of XXXIII Annual Conference and National Symposium of Indian Poultry Science Association* held at AAU, Khanapara. Guwahati, Assam on 3-5 Nov 2016 [Lead Paper 1, pp. 53]

Saran Sandeep and Satyapal (2016). Poultry Sector in India: Opportunities and Challenges. In: 24th Annual Conference of Agricultural Economics Research Association (AERA) on *Agriculture for nutritional security*. December 15-17, 2016, Indian Veterinary Research Institute, Izatnagar-243 122 (UP).

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Technical Papers/Popular Articles

Bhanja, S.K. (2016). Location, orientation and construction of layer houses. In: Training Compendium of *Specialized Training on Layer Production* held from 16- 27August, 2016. pp 5-8.

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Yadav, A.S. (2016). Principles of longitudinal and integrated food safety assurance. Compendium of ICAR sponsored winter school on "*Advances in Value Addition and Quality Evaluation of Meat and Poultry Products*" organized by LPT Division, ICAR-IVRI, Izatnagar from 20th September- 10th October 2016.

Radio Talks

Kumar Sanjeev (2016). Delivered Radio Talk on "Kukkut Palan evam Jaruri Sujhav, on 19.12.2016 at AIR, Bareilly.

Kumar Sanjeev (2017). Delivered Radio Talk on "Kaushal Vikas evam Kukkut palan" on 27.3.2017 at AIR, Bareilly.

Narayan Raj (2016). Barsat me murgiyon ki dekhbhal at AIR, Rampur recorded on 03/08/16 and broadcasted on 12/08/16.

Narayan Raj (2016). Kukkut palak kistarah apnevya vasaye ko labhkari banaye at AIR Rampur recorded on 29/03/17.

Narayan Raj (2016). Kukkut palan kuch jaroori sujhao at AIR, Bareilly recorded on 16/02/17 and broadcasted on 20/02/17.

Narayan Raj (2016). Murgi palan tatha kukkut palan hetu sarkari yojnaye, at AIR, Bareilly recorded on 23/05/16 and broadcast on 30/05/16.

Narayan Raj (2016). Thand ke mausam me kukkuto me hone walibimariya se bachaov at AIR, Rampur recorded on 20/12/16 and broadcasted on 20/12/16.

Saran Sandeep (2016). Delivered a talk on Labhprad murgipalan hetu bazaar vyavastha during Farmers'-Scientists Interactive Meeting (sangoshthy) to mark the celebrations of Institute's Foundation Day on Nov. 2, 2016.

Saran Sandeep (2016). Kukkut palan 66en aye aayam (new dimensions of poultry farming). Radio talk recorded on 22.4.2016 at All India Radio, Rampur, U.P.

Simmi Tomar (2017) Kukkut palan kuch vagyanic sujav. AIR Rampur, broadcasted on 10.03.17.

T.V. Talks

Giri, S.C. (2016). Duck Farming and Pearl culture**.** Delivered talk on DD Kisan Channel in Hello Kisan programme on 23rd March. 2017.

Giri, S.C. (2016). Duck Farming and Psciculture. Delivered talk on DD Kisan Channel in Hello Kisan programme on 27th Oct. 2016.

Kataria, J.M. (2016). Duck production for rural farmers. Delivered talk on DD Kisan Channel in Hello Kisan programme on 8th April.

Narayan Raj (2017). Vyavasayak Japanese bater palan ka mahetav, murgi ka vikalp, vividhikaran kukkut palan ka mahetvpurn vyavasaya on DD kisan channel, New Delhi on 16 February, 2017.

Saxena, V.K. (2016). Delivered talk on Vaigyanik Kukkut Palan on DD Kisan channel in Hello kisan programme on 17th Nov 2016

Yadav, A.S. (2017). Participated in Live show on MURGI PALAN (मुर्गीपालन) telecasted on DD Kisan channel in Hello kisan programme on 23rd February, 2017.

PARTICIPATION OF SCIENTISTS IN CONFERENCES, SEMINARS, SYMPOSIA, WORKSHOPS, TRAININGS ETC IN INDIA AND ABROAD

Sl. No.	Name of symposia/seminar/workshop	No. of scientists attended
1.	Workshop on Financing Poultry: Status, Constraints and Way Forward held on March 1, 2017 at ICAR-CARI under the aegis of Agribusiness Incubation (ABI) Centre.	20
2.	25th World's Poultry Congress at Beijing, China from 5- 9th September, 2016	4
3.	Computational Approaches for Next Generation Sequencing (NGS) Data Analysis in Agriculture held at ICAR-Indian Agricultural Statistics Research Institute, New Delhi, from 08-28th February, 2017.	1
4.	Technical Seminar and Knowledge Day at Poultry India, Hyderabad from 23-25th November, 2016.	2
5.	Workshop on Metabolomic for Plant, Human, and Animal Health organized at TERI, New Delhi from 17-18th November, 2016.	2
6.	IInd AAHP Convention and National Symposium on Poultry Health and Welfare: Riding the wave to the future from 20-21st October, 2016 at Goa, India.	7
7.	Annual Review Meeting of AICRP on Poultry Breeding at Gangtok, New Delhi from 23-24th May, 2016	1
8.	Ist International Satellite Symposium (e-symposium) of International Academy of Biosciences on Advances in Animal Sciences and Biomedicine in 21st Century held at Dubai on October 12, 2016.	1
9.	National Acadamy of Veterinary Sciences Conference held at Amritsar w.e.f. 22-23, October, 2016	2
10.	Smallholder poultry-Challenges and Opportunities: a joint workshop of CARI-GALVmed held at Hotel Royal Plaza, New Delhi on 2nd December, 2016.	4
11.	33rd IPSACON-2016 held at College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati from 2nd to 5th Nov., 2016.	7
12.	Brainstorming Session on Innovative interventions for genetic upgradation and effective disease management in ducks organized by DBT at AAU, Guwahati on 27 July, 2016	1
13.	South East Asia Poultry Stakeholders workshop", at Faculty of Veterinary Medicine and Animal Science, University of Peradeniya, Kandy, Sri Lanka from 27. 02. 2017 to 03.03. 2017	1
14.	28th Annual Australian Poultry Science Symposium, Sydney, Australia from 12-15 February, 2017	1
15.	Training Programme on "Intellectual Property and Technology Management for Researchers" from 13-18, June, 2016 at NAARM, Hyderabad.	1
16.	"RTI Request Application and Appeal Management System (RTI-MIS) at ICAR Institutes" organized by DoP&T, Govt. of India on 21st October, 2016 at NASC Complex, New Delhi.	1
17.	"Challenges in Quantitative Genetics for Improvement of Indigenous Animal Genetic Resources (AnGR)" held at ICAR-Indian Veterinary Research Institute, Izatnagar during 19-20 January, 2017.	6
18	National Symposia on '*Krishi Unnati Mela and Seminar'* at Indian Agriculture Research Institute (IARI), New Delhi on 15-17th March 2017	3

19	International Live Webinars on Recent trends in Poultry Production and Health Management (6 live e-sessions)	1
20.	International Conference on 'Innovative Research in Agriculture, Food Science, Forestry, Horticulture, Aquaculture, Animal Sciences, Biodiversity, Ecological Sciences and Climate Change' (AFHABEC-2016) at Convention centre, Jawaharlal Nehru University, New Delhi on 22nd October, 2016	1
21.	International Workshop on "Production Welfare Research" jointly organized by Indian Council of Agricultural Research, New Delhi, India and The University of Edinburg, UK at NASC Complex, New Delhi from 1-2 December, 2016	4
22.	Short Course on "Organic Animal Husbandry- Concept, Standards and Practices" held at Division of Extension Education, ICAR-Indian Veterinary Research Institute, Izatnagar, Bareilly (UP) from 28.11.2016 to 07.12.2016.	1
23.	XXIII meeting of ICAR Regional Committee II at NAARM, Hyderabad held on 24-25 June 2016.	1
24.	Xth Biennial Animal Nutrition Association Conference at College of Veterinary Science, Tirupathi from 7-9 November 2016	1
25.	Agri-Tech Commercialization Workshop jointly organized by Technology Development Board, Indian Institute of Corporate Affairs and Technology Information, Forecasting and Assessment Council for identifying commercially viable projects during 18-20 Jan. 2017 at NASC, New Delhi.	1
26.	XXIV Annual Conference of Agricultural Economics Research Association (AERA) on Agriculture for Nutritional Security during 15-17th December 2016 held at Indian Veterinary Research Institute, Izatnagar.	1
27.	Meeting on "Showcase Production Technologies of the Animal Science Division and to deliberate the issue pertaining to doubling farmers' income" convened by the DG, ICAR and Secretary, DADF, New Delhi during 10-14 June, 2016.	1

CONSULTANCY, PATENTS, COMMERCIALIZATION OF TECHNOLOGIES

Consultancy/ Advisory Services

- Provided low-cost feed formulae to about 80 poultry farmers and small feed industries from different states (Uttar Pradesh, Karnataka, West Bengal, Uttarakhand, Haryana, Bihar, Jharkhand, Chattishgarh and MP) 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 1600 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.

Patents/Technologies for Registration

- Trademark applications were filed to register germplasm developed by CARI, namely, CHITAMBARI, CARIBRO-VISHAL, CARI-DEBENDRA, CARI-VIRAT, CARI-NIRBHEEK, CARI-SHYAMA, UPCARI and HITCARI vide application no. 3290568 to 3290757 dated 22.6.2016 with the Trademark Registry Office, New Delhi.
- Registration of CARI-Dhanraja, the coloured broiler germplasm developed and evaluated at ICAR-CARI, Izatnagar is under active consideration.

Technologies Ready for Commercial Transfer

The processing technologies for development of egg sausage and egg rasmalai are available for transfer to poultry entrepreneurs

MoU/LICENCE SIGNED FOR TECHNOLOGIES (2016-17)

Particulars	Date of Signing MOU	Contracting Party
Supply of coloured broiler parent line DOC and CARI LALIMA parent line DOC	05.05.2016	Shri Manjeet Kumar Singh, Moradabad, U.P.
Supply of pure desi breeds- adults – over 20 weeks	14.12.2016	Shri Balwant Singh, Rasal, Rajastan
Evaluation of Grobig®BS as an alternate to antibiotic growth promotors in boilers (Contract Research Project)	03.11.2016	M/s Bayer Pharmaceuticals Pvt. Ltd, Thane, India

WORKSHOPS, SEMINARS AND TRAININGS ORGANIZED

Date	Event	No. of farmers/beneficiaries
Short term training programmes for farmers		
April 25-30, 2016	Short term training on *Poultry production management*	52 (farmers / unemployed youth from UP, Delhi, Uttarakhand, Bihar)
August 08- 13, 2016	Short term training on *Poultry production management*	44 (farmers / unemployed youth from Bihar, Uttarakhand, M.P, New Delhi, Chhattisgarh, UP)
December,19-24, 2016	Short term training on *Poultry production management*	39 (farmers / unemployed youth from UP, Delhi, Bihar, MP, Chhattisgarh)
March 20-25, 2017	Short term training on *Poultry production management*	77(farmers / unemployed youth from Delhi, UP, Uttarakhand, Jharkhand, Bihar, MP, Haryana)
Specialized training programmes		
16-28 May, 2016	Specialized training programme on *Poultry Hatchery Operation*	02 participants
13-25 June, 2016.	Specialized training programme on *Broiler Production*	10 participants
16-27 August,2016	Specialized training programme on *Layer Production*	15 participants
06th Feb.,2017 to 31st March,2017	Specialized training programme on *Chick Sexing*	04 participants
February 14-25, 2017	Specialized training programme on *Poultry Feeding and Quality Control*	03 participants
Workshops		
March 01, 2017	*Financing poultry: Status, constraints and way-forward at CARI, Izatnagar*	160 participants (farmers, bankers, representatives of insurance sector and SDA H, scientists and technocrats)
April 04, 2016	*Sarkari kam - hindi me karne ke tarike*	71(Scientists, Officers and staff of the Institute)
August 26-27, 2016	*Rajbhasha niti aur usaka karyanvayan*	71 (Scientists, Officers and staff of the Institute)
December 29, 2016	*Devanagari lipi aur usaka manakikaran*	27 (Scientists, Officers and staff of the Institute)
March 07, 2017	*Vyavasayikaran ke daur me rajbhasha hindi ki bhumika*	57 (Scientists, Officers and staff of the Institute)

DISTINGUISHED VISITORS

Date	Name	Address
April 29, 2016	Shri. S K Singh	Addl. Secretary and Financial Advisor DARE/ICAR, New Delhi
November 04, 2016	Dr H. Rehman	DDG (Animal Science) ICAR, New Delhi
November 05, 2016	Dr Trilochan Mohapatra	Secretary DARE and DG, ICAR, New Delhi
March 25, 2017	Prof. P.K. Uppal	Advisor, Animal Husbandry Dairy & Fisheries Punjab Govt. , Chandigarh

VIEWS OF DIGNITARIES

Visited the CARI and very impressed with activities of the institute. The birds are maintained in very systematic manner and displayed in desirable way. The director and his team deserves appreciation and I congratulate the scientists for their very good work for the development of poultry resources in the country.

Dr H. Rehman
DDG (Animal Science)
ICAR, New Delhi

Unique collection of poultry research activities, which will be the base for future research and development. Finally a good deal for the beneficiaries of India.

Prof. P. K. Uppal
Advisor, Animal Husbandry,
Dairy & Fisheries
Punjab Govt. , Chandigarh

PERSONNEL

DIRECTOR
Dr J.M. Kataria

HEADS OF DIVISIONS/SECTIONS

Division of Avian Genetics and Breeding	Dr V.K. Saxena
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 M.K. Padhi

ADMINISTRATION

Senior Administrative Officer	Shri R.N.Mallik
Assistant Administrative Officer	Shri Irfan Ali Khan
Assistant Administrative Officer	Shri B.S. Bisht (upto 31.12.2016)
Finance and Account Officer	Shri G.C. Joshi (upto 30.11.2016)
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 Jag Mohan	Principal Scientist	Ph.D.
5.	Dr V.K. Saxena	Principal Scientist	Ph.D.
6.	Dr Sanjeev Kumar	Principal Scientist	Ph.D.
7.	Dr Praveen Kumar Tyagi	Principal Scientist	Ph.D.
8.	Dr Jagbir Singh Tyagi	Principal Scientist	Ph.D.
9.	Dr Sandeep Saran	Principal Scientist	Ph.D.
10.	Dr C.K. Beura	Principal Scientist	Ph.D.
11.	Dr Raj Narayan	Principal Scientist	Ph.D.
12.	Dr Pramod Kumar Tyagi	Principal Scientist	Ph.D.
13.	Dr A.S. Yadav	Principal Scientist	Ph.D.
14.	Dr Chandra Deo	Principal Scientist	Ph.D.
15.	Dr S.K. Bhanja	Principal Scientist	Ph.D.

16.	Dr M.P. Sagar	Principal Scientist	Ph.D.
17.	Dr(Mrs.) Simmi Tomar	Principal Scientist	Ph.D.
18.	Dr Ram Singh	Principal Scientist (upto 18.03.2017)	Ph.D.
19.	Dr Divya	Principal Scientist	Ph.D.
20.	Dr Asim Kumar Biswas	Senior Scientist	Ph.D.
21.	Dr Avishek Biswas	Senior Scientist	Ph.D.
22.	Dr Chandrahas	Senior Scientist	Ph.D.
23.	Dr M. Sirajuddin	Scientist	M.V.Sc.
24.	Dr Gautham Kolluri	Scientist	M.V.Sc.
25.	Dr Rokade Jaydip Jawant	Scientist	Ph.D.
26.	Dr Gopi M.	Scientist	M.V.Sc
27.	Dr S.K. Mishra	Principal Scientist (RC)	Ph.D.
28.	Dr R.K.S.Bais	Principal Scientist (RC)	Ph.D.
29.	Dr S.K.Sahoo	Principal Scientist (RC)	Ph.D.
30.	Dr B.K. Swain	Principal Scientist (RC)	Ph.D.
31.	Dr K.V.H. Sastri	Principal Scientist (RC)	Ph.D.
32.	Dr M.K. Padhi	Principal Scientist (RC)	Ph.D.
33.	Dr S.C.Giri	Principal Scientist (RC)	Ph.D.
34.	Dr P.K. Naik	Principal Scientist (RC)	Ph.D.
35.	Dr Dhirendra Kumar	Scientist (RC)	Ph.D.
TECHNICAL STAFF			
1.	Dr A.Mishra	T-9 (Medical Officer)	M.B.B.S.
2.	Dr R.D.Sharma	T-9 (Chief Tech. Officer) (upto 31.01.2017)	Ph.D.
3.	Shri S. Bhatnagar	T-9 (Chief Tech. Officer)	B.Sc. M.A., B.Lib.
4.	ShriB.Arya	T-7-8 (Asstt. Chief Tech. Officer) (upto 30.09.2016)	M.Sc.
5.	Shri R.R.Saxena	T-6 (Sr. Tech. Officer)	M.A.
6.	Shri P.N.Yadav	T-7-8 (Asstt. Chief Tech. Officer)	M.A.
7.	Shri S.P.Singh	T-7-8 (Asstt. Chief Tech. Officer)	MA
8.	Shri Sharad Kumar Johri	T-6 (Sr. Tech. Officer)	M.Sc.
9.	Shri S.R.Meena	T-6 (Sr. Tech. Officer)	M.Sc.(Ag.Extension)
10.	Shri Lalit Kumar Mishra	T-6 (Sr. Tech. Officer)	M.Sc.
11.	Shri Ravi Prakash	T-6 (Sr. Tech. Officer)	M.Sc.
12.	Shri Shafiq Ahmad	T-6 (Sr. Tech. Officer)	Intermediate, Diploma (Elect Engg.).
13.	Shri A.K.Singh	T-7-8 (Asstt. Chief Tech. Officer)	M.A.
14.	Shri M.W.Raza	T-7-8 (Asstt. Chief Tech. Officer)	M.A.
15.	Shri M.C.Pathak	T-6 (Sr. Tech. Officer)	B.Sc.
16.	Shri A.K. Nanda	T-6 (Sr. Tech. Officer)	M.Sc.

EXPENDITURE STATEMENT AND REVENUE GENERATION

EXPENDITURE STATEMENT(2016-17)

(Rupees in Lakhs)

Sr. No.	*Heads of Account*	*Plan*		*Non-Plan*	
		Allocation	*Expenditure*	*Allocation*	*Expenditure*
1.	**CAPITAL**				
	Works	211.00	210.19	0.00	0.00
	Other	49.00	49.81	4.00	3.38
2.	**REVENUE**				
	Establishment Expenses	0.00	0.00	1661.06	1623.90
	Pension and Retirement Benefits	0.00	0.00	308.61	267.14
	T.A.	8.00	8.00	3.00	3.00
	Research and Operational Expenses	296.62	296.61	245.00	244.92
	Administrative Expenses	9.38	9.38	234.00	209.18
	Miscellaneous Expenses	6.00	5.93	4.83	3.13
	Total	**580.00**	**579.92**	**2460.50**	**2354.65**
	Loans and Advances	**0.00**	**0.00**	**10.00**	**5.38**

REVENUE GENERATION (2016-17)

(Rupees in Lakh)

Sr. No.	*Items*	*Amount*
1.	Disposal of Experimental By-product	135.97
2.	Royalty, Sale of Publications and Advertisement	0.72
3.	Licence Fee	5.78
4.	Leave Salary and Pension Contribution	0.00
5.	Analytical and Testing Fee	0.66
6.	Application Fee from Candidates	0.04
7.	Interest of Loan and Advances	25.21
8.	Interest on Short Term Deposits	12.07
9.	Internal Resource Generation	3.72
10.	Miscellaneous Receipts	9.66
	Total	**193.83**
	Loan Recoveries	16.38
	Sale of Assets	1.09
	Grand Total	**211.30**

OTHER RELEVANT INFORMATION

Institute Research Committee (IRC) Meeting

The annual Institute Research Committee (IRC) meeting of the Institute was held during July 11, 2016 under the chairmanship of Dr J.M. Kataria, Director, ICAR-CARI, Izatnagar, which was attended by the scientists of the Institute (Main Campus) present on the day. Dr Vineet Bhasin, PS, SMD(AS), ICAR HQ, New Delhi attended the meeting as invited expert.The IRC was conducted by Dr Sandeep Saran as Secretary, IRC. Dr Saran welcomed the Chairman and all the participants and he presented an overview of the ongoing research programmes. In the beginning, Dr J.M. Kataria, Director, ICAR-CARI appraised the house regarding various development at the Council level. He exhorted the scientists to apply for awards. He emphasized to submit projects for extramural funding and to be more critical while evaluating the work carried out during the period under report.

The Chairman's opening address was followed by presentations by the respective Heads of 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.

Research Advisory Committee (RAC) Meeting

The 10th Meeting of the Common Research Advisory Committee of ICAR-Central Avian Research Institute (ICAR-CARI), Izatnagar and ICAR-Directorate of Poultry Research (ICAR-DPR), Hyderabad was held on 10th and 11th June, 2016 at ICAR-DPR, Hyderabad under the Chairmanship of Dr V. Prabhakar Rao, Former Vice Chancellor, Sri Venkateswara Veterinary University, Tirupati. The RAC members Dr R.P. Sharma, Director (Retd.), ICAR-DPR, Dr M. Babu, Director (Retd.), TANUVAS, Dr C.G. Joshi, Prof.and Head, CVSc. and AH, AAU, Anand, Dr S.K. Mendiratta, Head, LPT Division, IVRI, Izatnagar, Dr A. Rajashekher Reddy, Former Assoc. Dean, SVVU, Hyderabad, Dr J.M. Kataria, Director, Central Avian Research Institute, Izatnagar, Dr R.N. Chatterjee, Director, Directorate of Poultry Research, Hyderabad and Dr M.V.L.N. Raju, Member Secretary attended the meeting. Dr A.B. Mandal, Head, Avian Nutrition and Feed Technology Division, CARI, Izatnagar acted as the Nodal Officer for ICAR-CARI, Izatnagar. The HODs/Scientists from ICAR-CARI (Dr A.B. Mandal, Principal Scientist and Head, ANFT Division, Dr V.K. Saxena, Principal Scientist and Head, AGB Division, Dr Jag Mohan, Principal Scientist and Head, P&R Division, Dr A.S. Yadav, Principal Scientist and Head, PHT Division and Dr M.K. Padhi, PS and I/c Regional Station, Bhubaneswar and ICAR-DPR presented the research progress in different disciplines. In addition, all the other scientists from ICAR-DPR, Hyderabad also attended the meeting. The concluding session was held on 11th June, 2016. Dr V. Prabhakar Rao, Chairman, appreciated the scientists of ICAR-CARI and ICAR-DPR for overall research achievements. He thanked all for the fruitful discussion and deliberations. The following recommendations were emerged out.

1. Both the Institutes shall intensify research efforts to promote rural backyard poultry by evolving suitable varieties and package of practices for providing food and nutritional security through efficient extension methodologies (CARI and DPR).
2. The elite indigenous germplasm like Aseel etc. need to be conserved and improved by selective breeding and propagated to improve rural economy. The RAC recommends that DPR will lay emphasis on conservation and improvement of indigenous chicken germplasm, while CARI

will lay emphasis on conservation and improvement of diversified poultry species as per the mandate. However, CARI can continue to work on existing chicken germplasm (CARI and DPR).

3. CARI is maintaining 5 broiler strains under AICRP on Poultry Breeding. The performance of remaining layer and broiler strains need to be evaluated for further continuance (CARI).
4. Diversified poultry supports small scale entrepreneurs and the demand is for small variety of bird like Japanese quail. Since CARI has been the leading Center for research on Japanese Quail, the RAC recommends that breeding and improvement of Japanese Quail should be allowed to continue (CARI).
5. It is observed that genetic gain in existing layer and broiler lines and ducks is slow. Therefore, it is necessary to introduce suitable exotic germplasm into the gene pool for enhancing the genetic gains (CARI and DPR).
6. High throughput genotyping should be incorporated into the ongoing genetic experiments and genomic selection should be initiated. Further, it is recommended that metagenomics work should be further strengthened using shotgun sequencing as well as metatranscriptome analysis (CARI and DPR).
7. Research on reducing the feed cost must be pursued vigorously (CARI and DPR).
8. Research efforts to mitigate heat stress shall be continued through nutritional and managemental interventions including EC housing. Research on Avian Health should be strengthened for control of emerging and re-emerging diseases (CARI and DPR).
9. Research on cage space requirements and housing systems for welfare of chickens must be taken up (CARI and DPR).
10. Higher research efforts are required to develop healthier and safe poultry products through dietary/ nutritional manipulations, biotechnological tools and processing technologies (CARI and DPR).

Implementation of RTI Request and Appeal Management Information System (RTI-MIS)

Under the supervision of Dr.Chandrahas, Nodal Officer, RTI-MIS, the Institute, has been made live on the RTI Online portal (https://rtionline.gov.in/ RTIMIS/) w.e.f. 20.10.2016 for receiving and processing RTI application/appeals online. Four quarterly returns have been uploaded on RTI Online portal on behalf of ICAR-CARI up to March, 2017.

Institute Management Committee (IMC) Meeting

The 44th Institute Management Committee Meeting was held on 20.09.2016 under the Chairmanship of Dr J.M. Kataria, Director, ICAR-CARI, Izatnagar consisting of Shri R.N. Mallik, Member Secretary, Dr R.S. Gandhi, ADG (AP & B), ICAR, New Delhi, Dr G.K. Singh, Dean, G.B. Pant University of Agriculturaand Technology, Pantangar, Dr G.N. Singh, Additional Director, Animal Husbandry, Bareilly, Shri Virendra Agawal, Member, Agra, Dr Jag Mohan, Principal Scientist, CARI, Shri Ravindra Kumar, Fin. and Accounts Officer, IVRI, Izatnagar and Shri G.C. Joshi, Finance and Accounts Officer, CARI, Izatnagar Special Invitee.

The Committee was satisfied with the research activities and achievements made by this Institute. Research Projects for the year 2016-17 were brought to the notice of all the members and were approved by IMC.

Adhar Enabled Biometric Attendance Systems (AEBAS)

Adhar Enabled Biometric Attendance System (AEBAS) is properly working at ICAR-Central Avian Research Institute. The attendance marked on

this system has link with Central Attendance Portal (http://attendance.gov.in) of NIC. Employee of ICAR-CARI can verify their marked attendance on http://cariicar.attendance.gov.in/. Two reports have been submitted to the Council regarding working of AEBAS and attendance marked by the employees during April, 2016 to March, 2017.

ICAR-ERP (MIS/FMS)

An ERP solution for ICAR, developed at IASRI, New Delhi, for Management Information System (MIS) including Financial Management System (FMS) has been successfully implemented at ICAR-CARI, Izatnagar under the supervision of Dr. Chandrahas, Nodal Officer. The system comprises of various modules like Financial Management, Project Management, Material Management, Human Resource Management and Payroll is working smoothly at the Institute. Six reports have been submitted to the Council regarding its working during April, 2016 to March, 2017.

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: 02.09.2016. The new IAEC consists of Dr J.M. Kataria, Director as Chairmanship & Drs Gautam Kolluri, Subrat Kumar Bhanja, Pramod Kr. Tyagi as members and Dr. Chandrahas as member secretary. The CPCSEA registration was renewed on 30.01.2017. The Annual Inspection of Breeding and Experimental facilities of ICAR-Central Avian Research Institute,

Izatnagar was undertaken on 30.11.2016 and accordingly report was submitted to the CPCSEA by Main Nominee. Two meetings of the Institute IAEC members were held on 23.08.2016 and 23.02.2017, respectively and 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.

Institute Technology Management Unit (ITMU)

The following MoUs were prepared and finalized for transfer of technologies between the Institute and various clients.

Name of Technology	Signed with	Date of signing	Revenue generated (Rs.)
Supply of coloured broiler parent line DOC and CARI LALIMA parent line DOC	Shri Balwant Singh, Rasal, Rajasthan	05.05.2016	Rs 205920/-
Supply of pure desi breeds-adults – over 20 weeks	Shri Balwant Singh, Rasal, Rajasthan	14.12.2016	Rs 243128/-
Contract Research Project - *Evaluation of Grobig®BS as an alternate to antibiotic growth promotors in boilers*.	M/s Bayer Pharmaceuticals Pvt. Ltd, Thane, India	03.11.2016	Rs 1082000/-

Experimental Hatchery Operations at ICAR-CARI

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 CARI, to hatch out required commercial / parent stock of 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. In addition to this, hatching of 24916 commercial stocks of CARI for supplying to various government/ private poultry farms was performed. Embryonated eggs (1100 eggs) and day old chicks (897) were supplied to other institutions (mainly IVRI) for preparation of vaccines and conducting experimental trials. 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 85.06 percent during 2016-17. The highest hatchability (FES) 98.81% was obtained in broiler chicken (Table).

Table 18: Hatching performance of various germplasm of poultry species during the year 2016-2017

Type of birds	Total eggs set	Fertile eggs (%)	Hatchability on total egg set (%)	Hatchability on fertile egg set (%)	Number of good chicks hatched
Layer	**35668**	**76.09** (63.28-85.16)	**70.94** (58.52-81.65)	**93.23** (85.82-98.81)	**25303**
Broiler	**49293**	**82.60** (72.83-93.75)	**75.86** (63.84-89.06)	**91.85** (83.12-96.24)	**37395**
Quail	**21376**	**75.15** (69.45-76.87)	**60.77** (55.83-63.53)	**80.88** (77.27-82.10)	**12991**
Guinea fowl	**16281**	**52.84** (37.93-70.02)	**35.32** (22.89-53.40)	**66.85** (38.78-90.74)	**5751**
Turkey	**12026**	**72.88** (62.08-82.39)	**61.73** (47.63-69.85)	**84.70** (76.32-88.27)	**7423**
Desi fowl	**31706**	**72.43** (54.35-85.14)	**63.18** (46.25-78.89)	**87.24** (76.63-92.93)	**20033**
Commercial (Demonstration farm)	**35168**	**78.17** (73.62-83.04)	**70.85** (63.78-73.10)	**90.65** (85.38-93.74)	**24916**

Figure in parenthesis denotes minimum and maximum range.

Experimental Hatchery Operations at RC ICAR-CARI

The Experimental hatchery of regional centre contributes for hatching of ducklings of various breeds / varieties which are supplied to farmers and also kept in the centre's farm under different research projects. The overall activities of experimental hatchery of RC CARI for the whole year are summarized in table below.

Table 19: Hatching performance of various germplasmof RC CARI in the year 2016-2017

Breed	No of eggs set	No of fertile eggs	No of ducklings hatched	Fertility percentage	Hatchability percentage	
					TES	FES
Khaki Campbell	16697	8338	6965	49.93	41.71	83.53
Deshi ducks	19512	10952	9952	56.12	51.00	90.86
White pekin	12958	7746	6511	59.77	50.24	84.05
Moti	1142	349	88	30.56	7.70	25.21
Total	**50309**	**27385**	**23516**	**54.43**	**46.74**	**85.87**

The highest percent of hatchability (FES) was observed in deshi ducks followed by White pekin and Khaki Campbell breed. Fertility and hatchability was very poor in Moti ducks. However, the overall hatchability (85.87 percent) in all the breeds for the whole year is quite satisfactory.

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 1159.2 tons of different types of poultry feed, Detailed break up of feed supplied to different projects is shown in total 20.

Table 20: Feed supplied to different divisions/ sections/ farms of the institute and other establishments (2016-17)

Project/Division	Total Quantity (Qtls)
Broiler farm	2767.5
Layer farm	3362.5
Desi fowl farm	1668.96
Quail farm	963
Guinea fowl unit	385.5
Turkey unit	951.05
Avian Nutrition and Feed Technology Division	83.2
Avian Physiology and Reproduction Division.	199.27
Poultry Housing and Management Section	158
Medicine Section	1.7
Technology Transfer Section	595
Hatchery Section	38
SAU Mathura and others	297
IVRI, Izatnagar	105.95
IVRI, Mukteswar	15.2
Total	**11591.84**

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 2016 to March 2017 is given in Table 21.

Table 21: Quantity of experimental by-products disposed off during 2016-17

Month	Eggs (Nos)		Processed poultry meat (kg)				
	Chicken	Quail	Chicken	Guinea fowl	Kadaknath	Quail	Turkey
April, 2016	63571	34500	1113.25	9.0	2.5	49.5	4.5
May, 2016	66459	56800	1660.50	5.0	14.25	50.0	12.0
June, 2016	57683	80850	1896.00	166.0	60.25	25.0	3.0
July,2016	76379	90850	876.00	57.0	22.0	44.0	16.5
August, 2016	94853	81750	1094.50	19.0	64.0	41.5	23.0
September, 2016	75984	55850	1147.00	38.0	42.25	43.5	24.0
October, 2016	108725	76700	1283.00	4.5	20.25	69.0	5.25
November, 2016	117313	34300	1874.00	-	155.0	48.5	13.25
December, 2016	138420	44150	2383.25	20.5	81.25	60.0	88.0
January, 2017	99325	32300	2054.00	-	13.50	112.0	7.0
February, 2017	107771	27500	1994.00	-	-	95.0	16.0
March, 2017	124652	54850	2457.75	9.0	3.25	28.0	9.0
Total	**1131135**	**670400**	**19833.25**	**328.0**	**478.50**	**666.0**	**221.50**

Table 22: Net revenue generated from the disposal of poultry eggs, poultry meat and poultry products during 2016-17

Commodity	Revenue (Rs)
Chicken eggs	4492456.00
Quail eggs	621605.00
Chicken meat	1913408.00
Guinea fowl meat	35995.00
Kadaknath meat	44910.00
Quail meat	360850.00
Turkey meat	23850.00
Poultry products	20410.00
Total	**75,13,484.00**

Marketing Centre of RC, ICAR-CARI

The marketing Centre of RC, ICAR-CARI, also generated revenue from supply and booking of germplasm to the farmers sale other items. During the year a total of 16684 ducklings were supplied from marketing Centre to the farmers/ organization/ entrepreneur along with 1080 hatching eggs. Total revenue collected by marketing Centre was Rs. 1288960/- from sale of live ducks, ducklings, table eggs and other miscellaneous farm produce items. Total revenue generated from Regional Centre CARI in the year 2016-17 was Rs. 13,12,265/-.

Agriculture Knowledge Management Unit (AKMU)

Agricultural Knowledge Management Unit (AKMU) is instrumental in establishment and management of Local Area Network (LAN) for providing internet, intranet, and intranet services to the scientists, officers/ staff and students in the Institute. It has established high speed internet connectivity (100 Mbps) lease line on fiber optic cable under National Knowledge Network (NKN) connectivity provided by NIC/ Railtel and also 4 mbps broad band line of BSNL for internet usages 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 around the clock (24X7) for the employees of the Institute.

AKMU has designed and developed Institute Website in English and Hindi as per the ICAR guidelines. 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, recruitment of staff, tender notices and other circulars/news items of the institute are also being periodically uploading on the Institute Website.

Library and Information Services

During the period under report 101 new publications were added in the Library collection. This brings the total number of books, bound volumes ofjournals and theses etc. in the library from 5966 to 5982.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 Newsletters 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

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. CARI, Library, being a member of Consortium for e-Resources in Agriculture (CeRA), is getting access to more than 2500 online full text journals. Document Delivery Request (DDR) services are also being exchanged among the members library under CeRA. ICAR-CARI Library also provides Internet, E-mail, Information retrieval through CD-ROM database and Xerox services to the Scientists and Students.

Rajbhasha Anubhag

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 for acquiring proficiency in Hindi.

A total number of four Hindi workshops were organized on 04 April, 2016, 26-27 August, 2016, 29 December, 2016 and 07 March, 2017 during the year for the scientific, administrative and technical staff to increase use of Hindi in official works of the Institute. The staff was acquainted with Official Language Act and Rules.

Beside this, circulars and instructions were issued for compliance of Official Language Act and Rules in the Institute. Scientific, technical and administrative materials received from various Divisions, Sections and Units of the Institute were translated and typed.

Hindi Pakhwara was also organized during 14-28 Sept., 2016 at the Institute. On this occasion, Dr J.M. Kataria, Director, ICAR- CARI, Izatnagar addressing the staff said that use of Hindi is not only being done in administrative works, but new technological achievements of the Institute are also spreaded out to the end users in Hindi language through research and popular articles, lectures delivered in hindi by the scientists during trainings for farmers and publications written 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 Hindi Pakhwara. Research papers writing in Hindi competitions are being organized for last twelve years in the Institute. This year also, research papers in Hindi competition was organized and total four research papers were received in Hindi and three of them were awarded as First, Second and Third prizes and remaining one was given consolation prize. Dr J.M. Kataria, Director of the Institute distributed prizes in cash and momentos to winners. Hindi fortnight programme was organized by Paras Nath yadav, Asstt. Chief Technical Officer and R.N Mallik, S.A.O. and Officer-incharge, Rajbhasha Anubhag.

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, CARI, Izatnagar, special Swachh Bharat Abhiyan was organized from 16th - 31th May, 2016. During this special drive, the employees of the Institute were administered the swachhta oath on 16th may, 2016. The lecture on personal hygiene was delivered by Dr A. Mishra, MO on 26th May, 2016. The cleanliness activities were also performed in and around office premises during the fortnight.

Another Special Swachh Bharat Abhiyan was performed from 16th to 30th Oct., 2016. During this special drive, a lecture on Scope and Importance of Cleanliness was delivered by Dr A Mishra, Medical Officer, Manav Hospital IVRI, Izatnagar. Cleanliness activities were also performed in the campus.

On the occasion of Birth anniversary of father of the Nation- Mahatma Gandhi on 2nd Oct., 2016, activities on Swachh Bharat were performed at the Institute. In order to motivate students to contribute to swachhta, essay writing and drawing competitions were conducted for junior and senior class students and the winners of the competitions were awarded.

Swachh Bharat Abhiyan at Village Level.

During the Swachhta Phakhwara from 16th - 31th May, 2016, a rally on swachhta was held on 24th May, 2016 at village panchayat Navdia harkisan of Bareilly district (UP). Scientists of the Institute delivered lectures on various aspects of swachhta to motivate villagers to keep their surroundings neat and clean. The staff of the institute also cleaned the streets and drains of the village.

During this pakhwara, swachhta awareness programme was conducted on 30th May, 2016 in the village Dandia of Bareilly district. Scientist of the institute delivered lecture on importance of swachhta in front of villagers.

Foundation Day Celebration

The Institute celebrated its 38th Foundation Day on 2nd Nov, 2015. The function was chaired by the director of the institute. The farmers from villages – Dandia, Navdia harkisan, Bhagautipur, Naugma-harsa-haipatti, Badshahnagar etc participated in the programme. On this occasion, Kisangoshthi was also held to provide the solution of problems being encountered by poultry farmers.

World Egg Day

In the leadership and guidance of Dr J.M. Kataria the Director, ICAR-CARI,the Technology Transfer Section and Post Harvest Technology Division of the Institute, jointly organized the World Egg Day on 14th Oct., 2016 at Primary and Junior Schools, IVRI, Izatnagar.

On this occasion, Dr Kataria delivered talk on role of egg in the diet to get rid on malnutrition in school children and advised students to include egg in their diet.

Other scientists of the Institute also exchanged their views with school children. The children were also offered boiled egg and bananas.

World Soil Day

The Technology Transfer Section and PME Section of the Institute organized world Soil Day on

5th Dec., 2016 jointly at village Dandia of Bithri chainpur development block, district Bareilly (UP).

During the programme, the principal scientists of CARI – Dr.M.P. Sagar and Dr Sandeep Saran, and Smt Puja Saxena, DHO, Bareilly addressed farmers of the village. The expert Smt Puja Saxena delivered a talk on soil health and about soil health card in detail. The farmers were motivated to get soil tested before application of fertilizers in it at Govt. Soil Testing Labs.

Krishi Education Day

The Agriculture Education Day" was organized on December 3, 2016. at ICAR- CARI, Izatnagar. on this occasion, visit to various Institute's farms was conducted for school children to make them acquainted with poultry breeds developed by the Institute. This was followed by a debate comptition for Institute staff and students on the topics - Advantage and disadvantage of demonetization in Agriculture with reference to poultry (for staff), and Role of poultry education, extension and training in rural poverty alleviation in India (for students).

A good number of staff members and students took part in the debate. Prizes were distributed to the winners of debate competition.

Before the debate competition, various speakers gave lecture on the importance of Agriculture education in reference to poultry science for carrier building and higher education for students. In the afternoon session, lectures were delivered by the PG poultry science students on different aspects of poultry production.

National Science Day

National Science Day was celebrated with especially abled persons on 28th February, 2017 on the theme "Science and Technology for Specially Abled Persons" given by Department of Science and Technology.

On this occasion, a three days training programme on backyard poultry farming was organised for specially abled persons from 25 – 28th February, 2016 at ICAR-CARI, Izatnagar. During the training, fifteen specially abled persons were motivated to start backyard poultry farming to earn money and get nutrition from eggs and meat. In the closing ceremony of the programme, specially abled children of Disha School were also invited to attend the function. Day old Chicks were distributed to all the participants by the Chief Guest Dr N.S. Rathore, DDG (Education), ICAR. New Delhi.

Cashless Transactions System Implementation

In order to implement the decision of the Hon'ble Prime Minister Sh. Narendra Damodardas Modi on cashless transactions during the demonetization and afterwards, the Institute has started the cashless transactions from 4th February, 2017. Since then, all the transactions on account of sale of poultry products, poultry germplasm, sale of culled birds, training registration fee etc. are being done through cashless means like POS machine, Bank Draft, Cheque, RTGS etc.

Staff Personalia

Posting / Appointment

- Smt. Saroj joined as trainee on 08.09.2016 at ICAR-CARI, Izatnagar

Transfer from other Institute

- Shri G.C. Joshi, F&AO joined ICAR-CARI Izatnagaron 01.06.2016 after transfer from IINRGN, Ranchi, Jharkhand

Transfer to other Institutes

- Dr Ram Singh, Pr. Scientist transferred to ICAR- Central Institute for Research on Buffaloes, Hisar on 18.03.2017

Promotions

- Shri S.P. Singh, Sr. Technical Officer (T-6) promoted to the post of Assistant Chief Technical Officer (T -7-8) w.e.f. 01.07.2016
- Shri A.K. Singh, Sr. Technical Officer (T-6) promoted to the post of Assistant Chief Technical Officer (T -7-8) w.e.f. 01.07.2016
- Shri M.W. Raza, Sr. Technical Officer (T-6) promoted to the post of Assistant Chief Technical Officer (T -7-8) w.e.f. 01.07.2016
- Shri A.K. Nanda, Technical Officer (T-5) promoted to the post of Sr. Technical Officer (T-6) w.e.f. 01.01.2016
- Shri Anoop Kumar Johari, Technical Officer (T-5) promoted to the post of Sr. Technical Officer (T-6) w.e.f. 03.02.2015
- Shri Virendra Kumar, Technical Officer (T-5) promoted to the post of Sr. Technical Officer (T-6) w.e.f. 01.01.2016
- Shri Vijay Kumar, Skilled Supporting Staff promoted to the post of LDC on 07.12.2016.

Retirements

- Shri P.D.Tiwari, Technical Officer (T-5) retired on 30.04.2016
- Shri Vijay Kumar, Assistant retired on 30.04.2016
- Shri Govind Bhaduar, Skilled Supporting Staff retired on 31.05.2016.
- Shri Hasmat Khan, Skilled Supporting Staff retired on 31.05.2016.
- Shri Ramesh, Skilled Supporting Staff voluntarily retired on 01.08.2016.
- Shri Omkar Singh, Skilled Supporting Staff retired on 31.08.2016.
- Shri B.Arya, Assistant Chief Technical Officer (T-7-8) retired on 30.09.2016.
- Shri G.C.Joshi, Finance andAccount Officer retired on 30.11.2016.
- Shri Chandra Pal, Skilled Supporting Staff voluntarily retired on 30.11.2016.
- Shri B.S.Bisht, Assistant Administrative Officer retired on 31.12.2016.
- Shri R.D.Sharma, Chief Technical Officer (T-9) retired on 31.01.2017.
- Shri K.K.Dass, Technical Officer (T-5) retired on 28.02.2017.
- Shri Tara Singh, Skilled Supporting Staff retired on 28.02.2017.
- Shri Om Prakash, Skilled Supporting Staff retired on 28.02.2017
- Shri R.R.Saxena, Sr. Technical Officer (T-6) retired on 31.03.2017
- Smt Reshma, Skilled Supporting Staff retired on 31.03.2017

APPROVED ONGOING RESEARCH PROJECTS (2016-2017)

Total Institute Projects – 24 Institutes + 2 AICRP + 5 Externally + 3 Service (Total 34 Projects)

Sl.	*Project Code No.*	*Project Title*	*Principal Investigator*	*Co-Investigator*
PROGRAMME-1: PRODUCTIVITY ENHANCEMENT OF SELECTED POULTRY SPECIES (21)				
Sub Programme (i) Enhancement of productivity, reproductive efficiency and immune-competence of selected diversified poultry species along with development of improved package of practices. (16)				
1.	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.
2.	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.) SimmiTomar	Dr V.K. Saxena Dr Jaydip J. Rokade
3.	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) Simmi Tomar Dr Jaydip J. Rokade
4.	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 Avishek Biswas
5.	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
6.	P-1/2012/1-IAV/L30/6100 DOS: 18.10.2012 DOC: 17.10.2017	Efficacy of herbs containing essential oils on performance and immunity in broiler chickens.	Dr (Mrs.) Divya	Dr A. Biswas Dr Ashim K. Biswas
7.	*P-1/2014/1-IAV/6000/3745* DOS: 1.8.2014 DOC: 31.7.2017	Ochratoxicosis in poultry	Dr Ram Singh(till 18.3.2017) Dr AvishekBiswas (w.e.f. 19.3.2017)	-
8.	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
9.	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.
10.	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
11.	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
12.	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

13.	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
14.	*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
15.	*Service project*	Quality assessment of feed stuffs and poultry feed	Dr A.B. Mandal	Dr Avishek Biswas
16.	*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
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 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

PROGRAMME 2: CLIMATE RESILIENT POULTRY PRODUCTION SYSTEM AND WASTE MANAGEMENT (4)

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 (upto 18.3.17.) Dr (Mrs.) Divya Dr Avishek Biswas
2.	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
3.	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 S. Majumdar	Dr Sandeep Saran Dr G. Kolluri
4.	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: 30.04.2017	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 (1)

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	-

EXTERNALLY FUNDED PROJECTS – (05)

Sl.	Sanction Order No.	Title of the Project	Name of PI	Name of Co-PI
1.	No.IPandTM-7(5)/2013-IPR dated 1.1.2016 (ABI Project) DOS: 01.01.2016 DOC: 31.3.2017	Poultry Entrepreneurship Development Initiative The Agri Business Incubator	Dr Sandeep Saran	Dr Chandrahas Dr M.P. Sagar
2.	No. ECR/2016/001898 dated 24.3.2017 (SERB) DOS: 24.03.2017 DOC:23.03.2020	Enhancing gut health and immunological functions in broilers through convergence of biotechnological and nutritional interventions	Dr Gopi M.	Dr Jaydip J. Rokade
3.	No. 5/258/89/215-NMITLI dated 30.3.2016 DOS: 30.3.2016 DOC: 29.3.2018(CSIR Project)	Kappaphy cusalvarezii and red seaweed based formulations for improving productivity and health of dairy and poultry animals	Dr A.B. Mandal	Dr Praveen K. Tyagi Dr S.K. Bhanja Dr Ashim K. Biswas Dr Avishek Biswas
4.	BT/PR9724/AAQ/1/571/2013 dtd. 27.03.2015 (DBT Project) DOS:27.03.2015 DOC:27.03.2018	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	Dr A.B. Mandal Dr S.K. Bhanja Dr A.S. Yadav
5.	SB/FT/LS-283/2012 dt.02.05.2013 (DST Project) DOS:16.07.2013 DOC:15.07.2016	Biochemical basis for detection of calpains and calpastatin and their role in post-mortem tenderization of meat	Dr Ashim K Biswas	-