

ICAR-CARI



annual report 2014-15



ICAR-Central Avian Research Institute
Izatnagar-243 122 (UP) INDIA

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Annual Report 2014-15



ICAR-CENTRAL AVIAN RESEARCH INSTITUTE
Izatnagar-243 122 (UP) INDIA





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Preface

“.....The backyard poultry,highly important for livelihood and nutritional securities of the rural poor, is, however, facing many problems. The focus, therefore, would be to provide appropriate support to this sector in the form of financial assistance, genetic stocks and improved technologies, scientific advice, extension/awareness, particularly on bio security measures. Conservation of indigenous poultry breeds would be encouraged for producing poultry birds suitable for backyard poultry.”

... National Livestock Policy 2013, GOI

Consistent with the National Livestock Policy of the country, the Central Avian Research Institute has been performing its assigned responsibilities ever since its inception on Nov.2, 1979. During the journey of past 35 years, the institute has lent a helping hand to the rural poor and unemployed youth to venture into the field of poultry business to enable them earn a decent livelihood. The poultry production technologies developed by the institute have been seamlessly and smoothly interwoven into various production systems across wide ranging agro climatic conditions throughout the country ensuring household nutritional security and women empowerment. As a result, poultry sector has witnessed an overall upward growth of about 8-10% per annum during last 10 years. The institute has significantly contributed towards popularization and growth of diversified poultry species such as ducks, turkey, Guinea fowls and quails in the country in addition to native chicken and commercial broilers and layers.



The Institute's research programme encompasses basic, strategic and applied aspects of diversified poultry species ranging from basic studies in poultry gene structure and function to applied works on breeding and management. For the first time, gut microbiome of Guinea fowl was analyzed using next generation sequencing of 16S hyper variable region for screening of Lactobacilli species for their probiotic potency and *L. plantarum* was evaluated for production, immunity and competitive exclusion against Salmonella and *E.coli* in Guinea fowl and broilers for use as probiotic in poultry rations. The institute has focused on developing economic rations incorporating newer feed stuffs as also by improving their feeding value for ever expanding poultry in the country. Research work has been initiated in the area of poultry waste management and climate resilient poultry production systems with special reference to heat stress. The institute has also standardized processing technologies for preparing poultry meat bites, finger chips, wafers and instant emu noodles. Differentiating domesticated Japanese quails from the wild ones has been made possible through molecular technique developed by the institute albeit in the preliminary stage. For the first time, institute's gross revenue generation has exceeded of Rs. 2 crore with the sincere efforts of its scientists and staff.

At the RC, Bhubaneswar, performance of crossbred (WPxKC) ducks was evaluated under rice based mixed farming and the conventional systems with encouraging results. Attempts have also been made to economize duck rations and to improve the reproductive efficiency of ducks through AI techniques using various semen extenders. Various models developed and standardized by the RC were successfully adopted by the farmers for rearing of ducks and chicken in the project area.

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

I feel elated to present this Annual Report duly acknowledging the sincere inputs by the dedicated team of scientists of the institute which is undergoing major restructuring for last couple of years. It is our endeavor to work continuously towards building up the Institute. I do believe that our determination to make India self sufficient and self reliant in the field of eggs and meat production will be realized and brightened with the cooperating and dedication of our scientists.

A handwritten signature in black ink, appearing to read 'J.M. Kataria', written over a light-colored rectangular background.

(J.M. Kataria)
Director



Contents

<i>Chapter</i>	<i>Page No.</i>
PREFACE	
1. Introduction	1
2. Executive Summary	4
3. Research Achievements	9-42
A. <i>Productivity Enhancement of Selected Poultry Species</i>	9-17
● Genetic improvement of quail germplasm	9
● Genetic improvement of guinea fowl varieties	10
● Conservation and utilization of indigenous chicken	10
● Genetic improvement of synthetic broiler lines	14
● Conservation of elite layer stocks	15
● Genetic improvement of Rhode Island Red	16
● Poultry waste management	17
B. <i>Nutrient Management</i>	17-21
C. <i>Physiological Intervention for Augmentation of Reproductive Efficiency</i>	21-23
D. <i>Shelter Management</i>	23-24
E. <i>Health Management</i>	25
F. <i>Processing Value Addition, Product Safety and Quality Parameters</i>	26-30
G. <i>Assessment of Poultry Production as Influenced by Market Dynamics</i>	30
H. <i>HRD and Technology Dissemination</i>	30-31
I. <i>Extended Funded Project</i>	31-36
4. Regional Centre, Bhubaneswar	37-42
● Maintenance, evaluation and conservation of important breeds of ducks for augmentating duck production in rural and tribal areas	37
● Reproductive physiology and semen characteristics of ducks to augment fertility and hatchability	38
● Nutrient requirements of ducks	38
● Surveillance and monitoring of duck diseases	40
● Diversified rice based farming system for livelihood improvement	40
● Backyard poultry and duck production as a tool to sustainable livelihood for rural women of Khurda district of Orissa (DST sponsored)	41
5. P.G. Students' Research	45-47
6. Technology Assessed and Transferred	48-49
7. Education and Training	50
8. Awards and Recognition	51
9. Linkages and Collaborations	52
10. List of Publications	53-66
11. Participation in Conferences, Workshops, Symposia and Trainings	67-68

12. Consultancy, Patents and Commercialization of Technology	69
13. Workshops, Seminars and Trainings Organized	70
14. Distinguished Visitors	71
15. Personnel	72-73
16. Expenditure Statement and Revenue Generation	74
17. Other Relevant Information	75-81
● Institute Research Committee	75
● Results Frame-work Document	75
● Right to Information	75
● Research Advisory Committee	75
● Institute Management Committee Meeting	76
● Institute Animal Ethics Committee	76
● Institutional Biosafety Committee	76
● Institute Technology Management Unit	76
● Hatchery Operations	77
● Feed Storage and Processing Unit	78
● Agricultural Knowledge Management Unit	78
● Marketing of Poultry Products	78
● Library and Information Services	79
● Hindi Cell	79
● Awareness Camp on Swachh Bharat	80
● Staff Personalia	81
18. Approved On-Going Research Projects	82-84

Introduction

Having established on the 2nd November 1979, Central Avian Research Institute (CARI), Izatnagar has emerged as the premier institute on poultry research in Asian sub-continent. Presently, its main campus is located in IVRI Campus, Izatnagar, Bareilly (U.P.) and the Regional Centre at Bhubaneswar (Odisha). Since its inception, CARI has been actively engaged in transforming subsistence backyard poultry rearing into a vibrant and aggressive agro-industry worth over Rs. 600 billion. Its contributions in development of superior genetic stocks of diversified poultry species along with complete packages of management practices to optimize growth and production in different agro-climatic conditions and under different farming frameworks; identification and evaluation of non-conventional feed stuffs and improvement in their feeding value including formulations to minimize feed cost; identification of toxins in feeds and development of their ameliorating methods; preparation and

standardization of value added processed products utilizing poultry egg, meat and byproducts and development of methods for their shelf-life extension etc. have been widely acclaimed and adopted by the industry. Institute's HRD programme has been providing trained manpower for manning large commercial poultry houses in the country. As a result, the Indian Poultry Sector has been growing @ about 8-10% per annum. However, the growth path is not devoid of hurdles as the industry is also faced with chronic shortages of major agro-feed ingredients and slow consumption trend of poultry products. Devising ways to lower the production cost for sustaining profits particularly under adverse climatic extremes and export competitiveness, tackling threats of new emerging poultry diseases like AI, poultry waste management and product quality assurance are some of the key challenges needing immediate redress.

MANDATE

Main Campus

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

Regional Centre

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

MAJOR R&D ACTIVITIES

- Genetic improvement, characterization and propagation of diversified poultry species through breeding and molecular tools; research in advance areas, conservation of indigenous chicken.
- Conducting research on basic and applied aspects of avian nutrition and rendering services viz advisory, consultancy, feed analysis, quality assurance and training.
- 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, consultancy, farm school on air for poultry farmers, participation in exhibitions, off-farm technology assessment, 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.

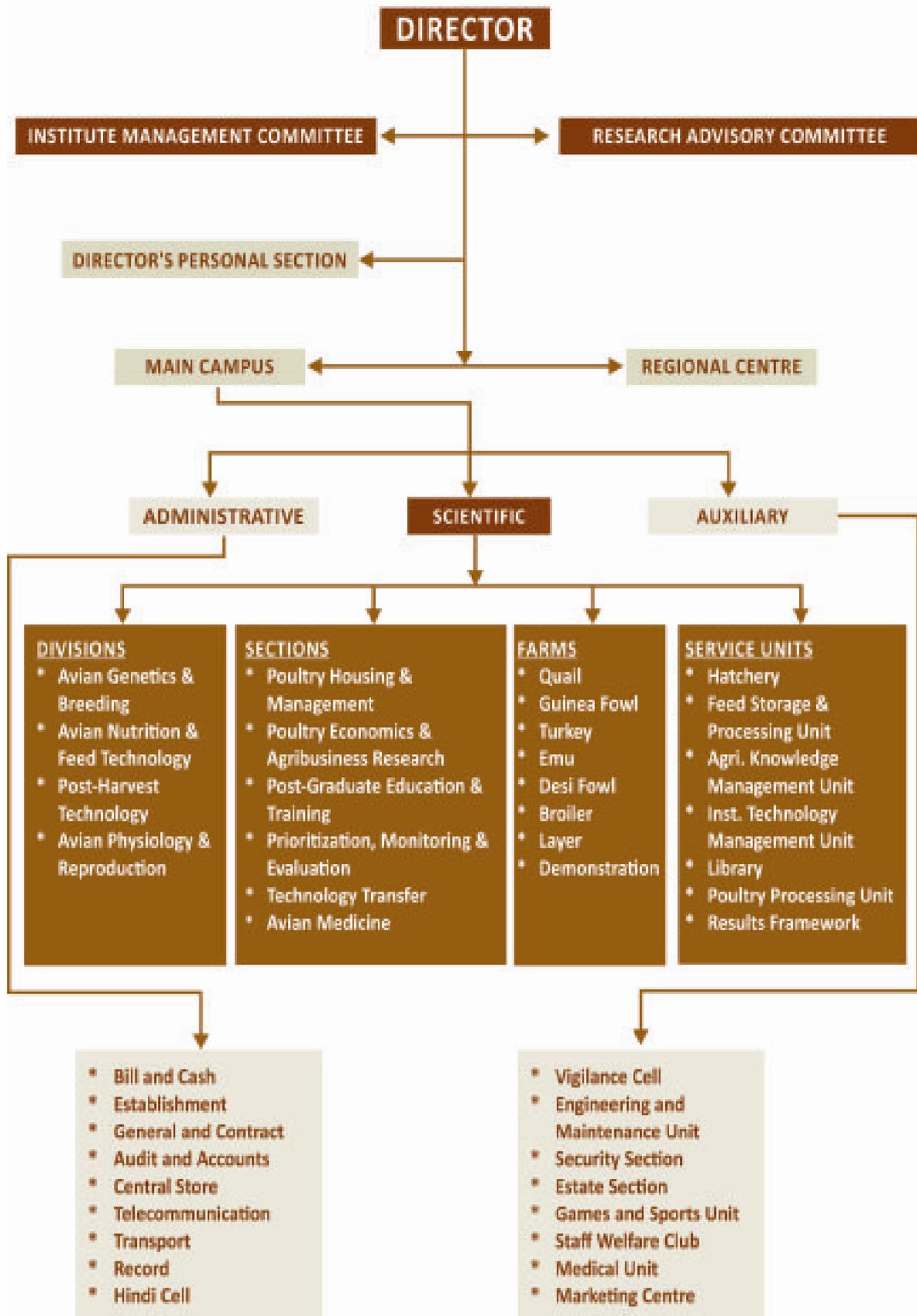
STAFF POSITION (As on 31.03.2015)

Ser.No.	Category	Sanctioned Strength	In-Position	Vacant
1.	Scientific	40+1	36 + 1	04
2.	Technical	61	40*	21
3.	Administrative	31	27*	4
4.	Skilled Support Staff	137	109*	28

*Including terminated employees (Tech.-4, Admin. 2, SSS-2)



ORGANOGRAM



Executive Summary

Productivity Improvement of Diversified Poultry Species

- Pedigree hatching of elite quail germplasm of Japanese quail *viz.* CARI-UTTAM, CARI-UJJAWAL, CARI-PEARL, CARI-SWETA, CARI-SUNEHERI, CARI-BROWN CROSSES & CONTROL, has been initiated as per ICAR letter No. AS/11/1/2013/ ASR-II dated 27 Feb 2015. Further work for recording of data and maintenance of these quail lines is going on. Earlier, the molecular tools were developed to differentiate wild quails from domesticated Japanese quail.
- Pearl variety of Guinea fowl germplasm was exchanged with TANUVAS, Chennai and both germplasms (CARI and TANUVAS) were evaluated at both locations. CARI-Guinea fowl were also evaluated at Mukteshwar. In IInd generation 12 wks body weights in pearl, lavender, white and control were 1053.0, 970.0, 951.2 and 908.7 g respectively. FCR (0-12 Wks) and dressing % (at 12 wks) were 3.2 and 71.2% respectively. Phenotypic gains for 12-week body weight over last 15 generations of selection in Pearl, Lavender and white varieties of guinea fowl were 15.14±2.54**, 19.44±2.54** and 9.51±1.99 g/ respectively.
- For the first time, gut microbiome of Guinea fowl was analyzed using next generation sequencing of 16s hypervariable region, which revealed 0.0026% Archaea, 59.94% Bacteria, 8.65% Eukaryota and 31.17% Viruses.
- A total of 2718 purebred chicks comprising of 536 Aseel Peela, 438 Nicobari, 254 Kadaknath, 513 Ankaleshwar, 678 Aseel Kagar and 299 major gene pool line were hatched. Total 7932 chicks of different crosses (CARI Nirbheek, HITCARI, CARI Shyama and UPCARI) were supplied to different organizations for rural poultry production.
- A complete 3x3 diallel cross using Aseel peela (AP), Kadaknath (KN) and CARI-Red (CR) revealed significant differences between mating system and among genetic groups for body weight, conformation and carcass quality traits. Pure bred CR had highest body weight at all the ages, whereas AP x CR revealed highest body weight and humoral immune response against RDV among all other crosses. Most of the crossbreds had better FCR and less mortality % than purebreds.
- The post-juvenile analysis (20-40 weeks of age) for growth and annual egg production traits revealed that crossbreds were superior to the purebreds for various economic traits *viz.* growth, body conformation, egg production and feed efficiency traits. CR as female line and AP as male line appear to be the best combination for crossing.
- Significant GCA, SCA, reciprocal and sex-linked/ maternal effects were recorded for growth and egg production traits. GCA was more important as compared to SCA for inheritance of body weight and body weight gain, body conformation traits and egg quality traits. For the inheritance of age at sexual maturity SCA was found more important. Both GCA and SCA played important role for the inheritance of annual egg production.
- Gompertz model was found to be the best fit mathematical function for explaining the pattern of growth curve and cumulative annual egg production curve for each of nine genetic groups.
- Four iron-made mini-composters for poultry waste and laboratory model of anaerobic composter for bio-gas production with 20 and 200 lit. capacities were fabricated. C:N ratio, TS%, VS% and N% and bacterial count (total count and *E. coli* count) of poultry waste from deep litter and cage rearing were recorded.
- Overall average body weight of mixed sexes at 5 weeks in SML and control were 1156.66 ± 3.74g, and 763.52±9.8 g, respectively. Phenotypic and genetic responses in SML were 13.44**±1.64 and 11.21*±1.79 g/generation, respectively. Corresponding values in CSML were 15.13**±2.11 and 13.12**±2.13 g/generation. The phenotypic response for 5-week body weight in the control population was non-significant (3.24±1.29 g/generation).
- The overall average of body weight at 5 weeks in SDL was 1149.69±3.27 with phenotypic

response as $13.09 \pm 2.41^{**}$ and genetic response as $10.87 \pm 2.39^{**}$.

- At 41st RSPPT (Gurgaon) CARIBRO-Vishal secured IV rank. Body weight at 6-weeks and 7-weeks were 1.28 and 1.52 Kg, respectively. FCR (0-6 Wks), mortality % and dressing % were 2.2, 6% and 71.9% respectively. Margin of receipt at 6-weeks was Rs 8.4/bird.
- Significant reduction in body weights at 4, 5, 6, 7, 8 and 9 weeks in PPAR γ and ACC lentivectors *in-ovo* injected groups was achieved. The serum cholesterol levels (mg/dl) were also reduced significantly at 5, 9, 15, 16 and 18 weeks of age in PPAR γ -2 shRNA injected group. The abdominal fat weights at 20 weeks was also reduced in shRNA injected groups compared to un-injected control
- Serum myostatin (ELISA) levels at 3rd week of age in chicks injected (i/v) with myostatin and TGF β 4 lentivectors were significantly low compared to NTC and uninjected groups. Myostatin and TGF β 4 genes were significantly down regulated in heart and breast muscle. Method of transfecting chicken sperm using lentiviral vector was standardized. The ideal site for intra-testicular injection was adjudged by ultrasonography to be between last 2nd and 3rd vertebrae.
- The sequencing of 16s rRNA gene (V3, V4 and V4-V6 hyper variable regions) from crop, jejunum, ileum and cecum samples of adult, grower and chicken stages of Assam indigenous bird was performed and datasets obtained were analysed through MG-RAST server. *Firmicutes*, *Bacteroidetes*, *Actino-bacteria* and *Proteobacteria* were the dominant phyla in all the metagenomes. Significant increment in the number of reads for *Lactobacillus* with the age of chicken was observed. Among all three age groups, grower had highest species richness. Some of the Lactobacilli and other bacterial species identified in chicken for the first time. Out of 52 isolates received from College of Veterinary Science, Guwahati, 5 isolates were selected, based on PCR based analysis using ISR primers and evaluation by Hi-carbo kit, for evaluation of probiotic properties.
- The 40th week body weight, egg weight, egg numbers and egg colour for RIRs were $1721.4 \pm 5.93g$, $50.93 \pm 0.09g$, 110.14 ± 0.60 nos. and

1.86 ± 0.018 point, respectively. On genetic scale, the ASM in RIRs declined significantly ($P < 0.01$) to the tune of -0.70 0.17 day/generation. Highly significant response per generation for 40 wk egg number and egg weight i.e. 1.08 0.12 eggs and 0.08 $0.02g$, respectively were observed.

- The elite WLH germplasm (IWH, IWI, IWG and IWJ strains) were maintained in conservation mode and data on various layer economic traits were recorded and analysed.
- Analysis of immunocompetence (IC) and layer economic traits, microsatellite (MS) profiling of egg production-associated and TLR4 expression/ disease resistance associated MS loci was performed in RIR^s chicks. Various immunological and production traits were recorded and analysed.
- Microsatellite profiling of four loci, ADL0149, HUI0002, MCW0330 and ADL0293, closely linked to TLR4 gene revealed a total 14 alleles (average 3.50 ± 0.29). Various population statistics were estimated. ² and likelihood ratio tests revealed that the population was in H-W disequilibrium. Significant differences among genotypes at MCW0330 were observed in TLR4 gene expression in bursa; higher expression in DD and CC genotypes.
- Allelic polymorphism at 10 microsatellite loci, linked to egg production traits, viz., ADL0020, ADL0023, ADL0102, ADL0176, ADL0210, MCW007, MCW0014, MCW0041, MCW0069 and MCW0103 in RIR^s were determined. Mean percent heterozygosity and PIC value were 0.4119 ± 0.2475 and 0.313 ± 0.064 , respectively. Various population statistics were estimated.
- Birds with low IgG concentration showed higher BW40 and BW64 and birds with highest lysozyme concentration had higher EN64. Molecular breeding by setting up the ADL176 genotype based mating was initiated and in S1 generation, HA, Lysozyme and IgG were recorded and analysed.

Poultry Nutrition and Feed Technology

- Addition of magnesium sulphate @ 1.2 or 2.4 g/kg basal diets improved body weight, feed conversion, immuno-competence, economics and other welfare parameters during both hot and hot-humid summer but results were more

encouraging at level 2.4 g/kg that too during hot-humid summer.

- The adverse effects on growth, feed conversion and immunity caused by high ambient temperature during extreme summer (hot and hot-humid) could partially be curbed by addition of aspirin (500 mg/kg) in diet
- A dietary energy level of 2600 kcal/kg was optimum for growing turkey poults during 8-16 weeks of age. Feed enzyme supplementation did not prove beneficial for improvement of performance.
- Inclusion of rice based dried distillery grains with soluble (rice DDGS, 46.5% protein on as such basis) up to 10% level did not exert any adverse effect on growth, feed conversion ratio, carcass traits and development of immune organs of broiler chickens, and thus could safely be included up to 10% level for profitable broiler production. Moreover, irrespective of source of protein commercial protease incorporation in diet was beneficial for improved feed utilization and reduction of broiler feed-cost in.
- High protein guar korma (53.72% on DM basis) can safely and economically be used up to 10% level in the diets of broiler chickens replacing costlier soybean meal for profitable broiler production.
- A dietary combination of 40 mg zinc and 3200 IU/kg diet vitamin A was found optimum for growth, carcass yield and immune response of growing (0-6 wk) Japanese quails.
- A dietary concentration of 0.35 and 0.25% available phosphorus during starting (0-21 d) and finishing phase (21-42d), respectively and 1500 IU/kg vitamin D3 with supplementation of phytase (500FTU/kg diet) was found optimum to obtain maximum growth performance, immune response and leg bone mineralization of broiler chicken.
- The tolerance level of Ochratoxin A was found to be 100 ppb in diet of broiler chickens.
- The carryover work of 2013-14 after analysis data revealed that dietary addition of coriander seed powder @ 3.0% was beneficial in reducing serum and egg yolk cholesterol and caecal microbial count in Japanese quails
- Incorporation of 0.5% of Beal leaves powder was effective in reducing total plate count as well as *Escherichia coli* count, however welfare

of birds (in terms of blood biochemistry, immunity, fat pad and FCR) improved with linear increase of Beal leave powder level from 1 to 2.0%.

- Supplementation of selenium @ 0.4 mg/kg basal diet was beneficial for lowering age at sexual maturity, improving egg production, egg quality traits and partheno-genetic character in female, and physio-biochemical characteristics of semen in male turkeys.

Physiological Intervention for Augmentation of Reproductive Efficiency

- Effect of endocrine disruptor- BPA (Bisphenol-A) was investigated on avian reproduction by employing *in vivo* and *in vitro* studies. *In vivo* studies have been carried out in Japanese quail using low (250 µg/bird/day) and high (1000 µg/bird/day) doses of BPA. This study indicated that BPA is having adverse effect on male reproduction of Japanese quail.
- *In vitro* studies have been carried out on chicken spermatozoa using environmentally relevant concentrations of BPA (0 mM, 0.18 mM, 0.37 mM, and 0.74 mM). BPA at concentration of 0.37 and 0.74 mM hampered mitochondrial function leading to reduction of fertilizing ability of spermatozoa.
- The relationship of body weight with arterial BP (blood pressure) and heart rate in broilers was studied. Broiler birds with high body weight showed significantly higher mean arterial blood pressure (117.40 mm Hg) compared to low and normal body weight broilers. Numerically higher heart rate was also observed in birds with high body weight than other groups.
- Elevated incubation temperature of 39.5°C for 18 days of incubation drastically reduced the hatchability (FES) in broiler chicks.

Poultry Products Technology

- Health oriented low-fat poultry meat wafers and finger chips were developed using refined vegetable oil at 5 and 7% level in the standardized formulations, respectively.
- Plant fibres in development of functional poultry meat finger chips and chicken meat bites were standardized using oat and fox-nut (Makhana) flours at 3.5 and 1.0% levels respectively, while that were standardized at

4.5 and 3.0% levels using oat and sorghum flours in development of fibre enriched poultry meat wafers.

- Processes for development of instant emu egg noodles, turkey breast fillets and functional chicken sausages were standardized. The developed products are selling through the institute marketing centre for popularization and income generation.
- Acidified sodium chlorite, tri-sodium phosphate and carvacrol were found effective antimicrobials for pre-dipping of dressed chicken carcasses before thermal treatment to inactivate *Salmonella* Typhimurium and *Salmonella* Enteritidis on dressed chicken.
- Out 100 chicken meat surface samples analyzed during the period of summer season, 14% were found positive for *Campylobacter jejuni* and the level was in the range of 1.7×10^2 to 1.3×10^4 cfu/cm².
- Simple and low-cost casein Zymography technique has been developed for determination of μ - and m -calpain enzymes from variety of tissue samples including blood irrespective of species, breeds, sex and age of animals.

Shelter Management

- Growing turkey poults (9-16 wk) reared in battery cages performed better at 1.25 sq. ft/bird and 2600 kcal/kg dietary ME, however, no significant effect of enzyme supplementation was observed.
- The feed-cost per kg meat production was significantly higher at 1.90 sq. ft floor space and 2400 kcal/kg dietary group.
- Profit potential per meter square (PPM) was significantly higher at 1.25 sq.ft floor space when the birds were sold as dressed meat and there was no significant interaction due to space, energy and or enzyme supplementation.
- Dressing yield was significantly higher ($P < 0.01$) in the birds provided 1.25 sq. ft space and fed diet with 2600 kcal ME/ kg diet but recorded higher cut-up value in 2800 kcal ME/ kg diet fed group.
- Cellular and humoral immune response did not differ due to space and enzyme supplementation but the cellular immune response was higher in high energy diet fed birds.

- Per cent hen day egg production (HDEP) in RIR birds reared on floor did not differ due to energy level of the diet, but when reared in cages birds fed 2600 kcal ME diet had more egg production.
- Age at first egg in CARI Deendra female was lower when reared at plains (CARI, Iztanagar) compared to high altitude at IVRI, Mukeswar (171.2d vs 194.0d). Hen day egg production was higher when reared on floor (33.4%) than cages (20.6%) during winter months.
- The average body weights of the turkey poults reared at high altitude at 12th, 16th and 36th weeks of age were 999.1 ± 18.8 g, 1561.7 ± 28.4 g and 3564.4 ± 82.3 g, respectively. The female turkey birds attained sexual maturity in 237 days at high altitude.
- The average body weight of guinea fowl chicks reared at high altitude at 8th, 12th & 24th weeks of age were 366.7 ± 22.4 g, 725.0 ± 25.0 g and 1350.0 ± 35.0 g, respectively. The female birds attained sexual maturity in 197 days.
- Cage reared White Leghorn (WLH) chicks weighed more at 42d, but the floor reared birds had higher body weight (556.7 ± 16.68 vs 609.5 ± 6.18 g) at 56d of age.
- Significantly higher ($P < 0.05$) fearful response (2.95 ± 0.15 vs 1.45 ± 0.13 sec) and time for first peck (6.35 ± 1.01 vs 1.51 ± 0.15 sec) in response to novel object test was observed in cage birds than the floor reared birds.
- Significant differences ($P < 0.05$) was found in the welfare parameters like feather conditions, claw length, gait scoring and tonic immobility of the birds between two system of rearing.
- Significant differences ($p < 0.05$) was found in the welfare parameters like feather conditions, claw length, gait scoring and tonic immobility of the birds between two system of rearing.

Education and Training

- During the period under report, 49 students (28 MVSc & 21 PhD) were on roll for different degrees courses in Poultry Science discipline under Deemed University, Indian Veterinary Research Institute, Iztanagar.
- Three PhD and 9 MVSc students submitted their theses and received degrees in Poultry Science discipline under Deemed University, Indian Veterinary Research Institute, Iztanagar.

- Three Specialized Short-Term Training courses in different areas of Poultry Science were organized.
- One International Training Programme on “on Advances in Poultry Nutrition and Feed Technology” for SAARC member countries was organized.
- Seventeen major credits, 10 minor credits, 17 ORW, 12 pre-thesis submission and 1 faculty seminars were organized by PGE&T Section at the Institute.

Extension and Transfer of Technology

- To create awareness and disseminate the knowledge about poultry farming, One village level *exhibition*, two *field days* and three *awareness camps* were organized in different villages of U.P. and Uttarakhand.
- Four sponsored and regular short term training programmes on poultry production management were organized.
- CARI participated in various exhibitions and Kisan melas viz. ASC-India Expo-2015 at Karnal, Northern zone Regional Agricultural Fair-2015 at Izatnagar, Bareilly (UP) and Kisan mela Mukteswar Nainital (UK).
- CARI organized Poultry Exhibition-2015 at its campus on 2nd November, 2014.
- Twelve *on-farm demonstrations* on CARI Debendra and two on-farm demonstration on CARI Dhanraja were organized in adopted and various other villages of Bareilly district, Uttar Pradesh and Champawat, Uttarakhand.
- Four *kisan goshthies* were organized to address the problems of poultry farmers in different aspects of poultry farming at different locations in UP and Uttarakhand.

Regional Centre, Bhubaneswar

- The average egg production (duck housed) up to 40 week of age (G-1 gen), recorded as 94.29, 77.55, 77.21 and 25.28 eggs for Khaki Campbell, Desi, White Pekin and Moti breeds, respectively, were far better than the base (G-0) generation.
- Similarly, the mean 40th week egg weights for corresponding breeds, observed as 64.77, 65.82, 73.03 and 69.67 g, were also better than the egg weights of the base generation.
- The mean per cent fertility of breeding stocks (G-1 gen), recorded as 56.67, 59.54, 60.34, 30.00,

75.49 and 68.43% for Khaki Campbell, Desi, White Pekin, Moti breeds and DK & PK crossbreeds respectively, were far better than previous generation.

- The per cent hatchability on total egg set & fertile eggs transferred basis, observed as 51.76 & 91.32; 55.43 & 93.08; 54.56 & 90.42; 10.48 & 34.95; 74.66 & 98.90 and 66.24 & 96.80% for corresponding breeds/ crossbreeds, were also far better than previous generation.
- Supplementation of synthetic form of essential amino acids like L-Lysine and DL-Methionine during starter stage can reduce the level of crude protein (CP) from the required level of 22% to 20% in the diet without affecting the growth and nutrient utilization.
- During grower stage the diet containing 12% CP can be fed to the Khaki Campbell ducks than the required level of 16% CP when the level of essential amino acids like L-Lysine and DL-Methionine were balanced with the diet containing 16% CP.
- In case of layer Khaki Campbell layer ducks it was observed that the level of CP in the diet can be reduced by 2% from the required level of 18% CP in the diet through supplementation of L-Lysine and DL-Methionine without affecting the egg production performance of the ducks.
- A total of 1117 ducks of different age groups died this year in experimental farm at Regional centre. The average mortality of duck found to be 2.40% as compared to last year (5.23%). Month wise highest mortality was in February, 2015 (580, 8.77%) and minimum mortality reported in May, 2014 (15, 0.466%). The mortality was mainly due to non-specific conditions and some other conditions viz. aflatoxicosis, bumble foot and colibacillosis. This year there was no death with predation, drowning and ascites. Age wise maximum mortality occurred in ducklings (661, 1.41%) followed by adult (305, 0.65%) and grower (151, 0.32%). Breed wise highest mortality occurred in white pekkin (653, 1.39%) followed by khaki Campbell (229, 0.5%), desi-pati (209, 0.44%) and Muscovy Moti (26, 0.05%). A total 4365 duck plague both grower and yearly booster vaccine and 7274 duck Pasturellosis vaccine were carried out.

Research Achievements

PRODUCTIVITY ENHANCEMENT OF SELECTED POULTRY SPECIES

GENETIC IMPROVEMENT OF QUAIL GERMPLASM

Breeding and research on Japanese Quail was stopped as per ICAR order No. AS/11/1/2013/ASR-II dated 26 June 2014 when the population of Japanese quail parent stock at Experimental Quail Farm was 7811. Subsequently since the maintenance of elite germplasm was permitted by ICAR vide order No. AS/11/1/2013/ASR-II dated 27 Feb. 2015; a total of 2649 fertile eggs of different quail germplasm were set for hatching. Further work on recording of economic traits and maintenance of the quail lines is underway.

Molecular markers are indispensable tools for determining the genetic variation and biodiversity with high levels of accuracy and reproducibility. Molecular markers were developed to differentiate domesticated Japanese and wild quails using mitochondrial and nuclear DNA. A partial fragment of mtDNA 12S rRNA gene (465bp) was amplified to screen for sequence variation between 8 avian species *viz.* Chicken (broiler), Desi fowl (Kadaknath), Japanese Quail, Wild Quail (Button Quail), Turkey, Guinea fowl, Emu and Peafowl using samples pooled from 6-8 birds in each. Analysis of 12S rRNA sequence between the species revealed that Synthetic broilers were more closely similar to Kadaknath (92.3%) followed by turkey and guinea fowl (91.4%); whereas Peafowl and Turkey were 88.9% similar. Wild Quail (Button quail) and domesticated Japanese quails have shown 24.1% sequence variation (only 73.9% similarity). Phylogenetic tree revealed that Japanese Quail and Wild Quail were far apart and situated in separate Clade. PCR-RFLP using Hph I displayed clear polymorphism aiding in species differentiation.

Next generation sequencing using Ion torrent sequencer for species specific microsatellite marker isolation with respect to Japanese and wild quails was carried out using nuclear DNA. Genomic DNA library prepared from Japanese and wild quails genome were enriched for STR regions and a large dataset of sequence reads was

generated. A total of sequences 2,33,963 sequences from Japanese and 7,03,447 sequences from wild quails were generated. About 50 primer pairs for each species (*viz.* Japanese and wild quails) were synthesized and tested in both species. In Japanese quail, 12 markers i.e. 24% were null alleles and failed to amplify, 6 markers (12%) were monomorphic, 12(24%) markers shown cross amplification in wild quails and the remaining 20 markers (40%) were polymorphic. In wild quails, 10 markers (20%) were null alleles 5 markers (10%) were monomorphic, 14 markers (28%) cross amplifiable in wild quails and the remaining 21 markers (42%) were polymorphic. In Japanese quail 4 out of 10 loci and 3 out of 9 loci in wild quail showed significant variation from HWE. PIC values from the means of the loci analyzed were 0.600 ± 0.16 and 0.511 ± 0.03 in Japanese and wild quails respectively. F_{IS} values were positive in only 2 loci in both the species whereas Shannon's Information Indices (I) was 1.167 ± 0.1179 and 0.9736 ± 0.166 in Japanese and wild quail, respectively. Thereby species specific microsatellite marker were developed for identification of quail species.

GENETIC IMPROVEMENT OF GUINEA FOWL VARIETIES

The guinea fowl-Pearl germplasms was exchanged between TANUVAS and CARI Izatnagar to evaluate them under different agro-climatic condition i.e. South, North and at high altitude. The experiment was carried out at the Poultry research station (PRS), Madhavaram, Chennai and Central Avian research institute (CARI), Izatnagar, Bareilly and IVRI, Mukteshwar. The birds were reared in deep litter system of management and performance parameters were are presented Table 1.

In IInd of generation 12 wks body weights in pearl, lavender, white and control were 1053.0, 970.0, 951.2 and 908.7 g respectively. FCR (0-12 Wks) and dressing% (at 12 wks) were 3.2 and 71.2% respectively in Pearl variety. Phenotypic gains for 12-week body weight over last 15 generations of selection (since 2000 onwards) in Pearl, Lavender and white varieties of guinea fowl

were 15.14±2.54**, 19.44±2.54** and 9.51±1.99 g/ respectively

Carcass traits evaluation: Sample of 40 birds of Pearl variety were slaughtered under standard procedures and different carcass traits were

recorded. The means are presented in Table 2. Females were reported to have higher means; however, further confirmation in future will be done.

Table 1: Body weight and reproductive traits of guinea fowl at different climate

Guinea fowl (Pearl)	Fertility (%)	Hatchability (%)	ASM(d)	Body wt.(12 wks)
CARI stock-at CARI	53.7	85.48	230	1053.0±3.86
CARI stock-at Chennai	53.7	85.48	153	766.05 12.55
CARI stock-at Mukteshwar	-	-	197	725±2.5
Chennai stock-at Chennai	-	-	150	750.00
Chennai stock-at CARI	75.8	88.19	166	672.98 10.05

Table 2: Carcass traits in guinea fowl at 12th week of age in pearl variety of Guinea fowl

Sex	Pre sl. wt. (g)	Def wt(g)	Evis. Wt.(g)	Giblet wt. (g)	Breast (g)	Thigh (g)	Drumstick (g)	Back (g)	Wings (g)	Neck(g)
Female (16)	975.6 ±17.2	829.3 ±26.8	702.06 ^a ±12.6	36.3 ±1.6	187.2 ±4.9	85.1 ±2.1	107.3 ±2.3	171.37 ^a ±3.6	101.21 ±2.2	43.0 ±3.4
Male (24)	936.8 ±14.0	808.5 ±32.8	665.25 ^b ±10.3	38.5 ±1.3	176.3 ±4.0	86.1 ±1.7	103.3 ±1.9	152.16 ^b ±3.0	95.25 ±1.8	44.5 ±2.7

Guinea fowl Gut Microbiom Analysis

For the first time, gut microbiome of Guinea fowl was analyzed using next generation sequencing of 16s hypervariable region, which revealed 0.0026% Archaea, 59.94% Bacteria, 8.65% Eukaryota and 31.17% Viruses. Total 32 species of *Lactobacillus* were isolated from crop of guinea fowl and characterized followed by the screening for their probiotic potency. A total of thirty two *Lactobacillus* isolates were characterized morphologically (Gram staining), physiologically and biochemically as well as by molecular methods. Probiotic properties were also assayed through different tests like aggregation test, resistance to bile salts and acidic conditions, enzymatic test (protease, phytase and lipase test), cell surface hydrophobicity, co-aggregation test, antagonistic test and antibiotic sensitivity test. *Lactobacillus* isolates showed significant difference among them for probiotic properties *in vitro*. Based on the results the isolates which scored highest points LGFCP4 and LGFP16 were sequenced and found to have 99% genetic identity with *L. plantarum* and *L. reuteri* respectively. Then, the lab isolated *L. plantarum* was put into *in-vivo* growth bioassay. 20% of daily ration for broilers and guinea fowl was fermented with 15% of broth culture having *L.plantarum*. A dose of 10⁸ cfu/kg feed of *L. plantarum* was used for fermentation.

The isolate showed better results for production, immunity and competitive exclusion against salmonella and *E.coli* in guinea fowl and broilers. Histomorphological analysis also revealed higher duodenal villi height and crypt depth and villi height: crypt depth ratio indicating better absorbability of nutrients

CONSERVATION AND UTILIZATION OF INDIGENOUS CHICKEN

Multiplication and reproduction performance of the various breeds:

A total of 2718 purebred chicks comprising of 536 Aseel Peela, 438 Nicobari, 254 Kadaknath, 513 Ankaleshwar, 678 Aseel Kagar and 299 major gene pool line were hatched brooded and being reared. Details of reproductive traits of different pure breeds/lines has been presented in Table 3. Highest fertility of 78.47% was observed in major gene pool line followed by Ankaleshwar (78.06%) and Nicobari (73.21%). Similar trend was observed on hatchability on TES but on FES.

Production and supply of different genotypes to different organizations and Farmers:

A total of 7932 chicks of different crosses (CARI Nirbheek, HITCARI, CARI Shym and UPCARI) were supplied to different organizations for rural poultry production.

Table 3: Details of reproductive traits of different pure breeds/lines

Breed	Good Chicks	Fertility %	Hatchability	
			TES%	FES%
Aseel Kagar	678	71.74	61.34	85.50
Gene pool Line	299	78.47	68.16	86.85
Nicobari	438	73.21	58.12	79.39
Ankaleshwar	513	78.06	71.58	91.69
Kadaknath	254	65.34	53.86	82.42
Aseel Peela	536	62.26	51.71	84.58
Fz WLH	746	84.52	69.04	81.69
NN WLH	553	87.56	69.08	78.90
Total	4017	75.20	62.72	83.40

DIALLEL EXPERIMENT

A complete 3x3 diallel cross experiment using Aseel peela (AP), Kadaknath (KN) and CARI-Red (CR) was undertaken to evaluate efficiency of pure and cross breeding performance with respect to Juvenile body weight, conformation traits, body weight gain, carcass quality traits and immunocompetence traits at the Age of 0-20 weeks of age. A total of 1298 good chicks were obtained in single hatch comprising 213, 143, 189, 102, 98, 135, 104, 134 and 181 for crosses of APxAP, CRxAP, KNxAP, APxCR, CRxCR, KNxCR, APxKN, CRxKN, KNxKN, respectively. From this population, 720 birds were chosen randomly (80 birds on each group) for the data recording. Griffing (1956) and Hyman (1954) methods were used for combining ability analysis.

(A) Juvenile growth parameters (0-20 week of age): Analysis of variance reveals significant difference between mating system and among genetic groups for body weight, conformation traits, body weight gain, various carcass quality traits but for immunocompetence traits difference was observed only among genetic groups. Among purebreds CR had highest body weight at all the ages whereas, among the crossbreds AP x CR revealed higher body weight. CR as female line and AP as male line appears to be the most elite cross among the cross bred studied. Crossbreds in general were heavier than pure breeds and had higher shank length, keel length and breast angle than purebred at all ages of measurement irrespective of sex. Among purebreds, CR had lowest (4.23) FCR (0-20 wk) followed by AP (4.67) and KN (4.77). Whereas in case of crossbred cross

CR x KN recorded lowest values (4.69) and AP x KN and the highest (5.39).

Among the purebred lowest mortality percentage was observed in CR (8.75%) and among the crossbred mortality was lowest in CR x AP (1.25%). Most of crossbred had lower mortality than the purebred groups showing heterosis for this trait. No significant difference was observed between crossbred and purebred for carcass quality and immune organ weight at irrespective of sex. Among the purebred, CR and among the cross bred, cross KNxCR had highest CMI (Foot web index). Among the purebred, CR and among the cross bred, cross CRxAP had higher humoral immune response against NDV.

GCA and SCA: Analysis of variance for body weight, conformation traits, body weight gain, immune organ weight and immunocompetence trait revealed significant difference for general combining ability at all ages in model A and B. In case of model B the GCA value are similar to GCA value of model A.

Specific combining ability (SCA) variance for body weight and conformation traits were highly significant under model A and B. It was also seen that GCA variance was more than the SCA variance showing that additive genetic effect was more importance than non-additive genetic effect in the inheritance of these traits. However, SCA variance in case of body weight gain, immune organ weight and Immunocompetence traits were not unidirectional.

Analysis of variance for reciprocal effect revealed significant effect on body weight in case of both the models A and B; and only in Model A for conformation traits, body weight gain, carcass quality traits, immune organ, and immunocompetence trait (humoral immune response against NDV).

Cross KNxAP had highest and positive value of heterosis percentage for body weight at all ages of measurement except at 0 and 2 wk of age irrespective of sex. Negative value of heterosis percentage for FCR and mortality percentage clearly shows that crossbreds were superior to pure bred. Both GCA and SCA were equally important for different economic traits which indicated that the improvement of cross bred may be brought about by modified RRS method.

(B) The post-juvenile study (20-40 weeks of age): The various economic traits viz. bi-weekly

body weight, weight gain; four weekly shank, keel lengths and breast angle, feed efficiency from 20th to 40th weeks of age, annual egg production from 20th to 72nd weeks of age and egg quality at 40th week of age were studied for nine genetic groups under diallel cross. The results revealed that crossbreds were superior to purebreds for various growth, body conformation, egg production and feed efficiency traits except egg quality traits. Among purebreds CARI Red males weighed significantly ($P \leq 0.05$) heavier than the males of Aseel and Kadaknath at 20th week of age (Table 4). Average 72nd week body weight in CARI Red females were significantly ($P \leq 0.05$) higher than Aseel females.

Table 4: Means and standard errors of different genetic groups for body weights

Crosses	Body wt (g) at		
	20 wks	40 wks	72 wks
Purebred crosses			
A × A	1405.68 ±1374 ^e	1664.44 ±1536 ^e	2019.83 ±1733 ^d
K × K	1025.46 ±18.11 ^a	1217.21 ±1761 ^a	1508.31 ±1765 ^a
C × C	1405.64 ±1236 ^e	1668.88 ±1070 ^e	2088.76 ±1199 ^e
Crosses			
A × K	1276.97 ±16.15 ^{cd}	1563.72 ±1490 ^{cd}	1940.72 ±1451 ^c
A × C	1454.43 ±1378 ^e	1774.46 ±1297 ^f	2162.39 ±1497 ^f
K × C	1199.60 ±1289 ^b	1472.24 ±1409 ^b	1844.64 ±1630 ^b
Reciprocal crosses			
K × A	1322.04 ±9.62 ^d	1616.45 ±1197 ^{de}	1979.30 ±1280 ^{cd}
C × A	1428.00 ±139 ^e	1743.95 ±1428 ^f	2089.92 ±1462 ^e
C × K	1252.32 ±1358 ^{bc}	1530.70 ±1352 ^{bc}	1865.55 ±1559 ^b

Effects bearing different superscripts across the column differ significantly ($P \leq 0.05$)

Crossbreds of all genetic groups weighed heavier than their counterpart purebreds at all ages. Among six crossbred groups, male of AP×CR recorded highest body weight from 20th to 40th week of age. Crossbreds KN×CR and CR×KN weighed lowest at all ages.

Study of body conformation traits *viz.* shank, keel length and breast angle indicated significant difference ($P \leq 0.01$) between genetic groups for both the sexes at all ages; male recorded longer

shank and keel bones, wider breast than females at all the ages. The mean shank length and breast angle of Aseel Peela were significantly ($P \leq 0.05$) higher than CARI Red and Kadaknath from 20th to 40th week of age. Keel length was higher in CARI Red. In general, the shank, keel length and breast angle of all the crossbreds were significantly ($P \leq 0.01$) more than the purebreds. Among crossbred, the mean shank, keel length and breast angle of cross AP × CR and its reciprocal were higher in both sexes than those of other crossbred from 20th to 40th week of age.

CARI Red pullets attained the sexual maturity at the earliest (179 days) followed by Kadaknath (194 days) and Aseel Peela (195 days). Significant differences ($P \leq 0.01$) were observed for age at sexual maturity among various pure and crossbreds. AP×CR crossbred pullets matured the earliest (167.1 days) as compared to other crossbreds (Table 5).

Table 5: Means and standard errors of different genetic groups for ASM, egg production and egg weight

Crosses	ASM (days)	Egg production (Nos.) at		Egg wt. (gm) at 40 wks
		40 wks	72 wks	
Purebred crosses				
A × A	19558 ±3.33 ^d	44.34 ±2.68 ^a	15740 ±4.78 ^a	45.69 ±0.73 ^b
K × K	19462 ±3.06 ^d	51.68 ±2.49 ^a	16626 ±5.78 ^a	41.83 ±0.59 ^a
C × C	17983 ±6.03 ^{bc}	63.75 ±5.62 ^b	20288 ±8.87 ^b	54.33 ±0.90 ^e
Crosses				
A × K	17277 ±3.00 ^{ab}	81.67 ±2.98 ^e	19946 ±6.33 ^b	47.44 ±0.72 ^{ab}
A × C	16712 ±3.07 ^a	78.00 ±5.76 ^{de}	22219 ±8.14 ^c	47.18 ±0.69 ^{ab}
K × C	17834 ±3.10 ^{bc}	75.71 ±3.54 ^{cd}	22576 ±4.62 ^c	47.87 ±0.55 ^c
Reciprocal crosses				
K × A	17724 ±2.63 ^{abc}	73.46 ±2.50 ^{bcd}	20284 ±4.82 ^b	45.33 ±0.51 ^b
C × A	17281 ±2.43 ^{ab}	70.96 ±2.96 ^{bcd}	20458 ±5.35 ^b	50.39 ±0.88 ^d
C × K	18362 ±2.97 ^c	67.07 ±2.71 ^{bc}	21444 ±4.77 ^{bc}	51.46 ±0.78 ^d

Means bearing different superscripts in a column differ significantly ($P \leq 0.05$)

Significant difference ($P \leq 0.01$) between genetic groups for annual egg production (AEP) was observed with highest annual egg production being in CARI Red purebred. The mean annual

egg production in various crossbreds varied from 199.46 to 225.76 eggs. Crossbreds had higher AEP than purebreds which indicated the evidence of heterotic effect in egg production. Various egg quality traits except yolk index differed significantly among all nine genetic groups. Among purebreds, CARI Red recorded the highest value for egg size, shell thickness, shell weight and albumen weight followed by Aseel and Kadaknath. Kadaknath recorded higher value for shape index as compared to other purebreds. Both native purebreds (AP and KN) recorded higher values for albumen index and Haugh unit score than CARI-Red. Mating system, however did not affect egg quality traits.

Among purebreds, CARI Red was found to be most feed efficient per kg eggs mass and feed consumption per dozen eggs while cross KN×CR were found to be most efficient among crossbreds. Crosses of Kadaknath were found to be superior to crosses of Aseel for feed conversion efficiency.

Heterosis % for body weight, shank length, keel length, breast angle, age at sexual maturity and annual egg production ranged from -1.31 to 18.05, -2.16 to 4.77, -0.18 to 8.22, 0.12 to 5.41, -1.93 to -11.45, 13.57 to 25.34, respectively. Highest (positive) heterosis was found in egg production traits as compared to growth traits which indicated the possibility of improving the laying performance of indigenous fowl by cross breeding.

The direct cross AP×KN males exhibited higher magnitude of heterosis for body weight among crossbred males. However, reciprocal cross KN×AP females showed higher magnitude of heterosis. It indicated the presence of maternal/sex-linked effect for body weight. Negative heterosis was recorded for age at sexual maturity in all crosses. The reciprocal crosses KN×AP exhibited the highest magnitude of heterosis (25.34%) followed by direct cross AP×CR (23.34%) for annual egg production. Heterosis in egg quality traits ranged from -10.84 to 11.51 per cent.

Estimates of GCA, SCA, and reciprocal effects have been presented in Tables 6, 7 and 8 respectively. Significant GCA, SCA, reciprocal and sex-linked/maternal effects were found for growth and egg production traits. GCA was more important as compared to SCA for inheritance of body weight and body weight gain, body conformation traits and various egg quality traits. For the inheritance of age at sexual maturity and yolk index SCA was found more important. Both GCA and SCA played important role for the inheritance of annual egg production. Significant GCA and SCA suggested that the improvement of crossbred may be brought about by modified RRS method of selection. Model A (Griffing's model) was adjudged better over model B (Hayman's model).

Table 6: Mean squares from combining ability analysis for economic traits

Source of Variation	d.f.	ASM (days)	Body wt (g) at			Egg No. at		Egg wt. at 40 wks
			20wk	40wk	72 wk	40wk	72wk	
G.C.A	2	65.51**	702632**	988288**	130126.2**	30.4*	7532**	41.4**
S.C.A	3	19283**	2491.5**	8548.1**	12985.8**	3566**	8739**	4.1**
Reciprocals	3	13.36	9182	1188.1*	1196.4	31.9*	74.9	4.6**
Error	-	10.42	3823	409.4	466.4	10	31.6	0.506

**Significant at $p \leq 0.01$, *significant at $p \leq 0.05$.

Table 7: Estimates of general combining ability effects

Purebreds	ASM (days)	Body wt (g) at			Egg No. at		Egg Weight (gm) at 40 wks
		20 wks	40 wks	72 wks	40 wks	72 wks	
AA	-0.03	74.34	87.68	90.95	-1.94	-0.12	-0.993
KK	3.32	-124.15	-147.31	-169.91	-0.53	-0.03	-1.986
CC	-3.29	49.81	59.62	78.96	2.47	0.15	2.979
SE (g _i)	1.08	6.56	6.79	7.19	1.06	1.88	0.24
SE (g _i -g _j)	1.86	11.36	11.76	12.47	1.83	3.25	0.41

Table 8: Estimates of specific combining ability and reciprocal effects

Purebreds	ASM (days)	Body wt (g) at			Egg No. at		Egg Weight (gm) at 40 wks
		20 wks	40 wks	72 wks	40 wks	72 wks	
SCA effects							
AK	-8.5	41.53	66.15	94.58	12.63	3.93	1.418
AC	-6.93	9.27	28.34	11.87	6.55	1.13	-1.147
KC	0.74	-7.49	5.59	1.67	2.04	1.21	0.726
SE (\bar{s})	1.70	10.37	10.73	11.38	1.67	2.97	0.38
SE (\bar{s}_{j-ijk})	2.64	16.07	16.63	17.63	2.58	4.59	0.59
Reciprocal effects							
r_{12}	-2.23	-22.53	-26.36	-19.29	4.11	1.5	1.054
r_{13}	-2.85	13.21	15.26	36.24	3.52	-0.27	-1.606
r_{23}	-2.64	-26.36	-29.23	-10.46	4.32	0.43	-1.794
SE ($\bar{\pi}$)	2.28	13.92	14.40	15.27	2.24	3.98	0.51
SE ($\bar{\pi}_{j-ijk}$)	3.23	19.68	20.36	21.59	3.17	5.62	0.72

Mathematical function for explaining growth and cumulative AEP curves:

Various non-linear mathematical function *viz.* Exponential, Gompertz, Monomolecular, Logistic and Modified logistic were tested to choose the best fitted mathematical function for growth and cumulative AEP curves. Data recorded on biweekly body weights from day old to 40th week of age for pure and crossbreds of males and females were used for analyzing growth curve and for egg production curves data on four weekly cumulative egg production from 20th to 72nd weeks of age for pure and crossbreds was used. On the basis of the measures of goodness of fit *viz.* MSE, MAE and AIC and higher adjusted R², Gompertz model was found to be the best fit mathematical function for explaining the pattern of growth curve and cumulative annual egg production curve for each nine genetic groups of chickens under study.

GENETIC IMPROVEMENT OF SYNTHETIC BROILER LINES

Synthetic Broiler Sire Line

So far, twelve 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 3190, 5152 and 1015 eggs were set in SML, CSML and control, out of which 2370, 2515 and 701 good chicks were produced in respective lines. Corresponding fertility percentages were 80.32, 83.89 and 80.1.

Hatchability percentages on TES and FES were 72.44 & 90.15, respectively in SML, 75.45 & 89.95, respectively in CSML and 69.75 & 87.08 in control.

Body weights at different ages: Overall average of body weight of mixed sexes at 5 weeks in SML, CSML and control were 1156.66 3.74, 1194.692 4.26 and 753.24±4.68 g, respectively. The phenotypic and genetic responses to selection for 5-week body weight in SML were 13.44**±1.64 and 11.21*±1.79 g/generation. The phenotypic response for 5-week body weight in the control population was non-significant (2.22±1.14 g/ generation).

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

Synthetic Broiler Dam Line

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

Incubation and Hatchability: A total of 4169 and 3367 eggs were in CSFL and SDL, respectively out of which 3283 and 2515 good chicks were hatched out in respective line. The fertility percentage was 87.67 and hatchability percentage based on TES and FES were 79.40 and 90.56, respectively in CSFL. Corresponding values in SDL were 84.7, 76.03 and 89.76 percent, respectively.

Body weights at different ages: The overall average of body weight at 5 weeks in CSFL and

SDL were 1188.87 ± 5.95 (till first hatch) and 1149.69 ± 3.27 g. The phenotypic and genetic responses to selection for 5-week body weight in SDL were observed as 13.09 ± 2.41** and genetic response as 10.87 ± 2.39** g/generation.

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

Random sample performance test: At 41st RSPPT (Gurgaon) CARIBRO-Vishal secured IV rank. Body weight at 6-weeks and 7-weeks were 1.28 and 1.52 Kg, respectively. FCR (0-6 Wks),

mortality and dressing percentage were 2.2, 6 and 71.9 percent, respectively. Margin of receipt at 6-weeks was Rs 8.4/bird.

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 coloured and control have been presented in Table 9.

Table 9: Reproductive performances in different broiler strains

Strain	Total Egg	Fertility%	Killed	Good Chicks	H% (TES)	H% (FES)
IR3	1633	86.71	9	1237	76.30	87.99
IC3	1365	85.42	11	1031	76.34	89.37
NNC	1947	82.85	9	1348	69.70	84.13
Tropicana	1081	72.62	9	528	49.68	68.41

Body weights: The mean body weight at 5-week of age in IR-3, IC-3, CARIBRO-Tropicana and Naked neck coloured were 1161.52 ± 4.31, 974.09 ± 3.39, 1028.31 ± 8.23, 1179.50 ± 49 g, respectively.

CONSERVATION OF ELITE LAYER STOCK

Pure part-period production strains: Data on various layer economic traits, viz, age of sexual maturity (ASM), body weight at 16 (BW16) and 40 (BW40) weeks of age, egg weight at 28 (EW28) and 40 (EW40) weeks of age and egg number up to 40 weeks of age (EN40) were recorded on IWG (n=309) and IWJ (n=331) part-period production strains and analyzed using mixed model least-squares (LS) analysis of variance. In IWG strain, LS means of corresponding traits were 135.75 ± 0.99 days, 984.56 ± 9.56 g, 1485.02 ± 13.10 g, 45.14 ± 0.24 g, 50.41 ± 0.275g and 120.35 ± 1.61 eggs. The influence of sire was significant on all the traits except for BW40. Hatch effect was significant on housing body weight i.e. BW16, which was higher in females of first hatch. The heritability estimates of respective traits were 0.183 ± 0.16, 0.257 ± 0.165, 0.101 ± 0.16, 0.559 ± 0.23, 0.223 ± 0.18 and 0.419 ± 0.21.

In IWJ strain, the LS means of ASM, BW16, BW40, EW28, EW40 and EN40 were 139.90 ± 0.77 days, 893.04 ± 8.03g, 1343.60 ± 12.13g, 42.11 ± 0.19g, 46.35 ± 0.21g and 110.56 ± 1.33 eggs, respectively. Significant effect of sire on BW16 and BW40 was

found, whereas, hatch had significant effect on ASM, EW28 and EN40. The heritability estimates of respective traits were 0.258 ± 0.158, 0.053 ± 0.137, 0.260 ± 0.19, 0.066 ± 0.15, 0.147 ± 0.18 and 0.020 ± 0.15, respectively.

Pure annual production strains: The pure annual production strains, IWH and IWI were regenerated with 546 and 693 chicks, respectively with average fertility of 78.7 and 84.1%. Data on various layer economic 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 were recorded and analyzed using mixed model least-squares (LS) analysis of variance. In IWH (n=194), the effects of sire and hatch were significant on all the traits except for hatch effect on BW40. The LS means of respective traits were 138.03 ± 1.75, 865.45 ± 10.80, 1344.57 ± 13.86, 46.32 ± 0.44, 51.00 ± 0.53, 121.27 ± 1.726, respectively. The heritability estimates of corresponding traits were 0.773 ± 0.305, 0.609 ± 0.279, 0.252 ± 0.207, 0.614 ± 0.280, 0.825 ± 0.313 and 0.257 ± 0.208. In IWI (n=228), the effects of sire and hatch were significant on all the traits except for hatch effect on ASM, BW40 and EW40. The LS means of corresponding traits were 137.10 ± 1.37, 880.068 ± 8.98, 1355.32 ± 13.96, 48.01 ± 0.51, 51.97 ± 0.38, 119.56 ± 1.95, respectively with respective estimates

of heritability as 0.400 ± 0.220 , 0.554 ± 0.252 , 0.425 ± 0.225 , 1.010 ± 0.327 , 0.253 ± 0.186 , 0.687 ± 0.277 .

GENETIC IMPROVEMENT OF RHODE ISLAND RED

Reproductive Performance of RIR strains: In 31st generation of RIRs and RIRc, a total of 5506 and 2310 nos, respectively, eggs were set. Corresponding fertility% ranged from 84.4 to 87.7 and 87.7 to 94.6, respectively. The hatchability on fertile eggs transferred basis was 83.7 to 88.6 and 85.7 to 93.2% in RIRs and RIRc, respectively, which was similar to the previous generation.

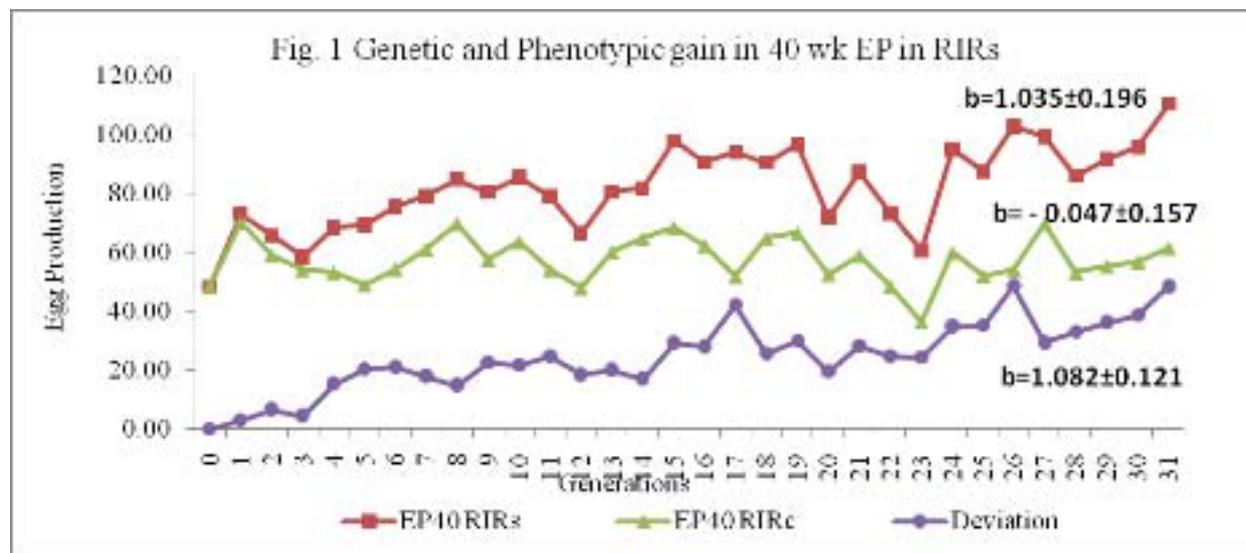
Production performance of RIR strains: In 31st generation, ASM, body weight at 20 and 40 week of age; egg weight at 28th and 40th week of age & egg number up to 40-week in RIRs was 132.45 ± 0.26 d, 1417.4 ± 3.76 g, 1721.4 ± 5.93 g, 43.42 ± 0.08 g, 50.93 ± 0.09 and 110.14 ± 0.60 nos, respectively. The corresponding values for RIRc were 167.61 ± 1.12 d, 1172.9 ± 6.96 g, 1552.9 ± 10.31 g, 42.53 ± 0.13 g, 49.44 ± 0.15 and 61.57 ± 0.97 nos, respectively. The colour of the eggs were compared by assigning numerical values (0-pure

white, 1-low brown, 2-medium brown, 3-deep brown) and the values for RIRs and RIRc at 40th week were 1.86 ± 0.018 and 2.44 ± 0.026 , respectively.

The phenotypic and genetic responses per generation for ASM, body weight at 20th and 40th weeks, EW 40, EN 40 have been presented in Table 10 & Fig. 1. Most of the traits exhibited significant responses in selected strain, whereas, in control the responses were non-significant.

Table 10: Genetic and Phenotypic response in RIR pure strain and control population during S₃₁ generation (2014-15)

Traits	RIRs		RIRc
	Phenotypic response	Genetic response	
BW at 20 th wk	9.07 2.92**	9.91 $\pm 1.60^{**}$	-0.115 ± 2.33
BW at 40 th wk	-8.83 2.27**	7.57 $\pm 1.50^{**}$	-16.402 $\pm 2.418^{**}$
ASM	-1.016 0.246**	-0.70 $\pm 0.17^{**}$	-0.316 ± 0.208
EW at 40 th wk	0.080 0.047	0.083 $\pm 0.017^{**}$	0.003 ± 0.042
EP at TO 40 th	1.035 ± 0.196	1.082 $\pm 0.121^{**}$	-0.047 ± 0.149



Annual egg production in RIR pure lines: The body weight, egg production and egg weight in RIRs line at 64 and 72 weeks of age were 1933.1 ± 23.4 g, 211.0 ± 5.1 nos, 53.2 ± 0.38 g and 2001.4 ± 27.6 g, 243.6 ± 2.4 nos and 53.4 ± 0.4 g, respectively. The corresponding values for RIRc line were 1683.5 ± 43.1 g, 141.3 ± 4.6 nos, 50.2 ± 0.82 g and 1858.4 ± 55.6 g, 196.8 ± 6.8 nos and 51.6 ± 1.01 g, respectively.

Performance of RIR crosses: The fertility, hatchability % on total eggs set basis and hatchability % on fertile eggs transferred basis in RIR crosses like CARI DEBENDRA (CD) and CARI Sonali (HR) was in the range of 86.1, 80.3, 93.2% and 86.5, 79.1, 91.4%, respectively. The ASM, 20th wk, 40th wk and 64 wk body weight of CARI Debendra and CARI Sonali were 171.0 ± 1.36 d, 1860.8 ± 26.6 g, 2326.4 ± 25.1 g and 2905.7 ± 42.1 g and 141.0 ± 1.07 d, 1369.5 ± 13.96 g, 1551.1 ± 20.56 g

and 1819.6±26.23g, respectively. The egg production at 40th and 64 wk, egg weight (g) at 28th, 40th and 64 wk CARI Debendra and CARI Sonali were 85.2±1.44 nos, 179.5±3.52 nos, 49.0±0.40, 55.2±0.45 and 63.4±0.52 and 118.0±1.55, 248.0±2.19, 46.4±0.31, 50.0±0.34 and 57.5±0.41, respectively.

Immunocompetence and microsatellite profiling in RIR

Analysis of immunocompetence (IC) and layer economic traits, microsatellite (MS) profiling of egg production-associated and TLR4 expression/ disease resistance associated MS loci, to determine associations between MS alleles/genotypes with layer economic traits/ TLR4 gene expression and candidate gene expression of selected immunity related genes was undertaken in RIR. LS means of HA, Lysozyme, IgG, BW16, EW28, EW40, EW64, EN40 and EN64 were 9.33±0.34, 4.42±0.18µg/ml, 8.72±0.41mg/ml, 1220.60±21.57g, 44.73±0.34g, 47.62±0.41g, 51.89±0.81g, 118.11±1.21eggs and 219.39±4.09 eggs, respectively in RIR females. The h² estimates for respective traits were 0.414±0.38, 0.109±0.48, 0.535±0.40, 0.245±0.49, 0.211±0.49, 0.922±0.53, 1.027±0.53 and 0.351±0.50, respectively.

Microsatellite profiling of four loci, ADL0149, HUIJ0002, MCW0330 and ADL0293, closely linked to TLR4 gene revealed a total 14 alleles (average 3.50±0.29). Nei's heterozygosity, Na and Ne number of alleles and Shannon's index were 0.6413±0.034, 3.500±0.289, 2.8620±0.266 and 1.1199±0.065. Ho and He were 0.3462±0.065 and 0.6463±0.034, respectively. Chi-square test and likelihood ratio test revealed that the population was in Hardy-Weinberg disequilibrium. Significant differences among genotypes at MCW0330 were observed in TLR4 gene expression in bursa; higher expression in DD and CC genotypes

No. of alleles at 10 microsatellite loci, linked to egg production traits, viz., ADL0020, ADL0023, ADL0102, ADL0176, ADL0210, MCW007, MCW0014, MCW0041, MCW0069 and MCW0103 were observed to be 4, 3, 3, 4, 2, 3, 2, 1, 6 and 2 alleles, respectively. Mean percent heterozygosity and PIC were 0.4119±0.2475 and 0.313±0.064. Various population statistics were estimated. Chi-square (χ²) and likelihood ratio (G-square) were also estimated.

Least Squares ANOVA revealed that birds with low IgG concentration showed higher BW40 and BW64 and Birds with highest lysozyme concentration produced had higher EN64. Molecular breeding by setting up the ADL176 genotype based mating was initiated and in S1 generation, HA, Lysozyme and IgG were recorded and analysed

Basal mRNA expression of IL1-beta gene in three lymphoid tissues, thymus, spleen and bursa, of RIR selected strain was estimated through RT-qPCR. Molecular breeding by setting up the ADL176 genotype based mating was initiated and in S1 generation, means for HA, Lysozyme and IgG were 9.40 0.22, 5.08±0.12 (µg/ml) and 7.15±0.50 (mg/ml), respectively. Egg production in 120 females, DNA samples collection and recording of IC traits is in progress.

Poultry Waste Management

Facilities for poultry waste composting and bio-gas production were generated. Four iron-made mini-composters and laboratory model of anaerobic compost for bio-gas production with 20 and 200 lit. capacities were generated. C:N ratio, TS%, VS% and N% of 30 raw poultry waste samples from deep litter and cage rearing were 17.89, 61.37, 65.92, 2.16 and 11.78, 30.44, 61.56, 3.14, respectively. Total Bacterial counts (Log₁₀) of raw poultry waste samples (09) from Cage System and 06 samples from Deep Litter system were 9.50 and 7.47, respectively. Corresponding values for *E. coli* counts were 6.00 and 4.38.

NUTRIENT MANAGEMENT

NUTRITION FOR HEALTH AND WELFARE

- In order to mitigate heat stress of broiler chickens through dietary approaches, aspirin (0, 250 and 500mg/kg) and magnesium sulphate (@ 0, 1.2 or 2.4 g/kg) were tested each at three supplementary levels in starter diets (21.44% CP and 2839 kcal ME/kg) during 14-21 days of age and finisher (19.75% CP and 2891 kcal ME/kg) diets for 21-42 days of age during dry hot (April-May, 31.0±0.7°C to 37.0±1.4°C, RH, %: 58.0±1.3-70.1±0.6) or hot humid (Aug.-Sept., 26.0±0.1-34.2±0.36°C, Rh, %: 76.3±0.9-86.1±0.1) summer. Dietary supplementation of aspirin was beneficial to improve feed conversion efficiency significantly during

overall growth phase (0-6 weeks of age). There was marked improvement in haematological profile, total protein, cost economics, total cholesterol, AST and ALT levels on addition of aspirin at any level during hot and hot humid summer. Aspirin at 500 mg/kg in diet down regulated relative expression of HSP70 in jejunum at 28th day during hot and hot-humid summer. Thus the adverse effects on growth, feed conversion and immunity caused by high ambient temperature during extreme summer (hot and hot-humid) was partially curbed by addition of 500 mg/kg aspirin in diet. Similarly, addition of magnesium sulphate @ 1.2 or 2.4 g/kg to basal diets significantly improved body weight, feed conversion, immune response, cost economics and other welfare parameters during both hot and hot-humid summer but results were more encouraging at level 2.4 g/kg, that too during hot-humid summer. Additional magnesium sulphate at any level down regulated expression of HSP70 in jejunum of birds.

- In spite of great role in hindering poultry production, Mycotoxins such as ochratoxin A (OTA) has received less attention compared to aflatoxins. Since it is produced mainly by *Aspergillus ochraceus* and *Penicillium verrucosum*, thus it is a natural contaminant of animal feedstuffs. It is, therefore, imperative to evaluate the tolerance level of this mycotoxin in diet. Accordingly, in the present study, the effect of varying levels of ochratoxin A (OTA) in the diet of broiler chickens was investigated. Day-old broiler chicks (200) were divided into 5 treatment groups (T1- control; T2 - T1 + 100 ppb OTA; T3 - T1 + 200 ppb OTA; T4 - T1 + 300 ppb OTA; and T5 - T1 + 400 ppb OTA. Each diet was fed to 4 replicated groups of 10 birds each from day-old to 42 days of age. During overall growth period (0-6 weeks), body weight gain (BWG) in T3, T4 and T5 was significantly lower than that of control group, whereas, the BWG of group T2 was statistically similar to that of control. OTA contamination at 200 ppb or higher resulted in significant reduction in BWG of broiler chickens. The overall feed intake (FI) in T5 was significantly lower than that of control group (T1). The FI in groups T2, T3 and T4 was statistically similar to that of control. OTA

contamination at 200 ppb or higher resulted in poor FCR and thus deteriorating feed utilization efficiency in broilers. OTA at 200 ppb or at higher level resulted in increased mortality. Addition of 100 ppb OTA in diet did not produce any change in relative weights of liver, kidney and bursa of Fabricius, however, OTA contamination at 200 ppb or higher resulted in increased relative weights of liver and kidney; and reduced relative weight of bursa of Fabricius. Inclusion of 100 ppb OTA in diet did not produce any change in biochemical parameters of broiler chickens also. It was concluded that ochratoxin A up to 100 ppb in diet had no adverse effect on growth performance, organ weight and certain biochemical parameters in broiler chicken.

- In another experiment, the tolerance level of ochratoxin was verified once again taking various levels (0, 100, 150 and 200 ppb) on the same diet and under similar conditions. The tolerance level was found to be 100 ppb as observed in earlier experiment.

VALUE ADDITION OF EGGS THROUGH DIETARY APPROACHES

The demand of designer eggs with high nutrient value and low cholesterol is increasing specially in health conscious society. In present study, the effect of dietary addition of coriander seed powder (CSP) the coriander seed powder (CSP) has been reported to decrease serum cholesterol in humans. The effect of dietary addition of coriander seed powder (CSP) on production performance, egg quality traits, egg sensory attributes, egg yolk cholesterol, serum lipid profile, serum glucose, liver cholesterol, caecal microbial population and feed cost per kg egg production was investigated in laying Japanese quails. The experiment was conducted on 80 laying quails following Completely Randomised Design (CRD) wherein CSP was fed to laying quails at four dietary levels (0, 1, 2 and 3%). The results revealed that the production parameters and egg quality traits of laying quails did not alter due to different dietary treatments. The egg yolk cholesterol gradually decreased over control group. Diet having 3.0% coriander seed powder recorded highest reduction in egg yolk cholesterol i.e. 15.67%. The hypocholesterolemic

effect of CSP was also evident on various lipid components of serum and liver cholesterol in laying quails. The effect on caecal microbial count found that reduced TVC highly significantly, Coliform count and *E.coli* significantly and had no significantly alter the count of *Lactobacilli*. It was concluded that dietary addition of coriander seed powder @ 3.0% was beneficial in reducing serum and egg yolk cholesterol and caecal microbial count in Japanese quails.

- Essential oils are being established as promising alternate to antibiotics for gut health promotion. Beal leaves are potent source of essential oils. Thus beal leaves were dried at 35°C under shed and tested in broiler chickens (n=336, 0-42d of age) through dietary rout at different levels (0, 0.5%, 1.0%, 1.5% and 2.0%). Another diet was prepared by adding antibiotics (BMD) in control diet. Each diet was offered to 7 replicated groups. The body weight gain did not differ significantly (P>0.05) but FCR during 0-6 weeks of age were better in groups fed with Beal leaves powder (BLP) than control or antibiotic groups. The weight of thymus and Bursa increased significantly (P < 0.05) in the BPL fed group compared to control or antibiotic treated group but weight of abdominal fat-pad decreased (P<0.05) linearly with increased level of Beal leaves Powder in feed. Serum triglyceride level did not differ but total protein increased (P<0.05) in 1, 1.5 and 2.0% BLP fed groups compared to control (T1). There were reduction (P<0.01) in blood cholesterol, ALT, AST, creatinine and uric levels in BLP fed groups at 42 d. Total antibody response to SRBC increased (P<0.01) in 1.5% and 2.0% BLP fed groups, while values remained similar in other groups. Though the values of total plate count and *Escherichia coli* count differed significantly among the groups (P<0.01) but no clear cut trend was observed. However, values of both the parameters were lower at 0.5% level in comparison to control. However, there was no difference was observed in *Lactobacillus* or coliform count among all the groups. So, it can be concluded that supplementation of 0.5% of beal leaves powder was effective in reducing total plate count as well as *Escherichia coli* count, however, welfare of birds (in terms of blood

biochemistry, immunity, fat pad and FCR) improved with linear increase of Beal leave powder to 1 to 2.0% level.

EXPANDING FEED RESOURCES AND IMPROVING NUTRIENT EXTRACTION FROM BIOMASS

- Maize and soybean, are the major source of energy and protein and their cost determines poultry feed cost. Among alternate feed, the rice based dried distillery gain with soluble (DDGS) is available in large quantities at cheaper price in India but is underutilized. DDGS contain high protein (45-52%) and high energy, rich in sulphur containing amino acids but deficient in lysine. The feeding value (nutritive value and safe level of inclusion) of DDGS was established in a six weeks biological trial conducted in broiler chickens involving five levels (0, 2.5, 5, 7.5 and 10%), with or without supplemental commercial protease. The body weight gain increased significantly (P<0.01) during 0-3 weeks at levels 5% or more. However, body weight gains did not differ statistically during 0-6 weeks of age but remained higher in DDGS incorporated diets. Feed intake, FCR, carcass traits (eviscerated and total meat yield), yield of visceral and immune organs, cut-up parts, abdominal fat pad and cellular immunity did not differ due to inclusion of DDGS in diet at any level. Commercial protease supplementation was beneficial to improve FCR significantly during 3-6 and 0-6 weeks of age. Feed-cost per kg of weight gain showed a significant reduction up to 10% DDGS in diet and due to inclusion of protease. It was concluded that the addition of DDGS up to 10% level did not exert any adverse effect on growth, FCR, carcass traits and development of immune organs of broiler chickens and thus could safely be included up to 10% level for profitable broiler production. Moreover, irrespective of source of protein commercial protease incorporation in diet was beneficial for improved feed utilization and reduction of feed-cost.
- A study was conducted to assess the effect of dietary inclusion of high protein roasted guar korma (RGK, 53.72% protein on DM basis) involving 200 broiler (CARBRO Vishal) chicks

during 0-42 days of age. The broilers were fed five with starter and finisher experimental diets incorporating five levels of RGK (0, 5, 7.5, 10 and 12.5%) replacing soybean meal. The energy, amino acids, Ca and av. P concentration in the diets were adjusted. Each diet was fed to five replicated groups of eight chicks each. There was significant reduction in body weight gain ($P < 0.05$) during 0-21d of age, while during overall growth phase, though body weight gain did not differ significantly ($P > 0.058$) but the value was lower in birds fed 12.5% RGK. Feed intake was also significantly lower during overall growth phase (0-42d of age). Feed conversion ratio (FCR) did not differ due to the dietary treatments containing 10% RGK, however, FCR was significantly poorer at 12.5% level in all the phases. Carcass traits and yield of organs (visceral and immune) did not differ but abdominal fat content decreased ($P < 0.05$) in diets containing beyond 5% RGK. Feed-cost per unit gain decreased linearly with incorporation of higher level of RGK, but total meat yield decreased significantly in the dietary treatments containing RGK than control. The results indicated that high protein guar korma can safely and economically be used up to 10% level in the diets of broiler chickens replacing costlier soybean meal.

STRATEGIC SUPPLEMENTATION OF MACRO AND MICRO-NUTRIENTS FOR IMPROVING POULTRY PRODUCTION

- Precise nutrient supply is essential for feed-cost efficient poultry production and welfare. In order to optimize dietary energy concentration of turkey poult (White turkey, CARI VIRAT, n= 120) during 8-16 weeks of age, a biological experiment was conducted involving three dietary energy levels (2400, 2600 and 2800 ME kcal/kg) with or without supplementation of commercial multi-enzyme (@ 250 g/ton feed) in iso-proteinic diet (protein, 20%). The levels of critical amino acids (lysine and methionine) remained similar in all the diets. Results indicated that body weight; body weight gain; feed intake and feed conversion ratio did not differ significantly. Feed intake and gain ratio was significantly ($P < 0.01$) lower in 2800 kcal/kg. Performance index was significantly higher ($P < 0.01$) in 2600 and 2800 kcal/kg than in 2400 kcal/kg diet. Feed enzyme supplementation did not improve performance. Dressing yield was significantly higher ($P < 0.01$) in 2600 kcal/kg. Cell mediated immune response was significantly higher in 2800 kcal/kg and 2600 kcal/kg than in 2400 kcal/kg. The fiber digestibility was significantly higher ($P < 0.01$) in 2400 kcal/kg and in enzyme supplemented groups. The nitrogen retention was significantly higher ($P < 0.01$) in enzyme supplemented groups. The fiber digestibility was significantly higher ($P < 0.01$) in 2400 kcal/kg and in enzyme supplemented groups. Fiber digestibility differed significantly ($P < 0.01$) due to interaction of energy and enzyme. The results indicated that the optimum dietary energy level was 2600 kcal ME per kg diet of growing turkey poult during 8-16 wk of age.
- Updating nutrient requirements ensuring precise nutrient supply to cope up with genetic improvement is a continuous process. Accordingly, the response of growing Japanese quails to varying dietary levels of vitamin A and Zinc on the growth, immune response, carcass yield, haematological and blood biochemical parameters was studied in a six weeks feeding trial involving two levels of zinc (40 and 80 mg/kg) each with four levels of vitamin A (1600, 3200, 4800 and 6400 IU/kg) in 2x4 factorial experiment. Each of such diet was offered ad lib as mash to four replicated groups of 9 each. Weekly body weight and feed intake were recorded and feed conversion ratio (feed intake/body weight gain) was calculated. The cellular and humoral immune response was studied at 22 and 28 days of age, respectively. At the end of feeding trial, 8 birds from each treatment were sacrificed for collection of blood samples and evaluation of carcass traits. Results indicated that a dietary combination of 40 mg zinc and 3200 IU/kg diet vitamin A was found optimum for growth, carcass yield and immune parameters of growing quails. However, better blood biochemical parameters were realized in a dietary combination of 80 mg/kg zinc and 3200 IU/kg vitamin A.
- Scanty information is available on the

requirements of vitamin D3 and interaction of available phosphorus concentration in diet with vitamin D3 and phytase. There has been a big gap in requirements of vitamin D3 prescribed by NRC (200 IU/kg) and actually being used commercially (1200 to 2500 IU/kg), or prescribed by BIS in 1992 (1200 IU), BIS in 2007 (3000 IU/kg diet) and ICAR in 2013 (2400 IU/kg diet). Moreover, reports indicate that phytase supplementation has been beneficial for improved performance and lowering the need for available P, the costliest mineral. Again, vitamin D3 improves phytase activity in the intestine and thus favours utilization of non-phytate P. An experiment (2×2×2 factorial) was thus conducted to evaluate the response of broiler chicks to two dietary levels of available phosphorus (Av.P 0.45 and 0.35% during 0-21d and 0.35 and 0.25%, respectively during 21-42d of age), vitamin D3 (1500 and 3000 IU/kg) and phytase (0 and 500 FTU/kg) on growth, immune response and carcass quality traits. Results indicated that a dietary concentration of 0.35 and 0.25% available phosphorus during starting (0-21 d) and finishing phase (21-42d), respectively and 1500 IU/kg vitamin D3 with supplementation of phytase (500FTU/kg diet) was found optimum to obtain maximum growth performance, immune response and leg bone mineralization of broiler chicken.

- Selenium (Se) is an important critical trace mineral associated with oxidation-reduction activities, immunity and reproduction besides sparing vitamin E and other anti-oxidants. Different levels (0.2, 0.4 and 0.6 mg Se/kg) of Se were tested in turkey for augmenting reproductive ability. Body weight and feed intake did not differ ($P>0.05$) among the different treated groups, whereas, age at sexual maturity differed ($P<0.05$) in T3 (0.4 mg Se/kg) and T4 (0.6 mg Se/kg) groups compared to control (T1) and T2 (0.2 mg Se/kg) group. First egg was recorded in earlier in T3 (178 d) and T4 (183 d) groups against 198 in 0.2 mg Se or 205 days in un-supplemented control. Egg quality traits (egg weight, albumen weight and yolk weight) differed ($P<0.05$) being higher in diet supplemented with 0.4 mg Se/kg. Egg quality traits (shape index, albumin index, yolk index, shell thickness and Haugh

unit score) did not differ ($P>0.05$). Physical characteristics of semen i.e., volume, concentration, progressive motility and live-dead count improved significantly at 0.4 mg Se/kg group as compared to T1 (control) or 0.2 or 0.6 mg Se/kg groups. However, biochemical parameters of semen (creatinine, acid phosphatase-ACP and alkaline phosphatase-ALP) concentration did not differ significantly among the groups, whereas, total protein, malondialdehyde (MAD) and cholesterol concentration differ significantly ($P<0.05$) in 0.4 mg Se/kg group compared to other groups. Parthenogenetic character increased significantly in CARI-VIRAT adult turkeys on Se supplementation @ 0.4 (12.5%) or 0.6 mg Se/kg (10%) diet. Results indicated that supplementation of 0.4 mg Se/kg basal diet was beneficial for lowering age at sexual maturity, improving egg production, egg quality traits and parthenogenetic character in female and physical and biochemical characteristics of semen in male turkeys.

PHYSIOLOGICAL INTERVENTION FOR AUGMENTATION OF REPRODUCTIVE EFFICIENCY

EVALUATION AND IMPROVEMENT OF REPRODUCTIVE EFFICIENCY IN GUINEA FOWL AND CHICKEN

Effect of Bisphenol-A (BPA) on reproductive functions of male Japanese quail: Attempts have been made to evaluate the effect of endocrine disruptors (ED) such as BPA (Bisphenol-A) on reproductive function of male Japanese quail. For this study, healthy adult male Japanese quail were taken and randomly divided into 4 groups consisting of 15 birds each viz, T1, T2, T3 and T4. T1 and T2 groups served as control and sham control group (DMSO as vehicle through oral route) whereas group T3 and T4 was denoted as low dose (BPA-250µg/bird/day) and high dose (BPA-1000 µg/bird/day) treatment group respectively. The oral administration of endocrine disruptors to birds was started from 8th week of age and continued till it affected the reproductive parameters. Body weight, cloacal gland index, foam discharge, physical-biochemical characteristics of semen, serum testosterone profile, testicular weight, fertility and hatchability were

recorded. Body weight was not affected by the BPA. Cloacal gland index and foam discharge frequencies were reduced significantly in BPA treated birds. The physical characteristics of semen observed with reduced semen volume, mass motility, concentration, live spermatozoa associated with higher dead and morphological abnormal spermatozoa in endocrine disruptors treated groups. Quail semen obtained from treated groups reduced methylene blue in longer time indicating that quail spermatozoa were metabolically very inactive. The enzyme profile of seminal plasma indicated a significant reduction of alkaline phosphatase in BPA treated groups. BPA reduced the testicular weight and testosterone profile in blood. Poor fertility and hatchability was observed when the birds were treated with this endocrine disruptor. In treated groups, all the above effects were prominent in high dose (T4) group than control. From this study, it can be concluded that BPA having adverse effect on reproductive functions of Japanese quail.

Bisphenol-A reduces fertilizing ability and motility by compromising mitochondrial function of sperm: Under this study, *in vitro* effect of environmentally relevant concentrations of BPA (0 mM, 0.18 mM, 0.37 mM, and 0.74 mM) on sperm functions in chicken has been investigated. Sperm were exposed to concentrations of BPA for 30 min and analyzed for motility, fertilizing ability, live sperm percentage, and mitochondrial membrane potential Q2 (Dcm). Results showed that BPA at a concentration of 0.74 mM significantly decreased motility, fertilizing ability, live sperm count percentage, and sperm Dcm. Sperm motility was positively correlated with fertility ($r=0.73$, $p<0.01$), live sperm percentage ($r=0.64$, $p<0.01$), and high Dcm ($r=0.44$, $p<0.01$). A dose and time-dependent effect of BPA was observed on sperm motility at all BPA concentrations. However, sperm's fertilizing ability was unaffected in low BPA concentration (0.18 mM and 0.37 mM). A significantly higher percentage of moribund sperm was observed at 0.37mM and 0.74mM BPA compared with at 0.18 mM BPA, control, and vehicle control. The present study confirms that environmentally relevant concentrations of BPA are capable of compromising sperm functions leading to reduction in fertilizing ability of chicken sperm.

ROLE OF HEAT SHOCK PROTEIN ON THE EFFICIENCY OF DIGESTIVE SYSTEM UNDER NORMAL AND STRESSED CONDITIONS IN POULTRY

Effect of incubation temperatures on the hatching performance and digestive enzymes in broiler chicken: In this study, effect of incubational temperature on hatchability on the total egg set basis (TES) and fertile egg set basis (FES) was investigated. A total of 745 white broiler hatching eggs was procured and incubated at 37.5°C (Control: 337 eggs), (Treatment: 408 eggs) with 55 per cent relative humidity. The treatment group was subjected to elevated incubation temperature 39.5°C and 65 per cent humidity for 12 hours/day from 7-16th days of incubation. Breakout analysis of unhatched eggs revealed 24 dead embryos (EED: 10; MED: 08; LED: 6) for normal and 57 dead embryos (EED: 16; MED: 23; LED: 18) for elevated temperature. Hatchability on TES were 78.0±5.8 and 66.4±5.8 in control and treatment groups respectively which were not significantly different. While hatchability on FES showed a significant difference between control and treatment groups with the hatchability being higher for control (87.90±4.35) compared to treatment group (79.20±4.35). No significant difference between control and treatment groups for chick weight, chick to egg weight ratio and moisture loss (1-18 days) was observed. It is interpreted that, high temperature (39.5°C) did not affect chick weight, moisture loss but compromised the hatchability. Experimental trial for studying the effect of incubation temperatures on digestive enzymes and jejunal HSP70 expression is under progress.

To study the arterial blood pressure and heart beat in broilers: Attempts have been made to investigate the relationship of body weight with arterial BP (blood pressure) and heart rate in broilers. Broiler birds were raised under uniform husbandry conditions and divided equally into three groups *viz.* high (above 1000 g), low (below 900 g) and control (900-1000 g) groups. Blood pressure was estimated invasively using AD instrument invasive blood pressure recording system under anesthetic condition. Broiler birds with higher body weight showed significantly higher arterial BP (117.40 mm Hg), compared to low (88.91 mm Hg) and control (88.22 mm Hg)

groups. However, no significant difference could be observed between low and control groups. Number of heart beats per minute (BPM) in broilers is found to be in range of 334 to 343 for low and high body weight, respectively. No significant difference could be observed for BPM in all the groups examined under this study.

SHELTER MANAGEMENT

EVALUATION OF MANAGEMENT PRACTICES TO OPTIMIZE TURKEY PRODUCTION

Effect of different floor space, dietary energy and enzyme supplementation on the growth performance and immunocompetence of turkey poults: Straight-run turkey chicks (n=120) from a single hatch and having similar body weight were randomly distributed into twelve experimental groups with four replicates each and reared in battery cages (1.64 ft X 2.30 ft) at two different floor space (1.25 & 1.90 sq ft/bird) from 9th - 16th week of age. Each group was fed diets having three levels of energy (2400, 2600 and 2800 kcal/kg) with or without supplementation of multi-enzyme (cocktail) but similar crude protein (20%) from 9-16th weeks of age and the critical amino acids (lysine 1.2% and methionine 0.37%) as suggested by NRC (1994).

The optimum floor space in battery cages for rearing growing turkey poults (9-16 wk) was 1.25 sq. ft/bird. A dietary energy level of 2600 kcal/kg was optimum for growing turkey poults (9-16 weeks). Dietary enzyme supplementation was not beneficial during growing phase in turkey poults. The feed-cost per kg meat production was significantly higher in floor space of 1.90 sq. ft than 1.25 sq.ft. Significantly (P<0.01) higher value for feed-cost per kg body weight gain and feed-cost per kg meat was observed in 2400 kcal/kg than 2600 kcal/kg and 2800 kcal/kg. While feed-cost did not differ significantly due to enzyme supplementation. Feed-cost per bird differed significantly (P<0.01) due to interaction of space and energy. Profit potential per meter square (PPM) was significantly higher in 1.25 sq. ft when the birds were sold as dressed meat than 1.90 sq. ft. PPM did not differ significantly due to interaction of space, energy and enzyme or space and energy or space and enzyme or energy and enzyme.

The shrinkage loss, dressing yield and eviscerated yield were significantly higher (P<0.01)

in turkey birds reared at 1.25 sq. ft than 1.90 sq. ft floor space. Dressing yield was significantly higher (P<0.01) in turkey fed diet with 2600 kcal/kg. The turkey birds recorded higher cut-up value in 2800 kcal/kg than 2600 kcal/kg and 2400 kcal/kg diet fed group. There was no significant difference on cut up parts due to enzyme supplementation.

The relative spleen weight of was significantly higher in low energy diet (2400-2600 kcal ME/kg) than the high energy (2800 kcalME/kg) and in enzyme supplemented poults. Cellular and humoral immune response did not differ due to space and enzyme supplementation but the cellular immune response was higher in high energy fed poults.

POULTRY REARING PRACTICES AT HIGH ALTITUDE

Energy requirements of Rhode Island Red (RIR) layers at high altitude: About 270 brown egg layer birds (RIR) were distributed in cage and floor system of management and provided iso-nitrogenous (16% CP) diet each at three different level of energy (ME: 2700, 2600 and 2500 kcal/kg) during Summer (May-July) at high altitude (>2000msl) of IVRI Mukteswar. Per cent hen day egg production (HDEP) in RIR birds reared on floor did not differ due to energy level of the diet, but when reared in cages birds fed 2600 Kcal ME diet had more egg production (Fig. 2). The average egg weight in low energy diet was more than other two diets, however, there was no effect of rearing system on egg weight.

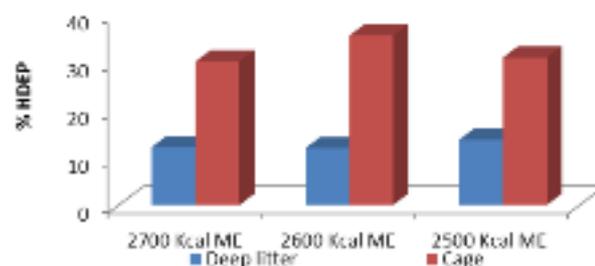


Fig. 2: Percent hen-day egg production in RIR female fed different energy diets and housed in litter and cages

Performance of CARI Debendra (Dual purpose bird) at high altitude: Age at first egg in CARI Debendra female was earlier when reared at plains (CARI, Izatnagar) compared to high altitude (171.2d vs 194.0d). The HDEP during 28-32 wks of age was also higher in layer birds reared at plain than those at high altitude (75.3% vs 27.0%). Hen

day egg production was higher when reared on floor (33.4%) than in cages (20.6%) during winter months (Fig. 3). Seven hundred CARI Debendra chicks were supplied to the farmers around Mukteswar and their production performance were recorded. CARI Debendra chicks weighed 1.8 kg after 12 weeks at farmer's house at Mukteswar, Nainital District (>2000msl).

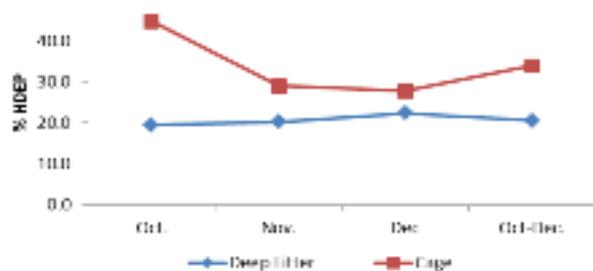


Fig. 3: Hen-day egg production in CARI Debendra birds during winter months at high altitude

Performance of Turkey birds at high altitude: The average body weight of the turkey poults reared at high altitude at 12th, 16th and 36th weeks of age were 999.1±18.8g, 1561.7±28.4g and 3564.4±82.3g, respectively. The female turkey birds attained sexual maturity in 237 days, which was comparable with those reared at plain.

Performance of Guinea fowl birds at high altitude: The average body weight of guinea fowl chicks reared at high altitude at 8th, 12th and 24th weeks of age were 366.7±22.4g, 725.0±25.0g and 1350.0±35.0g, respectively. The female birds attained sexual maturity in 197 days, which was earlier than those reared at plain.

Table 11: Effect of housing system on the welfare performance of layer birds during brooding period

Treatments	Claw length (mm)	Feather condition	Keel bone deformities	Foot lesion	Gait Score	Tonic Immobility (s)	latency for first peck (s)	Reaction (s)
Cage(n=10)	1.11±0.03 ^a	1.80±0.24	1.00±.00	1.20±0.13	1.50±0.16 ^a	178.00±15.50 ^a	6.35±1.01 ^a	2.95±0.15 ^a
Floor(n=10)	0.96±0.03 ^b	1.20±0.13	1.00±.00	1.40±0.16	0.30±0.15 ^b	88.20±8.41 ^b	1.51±0.15 ^b	1.45±0.13 ^b
Av.	1.03±0.02	1.50±0.15	1.00±.00	1.30±0.10	0.90±0.17	133.10±13.41	3.93±0.74	2.20±0.20
Sig level	P<0.01	NS	NS	NS	P<0.01	P<0.01	P<0.01	P<0.01

Mean bearing different superscript in a column differ significantly (P<0.05); NS- non-significant (P>0.05).

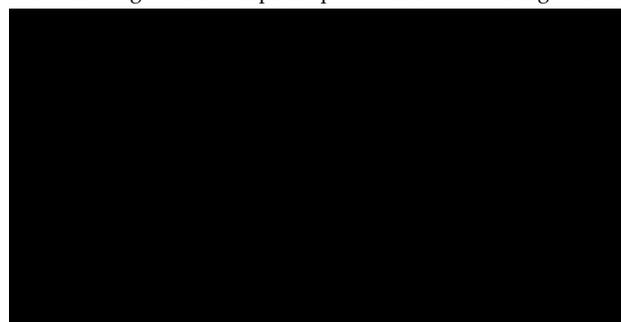


Fig. 4: Effect of housing system on weekly body weight in WL layers during brooding period

ASSESSMENT OF PERFORMANCE AND WELFARE OF CHICKEN UNDER DIFFERENT HOUSING CONDITIONS

Evaluation of performance and welfare of WLH chicks during brooding under two housing systems: White Leghorn chicks (n=800) were distributed into two treatment groups (floor and battery cages) having four replicates each. The chicks were brooded under standard managemental practices for first eight weeks of age. Cage reared layer chicks had significantly higher body weight at 42d (363.8±4.49 vs 307.3±12.13g), but floor reared birds had higher weight (556.7±16.68 vs 609.5±6.18g) at 56d of age (Fig. 4 & 5). Significantly higher feed consumption was recorded in floor reared chicks at 14, 42 and 52d of age. Housing system had a marked effect on the mortality rate, where it was more in floor birds compared to those in cages (7.5 vs 4.75%). Floor reared chicks were found to be more engaged in different behavioral activities compared to the cage birds. Significantly higher (P<0.05) fearful response (2.95±15 vs 1.45±13 sec) and time for first peck (6.35±1.01 vs 1.51±.15 sec) in response to novel object test was observed in cage birds than the floor reared birds. There was significant differences (P<0.05) in the welfare parameters like feather conditions, claw length, gait scoring and tonic immobility of the birds between two system of rearing, while no difference was found in keel bone condition and foot lesions (Table 11).

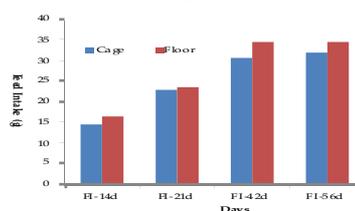


Fig. 5: Effect of housing system on weekly feed intake in WL layers during brooding period.



Novel object test to measure fear response and time for first peck in two housing system

MANAGEMENT

SURVEILLANCE AND MONITORING OF POULTRY DISEASES IN POULTRY FARMS AT CARI

As good poultry health management is an important component of poultry production. The healthcare of different poultry species viz chickens (layer, broiler and desi fowl), quails, turkey, guinea fowl & emu maintained at the institute was carried out as a regular activity. The day to day health management of poultry birds included both prophylactic as well as therapeutic treatment. The healthcare programme to be adopted for different poultry species was based on sero-surveillance, diagnosis of diseases/infections on the basis of post-mortem examination and detection of causative agent(s). Further, vaccinal immunity in different poultry species was also assessed for some important diseases to assess the efficacy of vaccination programme and the need to devise further vaccination strategy. As per the requirement, the vaccine schedule was re-devised and accordingly the birds were vaccinated from time to time. As a part of health monitoring programme pathogen profiling for *Salmonella*, Avian Leucosis Virus (ALV) and other pathogens was also carried out. Antibiotic sensitivity was carried out to assess the antibiotic sensitivity profiling and based on this, effective antimicrobial agents were used for treatment of the disease so as to avoid the problem of development of resistance in bacterial populations. Probiotics, gut acting

acidifiers, vitamins, minerals anti-coccidial drugs, electrolytes, immuno-modulators and water sanitizers were also used in different poultry species as part of health management programme which were used both as prophylactic or therapeutic purpose with an aim to prevent the infection/ disease and for treatment of affected birds. In addition, immuno-modulators supplementation either through feed or drinking water were found to be very effective and these were given to the birds for enhancing immunity as well as well beings. Chronic respiratory disease, coccidiosis, colibacillosis, parasitic infections etc. were seen occasionally and these were controlled using antibiotics, anticoccidial/ antimicrobial and anthelmintic drugs along with vitamins including multivitamins, electrolytes and immuno-boosters. Deworming was carried out regularly in all the poultry species. Administration of vitamins, electrolytes and immune-stimulants before and after deworming proved effective as stress reliever due to deworming. Drinking water and poultry feed samples were analyzed regularly for microbiological quality. Bio-security measures of all the farm premises as well as all in all the poultry sheds were further strengthened with regular disinfection of poultry sheds, providing foot water baths, education of farm workers etc. The waste generated from hatchery, processing plant and dead birds was disposed off hygienically so as to avoid further spread of the disease.

PROCESSING, VALUE ADDITION, PRODUCT SAFETY AND QUALITY PARAMETERS

OPTIMIZATION OF FAT LEVEL IN DEVELOPMENT OF LOW-FAT POULTRY MEAT WAFERS

For optimization of fat level in poultry meat wafers, three formulations were tried. T₁, the control sample contained standard formulation (10% added fat). The other two samples, T₂ and T₃ contained added fat at 5 & 7% levels respectively. The emulsions were extruded through manual extruder for microwave cooking. Results indicated that treated samples had significantly ($p < 0.05$) higher emulsion stability, cooking yield, protein and moisture but lower fat contents. However, emulsion or cooked product pH did not vary significantly. In regards to sensory attributes, T₂ sample showed higher acceptability as compared to T₁ and T₃. Finally, it was concluded that use of fat at 5% level (T₂) is optimum in development of suitable low-fat poultry meat wafers.

STANDARDIZATION OF FAT LEVEL IN DEVELOPMENT OF LOW-FAT POULTRY MEAT FINGER CHIPS

Several individual trials were conducted to standardize the fat level in poultry meat finger chips. A total three samples were prepared-control (T₁=10% fat) and other two samples (T₂ & T₃) containing 5 & 7% added fat, respectively. The products were prepared using cold extrusion techniques followed by microwave cooking. Results indicated non-significant differences in emulsion and cooked product pH, emulsion stability, cooking yield and moisture content amongst the control and treatment groups. Fat content was significantly higher in T₁. T₂ showed higher values for protein content. T₃ samples, however, showed comparatively higher sensory scores for appearance and colour, crispiness, texture and flavour. Therefore, formulations with 7% added fat could be helpful in improving functionality, nutritive value and acceptability of poultry meat finger chips.

DEVELOPMENT OF FIBRE INCORPORATED FUNCTIONAL POULTRY MEAT FINGER CHIPS

Fibre incorporated functional poultry meat finger chips were developed with reduced fat (7%), low sodium [0.15M NaCl (w/w) + 0.08M KCl

(w/w)] and addition of whole grain oat flour 2.5 (T₁), 3.5 (T₂) and 4.5% (T₃). The emulsions of all samples were prepared and formed into finger chips, and finally cooked in a microwave oven for 3-4 min. Results indicated that treated samples had significantly ($p < 0.05$) higher emulsion stability and cooking yield but lower emulsion and cooked product pH and moisture content. In regards to sensory attributes, treated samples exhibited significantly higher scores for appearance, colour, texture and flavour as rated by sensory panel members. Finally, it was concluded that addition of oat flour at 3.5% was optimum to process good quality poultry meat finger chips.



DEVELOPMENT OF FIBRE INCORPORATED FUNCTIONAL CHICKEN MEAT BITES

Processing for development of low-fat, low-salt and fibre enriched functional chicken meat bites was standardized with the formulation contain 5% added fat, 0.14M sodium chloride (NaCl, w/w) + 0.06 M potassium chloride (KCl, w/w) and addition of Makhana @ 1 (T₁), 1.5 (T₂) & 2.0 (T₃)% level. Control samples contained 10% added fat and 1.3% NaCl but no fiber. Results indicated that T₁ had significantly ($p < 0.05$) higher emulsion stability, cooking yield, moisture and protein content but lower emulsion and cooked product pH and fat content. With regards to sensory attributes, T₁ sample showed very good overall acceptability scores as compared to control. It was concluded that reduction of fat level and replacement of NaCl and addition of fiber at 1% level have positive impact on product quality besides improvement of nutrition value of developed chicken meat bites.

DEVELOPMENT OF FUNCTIONAL POULTRY MEAT WAFERS USING OAT AND SORGHUM FLOURS

Several individual trials were conducted for development of functional poultry meat wafers using oat and sorghum flours as functional ingredients. For optimization of oat flour, a total three treatments were assigned-control (contained standard formulation, but no flour) and treated samples (T₁, T₂ and T₃ contained 3.0, 4.5 and 6.0% oat flour, respectively). Emulsions were prepared and used for processing of wafers. Based on different physico-chemical quality and sensory evaluation studies it has been found that formulation containing 4.5% oat flour is considered to be most suitable in development of fibre incorporated poultry meat wafers. For standardization of sorghum flour in the formulation, products were developed using flour at 3.0, 4.0 and 5.0% levels for T₁, T₂ and T₃, respectively, and finally, it was concluded that use of sorghum flour at 3.0% level (T₁) is most suitable in development of poultry meat wafers.



DEVELOPMENT OF FUNCTIONAL CHICKEN SAUSAGES AND BITES USING MAKHANA POWDER AS FUNCTIONAL INGREDIENTS

Pilot scale development of functional chicken sausages and bites was standardized using fox nut (Makhana) seed flour at 1.0% level. In sausage processing, 68.35% minced spent hen meat was used. The meat batter was prepared and then vacuum encased into peelable cellulose casing, washed and water cooked at internal temperature of 75°C. Similar formulation except two additional ingredients i.e. textured soy nuggets (5%) and whole egg liquid (5%) were incorporated in the batter formulation of chicken meat bites and that

were replaced with lean meat. Both types of products were assessed for various physico-chemical and microbiological quality parameters before selling them through institute marketing centre.



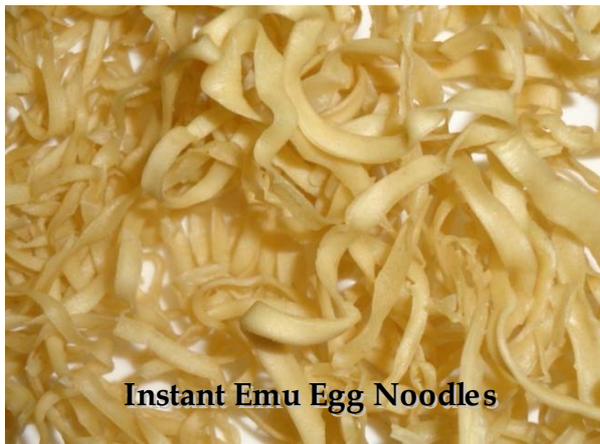
STANDARDIZATION OF PROCESSING TECHNOLOGY FOR DEVELOPMENT OF TURKEY BREAST FILLETS

Processing technology and formulation for development of turkey breast fillets were standardized for effective utilization and sale of dressed turkey carcasses. For processing, boneless fillets were blade tenderized, marinated into marinade, steam cooked, and finally, shallow fried until golden brown colour is developed. The products were shown to have very good acceptability by the sensory panel members.

STANDARDIZATION OF PROCESS FOR DEVELOPMENT OF INSTANT EMU EGG NOODLES

Process for development of instant egg noodles was standardized using emu eggs (60%) in combination with cereal flours, table salt and

other seasonings. For this, indirect water heated emu eggs were mixed properly with table salt (5.0%) and flour (40%) until suitable dough and then noodles are being made. Results indicated that emu egg noodles shows yield up to 60% with very good water absorption index. In regards to chemical composition, noodles contain moisture, protein, fat, ash, carbohydrate @ 8.3, 18.7, 14.6, 4.26, 54.08%, respectively. Sensory evaluation data revealed that this product had very good acceptability by the taste panel members. The product has shelf-life over 6 month at ambient temperature in air tight PET jar.



Instant Emu Egg Noodles

DECONTAMINATION OF DRESSED CHICKEN SURFACE USING ANTIMICROBIALS IN COMBINATION WITH THERMAL TREATMENT

Acidified sodium chlorite (ASC) or carvacrol were used as antimicrobials against *S. Typhimurium* and acidified sodium chlorite (ASC) or tri-sodium phosphate (TSP) were used against *S. Enteritidis* with an aim to develop a thermal death time regimes which can be applied during poultry processing for decontamination of these pathogens of human health significance on dressed poultry meat. Pre-dipping of skin or carcass in ASC (100, 200, 300ppm) or carvacrol (0.02, 0.04, 0.06%) before thermal treatment resulted in the rapid decontamination of skin or carcass surface from *Salmonella Typhimurium*. Results of experiment involving decontamination of dressed chicken skin from *Salmonella Enteritidis* showed that pre-dipping of skin in ASC (100, 200ppm) or TSP (0.5, 1.0%) before thermal treatment also caused decontamination of skin or carcass surface from *Salmonella Typhimurium* and *Salmonella Enteritidis*.

The D-values obtained in this study for *Salmonella Typhimurium* or *Salmonella Enteritidis* on dressed skin or carcasses were calculated and treatments of applicable D-values were applied to give 7D treatment of *Salmonella Typhimurium* on dressed carcass. After 7D treatment, meat quality was also checked for different parameters like sensory attributes, pH, texture (hardness), TBA (thiobarbituric acid) value and SDS-PAGE analysis. Selected treatments used for 7D inactivation of *Salmonella Typhimurium* did not show any major difference between treated and untreated control. Likewise, ASC or TSP increased sensitivity of *Salmonella Enteritidis* to heat without affecting organoleptic quality of chicken meat. This study will be further used for the calculation of D-values, z-values, D1 and D2-values of *Salmonella Typhimurium* and *Salmonella Enteritidis* on dressed skin or carcass pre-dipped in antimicrobials and thermal treatment. These values would be helpful in designing mathematical models to develop an effective thermal decontamination regime for *Salmonella Typhimurium* and *Salmonella Enteritidis* on dressed chicken skin and dressed carcass surface.

QUANTIFICATION AND ASSESSMENT OF SURVIVABILITY OF IMPORTANT BACTERIAL PATHOGENS IN CHICKEN MEAT

Salmonella spp. and *Campylobacter jejuni* are the important pathogens of human health importance worldwide. The data on level of these pathogens in chicken meat is limited, while it is essential to assess load of these pathogens in chicken meat as well as to study the survivability in poultry meat model system so as to apply effective intervention strategy with an aim to reduce/eliminate their presence in poultry meat ensuring human health safety. Out of 100 chicken meat samples collected from local markets of Bareilly as well as poultry processing plant, 14% were found positive for *Campylobacter jejuni* and with level in the range of 1.7×10^2 to 1.3×10^4 cfu/cm². *Salmonella* could not be detected in any of the chicken meat samples. Source wise, the occurrence of *Campylobacter jejuni* in chicken meat samples collected from processing plant was found low as 8% (4 out of 50) were found positive compared to local market samples where 20% were found positive. Survivability studies of

Salmonella Typhimurium (ST) in minced chicken meat under refrigeration ($4\pm 1^{\circ}\text{C}$) storage revealed that ST survived well during refrigeration storage and needs intervention strategy for elimination in minced meat.

DETECTION OF ANTIBIOTIC RESIDUES IN POULTRY MEAT, EGGS AND FEED SAMPLES

The samples of poultry feed, egg and tissues were collected from farm and market places of Bareilly, Delhi, Lucknow and Haldwani areas of northern India. It was found that the 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 0.01-0.22 ppm, 0.015-0.025 ppm, 0.017-0.025 ppm and 0.01-0.023 ppm, respectively. In all, the occurrence pattern of tetracycline, oxytetracycline and chlortetracycline were to the tune of 7%, 8% and 4% among all the samples. Higher drug residues were obtained in samples collected from Delhi sampling areas. The occurrence of residues of trimethoprim and sulfamethoxazole was recorded in samples of poultry feed (0.01-0.02 ppm), egg (0.015-0.025 ppm), liver (0.016-0.024 ppm) and muscle (0.012-

0.025 ppm) with higher residue levels observed in samples collected from Delhi and Lucknow. The level of residues recorded was within the permissible limit.

DETECTION OF CALPAINS AND CALPASTATIN ENZYMES FOR ASSESSMENT OF TENDERIZATION IN POULTRY

Standardization of method for detection of calpains and calpastatin in blood and animals tissues: Calpains (μ and m) and calpastatin are the key proteolytic enzymes of calpain system that greatly influence the tenderness of meat. Simple and low-cost casein zymography has been developed for determination of μ - and m -calpain enzymes from blood and post-mortem turkey muscle samples. The method was standardized using various sets of trials, in which extraction buffer was optimized; calpains and calpastatins were purified and separated by dialysis, and finally subjected to anion exchange chromatography. Casein Zymography was used to identify activity of calpains while SDS-PAGE was used to identify both the calpains as well as calpastatin enzymes (Fig. 6-11).

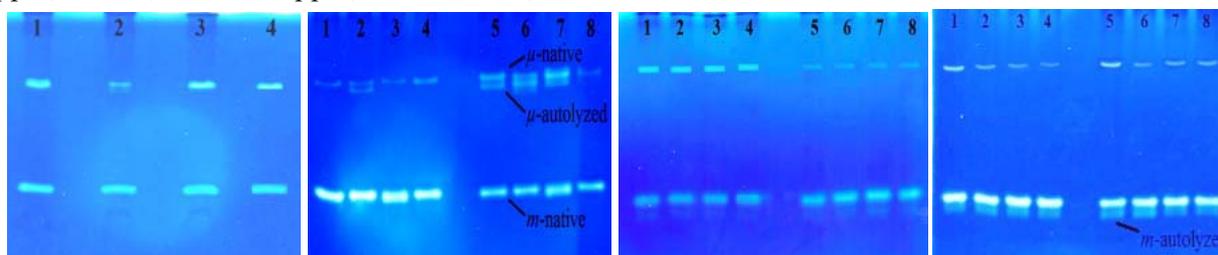


Fig. 6 **Fig. 7** **Fig. 8** **Fig. 9**
Showing clear bands (native and autolyzed form) of μ - and m -calpains on casein gels

Fig. 6: Chicken blood samples: Lane-1: WLH (\varnothing); Lane-2: WLH (σ); Lane-3: Desi Fowl (\varnothing); Lane-4: Desi Fowl (σ). **Fig. 7: Chicken muscle samples:** Lane-1: Desi Fowl Thigh (\varnothing); Lane-2: Desi Fowl Thigh (σ); Lane-3: WLH Thigh (\varnothing); Lane-4: WLH Thigh (σ); Lane-5: Desi Fowl Breast (\varnothing); Lane-6: Desi Fowl Breast (σ); Lane-7: WLH Breast (\varnothing); Lane-8: WLH Breast (σ). **Fig. 8: Guinea fowl muscle samples:** Lane-1: Swetambari Breast (σ); Lane-2: Swetambari Breast (\varnothing); Lane-3: Pearl Breast (σ); Lane-4: Pearl Breast (\varnothing); Lane-5: Swetambari Thigh (σ); Lane-6: Swetambari Thigh (\varnothing); Lane-7: Pearl Thigh (σ); Lane-8: Pearl Thigh (\varnothing). **Fig. 9: Turkey muscle samples:** Lane 1-2: Breast (σ); Lane 3-4: Breast (\varnothing); Lane 5-6: Thigh (σ); Lane 7-8: Thigh (\varnothing).

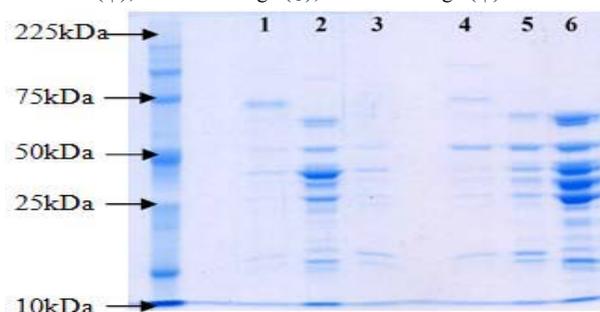


Fig. 10: Chicken SDS-PAGE analysis: [Breast Muscle: Lane-1: m -calpain (18, 28, 75 kDa); Lane-2: calpastatin (18, 28, 40, 70 kDa); Lane-3: μ -calpain (18, 28, 75 kDa)]; [Blood: Lane 4: μ -calpain (18, 28, 75 kDa); Lane-5: m -calpain (18, 28, 75 kDa); Lane-6: calpastatin (18, 28, 30, 60, 75 kDa)].

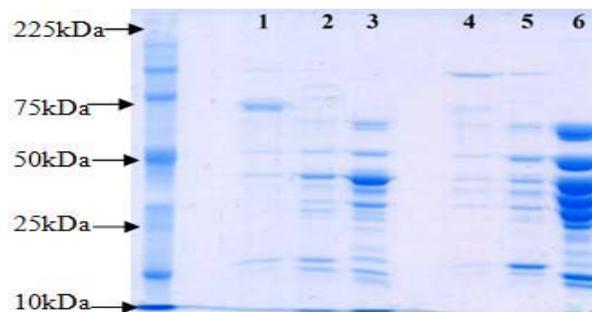


Fig. 11: Turkey SDS-PAGE analysis: [Breast Muscle: Lane-1: μ -calpain (28, 75 kDa); Lane-2: m -calpain (25, 28, 75 kDa); Lane-3: calpastatin (13, 25, 28, 40, 60 kDa)]; [Blood: Lane 4: μ -calpain (25, 28, 80 kDa); Lane-5: m -calpain (25, 28, 80 kDa); Lane-6: calpastatin (18, 28, 50, 60 kDa)].

Monitoring of the concentration of calpains and calpastatin in skeletal muscle and their activity in proteolysis: The activity and concentration of calpains and calpastatin have direct influence on post-mortem aging thereby tenderness of meat. So, to determine concentration of these enzymes, crude extracts were purified and separated by dialysis followed by anion exchange chromatography. Different concentrations of NaCl solution were used for gradient elution of calpastatins (100 mM) and μ - (200 mM) and m - (400 mM) calpains. The results are illustrated in the Fig. 12.

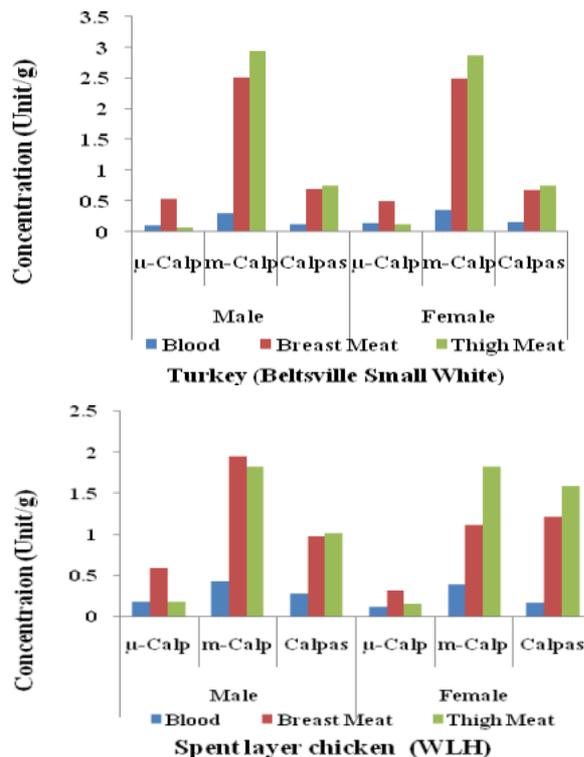


Fig. 12: Activity analysis of μ - and m -calpains and calpastatin in blood and tissue samples collected from different species, breed, sex and age of animals (Units/g)

ASSESSMENT OF POULTRY PRODUCTION AS INFLUENCE BY MARKET DYNAMICS

STUDY ON INSTITUTIONAL CREDIT SUPPORT TO POULTRY FARMING IN UTTAR PRADESH

Data from primary survey is nearing completion. Preliminary analysis has revealed that poultry is not a preferred area to finance by the banking sector especially for those engaged in small poultry business. Poor asset / resource base was one of the important factors for low credit worthiness of the small poultry farmers. Lack of

awareness about various schemes run by state Govt. or other Govt. Departments to promote poultry farming activities was yet another constraint in flow of credit to poultry business. It was observed that institutional finance was more readily available to those who sought loans for expanding the pre-existing poultry businesses rather than to those who intended to start a new poultry venture. Moral hazard was cited as one of the most important limiting factor in flow of credit to poultry sector. Further empirical analysis of data is under way to measure the constraints in flow of credit to poultry.

HRD AND TECHNOLOGY DISSEMINATION

TRANSFER OF PROVEN POULTRY PRODUCTION TECHNOLOGIES AND THEIR IMPACT ASSESSMENT

Organization of village level exhibition: The farmers of village panchayat Dandia in Bithari Chainpur development block were motivated to adopt backyard and broiler farming through putting up village level exhibition on poultry production technologies at this village panchayat. During the village level exhibition, farmers were acquainted with the germplasm developed by CARI Viz, CARIBRO-Dhanraja, CARIBRO-Vishal, CARI-Priya, CARI- Sonali, improved desi chicken- CARI- Nirbhik, Quail (CARI-Uttam, CARI- Pearl, CARI Ujjawal (white breasted quail), CARI- Sweeta (white feathered quail) CARI- Brown (brown feathered quail), Turkey- CARI- Virat, and Guinea fowl (Kadambari, Chitambari and Swetambari). Production characteristics and special features of these breeds were explained, which were appreciated by all the participants. Consequently, farmers of this village panchayat agreed to adopt backyard poultry farming.



Distribution of chicks for on-farm demonstration



Exhibition on poultry at village Panchayat Dandia



Field day at village Panchayat Kuandonda

On-farm demonstrations on CARI Devendra: The farmers, motivated using village level exhibition, were further convinced through on-farm demonstrations. Twelve selected farmers of village panchayat Dandia in Bithari chainpur development block of Bareilly district (UP) were given CARI Devendra (dual purpose chicken) in the month of November, 2014. Each selected farmer was given 15 chicks for rearing under semi-scavenging system of backyard poultry. Two farmers of this village panchayat were given 32 week old WLH laying birds to motivate them for layer farming.

Field day on WLH laying birds: In order to motivate farmers for backyard poultry and broiler farming in the selected area of Nawabganj development block, A field day was organized on 27th Aug., 2014 at Kuandonda village panchayat to show the performance of CARI laying birds and to further motivate the other farmers.

POULTRY PROMOTION IN KUMAON HILLS OF UTTARAKHAND

On-farm demonstrations on CARIBRO-Dhanraja: Two on-farm demonstration on CARIBRO- Dhanraja (multicolor broilers) was carried out at farmer field in the month of April,

2014 at two different places namely Kathar and Kuneel village of Champawat district of Uttarakhand. Earlier, poultry farmers were practicing broiler farming mostly with locally available croiler, which takes longer time and produce less weight.



Distribution of chicks to farmers for on-farm demonstration

Field day on CARIBRO- Dhanraja: A field day was organized at demonstration site in the village kuneel of Champawat district of Uttarakhand in the month of May, 2014 to show the performance of Dhanraja broiler. The participants were briefed about the characteristics of Dhanraja. After seeing the performance of Dhanraja broiler, the selected farmers want to rear this breed regularly as they got higher body weight in lesser time.

Awareness camp-cum- farm visit: In order to aware farmers about poultry farming, awareness camps and farm visits were conducted at three different villages-Chalthi, Kathar, and Tilon in Champawat district of UK. During the camps and visits, farmers were advocated about low cost poultry feed, poultry breeds suitable for rural masses such as CARI-Devendra, CARI-Shyama, CARI-Nirbhik etc. and other important management practices. The farmers of the project area were also acquainted with services being provided in starting the poultry farming.

EXTERNALLY FUNDED PROJECTS

APPLICATION OF RNAi TECHNOLOGY FOR AUGMENTING BROILER PRODUCTION (DBT Sponsored)

I/v administration of MSTN and TGF lenticlones: A total of 70 DOCs were divided in 5 groups for I/v injection with different lenticlones viz MSTN-2 (8000 cells), TGFβ4-2 (8000 cells), MSTN-2 (4000 cells) + TGFβ4-2 (4000 cells), NTC (8000 cells) and uninjected. Myostatin level was

estimated by ELISA using commercial kit at 3rd week in sample of 5 chicks from each group. The mean blood myostatin level in MSTN 2, TGFβ4-2, NTC and uninjected groups were 8.134±1.991, 5.218±1.737, 16.891±8.528 and 31.868±11.291 ng/ml. The differences among groups were significant. In TGF 4-2 + MSTN2 shRNA injected groups, the % knock down were not significant in breast muscle, however, TGF 4 and myostatin gene showed significant down regulation in heart. TGF 4 recorded significant down regulation in TGF 4-2 shRNA injected group in heart and breast muscle. Myostatin was significantly down regulated in heart of MSTN-2 shRNA injected group (Fig. 13).

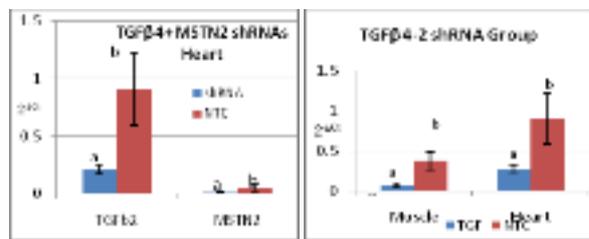


Fig. 13: Expression analysis of TGF 4 and myostatin genes in heart and breast muscles

In-ovo injection of PPARγ-2 and ACC-2 lentivector clones: On 16th day of incubation, *in-*

ovo injections of PPARγ-2 (8000TU), PPARγ-2 (4000 TU)+ ACC-2 (4000TU) and NTC were given. Uninjected control was also kept. The hatchability percentages in respective groups were 86.84, 72.22, 54.54 and 92.85. The chicks hatched in NTC group died in early age, therefore data could not be recorded in NTC group. The statistical comparison was done only in shRNA injected groups and uninjected control. Body weights at 4, 5, 6, 7, 8 and 9 weeks showed significant difference among groups (Table 12). Till 11 weeks of age chicks of both sexes were reared however, from 12 weeks onwards only females were kept in each group for further recording of data.

Body weights at subsequent ages (till 20 weeks) in females were not significantly different among groups.

Serum Cholesterol: Serum cholesterol was estimated at different ages in the three groups (shRNA injected and uninjected control groups). The serum cholesterol levels (mg/dl) were significantly different at 5, 9, 15, 16 and 18 weeks of age; lowest being in PPARγ2 shRNA injected group (Table 13).

Table 12: Means of body weights (kg) of combined sexes in different groups

Tr	Bw 0	Bw 3	Bw 4	Bw 5	Bw 6	Bw 7	Bw 8	Bw 9	Bw 10
1	0.04 ±0.01	0.33 ±0.01	0.48 ^a ±0.19	0.62 ^a ±0.022	0.83 ^a ±0.19	1.09 ^a ±0.04	1.389 ^a ±0.05	1.61 ^a ±0.06	1.81 ±0.07
2	0.04 ±0.01	0.37 ±0.01	0.53 ^{ab} ±0.021	0.72 ^{ab} ±0.025	0.94 ^a ±0.21	1.17 ^a ±0.04	1.51 ^{ab} ±0.05	1.81 ^{ab} ±0.07	2.00 ±0.07
3	0.04 ±0.01	0.38 ±0.02	0.58 ^b ±0.03	0.742 ^b ±0.0	1.11 ^b ±0.30	1.32 ^b ±0.06	1.63 ^b ±0.074	1.84 ^b ±0.096	2.04 ±0.11

Note: Tr1: PPARγ-2(8000 TU); Tr2= PPARγ-2 (4000 TU) + ACC-2(4000 TU); Tr3 = Uninjected
BW= Body weight; figures represent age in weeks

Table 13: Serum cholesterol in different groups at different ages

Groups	Serum Cholesterol (mg/dl) at					
	3 weeks	5 weeks*	9 weeks	15 weeks*	16 weeks*	18 weeks*
1	94.61±7.79	105.536±4.429 ^a	81.11±5.44	86.64±4.066 ^a	59.65±4.13 ^a	83.29±6.92 ^a
2	97.18±8.21	124.463±4.668 ^{ab}	94.75±5.74	86.64±4.31 ^a	61.75±4.38 ^a	96.75±7.34 ^a
3	96.94±8.22	112.060±4.668 ^{ab}	90.28±5.74	106.10±4.98 ^b	77.39±5.05 ^b	122.24±8.48 ^b

Note: Tr1: PPARγ-2(8000 TU); Tr 2= PPARγ-2 (4000 TU)+ ACC-2(4000 TU); Tr3 =Uninjected

Abdominal Fat weight: In preliminary trial, At the age of 20 weeks three birds from each groups viz. PPARγ-2(8000 TU); PPARγ-2 (4000 TU)+ ACC-2(4000 TU) and uninjected were sacrificed for evaluation of abdominal fat pad. The abdominal fat weights were 45.78±5.99, 77.82±19.2, 149.72±2.00 g in respective groups.

Sperm transfection using Lentiviral vector: Semen was washed 3 times in PBS to remove seminal fluid. Sperm motility and vigour was evaluated microscopically before and after each wash. Sperm upto two washes were adjudged to be suitable for fertilization of eggs. Sperm cells were diluted in CARI Semen-diluents and counted

spectrophotometrically. Two groups were prepared: Group 1- Control (Washed sperm without lentivirus vector), Group 2- (Washed sperm with lentivirus vector) among which sperm cells from group 2 were incubated with lentivirus vector and another was incubated without lentivector to serve as negative control. After incubation, exogenous vector which was not internalized was removed by 3 washes in sperm diluent and sperm cells were collected by centrifugation at 5000 rpm for 10 m.

PCR was performed to detect the association of lentivirus vector with sperm. RNA from both groups was isolated using QIAamp Viral RNA mini kit. cDNA was prepared using Verso cDNA synthesis kit (Thermo Scientific). PCR was performed targeting eGFP genes using specific primers targeting 137 bp sequences in eGFP. The amplified PCR product for eGFP was detected in 1.5% agarose gel. A band of 137 bp in sperm samples confirmed transfection (Fig. 14).

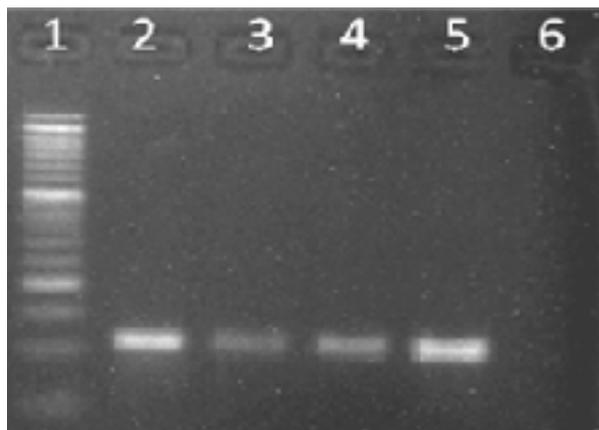


Fig. 14: PCR showing GFP amplification in sperm samples- Lane 1: 50 bp ladder; Lane 2,3,4,5: sperm samples showing GFP band (137 bp); Lane 6= negative control

In-ovo single window fertilization with reduced dose of sperm: In order to economize the transgenesis through SMGT in chicken, the dose of sperm used for insemination needs to be reduced. *In-ovo* sperm injection of two sperm doses (2×10^6 and 2.0×10^5 in $50 \mu\text{l}$ media) by making single window (approx. $3 \times 2 \text{ mm}$) was performed in infertile freshly laid eggs, just above the germinal disc. The total number of eggs used and fertility percents in different doses and trials has been presented in Table 14. The results revealed that sperm dose of $2 \times 10^6 / 50 \mu\text{l}$ of media was optimum. However, in repeat trials, fertility could not be observed.

Table 14. Details of *in-ovo* fertilization trials

Sperm dose	Eggs injected	No fertile	F %
$2 \times 10^6 / 50 \mu\text{l}$ media -I	7	6	85%
-II	08	1	12.5
Overall	15	7	46.7
$2 \times 10^5 / 50 \mu\text{l}$ media -I	7	1	14.3
-II	8	0	0
Overall	15	1	6.6

Intra-testicular Injection with lentivector: In order to produce transgene (with Intivector) sperm, the intra-testicular injection method was attempted. The testicular location was ascertained through ultrasonography of male adult chicken (Fig. 15). The ideal site for intra-testicular injection was adjudged to be between last 2nd and 3rd rib. The size of testicle was found to be 220 mm^2 . Trypan blue was injected from outside using spinal needle of 24 gauge and then the bird was operated to confirm the delivery (Fig. 16). The lentivector injection @25 l/ testis was injected using spinal needle. The trial was performed using the facilities and expertise available at Polyclinic IVRI, Izatnagar. Semen was collected on III and V day. DNA and RNA were isolated and PCR was performed to amplify GFP gene. The GFP gene could not be amplified in preliminary trial.



Fig. 15: Ultrasonograph of male chicken abdomen showing testide.



Fig. 16: Trypan blue injected into testes after locating the position.

IDENTIFICATION OF PROBIOTIC STRAIN(S) FROM GUT METAGENOME OF ASSAM INDIGENOUS CHICKENS (DBT Sponsored)

16s rRNA gene sequencing using Illumina MiSeq platform: High throughput Illumina paired end sequencing was carried out on the Illumina MiSeq through Sequencing by base synthesis (SBS) method by using four fluorescently labeled nucleotides to read 300 bases paired end. Once the clusters were generated, sequencing was performed again on the reverse strand.

Generation of multimillion Illumina reads and production of high quality reads: Targeting the V3, V4, V4-V6 hypervariable regions, a total of 74,98,342 paired end raw reads were obtained for twelve gut samples of Assam indigenous chicken using Illumina MiSeq platform. Averages of 6,24,861 reads were obtained for each sample. In order to eliminate the low quality reads, reads with more than 70% of bases with Phred value of greater than 20 alone were taken into account. Brooder caecum, crop, ileum and jejunum samples are referred as BCE, BCR, BI and BJ, respectively. Corresponding segments samples in grower as GCE, GCR, GI, GJ and in adult as ACE, ACR, AI and AJ.

Data analysis under MG-RAST: Once sequencing was completed, the raw data was extracted from the server using the proprietary Illumina pipeline software to obtain FASTQ files which were uploaded to MG-RAST server. FragGeneScan used by MG-RAST for gene prediction from reads generated by the Illumina sequencing. Proteins

clusters were built using the uclust implementation in QIIME. Longest sequence for each cluster was subjected to similarity analysis using sBLAT against protein databases derived from the M5NR database. In addition, ribosomal RNA genes are mapped to the rRNA databases under M5RNA. Based on protein and RNA gene fragments annotation, taxonomic profiling from domain level to strain level was done for each sample. Annotated reads were used to plot abundance graph at each taxonomic level. An overview of abundance graph at lower as well as higher taxonomic levels i.e. phylum (Fig. 17) and genus (Fig. 18) is being presented below.

At each age the bacterial taxa *Firmicutes* dominated in all the samples. In crop samples, the relative abundance of Firmicutes was higher as compared to other samples for all the age groups. Moreover, in caecum samples *Bacteroidetes* were also highly represented. Other phyla like, Actinobacteria Proteobacteria and Spirochaetes represented intermediate abundance with variable distribution in all the samples. Among eukaryotic taxa Arthropoda and Chordata were scarce in all the samples.

Analysis of common and unique species in each samples

To predict distribution of microbial species Venn diagram were drawn for each GIT segment at different ages. Most microbial species were unique for each sample whereas few species were shared (Fig. 19).

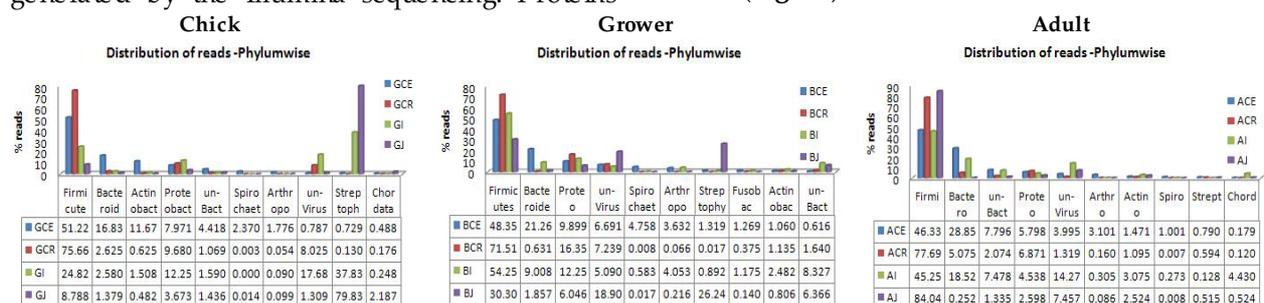


Fig. 17: Taxonomic profile at Phylum level for different GIT segment at each age.

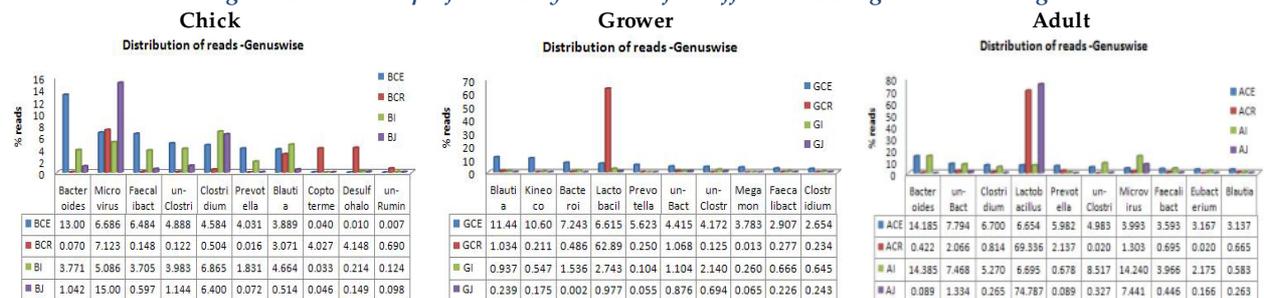


Fig. 18: Taxonomic profile at Genus level for different GIT segment at each age.

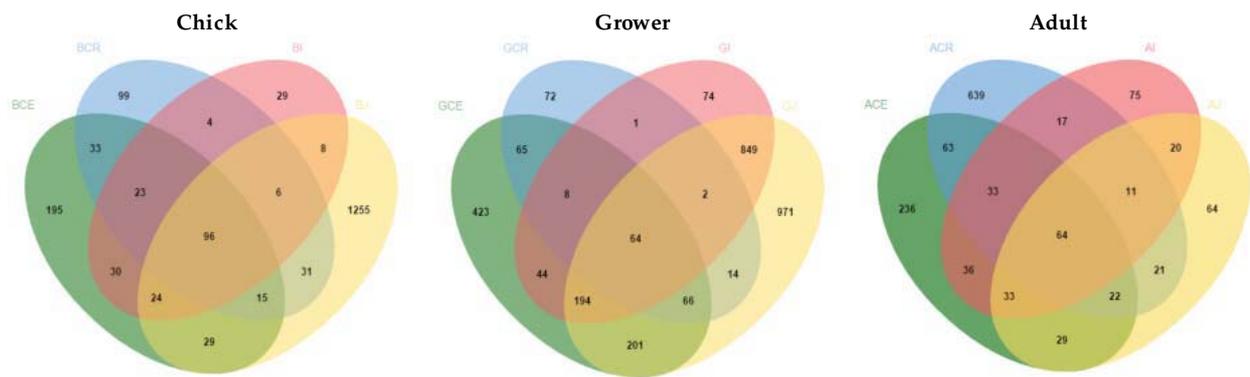


Fig. 19: Shared and specific microbial species among the GIT samples at chick grower and adult stage.

First 50 abundant species from each sample were based on reads annotation were used for analyzing Shared and specific microbial species. In crop samples, the lineages from Bacilli were dominated by Lactobacillus species like *L. salivarius*, *L. pontis*, *L. johnsonii*, *L. helveticus*, *L. reuteri* etc. In caecum, bacterial species like *Faecalibacterium prausnitzii*, *Ruminococcus obeum*, butyrate-producing bacterium A2-232, Bacteroides species like *Bacteroides ovatus*, *Bacteroides coprocola*, *Bacteroides barnesiae*, *Bacteroides plebeius*, *Bacteroides cellulosolvens*, *Bacteroides uniformis* and Desulfovibrio species like *Desulfohalobium retbaense* were dominant. In Jejunum, *L. helveticus*, *L. reuteri*, *L. delbrueckii* and *L. mucosae* were in high abundance. In Ileum, butyrate-producing bacterium A2-232, *Bacteroides plebeius*, *Faecalibacterium prausnitzii* and *L. helveticus* were highly dominant.

For the first time, Lactobacillus species such as *L. frumenti*, *L. antri*, *L. mucosae* in chicken crop were identified. Likewise, *Kineococcus radiotolerans*, *Desulfohalobium retbaense*, and *L. jensenii* were identified for the first time in chicken caecum. These bacterial species are known to possess multifarious probiotic properties.

Characterization of bacterial isolates obtained from AAU, Guwahati

From each 52 stab culture, bacterial isolates were revived through streaking on MRS agar plate. Individual well isolated colonies from streaked plates were picked up and sub cultured twice in MRS broth at same conditions.

Biochemical Characterization: All the bacterial isolates were found catalase -ve.

Molecular Characterization: DNA was extracted from 52 bacterial culture samples by Phenol-chloroform method. A 203-bp fragment of 16S

ribosomal region were amplified by specific genus primers. The PCR products were analyzed on 1.5% agarose gel (Fig. 20). Out of 52 bacterial samples, 41 samples showed PCR amplification (203 bp), therefore were Lactobacillus genus.

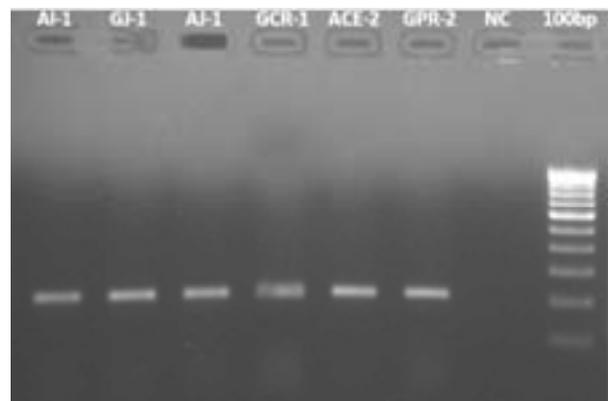


Fig. 20: Bacterial isolates showing genus specific band of 203 bp

Fermentation of Sugars: HiCarbo was used to analyse the set of sugars by different isolates. Out of 41 bacterial isolates found positive for Lactobacillus genus, 5 were identified for further studies.

CANDIDATE GENE ANALYSIS FOR LOCI AFFECTING SPERM QUALITY AND FERTILITY OF CHICKEN (DST Sponsored)

Single Nucleotide Polymorphisms (SNPs) in exon 3 & 4 of the GnRHR (Gonadotrophin Releasing Hormone Receptor) gene was detected in the genome of male white broiler chicken of control, SML and SDL. Further research in this direction is under progress. Sperm quality attributes of individual birds like volume, mass motility, sperm concentration, live sperm, normal sperm and fertility percentage in broilers showed a wide range of variation (Table 15).

Table 15: Various quality attributes of broiler chicken spermatozoa

Quality attributes	Minimum	Maximum	Mean	Std. Error
Volume (μl)	254	1395	76535	33.67
Mass Motility (%)	11.67	83.33	61.77	2.15
Sperm Concentration ($\times 10^9$)	0.07	5.78	3.74	0.20
Live Sperm (%)	29.73	93.82	70.89	6.89
Normal Sperm (%)	46.79	89.76	67.98	7.57
Fertility (%)	21.33	87.96	55.23	9.79



Regional Centre, Bhubaneswar

RESEARCH ACHIEVEMENTS

MAINTENANCE, EVALUATION AND CONSERVATION OF IMPORTANT BREEDS OF DUCKS FOR AUGMENTING DUCK PRODUCTION IN RURAL AND TRIBAL AREAS

Animal Genetic Resources: The adult stocks of four duck breeds (viz. Khaki Campbell, Desi, White Pekin and Moti) of G-1 generation exhibited the average body weights at 20 week as 1496.85, 1511.69, 2526.42 & 1773.32 g in respective breeds. The mean body weights at 40 week for corresponding breeds were 1406.38, 1289.68, 2148.59 & 1782.77 g. The average egg production up to 40 week of age were 94.29, 77.55, 77.21 & 25.28 eggs in respective breeds, which were higher than the base (G-0) generation. Similarly, the mean 40th week egg weights for corresponding breeds, recorded as 64.77, 65.82, 73.03 & 69.67 g, which were higher than egg weights of the base generation.

In G2 generation of Khaki Campbell, Desi, White Pekin, Moti breeds and DK & PK crossbreeds fertility percentage estimated on pooled records over the hatches, was observed as 56.67, 59.54, 60.34, 30.00, 75.49 and 68.43% for respective breeds and cross breeds. The per cent hatchability on total egg set & fertile eggs transferred basis was found to be 51.76 & 91.32; 55.43 & 93.08; 54.56 & 90.42; 10.48 & 34.95; 74.66 & 98.90 and 66.24 & 96.80% for corresponding breeds/crossbreeds. The highest fertility was recorded for DK crossbred followed by PK crossbred with almost similar trends for hatchability. Both the fertility and hatchability were better than the previous generation.

Table 16: Juvenile parameters of Pekins (2013-14)

No. hatched	BW4	BW6	BW8	Mortality (0-4 wk)	Mortality (0-6 wks)	H% (FES)
1156	950.48 ±13.26	1456.7 ±23.11	1742.35 ±27.26	3.5%	4.8%	>80.0%

DK=Desi x Khaki Campbell; PK=Pekin x Khaki Campbell

The pooled body weights of different duck breeds/ crossbreeds at day old age were recorded as 38.23, 42.58, 43.94, 39.03, 35.62 and 36.79 g, respectively, for Khaki Campbell, Desi, White

Pekin, Moti breeds and DK & PK crossbreeds. The pooled mean body weights for corresponding breeds/crossbreeds at 4 weeks of age were observed as 542.95, 528.99, 429.84, 404.38, 496.45 and 548.99 g. Corresponding average body weights at 8 weeks of age were 1080.01, 1075.92, 1277.96, 1471.00, 924.06 and 1043.95 g. Performance evaluation for growth traits of remaining hatches and egg production traits of different hatches of various breeds/ crossbreeds (G-2 gen) is under progress.

Evaluation, maintenance and utilization of Pekin breeds of ducks: Individual culling level (for BW6: 1500g for ♂ & 1400g for ♀; for BW8: 2000g for ♂ and 1700 for ♀) was fixed for the Pekins based on which best breeders were retained and bred for the 2014-15 generations. A total of 916 ducklings were hatched which were evaluated for juvenile body weights. In general, it was seen that juvenile weights of Pekins kept fluctuating over generation (Table 16 and 17). Pekin of previous generation recorded the duck-day egg production of 172 eggs for E.P upto 52 weeks of age and 266 eggs for E.P upto 72 weeks of age; however, confirmation of results is required in future generations.

Table 17: Mean parameters of Pekins (2015) for different traits

Trait	No. hatched	BW4	BW6	BW8	H% (FES)
H1	108	526.79 ±12.207	1086.69 ±19.407	1811.82 ±22.208	73.5
H2	118	541.04 ±13.203	1006.22 ±18.793	1300.82 ±18.822	67.7
H3	210	598.59 ±10.099	1031.69 ±13.750	--	80.2

INVESTIGATION INTO THE REPRODUCTIVE PHYSIOLOGY AND SEMEN CHARACTERISTICS OF DUCKS TO AUGMENT FERTILITY AND HATCHABILITY

Study of diluents in duck semen and artificial insemination for optimum fertility: Three conventional semen extenders viz. BPSE, Lake's diluents and Ringer's Lactate those are commonly used in chicken were tried for white pekin duck semen (2 parts semen: 1 part diluent). Motility, live sperm percent, MBRT and Hypo-osmotic swelling

test were conducted at 0hr, 1hr and 2 hrs. Simultaneously artificial insemination in laying ducks was done at same time interval. Eggs collected were subjected for incubation. Candling of eggs on 14th day was done to find the fertility percent. The observation revealed no significant improvement with any of the dilutors used. An intensive study in this regard including environment of sperm storage tubule is under progress.

Study of productive and reproductive performances of CB ducks (WPxKC) produced through artificial insemination: Artificial insemination in Khaki Campbell ducks using the semen of White pekin ducks was done. Eggs were incubated and three hatches of ducklings were produced. The day old ducklings were brooded and maintained under normal intensive management practice. Bi-weekly body wt upto 5th month of age and body weight at sexual maturity (female), no of egg production up to 50 wks of age, daily egg wt, carcass quality at 4th month, feed conversion ratio, mortality percent and study of various body conformation and egg traits were recorded to assess the performance of the birds. One group of such ducks were also reared in rice based farming system adopting semi-intensive practice. It was observed that CB ducks (WPxKC) perform better with least mortality in both type of management practices. The birds may be best suited in rural duck production practice due to the multi-color plumage, better scavenging ability and may be treated as a dual variety duck for optimum economic gain.

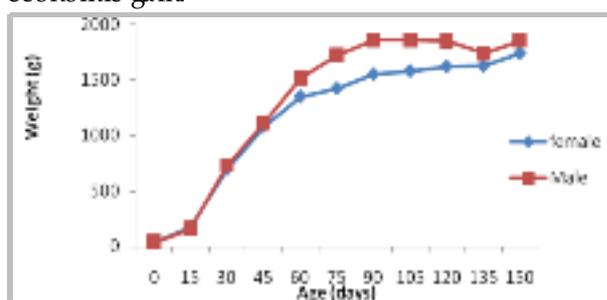


Fig. 21: Growth of CB (WPxKC) ducks under intensive system of management.



CB (WPxKC) ducks in backyard

Nutrient requirements of ducks

Reduction of dietary protein requirement through supplementation of synthetic amino during starter stage (0-8 weeks):

An experiment was conducted to study the performance of Khaki Campbell ducks on reduced levels of dietary protein than required recommended level through supplementation of synthetic amino acids like L-Lysine and DL-Methionine. For this experiment 360 Nos. of day old ducklings were taken and randomly divided into three groups having three replicates in each group with 40 ducklings in each replicate. Three experimental diets were prepared containing 22%, 20% and 18% crude protein. The level of essential amino acids like L-Lysine and DL-Methionine was balanced through supplementation of their synthetic form. Care was taken to balance the level of metabolizable energy content of all the diets. The experimental diets were fed upto 8th weeks of age. The required feed was offered ad libitum twice daily. Provision of clean drinking water was there for round the clock. The birds were maintained in deep litter system. Daily feed offered and residue left and weekly body weight were taken upto 8th weeks of age. After 8th weeks of age a metabolic trial was conducted to determine the metabolizability of the nutrients in different treatment groups. The final body weight (8th week) was 1245.17±12.24, 1229.47±24.57 and 1212.40±37.83 in 22%, 20% and 18% CP fed groups, respectively. No significant differences were observed between the groups. The dry matter (DM) digestibility in 22%, 20% and 18% CP fed groups was 80.61±0.41, 79.30±0.54 and 76.76±0.54, respectively. The DM digestibility was significantly ($P \leq 0.05$) higher in 22% and 20% CP fed groups than 18% CP fed groups. From this experiment it was concluded that level of crude protein in the diet of Khaki Campbell ducks can be reduced to 20% provided the level of essential amino acids are maintained at par with 22% CP in the diet without affecting growth and digestibility.

Reduction of level of dietary protein requirement of Khaki Campbell ducks during grower stage (8-16 weeks) through supplementation of amino acids:

An experiment was conducted to study the performance of Khaki Campbell ducks on three different levels of protein i.e. 12%, 14% & 16%. Care was taken to balance the level of essential

amino acids like L-Lysine and DL- Methionine through supplementation of their synthetic form. For this experiment 207 Nos. of grower ducks of 8 weeks of age are randomly divided into three groups having three replicates in each group. Care was taken to balance the level of metabolizable energy in all the treatment groups. Measured quantity of the experimental ration was offered twice daily as wet mash. The residue left was collected in the next day morning before feeding. Clean drinking water was supplied ad libitum. Average daily feed intake and bi-weekly body weight was recorded. A metabolic trial was conducted at the end of 16th week to study the nutrient availability in different treatment groups. The dry matter (DM) digestibility was 76.27±0.13, 77.17±0.65 and 79.65±0.73 in 12% CP, 14% CP & 16% CP fed groups, respectively. The final body weight (16th week) was 1450.33±4.67, 1429.00±27.79 and 1452.33±22.00 in 12% CP, 14% CP & 16% CP fed groups. From this experiment it was concluded that the level of dietary protein in grower ration can be reduced to 12% with supplementation of synthetic L-Lysine and DL-Methionine to balance their level of the diet containing 16% CP.

Reduction of dietary protein level in Khaki Campbell layer ducks through supplementation of synthetic amino acids: To study the performance of Khaki Campbell ducks on different levels of crude protein (CP) during layer stage, an experiment was conducted on layer ducks from 20-40th weeks of age. A total of 135 Nos of ducks of 20th weeks of age are randomly divided into three groups having three replicates in each treatment with 12 female and 3 males in each replicate. Three experimental rations containing 14% CP (T1), 16% CP (T2) and 18% CP (T3) were offered twice daily throughout the experimental period from 20th - 40th weeks of age as wet mash. Care was taken to balance the level of L-Lysine and DL-Methionine in all the rations. Clean drinking water was provided ad libitum throughout the experimental period. The birds were raised in deep litter system with rice husk as the litter materials. Average daily feed intake, egg production and egg weight were recorded throughout the experimental period. At the end of 40th week a metabolic trial was conducted. The duck day egg production was 61.14±6.31%, 73.92±2.65% and 74.77±6.02% in T1, T2 and T3, respectively.

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

Production of azolla (*Azolla pinnata*) in Silpauline pit: A pit (2.0m x 2.0m x 0.02 m) on ground was made in partially shady place. It was covered with green net to avoid exposure to direct sunlight and aerial contamination. Single silpauline sheet (15.0 ft x 12.0 ft) was mulched through the entire pit as inner covering to catch hold the water. Fertile soil (~ 10 kg), cow dung (2.0 kg), superphosphate (30.0 g) mixed with 10 litres of water was spread in the pit. Further addition of water was made to maintain the water level of 10 cm height in the pit. Azolla (*Azolla pinnata*) culture (500 g) was added to the pit by uniform spreading over the water surface. Fertilizer (1.0 kg cow dung and 20 g superphosphate) was added to the pit to enrich the water for proper growth of azolla. Replacement of fresh water (~ 25 percent) in the pit was made in every 10th day so as to maintain a fixed water level (10 cm) in the pit. Observations were made regularly for growth of azolla in the pond. It was recorded that more than 500 g of azolla was harvested from one pit everyday beyond 10th of culture inoculation.



Regular production and harvesting of azolla from the silpauline pit

Surveillance and monitoring of duck diseases and their bio-security measures

Monitoring of duck diseases and their bio-security measures: A total of 1117 ducks (dead) were presented for post-mortem from the existing stock of RC CARI during the year under report. It was found that the average mortality percent was 2.40 which is less than that of previous years. Mortality rate was highest during February (8.77%) and minimum (0.46%) during May. The various causes of mortality presented (Fig. 22).

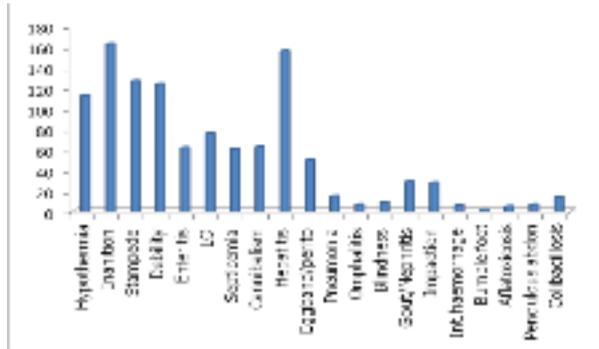


Fig. 22: Causes of mortality in ducks (RC CARI farm) as per autopsy finding.

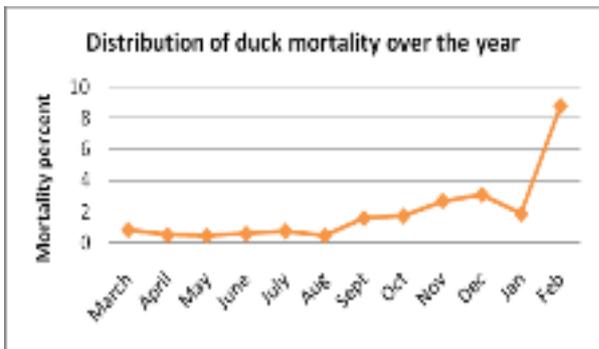
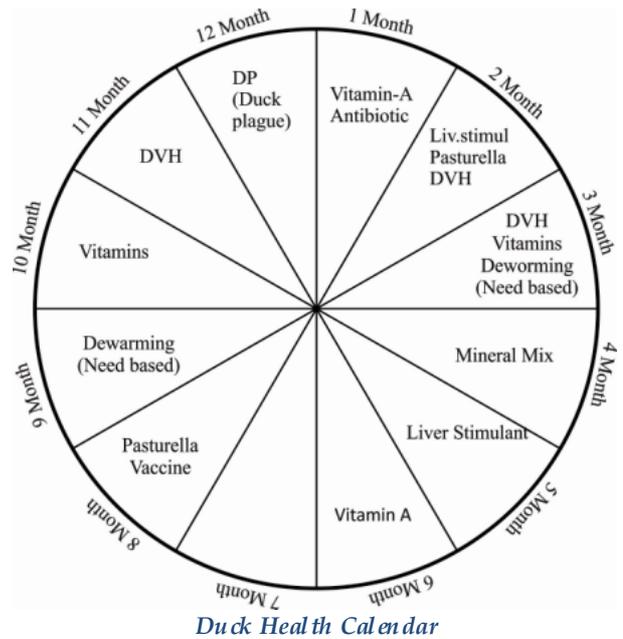


Fig. 23: The mortality of ducks observed during different months of the year is presented.

Diseases like amyloidosis, pericarditis, trichobezoar, pyometra (salpingitis), duck plague, predation, drowning and ascites were not reported this year. Specific infectious diseases like Colibacillosis was reported. Age wise highest mortality recorded in ducklings (1.41%), adult (0.65%) and least in grower (0.32%).

Development and improvement of diagnostics through Health Calendar: Based on the epidemiological pattern round the year, a health Calendar for duck was developed. It was modified to accommodate some other inputs as-well-as duck viral hepatitis (DVH) vaccine. Implementation of modified Duck Health Calendar helped in reducing the Duck mortality to a great extent.



Diversified rice based farming system for livelihood improvement of small and marginal farmers (Collaborative project)

Day old ducklings of cross-bred (WPxKC) ducks (97 nos) were brooded and introduced into the rice-based farming system of ICAR-Central Rice Research Institute, Cuttack. The ducks were allowed to graze in the rice field after one month of rice plantation. The ducks used to remain inside the rice field for 5-6 hrs daily. Little supplementation of feed (broken rice, rice bran and crushed wheat) was offered to birds @ 40g per day. Growth performance, mortality, age at sexual maturity and laying up to 35 wks of age (till rice harvest) were recorded. Observation revealed that duck production in rice field is economical and beneficial. The detail data regarding rice production and total output will be evaluated at the end of the project.



Duck (WPxKC) production in Experimental rice field at ICAR-CRRI, Cuttack

Backyard poultry and duck production as a tool to sustainable livelihood for rural women of Khurda district of Orissa (DST project)

The above project funded by Department of Science and Technology (S & T for Women) was prepared and implemented with an aim to empower the unemployed women of rural Orissa through livelihood improvement of the family. Also the project aims at extending nutritional security to the farmer family. The project was in operation in Kukudamundi, Jamujhari, Guptapada, Dalua, Mundasahi, Haridamada and Kantabada villages of Jatani block of Khurda district. Under the project 197 farmers were adopted against the Initial target of one hundred women farmers in five villages. Hundred and three units of backyard poultry were continued, and 94 duck units were initiated during the year 2014-15. The project continued on extension for one year (in two spells of six months each) and completed successfully on 23rd Feb 2015.

During the last year of project operation (2014-15) emphasis was given on continuation of practice by the farmers of their own. Most of the farmers procured the critical inputs from their own source (profit of previous years). Only the new participants and few existing women farmers were supplied inputs from project source. No commercial feed was supplied. Linkages between CPDO and farmers were established for procurement of colored chicks (2012 DOC). Ducklings were supplied from RC CARI as per the requirement of the farmers. The local veterinary dispensary extended co-operation and support for vaccination of adult laying birds with R2B and also for Lassota vaccination of chicks undergoing brooding (3677 doses). Few farmers constructed wooden houses and majority have improved the existing duck/chicken houses with wire netting which expressed their keen interest for continuing the practice and reliability on CARI models implemented by them for last few years.

Operational Area of the Project



District : Khurda

Block : Jatani

- Villages (Beginning):
- 1) Kukudamundi,
 - 2) Jamujhari,
 - 3) Guptapada,
 - 4) Dalua
 - 5) Mundasahi

- Villages added:
- 1) Chattabar
 - 2) Haridamada
 - 3) Kantabada



Distribution of critical input to the adopted women farmers.



Poultry house constructed by farmer



Brooding of chicks and ducklings in operational area

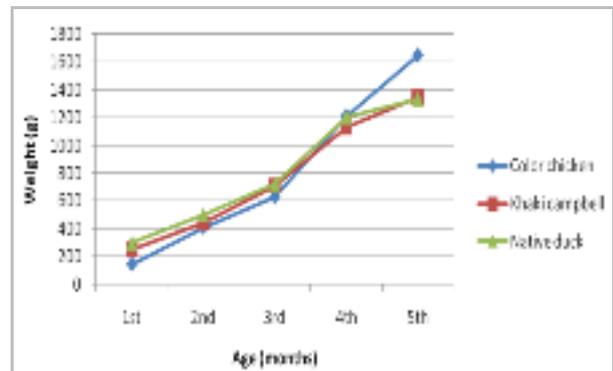


Lassota vaccination R2B vaccination against R.D.

Production performances of the birds (both chicken and ducks) were assessed by project personals. Since the same women farmers were doing the same practice since inception of the project, it was observed that regular monitoring was not needed by most of the farmers.

On the other hand, they guide the newly joined farmers to a great extent. In this context, a question-answer session was conducted in two villages during the field day programme and felt that the level of basic knowledge regarding backyard chicken/ duck production was significantly increased among the women farmers those were adopted from the first year of operation.

Growth performances of birds: The growth performances of birds supplied to the women farmers of different villages under DST programme were assessed and compared. Dual purpose colored chicken grow faster than two varieties of ducks. But, they are prone to attack by predators. On the other hand, colored chicken fetches little better price. So, farmers are tempted to sell the chicken at the early age with out waiting for egg production, where as they keep the ducks for longer period and used to get good number of eggs.



Growth performance of colour chicken and ducks in backyard



Adult color chicken flocks in different villages under operation (DST)



Adult ducks (Khaki campbell and Native) in different villages under operation (DST)

Success of CARI Models

CARI models i.e. “CARI-model of backyard chicken production”; “CARI-model of duck rearing in polythene ponds” and “CARI-model of rural duck production” which were being implemented by the adopted women farmers achieved great success for economic return point of view. The successful farmers could able to generate at-least one thousand rupees per month, which aids a great help to run the family.



Successful CARI- Models of backyard chicken and duck production in five villages

Capacity building

Many trainings, field demonstrations and displays through different tools were done in the village level to build confidence and make the farmers capable of doing bare necessary things like vaccination, house construction etc. It was aimed for the continuation of the programme even after the completion of the project. The success was recorded.

Impacts of backyard poultry and duck rearing on the women farmers of five adopted villages: A questionnaire was developed to record the impact of the project on women farmers. A total of 100

nos of adopted farmers of five villages were interacted. Their gain in knowledge about backyard poultry and duck production along with social developments was recorded. The salient observations found were:



Demonstration through i-pad

- i) Ranikhet disease through vaccination was important for success of backyard poultry production.
- ii) CARI-Devendra variety of chicken is performed better than other three varieties introduced through the project.
- iii) Successful Brooding of chicks/ducklings is key to success of backyard poultry production in rural condition.
- iv) Disposal of male birds (chicken/drake) from the flock by 4 months of age is proved to be the best innovative idea for maximum profit to the farmer.
- v) Brooding of chicks/ducklings before and after winter is ideal in the villages where there is no electricity supply.
- vi) Feeding white ant to chicks keeps the bird healthy.
- vii) Ducks need more feed than chicken.
- viii) Mortality is less in ducklings as compared to

chicken.

- ix) "Duck rearing in polythene pond" is a miracle told by few women farmers.
- x) Duck production as a group activity through SHGs is highly successful.
- xi) Field demonstration is beneficial for backyard chicken and duck rearing.
- xii) A dual purpose duck variety with multi-color plumage need to be developed.

Social Impact

Our observation in all the five operational villages revealed the change in social aspect of the farmers which can be summarized to:

- 1) Co-operation between the DST adopted farmers in each of the five villages found encouraging w.r.t. technology dissemination.
- 2) The adopted women farmers of all the villages behave like a self-Help-group even though they had not formed any SHG.
- 3) Non-adopted women farmers (those denied to join as participant in the beginning) of the operational villages showed their keen interest to join the programme as a bona-fide participant after seeing the success by others.
- 4) Women farmers started visiting the Veterinary dispensary (vaccination), CPDO (day old chicks) and block office (Govt ongoing programme for livelihood) and other organizations which symbolizes their social development.
- 5) It was observed that male members of the family extended support and co-operation to their female counterpart for poultry house construction, polythene pond preparation, marketing of eggs and birds in the local market and purchase of medicines for smooth operation of the chicken/ duck unit



P.G. Students' Research

Thesis title: Evaluation of certain stress alleviating agents in broiler chicken during hot dry and hot-humid summer using zoo technical, molecular and physio-biochemical tools (Thesis submitted to IVRI deemed University)

Scholar: Dr. Rokade Jaydip Jaywant, Roll No. 1441;
Advisor: Dr. AB Mandal

Four different stress alleviating agents such as vitamin E (150 and 250 mg/kg), aspirin (250 and 500 mg/kg), MOS (0.3% and 0.5%) and magnesium sulphate (1.2 and 2.4 g/kg) were used during hot (April-May: Temp., 31.0-37.0°C, RH, 58.0-70.1%) or hot humid (Aug- Sept: Temp., 26.0-34.2°C and RH, 76.3-86.1%) summer in broiler chickens. Each dietary treatment was fed to four replicated groups of 8 birds each. The humoral and cell mediated immune response was studied on 28th day post-hatch. Hematological parameters (hemoglobin and H:L ratio), blood biochemical's (total protein, cholesterol, AST and ALT) and expression of HSP70 in jejunum tissues were studied on 28th and 42nd day of age.

Supplementation of vitamin E at 150 mg/kg diet improved production performance ($P < 0.001$), breast and liver yield ($P < 0.05$), immune competence ($P < 0.05$) during extreme hot and hot-humid summer. The relative expression of HSP70 gene in jejunum was down regulated in hot and hot-humid summer when vitamin E was added @ 150 mg/kg or 250 mg/kg diet. Dietary supplementation of aspirin (500 mg/kg) was beneficial in reducing the adverse effects of high ambient temperature during extreme summer by improving growth, immunity ($P < 0.001$), hematological, biochemical profile and down regulation of HSP70 expression. Supplementation of MOS at 0.3% or 0.5% in diet improved body weight (hot summer), feed conversion ($P < 0.001$) and other welfare parameters during hot and hot-humid summer, but was more beneficial during hot-humid summer. MOS at lower concentration down regulated the expression of HSP70 in jejunum at 28th as well as 42nd day of age. Addition of $MgSO_4$ @ 1.2 and 2.4 g/kg basal diets improved body weight ($P < 0.01$), feed conversion ($P < 0.001$), immune response, hematological and biochemical profile, and other welfare parameters during both

hot and hot-humid summer but results were more encouraging during hot-humid summer. Addition of $MgSO_4$ at both level down regulated expression of HSP70 in jejunum. It was concluded that as all the nutritional supplements tried had beneficial functions in heat stressed birds. Thus premixes of such ingredients can suitably be developed for heat stressed broilers for improved performance, welfare and feed-cost efficient production.

Thesis title: Interaction of floor space, energy level and feed enzyme supplementation in diet of growing turkey.

Scholar: Dr Dev Kumar/MVSc/5196

Advisor: Dr S. Majumdar

The response of 'White turkey' (CARI VIRAT) at two floor space (1.25 and 1.90 sq. ft/poults) and three energy levels (2400, 2600 and 2800 ME kcal/kg) with or without supplementation (multi-enzyme cocktail @ 250g/ton) in a 2x3x2 factorial design was studied during 8-16 wk of age. Results indicated that body weight (BW), body weight gain (BWG), feed intake (FI) and feed conversion ratio (FCR) did not differ significantly due to floor space and enzyme supplementation, however higher performance index (PI) was recorded in 1.25 sq.ft. Cumulative FI and FCR were significantly ($P < 0.01$) lower in 2800 kcal/kg dietary group. The PI was significantly higher in 2600 and 2800 kcal/kg. Most of the growth parameters differed significantly due to interaction between space and energy. Spleen weight was significantly higher in 2400 and 2600 kcal/kg ($P < 0.01$) and in enzyme supplemented groups. Spleen and bursa weight differed significantly ($P < 0.05$) due to interaction of space, energy and enzyme. Cell-mediated immunity was significantly higher ($P < 0.05$) in 2800 kcal/kg. Serum biochemical were higher in 1.9 sqft or 2400 kcal/kg. Shrinkage loss, dressing yield and eviscerated yield were significantly higher ($P < 0.01$) in 1.25 sqft or in low energy diets. Space, energy and enzyme interaction influenced breast ($P < 0.01$), drum stick ($P < 0.05$) and wing ($P < 0.01$) yield. Dry matter or energy metabolism and N-retention were significantly higher ($P < 0.05$) in 1.25 sqft and 2800 kcal/kg. But fiber digestibility was

significantly higher ($P < 0.01$) in 2400 kcal/kg & in enzyme supplemented diet. Feed-cost/kg meat was significantly ($P < 0.05$) lower in 1.25 sqft and high energy diet. Feed-cost/bird differed significantly ($P < 0.01$) due to interaction of space and energy. It is concluded that the optimum floor space and energy requirement in battery cages was 1.25 sqft/bird 2600 ME kcal/kg, respectively for growing turkey poults. Feed enzyme supplementation was not found to be beneficial.

Thesis title: Estimation of crossbreeding parameters in a diallel cross of native chicken breeds with CARI-Red for growth and immunocompetence traits

Scholar: Dr Lata Kurrey/5199;

Advisor: Dr D.P. Singh

A complete 3×3 diallel cross experiment using three chicken breeds i.e. Aseelpeela (AP), Kadaknath (KN) and CARI - Red (CR) was undertaken to evaluate efficiency of pure and cross breeding performance with respect to body weight, conformation traits, weight gain, carcass quality traits, immune organ and immunocompetence traits. Griffing (1956) and Hyman (1954) methods were used for combining ability analysis. Body weight, conformation and carcass quality traits differed significantly between mating system and among the genetic groups. CR had highest body weight at all the ages of measurement in male, female as well as for combined sex. AP \times CR had higher body weight than all other crosses. Crossbreds were superior than pure breeds for conformation traits (SL, KL and BA), FCR and mortality %. Significant GCA and SCA under model A suggested that the improvement of crossbred can be brought about by modified RRS method of selection. Reciprocal difference, suggests use of specialized sire and dam line for profitable commercial chicken production. Cross AP \times CR showed higher humoral immune response against RDV and female progeny of CARI-Red pure bred showed higher CMI response against PHA-P. Gompertz model was found to be best fitted for growth pattern of male and female of all the genetic groups. It is concluded that the crossbreds were superior to purebreds for body weight, body weight gain, conformation traits and carcass quality traits. The Griffing method was better than

Hayman's method for calculating combining ability.

Thesis title: Study on decontamination of Salmonella Enteritidis on dressed chicken meat using antimicrobials in combination with thermal treatment

Scholar: Dr K. Karuppasamy/MVSc/5197

Advisor: Dr AS Yadav

An experiment was conducted to study the growth profiling of normal and starved (nutrient deprived) cells of Salmonella Enteritidis (SE) under different incubation temperatures. Results of growth profiling indicated that there were no notable difference in growth of SE (both starved and normal cells) at incubation temperatures of 30 and at 50 kl and 42 degree C, however, there was appreciable difference in growth profiling at 30 and at 50 and 58 degree C with SE surviving at all temperatures. Further, thermal inactivation of normal and starved cells of SE on dressed chicken skin surface with pre-dipping in different concentrations of acidified sodium chlorite (ASC) or tri-sodium phosphate (TSP) was carried out. Results indicated that time required to inactivate 5 log₁₀ normal SE cells was 14 min, 5.83 min and 2.92 min at 60, 64 and 68 degree C, respectively. Skin samples with pre-dipping in 100 ppm ASC showed 5 log₁₀ reductions in 7, 2.33 and 1.16 min at 60, 64 and 68 degree C, respectively. Again, 200 ppm showed 5 log₁₀ reductions in 3.5, 1.17 and 0.58 degree C, respectively; while with 1.0% TSP the time required for 5 log₁₀ starved SE cells, in this study was 21, 10.5 and 3.83 min at 60, 64 and 68 degree C respectively. Skin samples with pre-dipping in 100 ppm ASC showed 5 log₁₀ reductions in 14, 5.53 and 1.92 and 1.02 min. In a similar experiment carried out with TSP, we obtained 5 log₁₀ reduction with pre-dipping in 0.02% TSP the time required for 5 log₁₀ reductions at 60, 64 and 68 degree C was 7, 3.5 and 1.02 min. Likewise, similar pattern of inactivation was seen in total viable counts. D-values determined by linear regression, for normal cells on chicken skin, were 2.78-2.8, 1.15-1.19 and 0.53 min, while D-values for starved cells were 4.11-4.19, 1.82-1.84 and 0.64-0.67 at 60, 64 and 68 degree C respectively (with different controls for ASC and TSP). Similarly z values calculated for normal cell was 3.52-3.55 degree C and for starved cells, it was 2.25-2.33 degree C. When SE cells were heated on

skin with pre-dipping in 0 to 200 ppm of ASC or 0 to 1.0% TSP, D-values calculated were consistently less at all temperatures. z-values and D-values obtained in this study were used for the calculation of 7log10 reduction of SE at 60 degree C. Time calculated for 7-D reduction with or without antimicrobials was used for the decontamination of dressed chicken. After all treatments, a sensory of cooked poultry meat with intact skin was conducted for the evaluation of

product quality. Sensory and pH results indicated no significant difference for control and treatments. The results of this study indicated the addition of antimicrobials on dressed chicken skins effectively alter sensitivity of SE to the lethal effect of heat and these antimicrobials can be used for effective decontamination of dressed chicken SE without affecting organoleptic quality of the dressed poultry meat.



Technology Assessed

- Commercial chicks of CARI Nirbheek, CARIBRO Dhanraja and CARI Debendra were assessed for their production performance by supplying them to farmers and different organizations of country.
- Processing technology for development of turkey breast filets was standardized.
- Processing technique for development of instant emu egg noodles has been standardized.
- Duck rearing in polythene ponds- an innovative technology for rural farmers was assessed.
- Dual purpose chicken CARI Debendra and Ducks- Khaki campwel and native duck rearing under backyard poultry was assessed for production performance

TECHNOLOGY TRANSFER ACTIVITIES

Kisan Goshthies organized

Four kisan goshthies were conducted during the year. First kisan goshthi was conducted 31st May, 2014 at Chadani, Banbasa in Champawat district of UK. The problems encountered by poultry farmers in rearing the broilers were suitably addressed by the scientists. Second kisan goshthi was organized on 16th July, 2014 on occasion of ICAR Foundation Day. The topic of discussion was poultry production in present climatic conditions. The experts of the institute delivered the lectures on various aspects of poultry production keeping in mind the changing climate.



Kisan goshthi at village Navdia Harkisan

A kisan goshthi was also conducted on 18th Sept., 2014 at adopted village panchayat Navdia Harkisan to discuss the problems of farmers who

were rearing CARI Priya layer and CARI Debendra dual purpose chicken under semi-scavenging system of poultry farming.

Another kisan goshthi was organized on 2nd Nov. 2014 on the occasion of 36th Foundation Day of the institute. This event was given wide publicity in and around Bareilly district through farm visits, broadcasting on AIR and telephonic contact. During this kisan goshthi, lectures on commercial broiler farming, preparation of balanced broiler feed, disease management of poultry, desi breeds for backyard poultry, diversified poultry farming, and govt. schemes for poultry farming were delivered by the scientists of the Institute. The major problems enumerated by the poultry farmers were on diseases of poultry, low market price of live chicken, high cost of feed and availability of quality chicks. These were replied suitably in detail by the experts.

Participation/Organization of Exhibitions

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

- Kisan Mela-2014 organized by IVRI Mukteswar on 28th Oct., 2014 at Meuda, Ritha Pokhara, Nathuakhan, Dist. Nainital (UK).
- ASC-India Expo-2015 jointly organized by NAAS, New Delhi and NDRI, Karnal from 3-6th Feb., 2015 at Karnal (HR).
- Northern zone Regional Agricultural Fair-2015 jointly organised by IVRI, Izatnagar and DOE, min. of. Agril. New Delhi from 17-20th March, 2015 at IVRI, Izatnagar.
- Organized Poultry exhibition-2015 at CARI, Izatnagar on 2nd November, 2014.

Awareness camp for women entrepreneurs

An awareness camp for women entrepreneurs was organized at Navdiyaharkisan gram Sabha of Bithrichenpur block of Bareilly district of Uttar Pradesh. Women scientists of the institute also participated actively. A total of 34 women farmers attended the programme. Various issues related to poultry production were discussed viz. low cost poultry feed and nutritious

protein rich value added poultry egg and chicken, suitable rural poultry breeds and solution of related to various problems in poultry production in general. Farmers were apprised regarding performance of various rural type poultry germplasm like CARI-Devendra, CARI-Shyama, CARI-Nirbhik and practices for rearing them. The farmers were motivated and educated towards the rural poultry practice for better health and production.



Foundation Day Celebrations

The Institute celebrated its Foundation Day on 2nd Nov, 2014 by organizing a kisan mela. The five progressive poultry farmers were also awarded for running their poultry farms successfully with adoption of CARI technologies. An exhibition on diversified poultry was also put up, wherein, live quality germplasm of chicken, turkey and guinea fowl, low cost housing models, and extension activities were exhibited to the poultry farmers. The institute also promoted poultry products through promotional sale during the mela and Kisan goshthi was also held. The five progressive poultry farmers were also awarded for running their poultry farms successfully with adoption of CARI technologies.

Farmer-Industry-Scientist

The Farmer-Industry-Scientist (FIS) meet was held on March 02, 2015 to discuss the emerging issues being faced by the poultry industry

involving leading poultry farmers of Haryana, Punjab, Uttarakhand and Uttar Pradesh, leading poultry consultants, representatives from industry throughout India, Govt. Representatives, policy makers, animal welfare activists and Scientists of CARI, DPR and SAUs. Dr. Arun Varma, Former ADG & Acting DDG (Animal Sci), ICAR, New Delhi was the chief guest of the function. In the inaugural session, Dr. A.B Mandal, Head, AN&FT & Organizing Secretary FIS meet welcomed the delegates including progressive farmers, industry personals, Government of India's representatives, poultry consultants, animal welfare activists and scientist from different parts of India. Dr. J.M. Kataria, Director, CARI and organizing chairman, briefed the participants about the Farmer-Industry- Meet.



Supply of Germplasm: In order to promote diversified poultry production in the country, high yielding germplasm as parent stocks and commercial crosses were supplied to various agencies in different pockets of the country (Table 18).

Table 18: Supply of germplasm (2014-15)

Germplasm supplied	Fertile eggs		Day-old chicks		Growers	Adults	
	Parent line	Commercial	Parent line	Commercial		Parent line	Commercial
Layer chicken	2870	1988	12973	882	270	835	105
Broiler chicken	9260	21364	-	42273	606	-	1287
Desi fowl	1000	-	412	7520	-	51	-
Guinea fowl	190	-	-	-	16	390	-
Turkey	-	-	-	2114	-	562	-
Duckling	-	-	-	70067	-	-	-

Education and Training

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

Poultry Science Students on Roll

- MVSc- 28, PhD- 21
- NDPH- 2

Poultry Science Courses Offered

- MVSc/PhD- 97 courses
- NDPH- 24 courses

Poultry Science Degree Awarded

- MVSc- 9 students (Avian Genetics and Breeding-3, Avian Nutrition and Feed Technology-3, Avian Physiology and Reproduction-1, Post Harvest Technology-1, Poultry Housing Management-1)
- PhD- 3 students (Avian Genetics and Breeding-2, Avian Nutrition and Feed Technology-1)

Seminars Organized

- Faculty Seminar-1, ORW Seminar-17, Major Credit Seminar-17, Minor Credit Seminar-10 and Pre-Thesis Submission Seminar-12

Specialized Training Courses

S.No.	Training courses	Duration	Trainee	Benefactor
1.	Broiler Production	16-28 June, 2014	01	Sambhal (U.P.)
2.	Poultry Feeding and Quality Control	10-22 November, 2014	05	Shrinagar (J&K)
3.	Layer Production	11-23 August, 2014	24	East Champaran (Bihar) Deoria, Faizabad and Gorakhpur (U.P.)

International Short Term Training

S.No.	Training courses	Duration	Trainee	Benefactor (Name and country)
1.	International Training Programme for SAARC member countries on Advances in Poultry Nutrition and Feed Technology	06- 15 April 2014	14	Sri Lanka, Bangladesh, Nepal, Bhutan, Maldives and India



Awards and Recognition

Awards/ Recognition

- The Institute received first Best Stall Award during Northern zone Regional Agricultural Fair - 2015 held at IVRI, Izatnagar from 17-20th March, 2015.
- The Institute received third prize during Kisan Mela - 2014 held at IVRI, Mukteswar on 28th, Oct., 2014.
- Dr. Mandal, A.B. received ANA-Dr Usha Rani Mehra Lifetime Achievement Award for his contribution of animal science research in IX Biennial Conference on the theme Eco-responsive Feeding and Nutrition: Linking Livestock and Livelihood being held at AAU, Khanapara, Guwahati on 22-24, 2015.
- Dr. Chandra Deo, Dr. A.B.Mandal and Dr. Praveen K Tyagi received the first best research paper award for their paper on "Naked neck × white leghorn unde dene wali murgiyi me khaniz padartho ke pratidharan par vibhinn ahariya calcium avam justa ke stereo ka prabhava". During Hindi Chetna Mass (Sept.2014)at CARI Izatnagar.
- **Best poster Award** for research paper "Identification and characterization of calpains and calpastatin in chicken skeletal muscle authored by Biswas, A.K., Verma, R., Tandon, S., Saxena, V.K. and Jag Mohan. (2014) during 6th Conference of IMSA-2014" held on 28-30th Nov., 2014 at DUVASU, Mathura. Abstr. No. CFMQ-10:211
- Dr. D. Mondol received Rastriya Gaurav Award by Indian International Friendship Society on 24 November, 2014 at India International Centre, Max Muller Marg, New Delhi-110003.
- IPSA Dr. P. Kothandaraman Memorial Award, 2014 awarded to the research paper entitled "Screening of Lactobacillus Isolates from GIT of Guinea Fowl for Identification and Evaluation of Probiotics" authored by P.G. Vineetha, Simmi Tomar, V.K Saxena, Adil Khan during XXXI Annual Conference of Indian Poultry Science Association and National Symposium on *Poultry Production for Global Trade*. Dec 18-20. Namakkal, TN.
- IPSA Avitech Young Scientist Award, 2014 awarded to the research paper entitled "Metagenomic Analysis of Gut microflora of Guinea Fowl for Identification and Evaluation of Probiotic Lactobacillus sp." authored by P.G. Vineetha, Simmi Tomar, V.K Saxena, Sandeep Saran, Adil Khan, Mukesh Kapgate during XXXI Annual Conference of Indian Poultry Science Association and National Symposium on *Poultry Production for Global Trade*. Dec 18-20. Namakkal, TN.
- Dr. Simmi Tomar was selected and funded by UFAW, The Old School, Brewhouse Hill, Wheathampstead, St Albans, UK. to attend International Workshop on Keel Bone Damage in the commercial laying hen at Research Centre for Proper Housing of Poultry and Rabbits, Aviforum, Zollikofen, University of Bern, Switzerland held on April 7-9, 2014
- Dr. Sanjeev Kumar, elected (6.11.13 to 5.11.15) PG Faculty Representative to Academic Council, contributed significantly to Indian Veterinary Research Institute (Deemed University), Izatnagar for two years.



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	1971	-	Avian Genetics and Breeding Division, CARI, Izatnagar
2.	Development and evaluation of broiler dam Line	Dr. V.K. Saxena, PI Dr. Simmi Tomar, Co-PI Dr. Avishak Biswas Dr. Niranjana Lal (w.e.f. 20.9.2014)	1971	-	Avian Genetics and Breeding Division, CARI, Izatnagar
DBT, Govt. of India, New Delhi					
1.	Application of RNAi technology for augmenting broiler production	Dr. V.K. Saxena, PI Dr. K.V.H. Sastry, Co-PI	21.05.2010 (4 years)	44.09	Avian Genetics and Breeding Division, CARI, Izatnagar
2.	Identification of probiotic strain(s) from gut metagenome of assam indigenous chickens	Dr. V.K. Saxena, PI Dr. Simmi Tomar, Co-PI	07.01.2013 (3 years)	25.0	Avian Genetics and Breeding Division, CARI, Izatnagar
3.	Thermotolerance gene expression analysis in <i>Salmonella</i> Typhimurium and development of their thermal death time models applicable to poultry processing	Dr. A.S. Yadav, PI Dr. V.K. Saxena, Co-PI Dr. J.M. Kataria, Co-PI	19.07.2012 (3 years)	45.1028	Post-Harvest Technology Division, CARI, Izatnagar
DST, Govt. of India, New Delhi					
1.	Biochemical basis for detection of calpains and calpastatin and their role in post-mortem tenderization of meat	Dr. Ashim K. Biswas, PI	02.05.2013 (3 years)	21.82	Post-Harvest Technology Division, CARI, Izatnagar
2.	Backyard poultry and duck production as a tool to sustainable livelihood for rural women of Khurda district of Orissa	Dr. S.C. Giri, PI Dr. S.K. Sahoo, Co-PI Dr. S. Saran, Co-PI Dr. S.K. Mishra, Co-PI Dr. K.V.H. Sastry, Co-PI	10.01.2011 (till 23.08.2014)	15.947	CARI Regional Centre, Bhubaneswar
Inter-Institutional Collaborative Project					
3.	Identification RNA transcripts present in chicken sperm and their relation to fertility	Dr. Jag Mohan, CCPI Dr. R.P. Singh, Sacon	NA	NA	Avian Physiology and Reproduction Division, CARI, Izatnagar

List of Publications

Research Articles

- Aswathi, P.B., Biswas, A.K., Beura C.K. and Yadav, A.S. (2014). Physico-chemical and sensory characteristics of functional poultry meat finger sticks. *Int. J. Meat Sci.*, 48(2): 228-234 (Foreign Journal: NAAS Impact factor: NA).
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Technical/Popular Articles

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Biswas, A., Mandal, A.B. and Singh, R (2014). Biotechnological approaches for poultry feed industry in India. *Poultry Fortune*, 15(11): 44-48.

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Rashid, Tyagi, J.S., Sirajudeen, M., Mohan, J. and Raj Narayan. Effect of Elevated Temperatures during incubation on the post-hatch performance in Japanese Quail (*Coturnix coturnix japonica*). The CARI NEWS: XXVIII (2): 3.

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News Paper Coverage

Chicken meat bites, poultry meat wafers, finger chips and instant emu egg noodles etc developed under ongoing research project. Dainik Jagran, October 3, 2014.

Radio/TV Talk

Radio Talks Broadcasted from Akashwani, Bareilly

Raj Narayan (2014). *Barer palan ek swasth vyavasaye*. June 20.

Raj Narayan (2014). *Ba ter palan kitna labhkari*. June 31.

Raj Narayan (2015) *Kukkut palan aaj ki awasakta*. February 02.

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Radio Talks Broadcasted from Akashwani, Rampur

Sagar, M.P. (2014). *Backyard murgi palan*. October, 14 (Recorded).

Saxena, V.K. (2014). *Management of broilers birds*. October, 14 (Recorded)

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Participation of Scientists in Conferences, Workshops, Symposia, Trainings etc. in India and abroad

Sl. No.	Name of symposia/seminar/workshop	No. of scientists attended
1.	One month Orientation training from under FOCARS module at ICAR-CARI, Izatnagar, April 4-5, 2014.	1
2.	International Keel Bone Workshop-2014, ZTH, Bern University, Switzerland, April 7-9, 2014.	1
3.	SAARC regional international training on Advanced Avian Nutrition and Feed Technology, CARI, Izatnagar, India, April 06- 15, 2014.	2
4.	Global animal nutrition conference (Glance) on 'Climate resilient livestock feeding systems for global food security', Vivanta, Taj Yeshwantpur Bengaluru, India, April 20-22, 2014.	2
5.	Workshop on Priority Setting, Monitoring and Evaluation in NARES: Status, Experiences and Way Forward, NASC, Pusa, New Delhi, May 27, 2014.	1
6.	International Conference on Host-Pathogen Interactions (ICHPI), University of Hyderabad, Hyderabad, India, July 12-15, 2014.	1
7.	Three months Professional Attachment Training under FOCARS module at ICAR-CARI, Izatnagar, June 1 to August 31, 2014.	1
8.	Training programme on 'Knowledge management and knowledge sharing in organization', Indian Institute of Public Administration (IIPA), New Delhi, September 22-26, 2014	1
9.	National Seminar on "Revisiting Management Policies and Practices for Indigenous Livestock and Poultry Breeds as Eco-Friendly Economic Producers" and Silver Jubilee Convention of the Indian Society of Animal Production, NAU, Navsari, Gujarat, India, October 9-11, 2014.	1
10.	10th Asian Pacific Poultry Conference, ICC Jeju, Korea, October, 19-23, 2014.	1
11.	2 nd Annual Conference and National Symposium of Association of Avian Health Professionals on Integrating Poultry Health and Food Safety, Pune, Maharashtra, November 7-8, 2014.	2
12.	ICAR short course on Molecular characterization of bio-molecules using label-free biosensor and nanotechnology approaches for rapid, real time diagnosis of pathogens, ICAR-Indian Veterinary Research Institute, Izatnagar, November 17-26, 2014.	2
13.	11th Conference of APHV and National symposium on "Food security and public health: Present status and future road map" at NASC complex, New Delhi, India, November 24-25, 2014	1
14.	XXIII Annual National Conference of Society of Animal Physiologists of India and National Symposium on "Physiological Determinants of Climate Resilient and Sustainable Animal Production", CIRB, Hisar, Haryana, November 27-28, 2014.	4
15.	VI Conference and National Symposium of Indian Meat Science Association (IMSACON-2014) on "Sustainable meat production for nutritional and consumer well-being: Challenges and strategies" held at DUVASU, Mathura, November 28-30, 2014.	1

16.	XXXI Annual Conference of Indian Poultry Science Association (IPSACON-2014) and National Symposium on "Poultry production for global trade", Veterinary College and Research Institute, Tamil Nadu Veterinary and Animal Science University, Namakkal, December 18-20, 2014.	5
17.	ICAR short course on Hands on training on upstream physiological techniques, Indian Veterinary Research Institute, Izatnagar, January 16-29, 2015.	2
18.	Training programme on 'Science and Technology for Rural Societies for Women', Indian Institute of Public Administration (IIPA), New Delhi, January 19-23, 2015.	1
19.	IX Biennial ANA Conference on the theme Eco-responsive Feeding and Nutrition: Linking Livestock and Livelihood, AAU, Khanapara, Guwahati, January 22-24, 2015.	2
20.	XII Agricultural Science Congress on "Sustainable Livelihood Security of Small Holder Farmers" held at NDRI, Karnal, Haryana, February 3-6, 2015	2
21.	Bilingual International Conference on "Information Technology: Yesterday, Today, and Tomorrow", DRDO, Delhi, February 19-21, 2015.	1
22.	Training programme on 'Science, Technology and Emerging Trends in Governance', Indian Institute of Public Administration (IIPA), New Delhi, February, 23-27, 2015.	1
23.	3rd International Conference on "Impacting food value chain and leveraging innovation", National Institute of Food Technology Entrepreneurship and Management, Kundli, Sonapat (Haryana) India, February 26-28, 2015.	1
24.	One day workshop on Farmer's -Industry Scientists (FIS) meet organized by ICAR-CARI, Izatnagar, March 02, 2015.	All Scientists of Institute
25.	Two day workshop on SBS-ASM-ICAR Biosafety Awareness Programme, including workshops on: "Culture of Responsibility" "Pathogen Inventory Management" and "Safety is the Rule: Fundamentals of working with Biosafety Cabinets", NIHSAD, Bhopal, Madhya Pradesh March 13-14, 2015.	2

Consultancy, Patents, Commercialization of Technology

Consultancy/ Advisory Services

- Provided low-cost feed formulae to about 120 poultry farmers and small feed industries from different states-UP, Delhi, Uttarakhand, HR, AP, TN and Bihar) and solving the problems of many farmers from different states through personal contact, face to face interaction, postal letters, email, telephone call and kisan call centre.
- Consultancy services were also provided to different State Animal Husbandry Departments and private entrepreneurs.
- Free consultancy was also given to the poultry processors, poultry farmers and other entrepreneurs in the area of Poultry Products Technology.
- Least cost feed formulation technology is being disseminated through Make feed Poultry and Dairy softwares.
- Consultancy granted to Ms. Aftab D/o Shri Ainuddin-U.P. for preparing a bankable project for establishing a layer farm of 2000 birds capacity in cage rearing system. (Consultancy charges Rs. 10200/- deposited on 10.02.2015).

Patent/Technology Submitted to IITMC/ZITMC

- CARI Dhanraja, the coloured broiler germplasm developed and evaluated at CARI, Izatnagar is registered by GOI.

- CARI Priya (Layer) developed and evaluated at CARI, Izatnagar is registered by GOI.
- CARI Sweta (J. Quail), developed and evaluated at CARI, Izatnagar is registered by GOI.
- The patent entitled, "Nucleic acid amplification-Allelic differentiating restriction pattern (NAADRP)-A Novel method for determining the MHC genotype in chicken" submitted vide reference number 346/DEL/2009 dated 24/2/09 is under publication).
- The technologies for processing of **poultry meat finger chips, poultry meat wafers and functional chicken sausages** developed were submitted to IITMC for transfer of technology.

Technologies assigned for commercial transfer

1. Development and formulation of instant emu egg noodles.
2. Processing technologies for development of shelf-stable functional poultry meat wafers and finger chips.
3. Processes for development of functional chicken meat bites and sausages.
4. Process for decontamination of dressed poultry meat using antimicrobials and the thermal treatment



Workshops, Seminars and Trainings Organized

<i>Date</i>	<i>Event</i>	<i>No. of farmer/beneficiaries</i>
Short term training programmes for farmers		
June 02-07, 2014	Short term training on “Poultry production management”	44 (farmers/unemployed youth from Uttar Pradesh, Uttarakhand, J&K)
September 01-06, 2014	Short term training on “Poultry production management”	28 (farmers/unemployed youth from Bihar, Rajasthan, MP., New Delhi, Uttar Pradesh)
December 01-06, 2014	Short term training on “Poultry production management”	37 (farmers/unemployed youth from Uttar Pradesh, Uttarakhand)
March 23-28, 2015	Short term training on “Poultry production management”	36 (farmers/unemployed youth from Bihar, Delhi, Uttar Pradesh, Uttarakhand)
Specialized training programmes		
June 16-28, 2014	Specialized training programme on <i>Broiler Production</i>	01 participant (Broiler farming)
August 11-23, 2014	Specialized training programme on <i>Layer Production</i>	24 participants (Layer farming entrepreneurs)
November 10-22, 2014	Specialized training programme on <i>Poultry Feeding and Quality Control</i>	05 participants (Feed mill entrepreneurs)
International training programme		
April 06-15, 2015	SAARC regional international training on <i>Advanced Avian Nutrition and Feed Technology</i> ,	14 participants from SAARC countries (Sri Lanka, Bangladesh, Nepal, Bhutan, Maldives and India)
Other events		
March 02, 2015	Farmers - Industry- Scientists Meet	100 participants (progressive farmers, industrialist, scientists, policy makers, social activists)

Distinguished Visitors

<i>Date</i>	<i>Name</i>	<i>Address</i>
Main Campus, Izatnagar		
April 02, 2014	Dr. V.N. Sharda	Member Agricultural Scientist Recruitment Board, New Delhi
March 2, 2015	Dr. Arun Verma	Former ADG & Acting DDG (Animal Sci), ICAR, New Delhi,
Regional Centre, Bhubaneswar		
April 15, 2014	Shri Arvind R. Kaushal	Former Secretary, ICAR Min. of Agril, Govt. of India, New Delhi.
April 15, 2014	Dr K.M.L. Pathak	DDG (Animal Science) ICAR, New Delhi.

Highly impressed with the excellent display of major recommendations, work replicating widely at farmers, level for higher food and nutritional security.

Dr. V.N. Sharda
Member
Agricultural Scientist Recruitment Board
New Delhi



Personnel

DIRECTOR
Dr J.M. KATARIA

Heads of Divisions/Sections

Division of Avian Genetics and Breeding	Dr. D.P. Singh
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. S. Majumdar (till 16.01.2015)
	Dr. M.P. Sagar (w.e.f. 17.01.2015)
Prioritization, Monitoring and Evaluation Section	Dr. Sandeep Saran
Poultry Economics and Agribusiness Research Section	Dr. Sandeep Saran
Post-Graduate Education and Training Section	Dr. Praveen K. Tyagi
Avian Medicine Section	Dr. A.S. Yadav
Incharge, Regional Centre, Bhubaneswar	Dr. S.K. Mishra

Administration

Senior Administrative Officer	Shri J.L. Sharma (till 22.10.2014 as A.O.)
	Shri R.N. Mallik (w.e.f. 27.12.2014)
Assistant Administrative Officer	Shri Irfan Ali Khan
Assistant Administrative Officer	Shri B.S. Bisht
Assistant Finance and Accounts Officer	Shri Kailash Chand

SCIENTIFIC/ TECHNICAL STAFF

Scientific Staff			
1.	Dr. J.M. Kataria	Director	PhD
2.	Dr. A.B. Mandal	Principal Scientist	PhD
3.	Dr. S. Majumdar	Principal Scientist	PhD
4.	Dr. D.P. Singh	Principal Scientist	PhD
5.	Dr. Jag Mohan	Principal Scientist	PhD
6.	Dr. Praveen Kumar Tyagi	Principal Scientist	PhD
7.	Dr. Jagbir Singh Tyagi	Principal Scientist	PhD
8.	Dr. V.K.Saxena	Principal Scientist	PhD
9.	Dr. Sanjeev Kumar	Principal Scientist	PhD
10.	Dr. Sandeep Saran	Principal Scientist	PhD
11.	Dr. C.K. Beura	Principal Scientist	PhD
12.	Dr. Raj Narayan	Principal Scientist	PhD
13.	Dr. Pramod Kumar Tyagi	Principal Scientist	PhD
14.	Dr. A.S. Yadav	Principal Scientist	PhD
15.	Dr. Chandra Deo	Principal Scientist	PhD
16.	Dr. S.K. Bhanja	Principal Scientist	PhD
17.	Dr. M.P. Sagar	Principal Scientist	PhD
18.	Dr. (Mrs.) Simmi Tomar	Principal Scientist	PhD
19.	Dr. Ram Singh	Senior Scientist	PhD
20.	Dr. Divya	Senior Scientist	PhD
21.	Dr. Asim Kumar Biswas	Senior Scientist	PhD
22.	Dr. Avishak Biswas	Senior Scientist	PhD
23.	Dr. Chandahas	Senior Scientist (w.e.f 10.07.2014)	PhD
24.	Dr. Nirajan Lal	Scientist	PhD
25.	Dr. M. Sirajuddin	Scientist	MVSc
26.	Dr. (Mrs) Pragya Bhadauria	Scientist	MVSc
27.	Dr. Gautham Kulluri	Scientist (w.e.f 04.04. 2014)	MVSc
28.	Dr. Rokade Jaydip Jawant	Scientist (w.e.f 13.10.2014)	PhD
29.	Dr. S.K. Mishra	Principal Scientist (RC)	PhD
30.	Dr. R.K.S. Bais	Principal Scientist (RC)	PhD
31.	Dr. D. Mondal	Principal Scientist (RC)	PhD
32.	Dr. S.K. Sahoo	Principal Scientist (RC)	PhD
33.	Dr. B.K. Swain	Principal Scientist (RC)	PhD
34.	Dr. K.V.H. Sastri	Principal Scientist (RC)	PhD
35.	Dr. M.K. Padhi	Principal Scientist (RC) (w.e.f. 15.12.2014)	PhD
36.	Dr. S.C. Giri	Senior Scientist (RC)	PhD
37.	Dr. P.K. Naik	Senior Scientist (RC) (w.e.f. 27.10.2014)	PhD
Technical Staff			
1.	Dr. A. Mishra	T-9 (Medical Officer)	M.B.B.S.
2.	Dr. R.D. Sharma	T-9 (Chief Tech. Officer)	PhD
3.	Shri S. Bhatnagar	T-9 (Chief Tech. Officer)	B.Sc., M.A., B.Lib
4.	Shri B. Arya	T-7-8 (Asst. Chief Tech. Officer)	MSc
5.	Shri R.R. Saxena	T-6 (Sr. Tech. Officer)	MA
6.	Shri P.N. Yadav	T-7-8 (Asst. Chief Tech. Officer)	MA
7.	Shri Prem Chandra	T-6 (Sr. Tech. Officer)	MSc
8.	Shri Shafiq Ahmad	T-6 (Sr. Tech. Officer)	Inter, Diploma (Elect. Engg.)
9.	Shri Tasnim Ahmad	T-6 (Sr. Tech. Officer)	B.Sc., B.Tech.
10.	Shri Sharad Kumar Johri	T-6 (Sr. Tech. Officer)	MSc
11.	Shri S.R. Meena	T-6 (Sr. Tech. Officer)	MSc
12.	Shri Lalit Kumar Mishra	T-6 (Sr. Tech. Officer)	MSc
13.	Shri Ravi Prakash	T-6 (Sr. Tech. Officer)	MSc

Expenditure Statement and Revenue Generation

EXPENDITURE STATEMENT (2014-15)

(Rupees in Lakhs)

Ser. No.	Heads of Account	Plan		Non-Plan	
		Allocation	Expenditure	Allocation	Expenditure
1.	CAPITAL				
	Works	-	-	88.00	87.51
	Other	8.00	7.85	32.00	30.58
2.	REVENUE				
	Establishment Expenses	1430.00	1422.73	-	-
	Pension and Retirement Benefits	116.50	112.55	-	-
	T.A.	4.00	2.67	10.00	10.00
	Research and Operational Expenses	290.00	289.95	230.00	230.00
	Administrative Expenses	261.50	298.29	6.00	5.99
	Miscellaneous Expenses	6.50	4.44	3.00	2.99
	Total	2116.50	2088.48	369.00	367.07

REVENUE GENERATION (2014-15)

(Rupees in Lakhs)

Ser.No.	Items	Amount
1.	Disposal of Experimental By-product	133.39
2.	Royalty, Sale of Publications and Advertisement	1.21
3.	Licence Fee	5.21
4.	Interest of Loan and Advances	13.41
5.	Analytical and Testing Fee	0.69
6.	Interest on Short Term Deposits	8.55
7.	Internal Resource Generation	3.56
8.	Miscellaneous Receipts	16.31
	Total	182.33
	Loan Recoveries	23.16
	Sale of Assets	NIL
	Grand Total	205.49

Other Relevant Information

Institute Research Committee (IRC): The annual Institute Research Committee (IRC) meeting of the Institute was held during August 07, 2014 under the chairmanship of Dr J.M. Kataria, Director CARI Izatnagar. Dr Sandeep Saran, Head, PEAR/PME & Secretary IRC, conducted the meeting which was attended by the scientists (including Regional Centre, Bhubaneswar) of the Institute. He presented an overview of the ongoing research programmes continued during the XII Plan along with the major policy shifts vis-à-vis O&M reforms in the ICAR system as a whole and in the SMD(AS) in particular. He also presented the major accomplishments of the Institute in respect of such reforms.

In his welcome address, Dr J.M. Kataria, Director referred the speech of the PM delivered during the ICAR's Foundation Day function and emphasized to be more critical while self-evaluating the work carried out during the period under report, since there were no outside experts in IRC meeting. He also appraised the house about the proceedings of 86th ICAR foundation day. This was followed by presentations by the respective divisions/sections of the Institute. The Action Taken Report (ATR) on the last year IRC general recommendations was presented by the respective HDs and the project-wise recommendations by the concern PIs. Besides, the main IRC meeting, four additional IRC meetings were convened on 5.10.2014, 5.11.2014, 20.1.2015 and 9.3.2015 to discuss project proposals to be submitted by the concerned scientists for external funding.

- Dr Sandeep Saran while serving as **Member Secretary, Institute Animal Ethics Committee** (till 7.1.2015) complied with all the statutory requirements for conducting animal experimentations in various projects of the Institute.
- Dr Sandeep Saran serving as **Management Representative, ISO Implementation Committee** of the Institute initiated the process for implementation of the ISO in the institute. Order has been placed to the consultant and as per the advice of the consultants; records are being streamlined/ documented. The process of ISO

implementation is likely to be completed in next 2-3 months.

- **Result Framework Document:** Results Framework Document (RFD), CARI, Izatnagar, respectively. The RFD 2014-15 of the institute was finalized and submitted to the Council by Dr V.K. Saxena and Dr Sandeep Saran, Nodal Officer and Co-Nodal Officers, respectively. The monthly report of RFD was also submitted to the Council regularly.
- **Right to Information:** Dr Sandeep Saran disposed-off RTI requests pertaining to all scientific matters in the Institute in the capacity of the Central Public Information Officer (Scientific Matters), CARI, Izatnagar. In all 10 requests were received during the year.

Research Advisory Committee (RAC) Meeting:

The 8th Meeting of the Common Research Advisory Committee of Central Avian Research Institute (CARI), Izatnagar and Directorate on Poultry Research (DPR), Hyderabad was held on 22nd July 2014 at CARI, Izatnagar under the Chairmanship of Dr. R. Prabakaran, Ex-Vice Chancellor, Tamil Nadu Veterinary and Animal Sciences University, Chennai. The RAC members attended the meeting include Dr. G. Devgowda, Ex Professor and Head, Dept. of Poultry Science and Animal Sciences, Agricultural University, Bangalore; Dr. Vivek Vinayak Kulkarni, Director, NRC on Meat, Hyderabad; Dr. P.K. Shukla, Professor & Head (Poultry Science), Uttar Pradesh Pandit Deen Dayal Upadhyaya Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go Anusandhan Sansthan, Mathura. Dr. J.M. Kataria, Director, CARI, Izatnagar; Dr. R.N. Chatterjee, Acting Project Director, PDP, Hyderabad and Dr. A.B. Mandal, Principal Scientist and Head, Avian Nutrition & Feed Technology Division, CARI, Izatnagar (Member Secretary). The scientists from CARI and PDP participated in the meeting and presented the research progress in different disciplines. The following recommendations were emerged out.

RECOMMENDATIONS

1. Further strengthening of mycotoxins analysis facilities in both the institutes.

2. Research should be concentrated on more and more alternative raw materials to replace the traditional feed resources in poultry diet in both the institutes.
3. Improving immuno-competence in birds by nutritional and genomics approach, dietary manipulation for ameliorating stress and gut health in both the institutes.
4. More emphasis on 'Food safety', sustainability of environment and welfare issues.
5. Developing institute-industry linkages for contractual research.
6. Avian Nutrition and Post Harvest Technology divisions of CARI should interact with corporate poultry sector, while DPR on rural poultry.



Institute Management Committee (IMC)

Meeting: The 42nd Institute Management Committee Meeting was held on 17.06.2014 under the Chairmanship of Dr. J.M. Kataria, Director CARI, Izatnagar consisting of Shri J.L. Sharma Member Secretary, Deputy Director- Animal Husbandry Bareilly, Dean, GBPUA&T, Pantnagar, Dr. Jagmohan, Dr. B.P. Mishra, Dr. P.K. Raut, Dr. V.K. Saxena and Shri Kailash Chand.

The Committee was satisfied with the research activities and achievements made by this Institute. Research projects for the year 2013-14 were brought to the notice of all the members and were approved by IMC.

Institute Animal Ethics Committee (IAEC): The Institute Animal Ethics Committee was reconstituted as per instructions received from the CPCSEA, New Delhi. The new IAEC under the chairmanship of Dr J.M. Kataria, Director has Drs J.S. Tyagi, Chandrabas, G. Kolluri and S.K Bhanja as members and Pramod Kr. Tyagi as member secretary. The new IAEC has started functioning w.e.f. 08.01.2015.

Institutional Biosafety Committee (IBSC): A meeting of IBSC was held under the chairmanship of Dr. J.M. Kataria, Director, CARI and Chairman, IBSC on 11.12.2014 to screen the research proposals from biosafety point of view. All the ongoing and newly submitted research proposals as received by Dr. A. S. Yadav, Secretary, IBSC were examined and cleared by the Committee and the reports were sent to DBT (Govt. of India), New Delhi.

Institute Technology Management Unit (ITMU)

Registration of Trademarks: The institute got trademarks for two strains of chicken and one quail strain during the year. The details are as under.

TRADE MARK	Certificate No./ Application no.	Date of Registration/ application	Current Status
CARIBRODHAN RAJA (Broiler)	1170070	20/05/2014	Granted/ Registered
CARIPRIYA (Layer)	1170097	21/05/2014	Granted/ Registered
CARISWETA (J. Quail)	1170714	23/05/2014	Granted/ Registered

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

Name of Technology	Signed with	Date of Signing
Supply of coloured broiler parent lines (fertile eggs)	The Deputy Director (A.H.) Intensive Poultry Development Project, Vadodara, Gujrat	16.09.2014
Supply of broiler parent lines (fertile eggs)	The Deputy Director (A.H.) Intensive Poultry Development Project, Dahod, Gujrat	27.11.2014

Institute Technology Management Committee (ITMC) Meetings held:

Sl. No.	Date	Purpose
1.	27.11.2014	a. Finalizing the cost of licensing of Intermediate Moisture Chicken Meat Technology requested of Mr. Saif, AgriInnovate India Ltd. b. Decided the cost of licensing of three technologies namely chicken wafers, chicken noodles and chicken sausages requested of Mr. Dinesh Soni.

2.	07.02.2015	To finalize the modalities of MoU between the institute and the client Mr. Sunil Bhagwani, Kalinga Agro Products Ltd, Odisha, for Duck Production Technology with Germplasm and provision of training
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Hatchery Operations: With incubation/ hatching capacity of about 80,000 eggs at a time, the major responsibilities of the Experimental Hatchery Section are to hatch out the required number of replacement stock of different pure line/ pedigree flocks pertaining to different strains of various germplasm e.g., chicken, quails, turkey, guinea fowl, etc. being maintained at CARI, to hatch out required commercial / parent stock broilers, layers and Desi breeds of CARI for supplying to various government / private poultry farms, supply of embryonated eggs and day-old chicks to IVRI and CARI for preparation of vaccines and conducting experiments to serve their academic and other mandates, to teach courses PSC-503, PSC-504,603

and 604 as well as to provide necessary support for teaching & conducting practical for other post graduate courses on incubation and hatching, to conduct specialized training course on “Incubation and Hatchery Management” with the collaboration of PGE&T section for the poultry entrepreneurs and government/ private personnel. In addition to this, hatching of 32220 commercial stocks of CARI for supplying to various government/ private poultry farms was performed. Also, for preparation of vaccines and conducting experimental trials, embryonated eggs were supplied to other institutions (mainly IVRI) to serve their academic and other mandates. Consultancies pertaining to establishing poultry hatchery and/or sorting out specific problem to government/private personnel were also provided.

On the whole, the average hatchability in various germplasm on fertile egg set (FES) basis was recorded 93.40 percent during 2014-15. At occasion, the highest hatchability (FES) 100.00% was obtained in broiler chicken (Table 19).

Table 19: Hatching performance of various germplasm (2014-15)

Type of birds	Total eggs set	Fertile eggs (%)	Hatchability on total egg set (%)	Hatchability on fertile egg set (%)	Number of good chickshatched
LAYER	37030	72.79 (43.82-92.00)	69.54 (39.31-90.00)	95.53 (82.67-98.97)	25749
BROILER	45812	76.40 (25.00-88.89)	72.69 (46.53-83.33)	95.15 (81.03-100)	33301
QUAIL	18626	58.99 (47.32-64.12)	52.73 (34.39-59.59)	89.39 (64.38-92.81)	9821
GUINEA FOWL	9788	43.92 (35.73-50.27)	39.46 (31.65-44.50)	89.83 (86.06-92.56)	3862
TURKEY	12233	63.62 (55.00-86.44)	59.36 (46.90-74.10)	93.32 (79.41-96.55)	7262
DESI FOWL	20385	73.13 (43.14-81.46)	69.59 (40.00-77.69)	95.16 (89.19-97.23)	14186
Commercial (TT section)	47623	70.89 (54.38-84.56)	67.66 (46.21-76.85)	95.44 (88.89-97.87)	32220

Figure in parenthesis denotes minimum and maximum range

Table 20: Hatching performance of various germplasm (2014-15) at experimental hatchery, RC, CARI

Breed	Total no of set eggs	Total no of fertile eggs	Total no. of duckling hatch out	Fertility percentage	Hatchability percentage	
					TES	FES
KHAKI	64504	30514	25645	47.30	39.75	84.04
DESI	32335	16858	14238	52.13	44.03	84.45
W-P	78158	40004	33792	51.18	43.23	84.47
MOTI	1166	414	118	35.50	10.12	28.50
KP	8589	4600	4125	53.55	48.02	89.67
KD	2093	1297	1247	61.96	59.57	96.14
TOTAL	186845	93687	79165	50.14	42.36	84.49

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 10386.54 qtls. of different types of poultry feed, Detailed break up of feed supplied to different projects/ divisions is shown below:

Quail farm	708.00
Guinea fowl Unit	494.50
Turkey Unit	652.90
AN&FT Division	135.40
P&R Division	137.00
PHM Section	169.90
IVRI, Izatnagar	52.20
TT Section	676.42
Bio tech. Lab.	3.00
NAIP	2.00
SAU Mathrua	25.00
Hatchery Section	18.00
HAPP Mukteswar	203.00
Total	10386.54

Table 21: Feed supplied to different projects/ divisions (2014-15)

Project/Division	Total Quantity (Qtls)
Broiler project	2739.0
Layer project	2677.0
Desi fowl	1691.22

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 2014 to March 2015 is given in Table 22.

Table 22: Quantity of experimental by-products disposed off

Month	Eggs (Nos)		Processed poultry meat (kg)				
	Chicken	Quail	Chicken	Guinea fowl	Kadakhnath	Quail	Turkey
April, 2014	94414	70090	2506.75	-	60	62.50	17.75
May, 2014	83696	61930	3326.25	-	22.75	69.00	78.50
June, 2014	69915	71175	693.75	-	1.5	31.50	218.50
July, 2014	86209	73050	723.50	-	-	4.00	230.75
August, 2014	87003	60200	1015.25	105	80.75	12.00	30.00
September, 2014	92634	52700	1077.25	46	98.75	6.50	119.50
October, 2014	127270	51800	1627.75	-	31.00	4.50	110.00
November, 2014	122038	52090	1374.25	370	107.25	3.00	28.25
December, 2014	123823	52650	1738.50	-	57.75	-	94.00
January, 2015	108911	43700	1159.75	186.75	-	-	-
February, 2015	114385	35200	1929.50	125.75	-	0.75	31.00
March, 2015	125310	31490	2133.00	557.25	26.00	-	2.00
Total	12,40,608	6,56,075	19305.50	1390.25	485.75	193.75	960.25

Table 23: Net revenue generated from the disposal of poultry eggs, poultry meat and poultry products

Commodity	Revenue (Rs)
Chicken eggs	45,30,955
Quail eggs	5,99,868
Chicken meat	18,77,925
Guinea fowl meat	1,25,375
Kadakhnath meat	46,400
Quail meat	87,188
Turkey meat	95,805
Poultry products	80,130
Total	74,01,646

Agriculture Knowledge Management Unit (AKMU)/ARIS Cell: Agriculture Knowledge Management Unit (AKMU)/ARIS Cell provide

computational/ statistical support to the scientists, students and administration as well as to provide high bandwidth (100 Mbps) internet connectivity through National Knowledge Network (NKN), National Informatics Centre (NIC)-Government of India. For this connectivity, the AKMU is maintaining the Local Area Network (LAN) connecting about 100 functional nodes based on fiber optic and UTP cables to provide round the clock internet connectivity (24X7) on switching network to the all scientists, officers, staff and students of the institute. Security service in all the computers maintained with managed server based antivirus software allows centralized updation of the software and system maintenance.

The institute is also maintaining the website (www.icar.org.in/cari) of the institute. The contents of the institute website are being updated regularly to keep the information of the institute activities up-to-date. Recently, website in Hindi were prepared and launched with the exiting website of the institute.

Library and Information Services:

During the period under report, 62 new publications were added in the library collection. This brings the total number of books, bound volumes of journals and theses etc. in the library from 5820-5882. The library subscribed 23 journals, out of which 11 were reputed foreign scientific journals/magazines (in print) and one journal subscribed online only. In addition of these, a number of national and international serial publications, annual reports and news letters were received on gratis.

The following library activities have been updated / automated:

- The data of all newly added/purchased Books, Theses, bound journals, and current issues of periodicals, with complete bibliographic information were updated, using LIBSYS database/software.
- Online catalogue, OPAC (Online Public Access Catalogue) services accessible to the library users.
- Library membership has been computerized and, circulation of books and other publications were also done through LIBSYS-7 software
- Renewal of journals for the year 2015 were also updated in the LIBSYS software/database

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

Hindi Cell: The meetings of Official Language Implementation Committee were held time to time for review of progressive use of Hindi in the Institute. Quarterly Reports of Official Language

have been sent to ICAR as well as Department of Official Language, Govt. of India. Data regarding working knowledge in hindi and proficiency of hindi of the officials have been updated and individual orders/instructions were issued for doing official work in hindi.

Hindi workshops were organized during the year for the administrative staff to increase use of Hindi in the Institute. The staff was acquainted with Official Language Act and Rules and 165 Officers and 117 employees were trained through the Hindi workshops organized in four quarters viz., 11 Feb.2014, 27 June.2014, 01 Sept. and 21 March, 2015 during the period under report. Beside this, circulars and instructions were issued for compliance of Official Language Act and Rules in the Institute. The scientific, technical and administrative materials were translated in to hindi and typed the same received from divisions, sections and units of the Institute.

Hindi Fortnight was organized during 15-30 Sept., 2014 in the Institute. Dr. J.M. Kataria, Director, CARI, Izatnagar addressed the staff and said on this occasion that use of hindi is not only in administrative works, but new technological achievements of the Institute are spreading to the end users in hindi through research papers written in hindi and lectures delivered by the scientists, trainings for the farmers and publications in hindi. Various competitions such as essay writing in hindi, debate, typing in hindi on computer, noting/drafting, general knowledge, translation and shabdawali parichaya were conducted in the Hindi fortnight. Research papers writing in Hindi competitions are organizing for last ten years in the Institute. Research papers in Hindi competition was also organized during the reviewing period and total seven research papers were received in hindi and three of them were awarded as first, second and third prizes and remains four were consolidated. Prizes were distributed in cash to competitors. A Kavi Gosthi was also organized on this occasion. Dr. J.M. Kataria, Director of the Institute distributed prizes and momentous to winners and Kavis, respectively. Hindi fortnight programme was organized by Paras Nath yadav, Asstt. Chief Technical Officer, Hindi Anubhag.

Awareness Camp on Swachh Bharat at Village Level: 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, the institute organized an awareness camp on sanitation on 11th December, 2014 at adopted village panchayat Navdia Harkisan in Bareilly district. During the camp, villagers were made aware with how to keep themselves and their surroundings neat and clean, and importance of sanitation to keep away the diseases. A team of scientist, medical officer and other employees of the institute surveyed the village by taking round and contributed in sanitation of village streets.



Scientists of CARI creating awareness about swachhta at village Navdia Harkisan



CARI employees cleaning village streets

Swachha Bharat Mission at Regional Centre: The women farmers of each adopted village joined in groups to cut the bushes and clean their village roads under the guidance of scientists of regional centre and contributed in "Swachha Bharat Mission" initiated by Honourable Prime-Minister of India Sri Narendra Damodar Modi.

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, Swachh Bharat Abhiyan was initiation of on 27th Sept. 2014 onwards. Swachh Bharat oath taking programme was performed on 2nd Oct., 2014. Apart from physical contribution, publicity in news papers was also done.



Cleaning of village road under "Swachh Bharat Mission" by adopted women farmers



The Director of the institute performing oath ceremony on the occasion of Swachh Bharat Abhiyan



Oath taking ceremony at institute on the occasion of Swachh Bharat Abhiyan

On the new year occasion, a human chain with holding slogans was made to give the message of sanitation. Afterwards, institute's employee performed sanitation activities at new campus of the institute.

Staff Personalia:

Posting/Appointment

- Dr. Gautham Kolluri, Scientist joined on 04.04.2014 at CARI, Izatnagar.
- Dr. Rokade Jaydip Jaywant, Scientist joined on 13.10.2014 at CARI, Izatnagar.

Promotions

- Shri Ravi Prakash, T-5 (Tech. Officer) promoted to the post of T-6 (Sr. Tech. Officer) w.e.f. 24.09.2013.
- Shri Lalit Kumar Mishra, T-5 (Tech. Officer) promoted to the post of T-6 (Sr. Tech. Officer) w.e.f. 24.09.2013.
- Shri Santosh Kumar, S.S.S promoted to the post of T-1 (Field Farm) w.e.f. 18.05.2013.

Transfer from other Institute

- Shri R.N. Mallik, Sr. Administrative Officer joined CARI, Izatnagar on 27.12.2014 after transfer from IVRI, Izatnagar.
- Dr. P.K. Naik, Senior Scientist joined CARI Regional Centre, Bhubnewar on 27.10.2014 after transfer from ICAR Research Complex, Goa.
- Dr. M.K. Padhi, Principal Scientist joined CARI Regional Centre, Bhubnewar on 15.12.2014 after transfer from ICAR-DPR Hyderabad.

Transfer to other Institutes

- Shri J.L. Sharma, Administrative Officer transferred to NRCAF, Jhansi on 22.10.2014.

Retirements

Shri M.N. Pandey, T-5 (Tech. Officer) retired on 31.07.2014.
Shri Har Lal, Skilled Supporting Staff retired on 30.04.2014.
Shri Sukh Lal, Skilled Supporting Staff retired on 30.06.2014.

Demises

- Shri Pearson, Skilled Supporting Staff expired on 09.08.2014.
- Shri Jivan Singh, Skilled Supporting Staff expired on 02.12.2014.

Approved on-going Research Projects

Sl. No.	Project Code No.	Project Title	Principal Investigator	Co-Investigator
PROGRAMME-1: PRODUCTIVITY ENHANCEMENT OF SELECTED POULTRY SPECIES (18)				
<i>Sub Programme- (i) Enhancement of productivity, reproductive efficiency and immune-competence of selected diversified poultry species along with development of improved package of practices. (13)</i>				
1.	P-1/2012/1-IAV/L30/6600 DOS: 17.10.2012 DOC: 16.10.2015	Improving reproductive performance and immune-competence in turkey through nutritional intervention.	Dr. Avishak Biswas	Dr. (Mrs.) Divya Dr. S. Majumdar
2.	P-1/2010/1-IAV/L50/6400/6100 DOS: 01.6.2010 DOC: 31.5.2015	Evaluation and improvement of reproductive efficiency in guinea fowl and chicken.	Dr. Jag Mohan	Dr. Jagbir Singh Tyagi Dr. Gautham Kolluri (w.e.f. 15.09.2014)
3.	P-1/2012/1-IAV/L50/6510 DOS: 01.03.2013 DOC: 29.02.2016	Phytohormonal strategies for augmenting reproductive efficiency of Japanese Quails.	Dr. M. Sirajuddin	Dr. Jagbir Singh Tyagi Dr. Jag Mohan
4.	P-1/85/95/1-IAV/L10/6100/9705 (Component-AICRP-PB, Hyderabad) DOS: 01.4.1985 DOC: 31.3.9999	Development and evaluation of synthetic broiler sire line.	Dr. (Mrs.) Simmi To mar	Dr. V.K. Saxena
5.	P-1/85/95/2-IAV/L10/6100/9705 (Component-AICRP-PB, Hyderabad) DOS: 01.4.1985 DOC: 31.3.9999	Development and evaluation of synthetic broiler dam line.	Dr. V.K. Saxena	Dr. (Mrs) Simmi To mar Dr. Avishak Biswas Dr. Niranjana Lal (w.e.f. 20.9.2014)
6.	P-1/2008/1-IAV/L30/6200 DOS: 01.12.2008 DOC: 30.11.2014	Nutrient requirements of ducks.	Dr. S.K. Sahoo	Dr. S.C. Giri Dr. D. Mondal Dr. B.K. Swain
7.	P-1/2009/2-IAV/L30/6000-3790 DOS: 01.4.2009 DOC: 31.3.2015	Maximizing nutrient utilization and welfare of poultry through precise nutrient supply and application of biotechnology.	Dr. A.B. Mandal	Dr. Pramod K. Tyagi Dr. A.S. Yadav Dr. Chandra Deo Dr. S.K. Bhanja Dr. Ram Singh
8.	P-1/2012/1-IAV/L30/3700-3755 DOS: 01.07.2012 DOC: 30.06.2015	Establishing dietary requirement of critical minerals and vitamins for poultry.	Dr. Chandra Deo	Dr. A.B. Mandal Dr. Praveen K. Tyagi
9.	P-1/2012/1-IAV/L30/6100 DOS: 18.10.2012 DOC: 17.10.2015	Efficacy of herbs containing essential oils on performance and immunity in broiler chickens.	Dr. (Mrs.) Divya	Dr. A. Biswas Dr. Ashim K. Biswas
10.	DOS: 1.8.2014 DOC: 31.7.2017	Ochratoxins in poultry	Dr. Ram Singh	-
11.	<i>Service Project</i>	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 (w.e.f. 03.05.2014)

12.	<i>Service Project CARI Regional Centre</i>	Monitoring of duck diseases and their bio-security measures.	Dr. Dayamoy Mondal	Dr. S.K. Sahoo
13.	<i>Service project</i>	Quality assessment of feed stuffs and poultry feed	Dr. A.B. Mandal	--
14.	<i>Service project</i>	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. D.P.Singh Dr. Jagmohan Dr. (Mrs) Pragya Bhadauria
3.	P-1/2012/1-IAV/L10/6200 DOS: 01.10.2012 DOC: 30.09.2017	Maintenance, evaluation and conservation of important breeds of ducks for augmentating duck production in rural and tribal areas.	Dr. R.K.S. Bais	Dr. S.K. Mishra Dr. K.V.H. Sastry Dr. S.C. Giri (w.e.f. 08.08.2014) Dr. B.K. Swain
4.	P-1/2010/1-IAV/L10/6100 DOS: 01.6.2010 DOC: 30.6.2015	Evaluation and maintenance of native chicken genetic resources and their utilization.	Dr. D.P. Singh	Dr. Raj Narayan Dr.(Mrs.) Pragya Bhadauria Dr. Chandrahas (w.e.f. 20.09.2014)
5.	DOS: 01.04.2013 DOC: 31.03.2018	Conservation of Elite layer stock	Dr. Sanjeev Kumar	Dr. Niranjan Lal Dr. S.K. Bhanja
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 Dr. (Mrs.) Divya Dr. Avishkek Biswas
2.	P-1/2010/1-IAV/L50/6000/3730 DOS: 01.07.2010 DOC: 30.06.2015	Role of heat shock protein on the efficiency of digestive system under normal and stressed conditions in poultry.	Dr. Jagbir Singh Tyagi	Dr. Jag Mohan Dr. M. Sirajudeen (till Dr. Gautham Kolluri (w.e.f. 27.10.2014)
3.	P-1/2008/2-IAV/L05/6100 DOS: 03.01.2008 DOC: 02.01.2015 (including the extension period)	Poultry rearing practices at high altitude	Dr. S.K. Bhanja	Dr. A.B. Mandal Dr. A.K. Sharma# Dr. S. Majumdar Dr. Praveen Tyagi Dr. B.B. Dash# Dr. B. Sahoo# # IVRI, Mukteshwar
4.	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
5.	DOS: 1.9.2014 DOC: 31.8.2017	Assessment and performance and welfare of chicken under different housing conditions	Dr (Mrs) Pragya Bhadauria	Dr. S. Majumdar Dr. S. Saran Dr. G. Kolluri

PROGRAMME 3: VALUE ADDITION, FOOD SAFETY, QUALITY ASSURANCE AND PRODUCT DEVELOPMENT (3)				
<i>Sub Programme - Development of value added poultry feed and poultry products with functional attributes and quality assurance including product development.</i>				
1.	P-1/2012/1-IAV/L30/9640/6510 DOS: 01.7.2012 DOC: 30.6.2015	Egg cholesterol reduction and nutrient enrichment in quails.	Dr. Praveen K. Tyagi	Dr. Pramod K. Tyagi Dr. Chandra Deo
2.	P-1/2012/1-IAV/Q10/9705-6600 DOS: 01.11.2012 DOC: 31.10.2015	Development and shelf-life extension of functional meat products prepared from turkey and spent chicken meat	Dr. Ashim K. Biswas	Dr. C.K. Beura
3.	P-1/2009/1-IAV/L73/6000-4200 DOS: 01.10.2009 DOC: 30.09.2014	Detection and quantification of bacterial pathogens in poultry products and poultry environment	Dr. A.S. Yadav	-
PROGRAMME 4: HRD, MARKET INTELLIGENCE AND TECHNOLOGY DISSEMINATION (3)				
<i>Sub Programme - (i) Market intelligence, contingency planning and economic implications of emerging issues in poultry value chain. (2)</i>				
1.	P-1/2012/1-IAV/E10/6000 DOS: 01.7.2012 DOC: 30.6.2015	Study on institutional credit support to poultry farming in Uttar Pradesh	Dr. Sandeep Saran	-
2.	P-1/2012/1-IAV/C00/6000 DOS: 01.10.2012 DOC: 30.09.2015	Poultry production in Kumaon hills of Uttarakhand	Dr. Niranjan Lal	Dr. M.P. Sagar
<i>Sub Programme - (ii) Skill development, capacity building for different stakeholders and transfer of technology. (1)</i>				
1.	P-1/2011/1-IAV/C00/6000 DOS: 01.09.2011 DOC: 31.08.2014	Transfer of Proven Poultry Production technologies and their impact assessment.	Dr. M.P. Sagar	Dr. Niranjan Lal

EXTERNALLY FUNDED PROJECT S- (05)

Sl.	Sanction order No.	Title of the project	Name of PI	Name of Co-PI
1.	BT/PR12887/AGR/36/622/2009 dated 21.5.2010 (DBT Project) DOS: 21.5.2010 DOC: 20.5.2015	Application of RNAi technology for augmenting broiler production.	Dr. V.K. Saxena	Dr. K.V.H. Sastry
2.	No.SSD/WS/089/2009 dated 10.01.2011 (DST project) DOS: 10.01.11 DOC: 23.2.2015	Backyard poultry and duck production as a tool to sustainable livelihood for rural women of Khurda District of Orissa.	Dr. S.C. Giri	Dr. S.K.Sahoo Dr. Sandeep Saran Dr. S.K. Mishra Dr. K.V.H.Sastry
3.	BT/PR4326/AAQ/1/496/2012 dated 16.7.2012 (DBT Project) DOS: 19-7-2012 DOC: 18-7-2015	Thermotolerance gene expression analysis <i>Salmonella Typhimurium</i> and development of their thermal death time models applicable to poultry processing	Dr. A.S. Yadav	Dr. V.K. Saxena Dr. J.M. Kataria
4.	BT/374/NE/TBP/2012 dated 07.01.2013 DOS: 07.01.2013 DOC: 06.01.2016	Identification of probiotic strain(s) from gut metagenome of Assam indigenous chicken.	Dr. V.K. Saxena	Dr.(Mrs.) Simmi Tomar
5.	SB/FT/LS-283/2012 Dated 02.5.2013 DOS: 02.5.2013 DOC: 01.5.2016 (DST Project)	Biochemical basis for detection of calpains and calpastatin and their role in post mortem tenderization of meat.	Dr. Ashim K. Biswas	-

INTER-INSTITUTIONAL COLLABORATIVE PROJECT (1)

1.	SR/FT/LS-147/2011 DOS: NA DOC: NA	Identification RNA transcripts present in chicken sperm and their relation to fertility	Dr. Jag Mohan (CCPI)	Dr. R.P. Singh (SACON)
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