CARI

Annual Report 2013-14

CENTRAL AVIAN RESEARCH INSTITUTE

Izatnagar-243 122 (UP) INDIA

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2013-14

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Izatnagar-243 122 (UP) INDIA

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Preface

Poultry egg and meat are regarded among the cheapest animal protein sources and play a vital role in alleviating malnutrition in millions of rural children in the country by means of the mid-day meal programme. Erratic climate and forecast of a deficient monsoon has already affected the livestock feed compounding industry, which in turn influences economic poultry production. The need of the hour is to think beyond the conventional poultry production systems as we meet the challenge of keeping pace with the existing growth rates in layer and broiler production. This task calls for the best ever effort in avian breeding, nutrition/feeding, biotechnology, physiology, shelter management, product development marketing, health care and extension activities. I anticipate more thought and effort being focused towards climate resilience and safer poultry production.

Over the last 35 years, CARI has proven itself to be the leading institution in poultry research, post-graduate education, training and extension activities in the country. Our focus of research has been developing superior germplasm that can perform best in our agro-climatic conditions through the support of precision nutrition, physiological adaptability and environment friendly management practices. The Institute has also played a pivotal role in providing need based R&D support to commercial and small scale rural poultry production systems in India for augmenting household income and nutritional security.

The continual genetic improvement in different breeds/strains of diversified poultry species maintained at the Institute is now attracting various agencies/entrepreneurs to enter into a profitable poultry business. Five different models for backyard chicken and duck rearing developed under NAIP programme at our regional station, Bhubaneswar were readily adopted by farmers and helped them economically. Our research programs have also been linked with DBT, DST, SAUs and the private sector to cater to their requirements. Several training programs covering different areas of chicken, quail, turkey and duck production were conducted this year. We also successfully organized a major international training programme on "Chick Vent Sexing" sponsored under the West Africa Agricultural Productivity program of the Agricultural Research Council of Nigeria. There has also been a huge demand from Department of Animal Husbandry, Government of Uttar Pradesh for specialized training in Layer Production.

Notable contributions were also made in the area of post-graduate education. Last year, eight M.V.Sc. students were awarded degree in Poultry Science by Deemed University, IVRI, Izatnagar. Under our outreach activity, XIV Farm School on Air on "*Turkey evam bater palan- Gramino ke liye ek labhdayak vyavasay*" broadcast from Prasar Bharti (Akashwani Rampur). In addition, field demonstrations and participations in exhibitions disseminated the latest technological advancements in poultry production systems. Apart from this, a large number of parent and commercial stocks of different poultry species were supplied to public and private sectors across the country. The Institute also successfully organized XXX Conference of Indian Poultry Science Association and National Symposium (IPSACON -2013) on the theme "*Poultry Production: Feed, Food and Environmental Safety*" during November 2013.

It is my privilege to put before you the salient achievements in the form of Annual Report (2013-14) of the Central Avian Research Institute (CARI), Izatnagar for your perusal and critical comments. The report possibly will also serve as reference for those engaged in the poultry business, the scientific community, professionals, extension workers and students.

I am highly indebted to Dr. S. Ayyappan, Secretary (DARE) and DG, ICAR, Shri Arvind Kaushal, Additional Secretary (DARE) and Secretary ICAR, Dr. K.M.L. Pathak, DDG (Animal Science), and Dr. R.S. Gandhi, ADG (AP&B) for their generous support, guidance and encouragement in overall development of the Institute.

It will be unfair to not put on record the un-tiring effort of the scientists and other staff of the Institute. Their hard work and dedication has been duly reflected in this report. I also congratulate the entire team of the Editorial Board for bringing out this report on time.

June 30, 2014

(J.M. Kataria)
Director


अधिक ऊँचाई पर कुक्कुट पालन पद्धतियाँ
(सी.ए.आर.आई.-आई.वी.आर.आई. सह परियोजना)
POULTRY REARING PRACTICES AT HIGH ALTITUDE
(CARI-IVRI COLLABORATIVE PROJECT)

Contents

Introduction

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 Izatnagar, Bareilly (U.P.) and the regional centre at Bhubaneswar (Odisha).

MANDATES

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 its allied fields.
- To transfer the proven technologies to the end-users employing efficient and cost-effective methods.
- To provide referral and consultancy services in all aspects of production, processing and marketing (value chain) of diversified poultry.

Regional Centre

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

MAJOR R&D ACTIVITIES

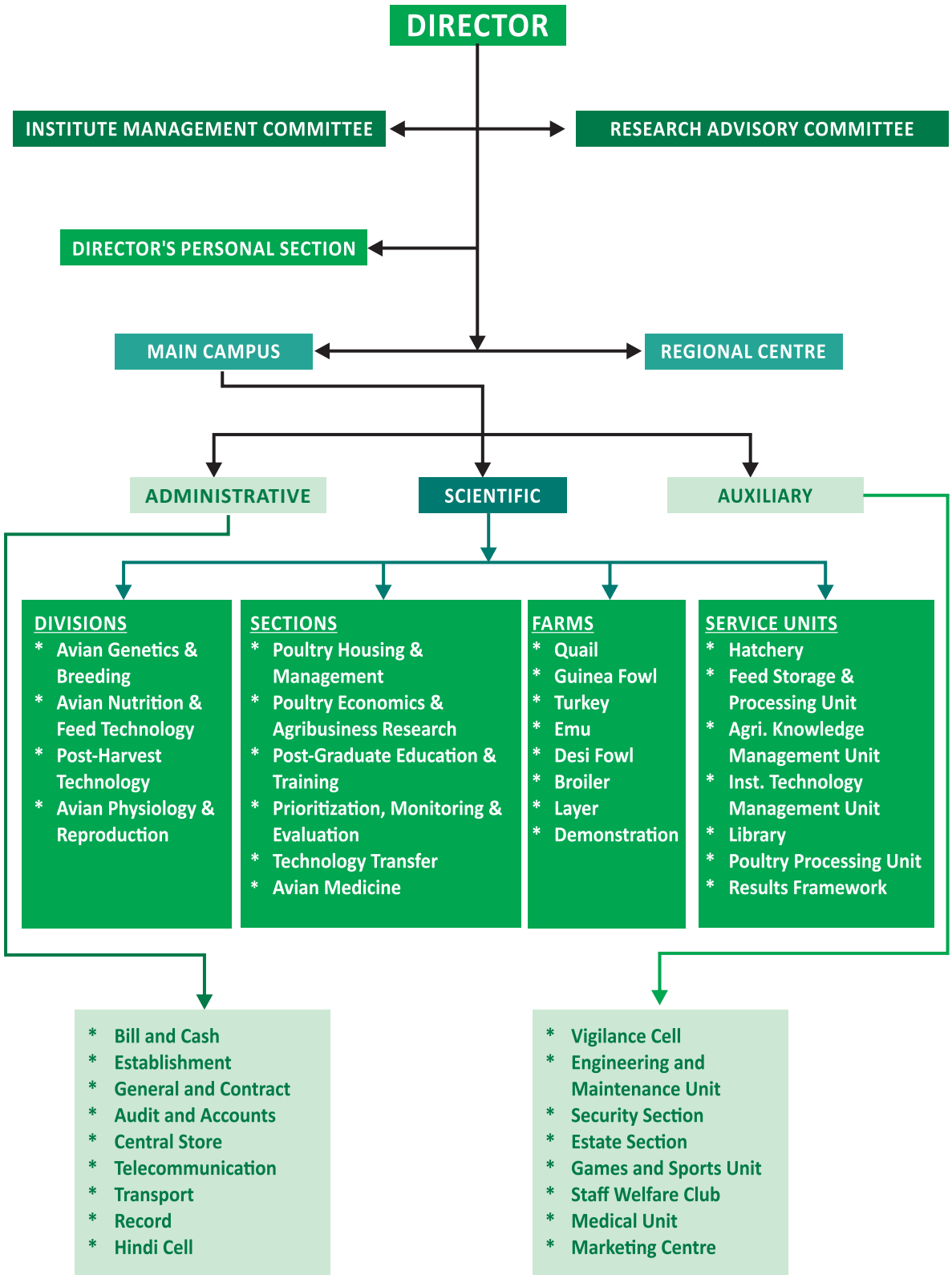
- Presently, total 43 projects (32 institute funded projects and 11 extramural) are running in the Institute.
- Genetic improvement, characterization and propagation of diversified poultry species through breeding and molecular tools; research in advance areas, conservation of indigenous chicken.
- Conducting 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 shelf-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 31.03.2014)

S.No.	*Category*	*Sanctioned Strength*	*In-Position*	*Vacant*
1.	Scientific	40+1	31+1	09
2.	Technical	61	45*	16
3.	Administrative	31	30*	03
4.	Skilled Supporting Staff	137	115*	22

*Including terminated employees (Tech.- 4, Admn.- 2, S.S.S.- 2)

ORGANOGRAM


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

Executive Summary

Productivity Improvement of Diversified Poultry Species

- Different varieties of Japanese quail viz. CARI Uttam, Ujjawal, Sweta and Pearl were improved through genetic selection for 5-week body weight. After 7th generation of selection in crosses, the 5-week body weights in corresponding varieties were 218.1, 166.1, 163.2 and 135.1 g, respectively.
- The trade-marked registration of CARI Uttam (Trade-mark No. 2312766 dated 10.04.2012) and CARI Sweta (Trade-mark No. 2409824 dated 11.10.2012) varieties of Japanese quail was obtained from GoI.
- As an impetus to quail R&D, the joint efforts of ICAR and CARI have resulted into amendment of Schedule IV of wild life protection act of Ministry of Environment and Forests Notification [F. No. 1-15/2013-WL dated 06.12.2013] by which the *Coturnix japonica* (Japanese Quails) a farm bred variety henceforth and will not be covered under wild life protection act.
- Genetic selection and breeding in guinea fowl varieties (Pearl, Lavender and White) has resulted improvement in production and reproduction traits; in present generation the 12th week body weight in corresponding varieties were 1084.2, 1068.6 and 964.1 g, respectively.
- Indigenous poultry germplasm viz. Aseel Peela, CARI Red, Nicobari, Kadakanath, Ankaleshwar, coloured Frizzle, coloured Naked Neck and other gene pool line were regenerated and maintained under conservation programme and for supply to various agencies and farmers.
- After 12 generation of selection, genetic and phenotypic gains for 5-week body weight in male lines (CSML and SML) and female lines (CSFL and SDL) ranged from 10.7 to 17.8 g/generation. In 40th RSPPT at Gurgaon, CARIBRO Dhanraja attained 1.5 and 1.9 kg body weight at 6 and 7 weeks, respectively. FCR at 0-6 weeks was 2.4 and margin of receipt at 6-weeks as Rs. 11.16 and at 7-weeks Rs. 05.76. CARIBRO Dhanraja also performed well at farmers' door.
- Genetic response per generation for 40 week egg number was 1.02 eggs/generation; ASM declined significantly (-0.64 day/generation) in RIR.
- Gene silencing through RNAi technology for increasing body weight, reduction in cholesterol and fat deposition in broilers was achieved by silencing the genes viz. myostatin, TGFβ4, ACC and PPARγ *in-vitro*, *in-ovo* and *in-vivo* systems.
- Immunocompetence traits i.e., sheep RBCs HA titre and serum lysozyme were evaluated in RIR; the averages were 9.09 and 4.70 µg/ml, respectively.

Poultry Nutrition and Feed Technology

- Dietary addition of black cumin (3%), fenugreek (3%), holi basil (3%) or curry leaves (5%) was beneficial in reducing serum and egg yolk cholesterol in Japanese quails.
- Dietary vit. E (250 mg/kg) or MOS (0.03%) was beneficial for ameliorating hot and humid stress in broilers.
- Aflatoxin production in mixed feed during storage could be inhibited completely by adding propionic and benzoic/tartaric acids @ 0.25% and 0.30%/0.4% at 13% moisture level.
- Addition of 40 ppm Zn or 0.1% Methionine (above NRC recommendation) to the aflatoxin (250 ppb) contaminated diet, ameliorated the effects of aflatoxicosis on production, gut health and immunity of broilers.
- Alternate feed resources viz. solvent-extracted decorticated high protein cotton seed meal (20% level), curry leaves (*Murranya koenigii*) powder @ 1.5 or 2% levels were found as suitable substitute for protein source or to improve oxidative control and meat palatability in broilers.
- Epigenetic temperature adaptation through elevated incubation temperatures (38.5, 39.5°C) exhibited significant up-regulation of nutrient transporter genes viz. SGLT1,

GLUT5, PepT1 and EAAT3 in CARI Uttam and Pearl varieties of Japanese quail; up-regulation was higher in CARI Uttam.

- Effect of DES, a common endocrine disruptor which is being increasingly present in daily life on male fertility of Japanese quail under the treatment of low, medium and high doses for 15 days exhibited a drastic reduction in semen volume, sperm motility, live count, and sperm concentration along with increase of morphological abnormality of spermatozoa. The effect was found reversible after 15-days post-treatment withdrawal.
- CARI Debendra birds recorded low body weight (877 g) at high altitude as compared those reared at plain (1593 g) at 12 week of age. During summer months, egg type birds (CARI Priya) at high altitude (>2000 msl) require high energy diet (2700 kcal ME) but during winter require low energy diet (2500 kcal ME) for optimum production.

Poultry Products Technology

- Process for development of chicken meat bites was standardized using formulation containing lean meat, refined vegetable oil, ice-cubes, binders + extender + fillers, and other seasonings. Standardized product was hurdle treated with acidulants and natural antioxidants/ antimicrobials for shelf-life enhancement.
- Hurdle treated poultry meat wafers and finger chips were developed using lean turkey and chicken meats along with other seasoning, acidulants, humectants and natural antioxidants and/antimicrobials. Both types of products can be well stored more than 40 days at ambient temperature under aerobic packaging conditions.
- Gene expression analysis of stress related genes (*rpoE, rpoH, rpoS, htrA, uspA* and *uspB)* in *Salmonella* Typhimurium isolate and *Salmonella* Enteritidis indicated key role of heat stress related genes (rpoE, rpoH and htrA) in survivability of *S.* Typhimurium and *S.* Enteritidis in lethal heat stress conditions. Knowledge generated can be applied for effective decontamination of these pathogen in poultry carcasses.
- MoUs were signed for Quail Egg Pickle technology (M/s MPM Japanese Quail Layer Farm and Agro Foods, Tamil Nadu) and Salted Chicken Eggs (M/s GLD Poultry Farms, Namakkal).
- PCR based protocol was standardized for rapid and early detection of *Salmonella* and *Campylobacter jejuni* in chicken meat and egg with different annealing temperatures.

Education and Training

- During the period under report, 56 students were on roll for different degrees courses in Poultry Science discipline under Deemed University, Indian Veterinary Research Institute, Izatnagar.
- Seven MVSc students submitted their theses and received degrees in Poultry Science discipline under Deemed University, Indian Veterinary Research Institute, Izatnagar.
- Four specialized short-term training courses in different areas of Poultry Science and one International training on "Chick Vent Sexing" for Nigerian nationals were organized.
- 14 major credits, 8 minor credits, 15 ORW, 9 pre-thesis submission and 7 faculty seminars were organized by PGE&T Section at the Institute.

Extension and Transfer of Technology

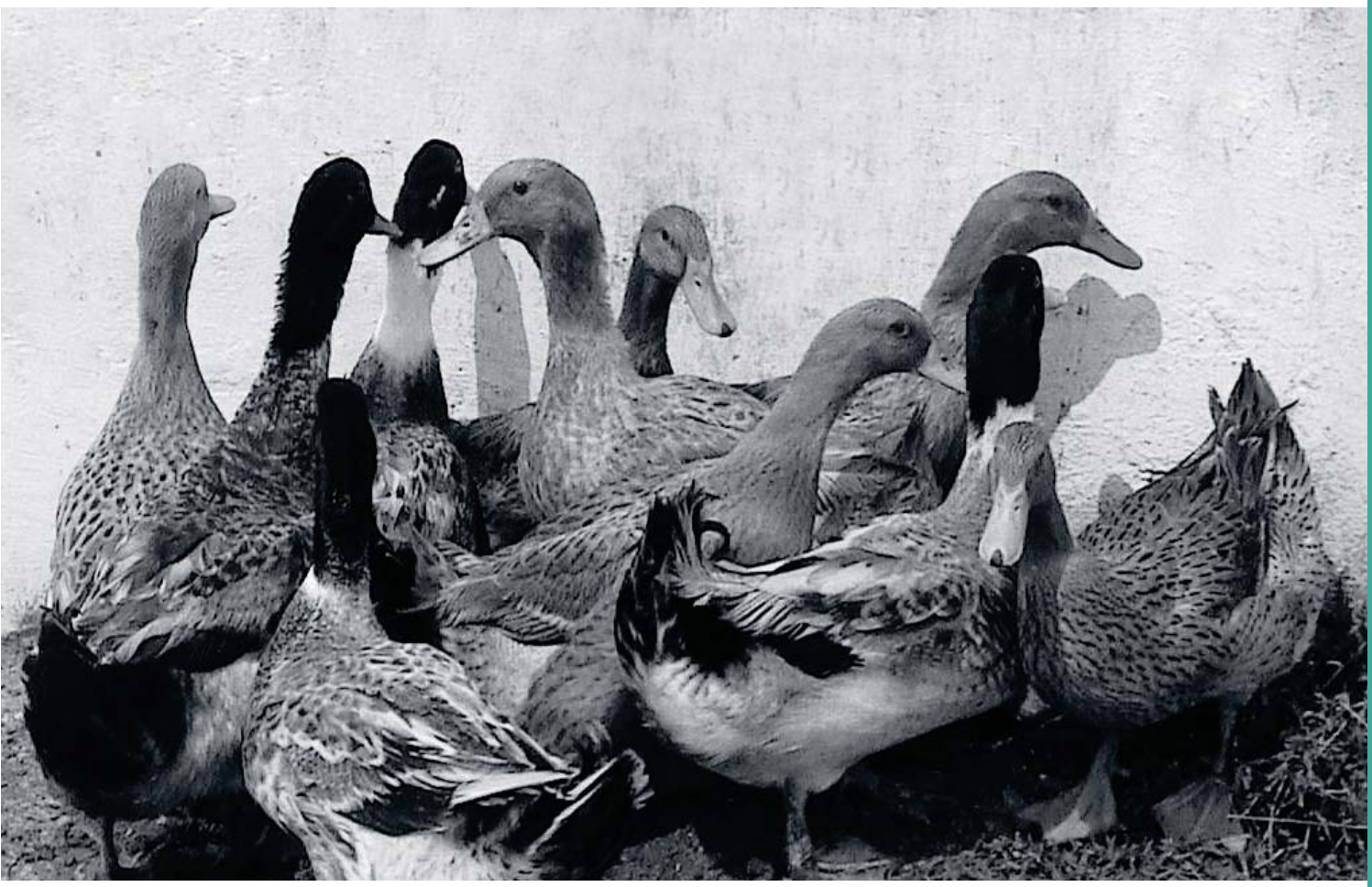
- To disseminate the knowledge regarding poultry farming, the Farm School on "*Turkey evam bater palan-Grameenon ke liye labhdayak vyavasay*" was organized through Prasar Bharti, Akashwani Rampur during September-October 2013. Large number of farmers belonging to U.P. and Uttarakhand participated.
- Four sponsored and regular short-term training programmes on poultry production management were organized for 108 farmers and unemployed youth, and 12 farmers of JEEVIKA, Bihar.
- Four training courses on "Rural poultry production" and "Sustainable poultry production technology" were organized for veterinary officers and para-veterinarians nominated by State Veterinary Council, Raipur, Chhattisgarh.
- CARI participated in various exhibitions and Kisan melas viz. National agricultural exhibition 'Krishi Vasant' at Nagpur and

Kisan mela at Izatnagar, Bareilly. Besides, exhibitions were also organized in two village panchayats of Bareilly.

- Several front line on-farm demonstrations were organized in adopted and various other villages of Bareilly district, Uttar Pradesh and Champawat, Uttarakhand.

Regional Centre, Bhubaneswar

- The regeneration of replacement stock of Khaki Campbell, White Pekin, Moti and Desi duck-breeds for G-1 generation was completed. Genetic analysis of growth and immuno-competence in different populations of ducks was carried out.
- The diet containing 22% crude protein and 2750 kcal ME/kg was found to be optimum for growth and nutrient utilization for Khaki Campbell ducks during starter stage whereas, the diet containing 16% CP and 2400 kcal ME/kg diet was optimum for Khaki Campbell ducks during grower stage. During layer stage of Khaki Campbell ducks, the diet containing 18% CP and 2600 kcal ME/kg diet was found to be optimum.



Research Achievements

PRODUCTIVITY ENHANCEMENT OF SELECTED POULTRY SPECIES

GENETIC IMPROVEMENT OF QUAIL GERMPLASM

Study of growth and egg production traits in four different plumage colour varieties of Japanese quails: In view of growing importance of quail production and increasing interest among poultry farmers for quail farming, the quail improvement project evaluated the genetic parameters of four different plumage colour lines of Japanese quail. Total of 9413 pedigreed chicks of 6th plumage colour varieties were hatched out.

- The hatchability % on total fertile eggs sets basis in parent lines of various plumage colour varieties of Japanese quail ranged from 42.51 to 57.74%; whereas 40.42% in control population.
- The lowest ASM was recorded in CARI Uttam (39.26±0.29 day) followed by CARI Sweta (49.00±0.30 day), CARI Pearl (49.74±0.33 day) and CARI Ujjawal (52.07±0.27 days).
- The highest 5th week body weight was recorded in CARI Uttam (218.09±0.54 g) followed by CARI Ujjawal (166.12±0.7 g), CARI Sweta (163.24±0.72 g) and CARI Pearl (135.09±0.42 g) and corresponding values for egg production up to 15th week were 50.60±0.37, 44.29±0.52, 45.81±0.55 and 42.12±0.74, respectively (Fig. 1 and 2).

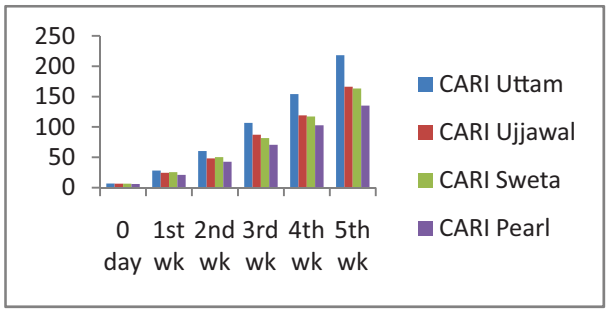


Fig. 1: Body weight at different weeks of four varieties of Japanese quail

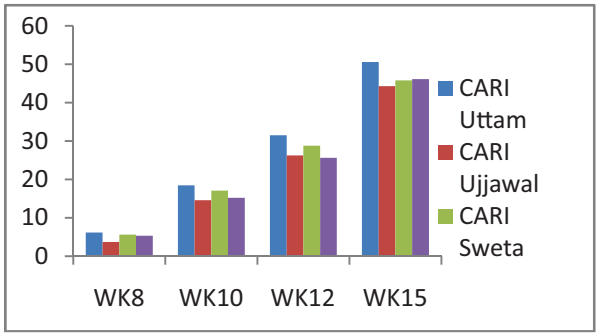


Fig. 2: Egg production at different weeks of four varieties of Japanese quail

Feed conversion ratio (FCR): The FCR (0-5 week) in CARI Uttam, CARI Ujjawal, CARI Sweta and CARI Pearl were 2.65±0.003, 2.78±0.002, 2.80±0.003 and 3.07±0.004, respectively.

Heritability estimates of ASM and production traits: The heritability estimates for ASM in CARI Uttam, CARI Ujjawal, CARI Sweta and CARI Pearl were 0.54±0.39, -0.14±0.26, 0.14±0.32 and 0.65±0.40, respectively. The heritability estimates for 8th week egg production in corresponding varieties were 0.46±0.37, -0.06±0.27, 0.06±0.30 and 0.57±0.39; corresponding values of 15th week egg production were 0.23±0.32, -0.13±0.29, -0.06±0.27, -0.31±0.21.

GENETIC IMPROVEMENT OF GUINEA FOWL VARIETIES

Incubation and hatchability: A total of 3403 keets were hatched from 8008 eggs with fertility percentage as 54.38 and the overall hatchability on fertile eggs set basis as 76.87%. In Pearl, Lavender, white and control, the fertility percentages were 58.24, 54.58, 53.86 and 50.83% whereas, hatchability on fertile egg set were 75.86, 82.27, 75.11 and 74.23%, respectively.

Body weights at different ages: The body weights at day 0, 4th, 8th and 12th week of age were recorded in all the three varieties. The variety-wise mean performance is presented in Table 1.

Table 1: Mean body weight at different ages in different varieties

Body wt.	*Pearl*	*Lavender*	*White*
4 wk	261.24±0.98	259.86±2.17	246.84±2.93
8 wk.	625.32±3.07	624.46±4.62	568.90±8.04
12 wk.	1084.20±3.86	1068.6±4.3	964.11±4.67

Feed conversion efficiency (FCR): In Pearl variety the FCR from 0-12 weeks of age was 3.35.

Phenotypic gains for 12-week body weight: The phenotypic gains over last 14 generations of selection (since 2000 onwards) in Pearl, Lavender and white varieties of guinea1 fowl were 12.68± 3.27, 19.68±3.27 and 8.20±2.30 g/generation, respectively.

Carcass traits: At 12th week of age in pearl variety of guinea fowl carcass traits such as defeathered weight, dressing %, giblet, breast, leg, drumstick, back, wing and neck weights in males were 899.95 g, 76.70%, 41.52, 200.02 g, 94.3 g, 114.55 g, 162.65 g, 110.95 g, 44.6 g. Corresponding values in females were 849.1 g, 75.83%, 41.97 g, 186.05 g, 85.72 g, 106.37 g, 161.52 g, 98.6 g, 44.7 g.

Egg production traits: Means of age at first egg in Pearl and Lavender variety were 241 and 246 days, respectively. Various egg quality traits were measured during peak egg production; means are given in Table 2.

CONSERVATION AND UTILIZATION OF INDIGENOUS CHICKEN

Multiplication and reproduction performance of the various indigenous chicken breeds: Aseel Peela, CARI Red, Nicobari, Kadakanath, Ankaleshwar, coloured Frizzle, coloured Naked Neck and gene pool line chicks were hatched, brooded and reared. Details of the reproduction traits and good chicks have been presented in Table 3. All the breeds of native chicken were maintained in pure form without any selection for conservation purpose and utilized for production of commercial scavenging chicks for utilization under rural poultry production.

Production and supply of different genotypes to different organizations and farmers: A total of 12291 chicks of CARI Nirbheek, Hitcari, CARI Shyama and Upcari were hatched. Details of reproductive traits for different pure breeds/lines are presented in Table 4. Total 9342 chicks of different genotypes were supplied to NAIP projects and 1346 chicks to KVK's.

Table 2: Egg quality traits in Pearl, Lavender and White

Traits	*Pearl*	*Lavender*	*White*
Egg weight (g)	$42.64^{a} \pm 0.64$	$42.52^{a} \pm 0.47$	$40.14^{b} \pm 0.81$
Shape index	77.45 ± 0.86	76.75 ± 0.75	75.64 ± 1.93
Albumen index	10.98 ± 0.21	11.4 ± 0.21	11.6 ± 0.27
Yolk colour	$8.00^{b} \pm 0.24$	$8.36^{ab} \pm 0.18$	$8.43^{a} \pm 0.13$
Yolk index (height/width)	$0.47^{b} \pm .0.49$	$0.66^{a} \pm 0.83$	$0.46^{b} \pm 0.48$
Egg shell thickness (mm)	0.63 ± 1.66	0.61 ± 1.7	0.65 ± 2.37

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

Breed	*No. of egg set*	*Good chicks*	*Fertility (%)*	*Hatchability*	
				TES (%)	*FES (%)*
Nicobari	1440	741	68.47	52.22	76.26
Ankaleshwar	1204	720	75.49	60.88	80.63
Fz Colour	789	349	65.77	44.23	67.24
NN Colour	610	375	74.59	61.96	83.07
Assel Peela	1247	814	77.22	66.15	85.66
Kadakanath	1878	1012	63.79	54.31	85.14
NN WLH	1627	873	67.85	54.51	80.34
Fz WLH	1854	1097	75.24	60.35	80.21
CARI Red	2867	1566	70.07	55.21	78.79
Silky	729	447	72.56	62.82	86.57
G. Total	**14245**	**7994**	**70.67**	**56.89**	**80.50**

Table 4: Details of reproductive traits of different crosses

Breed	No. of egg set	Good chicks	Fertility (%)	Hatchability	
				TES (%)	FES (%)
Nirbheek	16241	10389	75.34	63.99	84.94
Shayama	1631	913	72.22	56.34	78.01
Upcari	1010	569	76.03	56.43	74.21
Hitcari	575	420	84.86	73.56	86.68

Genetic parameters of juvenile body weight of Kadakanath: A total of 487 males and 533 females progenies belonging to 61 sire families were hatched in six hatches in two years. Chicks were brooded and reared under standard feeding and managemental practices up to 20 weeks of age. The mean body weights of combined sexes were 32.4, 136.6, 379.3, 655.3, 949.7 and 1171.4 g at day-old, 4, 8, 12 16 and 20 weeks of age, respectively.

Heritability estimates of body weight ranged from 0.20±0.13 to 0.56±0.17 in males and 0.28±0.13 to 0.47±0.15 in females at various ages. Range of heritability estimates for shank and keel length were 0.26±0.13 to 0.43±0.15 and 0.17±0.12 to 0.27±0.13 in males and the corresponding values for females were 0.21±0.12 to 0.31±0.13 and 0.26±0.13 to 0.45±0.15, respectively. High and positive genetic correlation coefficients among various body weights and body measurements were recorded.

Growth models for Ankaleshwar: The average body weight of male and female birds at day-old, 8th week and 28th weeks of age were 28.97 ± 0.53, 29.77 ± 0.41; 442.02 ± 14.36, 382.98 ± 9.47 and 1775.81 ± 32.59 and 1390.44 ± 25.93 g, respectively. The males and females attained about 1 kg body weight at 14th and 18th week, respectively. The maximum weekly weight gain for male and female were 124.70 g and 83.56 g, respectively at 12th weeks of age. The growth of both sexes was sigmoid, therefore the non-linear models viz. exponential, monomolecular, logistic, Gompertz, Bertalanffy and Modified logistic models were fitted to average body weights of males and females from day-old to 28th week of age. On the basis of different measures of goodness of fit, the Gompertz followed by Bertalanffy models was found the best.

Body weights and body weight gains of white plumage Frizzle: Body weights of White plumage Frizzle from day-old to 30th week of age at bi-weekly interval are presented in Table 5. Males registered significantly higher body weights than females (sex dimorphism) from 4th to 30 week. Males weighed nearly one kilogram at age of 16 week whereas females attained this weight at 20th week of age.

Table 5: Means along with standard errors of 4 weekly body weight gain of male and female frizzle varieties of egg type chicken

Age	Frizzle	
	Male	Female
Day old-4 wk	140.67 ± 2.11^{b}	133.43 ± 1.78^{a}
4 wk-8 wk	297.11 ± 6.15^{c}	236.72 ± 4.38^{a}
8 wk-12 wk	409.66 ± 8.04^{d}	219.76 ± 6.43^{a}
12 wk-16 wk	302.70 ± 7.23^{c}	188.47 ± 6.68^{a}
16 wk-20 wk	285.43 ± 9.78^{d}	213.96 ± 9.10^{a}
20 wk-24 wk	205.20 ± 8.88^{b}	206.66 ± 8.24^{c}
24 wk-28 wk	168.76 ± 8.67^{b}	70.81 ± 10.99^{a}

Means (row-wise) with same superscript do not differ significantly ($P < 0.05$)

Growth models and growth curves: The four models under study viz. Monomolecular, Logistic, Modified logistic, Gompertz model were fitted to average bi-weekly body weight by the method of nonlinear optimization technique. The estimated parameters such as a, b, c and d of different models along with their asymptotic standard errors and four measures of goodness of fit such as adjusted (R^2), MSE (Mean squares errors), MAE (Mean absolute errors), AIC (Akaike Information Criterion) were estimated. The minimum values of these measures but the higher adjusted (R^2) ensure best fitting of model to given data set. Among three parameter models, the Gompertz model was the best model to describe the growth pattern of male Frizzle followed by monomolecular and logistic models. While considering the four parameter model, modified logistic model was found the best suitable model to describe the growth pattern of Frizzle male. Therefore the modified logistic model was the best model to describe growth pattern in male Frizzle.

Gompertz model was best suitable model to describe the growth pattern of Frizzle female followed by modified logistic, logistic and monomolecular.

The curves plotted on the basis of the observed values and estimated values for the best fitted models for frizzle males were found very close to each other (Fig. 3) which proved the efficiency of the growth models.

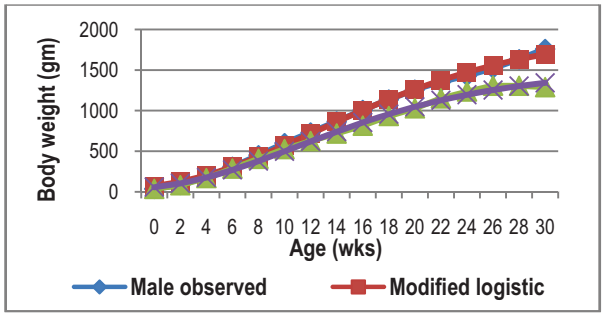


Fig. 3: Observed and estimated growth curves of Frizzle

Genetic parameters: Hierarchical mating design was applied utilizing 23 sires and 138 dams to estimate the genetic parameters from sire, dam and sire+dam components of variance for various parameters. The traits recorded were day-old body weight followed by bi-weekly weight up to 30 weeks of age, age at sexual maturity (ASM), body weight at 20 week (20 wk BW) egg production up to 40 weeks of age (EP40), egg weight at 40 week (EW40) and body weight at 40 week (40 wk BW).

Heritability and correlations of juvenile body weight: Heritability estimates ranged from moderate to high for day-old to 30 weeks of age. The values of heritability estimates for h^2_S, h^2_D and h^2_{S+D} for Frizzle males and females ranged from 0.968±0.385 to 0.390±0.218, 0.567±0.229 to 0.264±0.226, 0.258±0.144 to 0.666±0.215 and 0.711±0.307 to 0.377±0.277, 0.534± 0.187 to 0.260±0.246, 0.237±0.138 to 0.598± 0.180, respectively.

All the genetic correlations among body weights at different weeks of age were positive and high except correlations between hatch weight with weights at different ages which were low irrespective of sex. The phenotypic correlations were positive, varied from moderate to high and were usually smaller than their respective genetic correlations which indicated that environment played the important role.

Heritability and correlations of production traits: The heritability estimates of ASM, 20 wk EP, 40 wk EP for naked neck and frizzle obtained from sire, dam and sire+dam components were moderate to high (0.162±0.023 to 0.636± 0.026).

Genetic correlation $r_{G(S+D)}$ among ASM with 20 wk BW, EP 40, EW 40 and 40 wk BW in Frizzle ranged from -0.448±0.087 to 0.434± 0.130. Negative genetic correlations of ASM with 20 wk BW, EW, EP indicated that selection for decrease in ASM will result increase in 20 wk BW, EP and EW. Genetic association of EP 40 with ASM, EW 40, 40 wk BW was negative and positive with 20 wk BW in both Naked neck and Frizzle varieties.

CONSERVATION OF ELITE LAYER STOCKS

- The LS means of BW16, ASM, EW28, EW40, BW40 and EP40 in IWG strain were 914.88±10.76 g, 155.20±0.98 days, 44.13±0.22 g, 49.42±0.25 g, 1494.57± 19.43 g and 97.85±1.48, respectively. The corresponding estimates in IWJ strain were 888.82±10.10 g, 155.37±1.01 days, 43.44±0.26 g, 46.29±0.35 g, 1420.77± 15.95 g and 93.93±1.88. Overall fertility % was 91.9 and 86.3 in IWG and IWJ part-record pure strains, respectively. Total 820 and 852 chicks were hatched in respective strains.
- The LS means of BW16, ASM, EW28, EW40, EW64, BW40, BW64, EP40 and EP64 in IWH pure annual production strain were 152.9±0.5 days, 1004.4±6.4 g, 1383.3± 8.65 g, 1403.69±9.45 g, 46.99±0.9 g, 49.75±0.18 g, 53.54±0.24 g, 95.21±0.78 and 220.22±0.22, respectively. The corresponding estimates in IWI strain were 156.45±0.53 days, 948.49±8.07 g, 1392.14±8.65 g, 1436.67±11.92 g, 48.02± 0.10 g, 51.12±0.1 g, 54.46±0.23 g, 94.70± 0.79 and 212.41±1.7 and in IWC were 173.15±0.75 days, 996.77±8.08 g, 1430.36±10.74 g, 1582.27±15.19 g, 47.58±0.15 g, 51.1284±0.17 g, 53.43± 0.41 g, 76.85±0.08 and 186.70±1.8.

GENETIC IMPROVEMENT OF RHODE ISLAND RED

Reproductive performance: The reproductive performance of selected strain of Rhode Island Red (RIRs), its control (RIRc) and RIR white

(RIRw) populations for S_{30} generation was recorded. The fertility in these strains was within the range of 81.0 to 94.0%. The hatchability % on fertile eggs transferred ranged from 83.7 to 94.0 and 78.7 to 85.9 in pure and cross bred, respectively.

Comparative performance of Rhode Island populations: RIR populations being improved for the development of multi-coloured strains for rural poultry production, in 30th generation of selection the average age at sexual maturity in RIRs, RIRc, RIRw were 153.36±0.51, 183.43±1.12 and 179.43±2.34 days, respectively. 40th week egg number in respective strains were 95.65±0.75, 59.57±1.07 and 75.48±2.61 nos. with corresponding 40th week egg weight as 51.29±0.11, 49.19±0.21 and 52.69±0.45 g.

Genetic and phenotypic gains per generation: In S_{30} generation of selection based on part period egg number up to 40-wk of age using a family index (Osborne 1957 a, b). Phenotypic response for the ASM, 40th week egg weight, 20 wk. body weight, 40 wk body weight and egg number were -0.921±0.256, 0.096±0.05, 10.01±3.05, -8.59±2.42 g/gen and 0.957±0.204/gen. Genetic responses for body eight at 20th and 40th week, ASM, egg weight at 20th and 40th week were 10.80±1.46 g, 8.41±1.51 g, -0.64±0.17 day, 0.09±0.02 g and 1.02±0.20 g/generation, respectively. Phenotypic responses for most of the economic traits in control population were found to be non-significant indicating a stable control. The genetic and phenotypic gains for 40-week egg number over 30 generation of selection have been shown in Fig. 4.

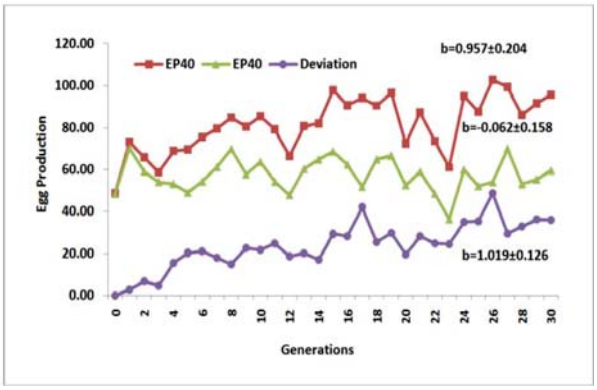


Fig. 4: Genetic and phenotypic gain in RIRs

Immunocompetence, microsatellite analysis and candidate gene expression profiling in RIR: Analysis of immunocompetence, layer economic traits and microsatellite (MS) profiling of egg production-associated MS loci was performed in 325 chicks of RIRs. Expression of selected immunity related candidate genes was also undertaken. The fertility % and hatchability% on fertile eggs set were 73.2 and 78.1, respectively. SRBC response (HA titre) averaged 9.09±0.20. The overall LS mean of serum lysozyme level was 4.70±0.10 μg/ml. Difference due to sex were non-significant. LS mean of body weight at 16, 20 and 40 weeks were 1362.62±21.42 g 1791.60±24.59 g and 2184.58±26.19 g, respectively. Males had significantly higher weight at all ages than females. The LS means of age at sexual maturity (ASM), egg weight at 28 and 40 weeks of age and egg number up to 40 weeks of age were 134.52±0.86 days, 44.81±0.34g, 47.73±0.38 g and 118.27±1.20 eggs, respectively. The heritability estimates for BW16, BW20, BW40 and EW28 were 0.55±0.22, 0.42±0.19, 0.29± 0.18 and 0.17±0.29, respectively.

GENETIC IMPROVEMENT OF SYNTHETIC BROILER LINES (AICRP Component)

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 synthetic male parent broiler lines.

Incubation and hatchability: A total of 1900, 4656 and 1325 eggs were set in SML, CSML and control out of which 1287, 3227 and 903 good chicks were hatched in respective lines. Corresponding fertility percentages were 83.16, 81.85 and 79.50. Hatchability percentages on TES and FES were 72.47 and 87.15, respectively in SML, 71.84 and 87.72, respectively in CSML and 69.02 and 87.00, respectively in control.

Body weights and responses: Overall average body weight of mixed sexes at 5 weeks in SML, CSML and control were 1144.35±5.14, 1187.61±4.66 and 753.24±4.68 g, respectively. The phenotypic and genetic responses to selection for 5-week body weight in SML were 13.80**±1.82 and 11.48**±2.09 g/generation, respectively. Corresponding values in CSML were 17.56**±1.26 and 15.23** 1.64 g/generations. The phenotypic response for 5-week body weight in the control population was non-significant (2.46±1.32 g/generation).

Table 6: Reproductive performances in different broiler strains

Strain	*No. of egg set*	*F %*	*Killed chicks*	*Good chicks*	*Total chicks*	*H % (TES%)*	*H % (FES)*
IR-3	752	83.51	10	509	519	69.02	82.64
IC-3	801	85.64	3	542	545	68.04	79.45
NNC	746	77.61	4	456	460	61.66	79.45
NNW	183	88.52	1	130	131	71.58	80.86
Tropicana	1147	66.61	4	475	479	41.76	62.70

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.

Random sample performance test: At 40th RSPPT (Gurgaon), CARIBRO-Dhanraja secured V rank by attaining 1.592 and 1.936 kg body weight at 6 and 7 weeks, respectively with a mortality of 8.3% during 0-7 weeks period. FCR at 0-6 and 0-7 weeks were 2.14 and 2.37 with dressing percentage of 69.07 and margin of receipt at 6-weeks as Rs. 21.6 and at 7-weeks Rs. 15.03.

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 synthetic female parent broiler lines.

Incubation and hatchability: A total of 5359 and 2742 eggs were recorded in CSFL and SDL, respectively out of which 3955 and 2108 good chicks were hatched out in respective line. The fertility percentage was 82.01 and hatchability percentage based on TES and FES were 73.80 and 89.98, respectively in CSFL. Corresponding values in SDL were 88.51, 77.72 and 87.80%, respectively.

Body weights and responses: The overall average of body weight at 5 weeks in CSFL and SDL were 1175.09±3.51 and 1115.05±3.44 g. The phenotypic and genetic responses to selection for 5-week body weight in SDL were observed as 13.00±2.81 and 10.67±2.80 g/generation, respectively. Corresponding values for CSFL were 18.61±1.37 and 16.27±1.73 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 40th RSPPT (Gurgaon), CARIBRO Vishal secured IV rank by attaining 1.510 and 1.968 kg body weight at 6 and 7 weeks, respectively. FCR at 0-6 and 0-7 weeks were 2.37 and 2.50 with dressing percentage of 71.84 and margin of receipt at 6-weeks as Rs. 11.16 and at 7-weeks Rs. 05.76.

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 6.

Body weights: The mean body weight at 5-week of age in IR-3, IC-3, CARIBRO Tropicana, Naked neck coloured and naked neck white were 1156.69±7.85, 934.08±5.52, 1039.13±9.43, 1265.63±8.75 and 1207.15±13.94 g, respectively.

Expression levels of growth factors in coloured broilers under symbiotic feeding: One day old mixed sex coloured synthetic male line chicks (180) divided randomly into five groups of 30 chicks each, in five dietary treatments were used. Chicks in treatment 1 were fed a basal diet (Starter feed); treatment 2, basal diet + multistrain probiotic; treatment 3, basal diet + Bacillus Subtilis ($5x10^9$ cfu/g); treatment 4, basal diet + Lactobacillus acidophilus ($6x10^9$ cfu/g); treatment 5, basal diet + Lactobacillus sporogenus; treatment 6, basal diet + Saccharomyces boulardii (20 billion cfu/g). All the four single strain and sole multistrain probiotics were given @ $1x10^9$

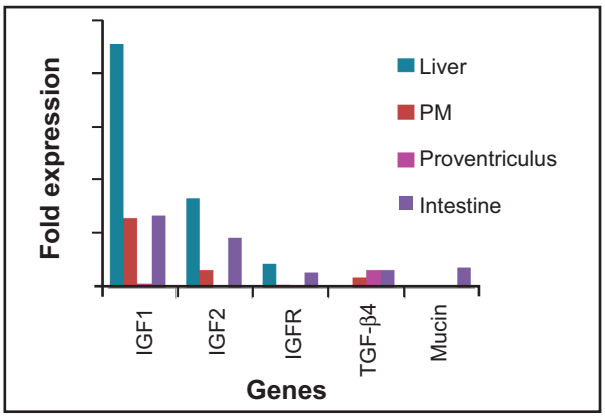


Fig. 5: Expression profile of various growth factor genes in different tissues under symbiotic feeding at 3-wk of age

cfu/chicks throughout the experimental period. Expression profiles of different growth related genes IGF1, IGF2, IGFR, TGF-β4 and mucin in liver, breast muscle, proventriculus and intestine were analysed (Fig. 5). Tissue specific expressions of various genes were exhibited. Expression profile of various genes revealed reverse pattern between liver and Pectoris majors muscle. Mucin was expressed only in intestine.

NUTRIENT MANAGEMENT

NUTRITION FOR POULTRY HEALTH AND WELFARE

- In the process of improving consumers' health and nutritional status by designing nutritional profile of poultry meat and eggs through dietary approaches, efforts are presently going on lowering cholesterol content of quail egg through use of additives, nutritional agents, herbs, dietary fiber, pharmacological drugs, etc. Accordingly, black cumin, fenugreek and certain herbs (holi basil and curry leaves) either singly or in combinations were fed to Japanese quails in laying. The results of feeding spices indicated that dietary addition of black cumin and fenugreek @ 3.0% in diet significantly reduced the serum cholesterol, triglycerides, LDL, VLDL, liver and egg yolk cholesterol. The HA titre was also increased significantly but CMI response was not affected. The results of experiment on herbs revealed that feeding of holi basil at 3.0% and curry leaves powder at 5.0% levels significantly reduced the serum cholesterol, triglycerides, LDL, VLDL, liver and egg yolk cholesterol. The HA titre was also increased significantly.
- All the feedstuffs and finished feeds are suitable media for growth of a wide variety of moulds provided the moisture contents of feedstuffs and environmental temperature are suitable for mould growth leading to production of various mycotoxins, aflatoxins being most prominent. Accordingly the efficacy of certain organic acids in preventing mould growth in mixed feed containing different moisture levels was investigated. Aflatoxin biosynthesis did not occur at 11% moisture level in feed but there was linear increase in aflatoxins production with increase in moisture content from 11 to 17% in feed. Complete inhibition of aflatoxins synthesis at 13% moisture level was achieved with 0.25% propionic, 0.30% benzoic or 0.40% tartaric acid. Similarly, at 15% moisture aflatoxins production was completely inhibited with 0.50% propionic or benzoic acid. However, propionic, benzoic or tartaric citric acid at 0.50% level, failed to completely inhibit the synthesis of any of the four fractions of aflatoxins in feeds with 17% moisture. Propionic acid was more efficacious than benzoic or tartaric acid in inhibiting the aflatoxins production.
- Fungal toxins also have major impact on production performance, immunity and health. Various measures are being applied to manage mycotoxicoses, however, nutritional management has been the effective and handiest tool. Accordingly, efficacy of zinc and DL-methionine in ameliorating aflatoxicoses was investigated. Supplementation of additional 40 mg Zn/kg (total 80 mg Zn/kg) in AF contaminated diet significantly improved the body weight gain (BWG), feed intake (FI), feed conversion ratio (FCR), weight of bursa, blood biochemical profile, and CMI response as well as humoral immunity, and reduced the severity of the intestinal damage caused by aflatoxins with improved the villi length/crypt depth ratio. It was concluded that aflatoxin contamination (250 ppb) in broiler diet impaired the performance in terms of BWG, FI and FCR and relative organ weights. Supplementation of 40 mg Zn/kg to the aflatoxin contaminated diet ameliorated the ill effects of aflatoxicosis on performance of the birds. Addition of total 80 mg/kg dietary zinc in starting and finishing diets ameliorated the adverse effects of aflatoxin in broiler chickens.

- The efficacy of methionine in combating the experimental aflatoxicosis in broiler chickens (0-6 weeks) was also evaluated. Feeding diets with 250 ppb aflatoxin to broiler impaired the performance in terms of BWG, FI, FCR and relative organ weights. Supplementation of 0.1% methionine to the aflatoxin contaminated diet had pronounced ameliorative effect on performance as well as organ weight of the birds. AF in feed increased the requirement of dietary methionine as addition of methionine @ 0.1% above the NRC recommendation in starting (total 0.6% Met) and finishing diet (total 0.48% Met) in the AF contaminated diet (250 ppb) improved the blood biochemical and haematological parameters and immune response of broiler chickens. Moreover, severity of the hepatic and intestinal histopathological changes (villus length/crypt depth ratio) associated with aflatoxicosis was counteracted though supplementation of 0.1% methionine.
- Ochratoxins, another group of fungal toxins, are produced by several species of Aspergillus (*Aspergillus ochraceous*) and Penicillium (*Penicillium viridicatum*). The incidence of its toxicity is commonly encountered in poultry birds. Thus, there is need for standardization of its production characteristics and analysis for further study. Ochratoxin A (OTA) production by Aspergillus westerdijkiae NRRL 3174 in liquid medium (yeast extract and sucrose) and solid substrates (maize and rice) was studied under laboratory conditions. Liquid medium containing 2% yeast extract with various concentrations of sucrose (0-16%) was inoculated with fresh spores of Aspergillus westerdijkiae NRRL 3174 and incubated for 14 days at 25±0.5°C as stationary cultures. The OTA production increased with the increase in sucrose concentration up to 8%, however, above 8%, OTA production decreased. The highest production of OTA (21 mg/100 ml) was recorded at 8% sucrose concentration containing 2% yeast extract medium. In case of solid substrates, the OTA yield increased with the increase in moisture content of the substrates from 15 to 35%. Considerably lower yield of OTA was recorded at 20 and 35°C as compared to 25 and 30°C temperatures. The highest production of OTA (0.99 g/kg maize and 0.98 g/kg rice) was harvested at 35% moisture and 30°C temperature in 14 days of incubation period. It is thus concluded that fungal growth is not related to ochratoxin production and the maximum yield of OTA can be harvested at 8% sucrose and 2% yeast extract medium. Further, the maximum yield of OTA on solid substrate can be harvested at 35% moisture level and between 25 and 30°C.
- Commercial broiler stocks are prone to thermal stress. Considerable attention has been paid for ameliorating heat stress through nutritional manipulation. Accordingly the effect of vitamin E (150 and 250 mg/kg) and mannan oligosachharides (0.3% and 0.5% MOS) was assessed through growth performance, blood biochemical and immune competence of broilers during hot summer (April-May, Temperature 30.0±0.73 to 37.0±1.4ºC, relative humidity 58.05 to 70.11%) and during hot-humid summer (August-September, Temperature 26.0± 0.123 to 34.25±0.368ºC, relative humidity 76.95 to 86.15%) involving 200 broiler chicks under each experiment. Addition of vitamin E (250 mg/kg) or MOS (0.03%) in the diet was beneficial for ameliorating heat stress of broiler chickens during dry and hot-humid summer.

EXPANDING FEED RESOURCES AND IMPROVING NUTRIENT EXTRACTION FROM BIOMASS

- In a bid to reduce feed cost, identification of alternate feed resources has been an important area in nutritional research. Decorticated cottonseed meal (DCSM), obtained during oil extraction from decorticated cotton seeds, is widely available plant protein in India; but is largely under-utilized in commercial practice due to the anti-nutritional factors and the low levels of available lysine. DCSM is available at a lower price than other protein sources, and therefore, more attractive to the poultry producer. Hence, there is a need to establish the inclusion rate and feeding value of de-corticoid cottonseed meal in poultry ration. A biological trial of six week duration was conducted to assess the feeding value of DCSM in broiler chickens. The body weight gain decreased ($P<0.05$) in diets with 25 and 30% of DCSM during 0-6 wk growth

phase. The FCR was similar to control diet in birds fed DCSM up to 20% while carcass traits did not differ. Feed-cost per kg of weight gain showed a significant reduction up to 20% DCSM in diet. It is concluded that the addition of decorticated cotton seed meal at 20% level did not exert any adverse effect on growth, FCR and carcass traits in broilers.

- Herbs play important role as feed additive in poultry. Accordingly, a study was conducted to assess the effect of dietary inclusion (0.5%, 1.0%, 1.5% and 2.0%) of curry leaves powder (*Murranya koenigii*) on performance and meat quality traits of broiler chicken. The average body weight gain of the birds did not differ however meat quality in terms of palatability score, extent of oxidation in terms of malondialdehyde (MDA) concentration of meat during refrigerated storage (4°C for 6 days) were improved in higher levels of curry leaves treated groups (1 and 2%).

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

- Zinc is interrelated with vitamin A. Thus, the response of broiler chickens to varying dietary levels of vitamin A and Zinc on the growth, immune response, carcass yield, haematological and blood biochemical parameters was studied through 3x4 factorial design involving three Zn levels (40, 60 and 80 mg/kg) each with four vitamin A levels (1500, 3000, 6000 and 10,000 IU/kg diet) from 0-6 wks of age. Results indicated that a dietary combination of 40 mg Zn/ kg with supplemental vitamin A 6000 IU/kg diet was found adequate to obtain optimum growth, carcass yield, haematological and blood biochemical parameters. However, better immune response was realized on dietary levels of Zn 60 mg/kg with 3000 IU/kg vitamin A. Dietary combination of 60 mg Zn/kg diet with 3000 IU/kg vitamin A was found adequate for optimum bone morphometry and mineralization of tibia bone in broiler chickens.
- An experiment with three levels of chromium piclonate (CrP) i.e., 250, 500 and 750 µg/kg diet both in male and female turkeys (144) indicated that egg quality traits in terms of shape index, albumin index and yolk index did not differ significantly ($P > 0.05$), whereas the Haugh unit score and shell thickness were significantly higher ($P < 0.05$) in T_4 than the control (T_1) and other two treatment group (T_2 and T_3). Percentage of carcass traits did not differ significantly ($P < 0.05$) except the percentage of bleeding loss, wings and giblets among the control and CrP treated groups. Significant ($P < 0.05$) differences (increase/decrease) were recorded in total protein, glucose, triglyceride and cholesterol concentration in T_3 (500 µg/kg diet) and T_4 (750 µg/kg diet) group in comparison to other two groups (control and T2 group).

PHYSIOLOGICAL INTERVENTION FOR AUGMENTATION OF REPRODUCTIVE EFFICIENCY

EVALUATION AND IMPROVEMENT OF REPRODUCTIVE EFFICIENCY IN GUINEA FOWL AND CHICKEN

Effect of Di-ethylstilbestrol on male Japanese quail reproduction: Effect of prominent endocrine disruptors (EDS)- Diethylstilbestrol (DES), on male quail reproduction was investigated. Four groups of randomly chosen quail (15 quails/gp) were placed in individual cages uniform management and nutrition. Birds from the first group served as control (T_1) whereas birds of the second group termed as sham control (T_2) which received olive oil (vehicle) only through oral route. Group 3rd and 4th experimental birds (T_3 and T_4) were given DES (Sigma Chemicals Co., USA) dissolved in olive oil through oral route at the rate of 1.0 mg/ bird (low dose), and 5.0 mg/bird (high dose) for 15 days. A drastic reduction in semen volume, sperm motility, live count, sperm concentration associated with increase of morphological abnormality of spermatozoa was noticed in treated birds. The area of the cloacal gland was declined in the treated groups with reduction in the serum testosterone profile. Semen biochemical characteristic also exhibited significant changes in treated birds. After 15 days of the withdrawal of the treatment, recovery in these parameters were recorded. It could be concluded that DES is having the reversible effect on male Japanese quail reproduction.

Optimization of RNA isolation protocol from chicken sperm: The optimized RNA isolation protocol from chicken sperm were developed. Briefly, after removing the debris by centrifugation, the diluted semen (500-800x10^6

sperm/mL) was gently placed over 3mL of 40% PureSperm or 45% and 90% Percoll, and centrifuged to remove somatic cells and immature diploid spermatocytes. RNA was isolated from sperm by using RNAzol or TRIzol reagent or RNeasy Micro kit with certain modification. RNA quantity and quality was evaluated by a NanoDrop spectrophotometer and bioanalyzer. Standardized RT-PCR with chicken primers for *CD4* gene was developed to determine genomic DNA or somatic cells RNA contamination in sperm RNA samples. A PCR protocol was developed to amplify GC (88%) rich *PRM* (Protamine) gene. RNA isolated by using RNAzol or RNeasy Micro Kit yielded good quantity and quality of RNA for downstream applications compared to TRIzol. 40% PureSperm was found effective in removing somatic cells. All the sperm RNA samples were positive for *PRM* and *PLCZ1*, markers of sperm RNA (Fig. 6). The developed protocol provides a foundation to identify fertility bio-markers in chicken.

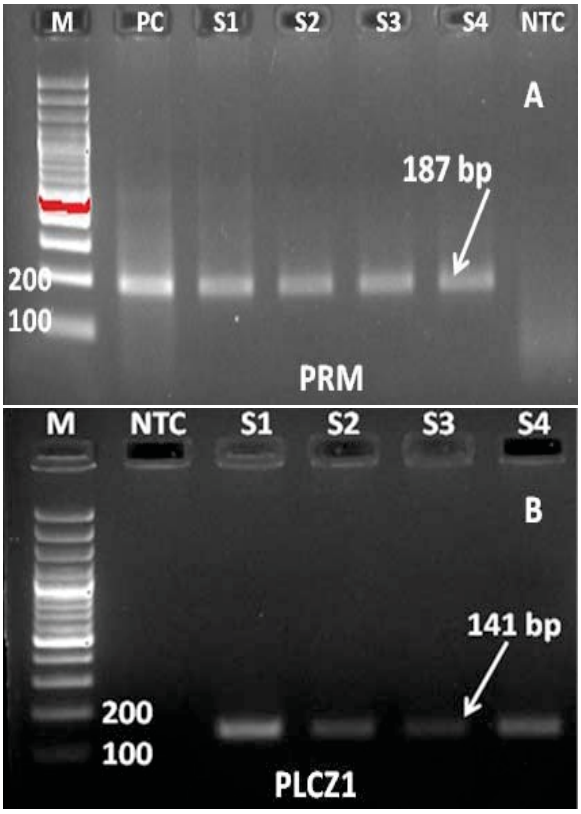


Fig. 6: Agarose gel image showing PCR results. (A) Amplification with PRM; and (B) Amplification with PLCZ1. M-100bp marker; NTC-non template control; PC- testis RNA sample; S1-S4-four different sperm RNA samples

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

Effect of incubation temperatures on the hatching performance in Japanese quail: A total of 720 hatching eggs (360 of each variety i.e., CARI Pearl-low body weight and CARI Uttam-high body weight varieties) were randomly divided into three treatment groups. Each treatment having 240 eggs (120 from each variety, which were further divided into 4 replicates with 30 eggs in each replicate). The first treatment group served as control wherein the eggs were incubated at 37.5°C. In 2nd and 3rd treatment group, the eggs were incubated at 37.5°C for initial 10 days and thereafter at 38.5°C and 39.5°C, respectively. The hatching performance was adversely affected by the elevated incubation temperatures. Elevated incubation temperature reduced ($P \leq 0.05$) hatchability, chick weight, chick to egg weight ratio, whereas moisture loss, mal-positions, embryonic mortality increased (Table 7). These adverse effects of elevated incubation temperatures were more pronounced in CARI Uttam quails.

Influence of incubation temperatures on expression of nutrient transporter genes (NTG) in Japanese quail: Effects of elevated incubation temperature (EIT) on the mRNA expression of NTG in two varieties of Japanese quail (CARI Uttam and CARI Pearl) was analsyed. A total of 96 hatching eggs (48 from each variety) were randomly divided into three treatment groups (32 eggs, 16 from each variety). The eggs of first treatment group served as control and were subjected to 37.5°C), throughout the entire incubation period (17 days). Eggs in 2nd and 3rd treatment group, the eggs were incubated at 37.5°C for initial 10 days and thereafter at 38.5°C and 39.5°C, respectively. mRNA expression of nutrient transporters (SGLT1, GLUT5, PepT1 and EAAT3) in jejunum of chicks (4/ variety/time) from each treatment group at hatch (DOH), 3rd, 7th and 10th day of age revealed a significant ($P \leq 0.05$) up-regulation in the mRNA expression of all NT genes studied at elevated incubation temperatures; except PepT1 and EAAT3 genes on different time points. Expression profiles of different genes are shown in Figs. 7, 8, 9 and 10.

Table 7: Effect of incubation temperatures on the hatching performance in Japanese quail

Temperature x variety	*Variety*	*Hatchability (%) on fertile egg set*	*Chick weight (g)*	*Chick : Egg weight ratio*	*Egg moisture loss (%)*	*Malpositions (%)*
37.5°C	Pearl	93.30±0.472	8.21 ± 0.069^{pq}	0.776 ± 0.006^{r}	6.83 ± 0.101^{p}	0
	Uttam	93.20±1.228	8.88 ± 0.047^{s}	0.714 ± 0.007^{q}	7.19 ± 0.026^{q}	0.83
38.5°C	Pearl	83.00±2.234	8.18 ± 0.018^{pq}	0.772 ± 0.006^{r}	7.10 ± 0.046^{q}	0.83
	Uttam	81.40±3.835	8.69 ± 0.022^{r}	0.708 ± 0.011^{q}	7.42 ± 0.076^{r}	1.66
39.5°C	Pearl	78.42±2.800	8.13 ± 0.024^{p}	0.763 ± 0.007^{r}	7.56 ± 0.055^{r}	1.66
	Uttam	76.53±2.973	8.27 ± 0.059^{q}	0.691 ± 0.009^{p}	7.92 ± 0.024^{s}	2.50
Temperature	37.5°C	93.28 ± 0.609^{B}	8.55 ± 0.133^{C}	0.743 ± 0.012^{B}	7.01 ± 0.083^{A}	0.42
	38.5°C	82.27 ± 3.312^{A}	8.44 ± 0.211^{B}	0.740 ± 0.007^{B}	7.26 ± 0.073^{B}	1.25
	39.5°C	77.47 ± 2.173^{A}	8.20 ± 0.113^{A}	0.661 ± 0.013^{A}	7.74 ± 0.074^{C}	2.08
Variety	Pearl	84.95±3.269	8.17 ± 0.025^{a}	0.771 ± 0.012^{b}	7.16 ± 0.098^{a}	0.83
	Uttam	83.73±3.091	8.61 ± 0.078^{b}	0.704 ± 0.012^{a}	7.51 ± 0.095^{b}	1.66
Significance	Temp	P<0.01	P<0.01	P<0.01	P<0.01	
	Variety	NS	P<0.01	P<0.01	P<0.01	
	Interaction	NS	P<0.01	P<0.05	P<0.01	

(p, q, r, s) Interaction; (A, B, C) Temperature; (a,b) Variety. Values bearing different superscripts differ significantly

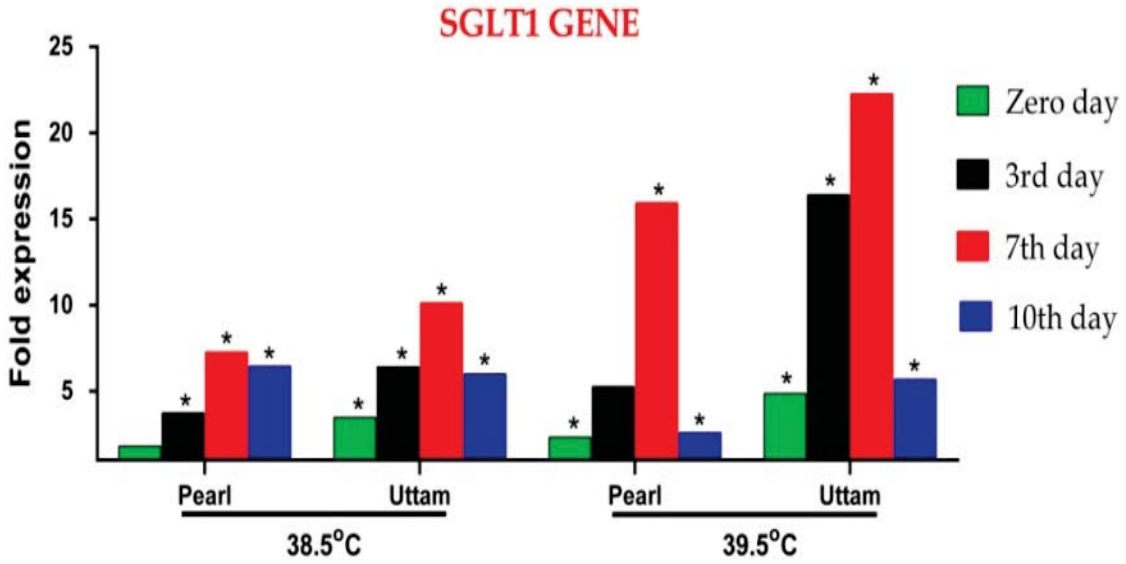


Fig. 7: Effect of elevated incubation temperatures on the relative fold expression SGLTI gene in Japanese quail as compared to normal incubation temperature

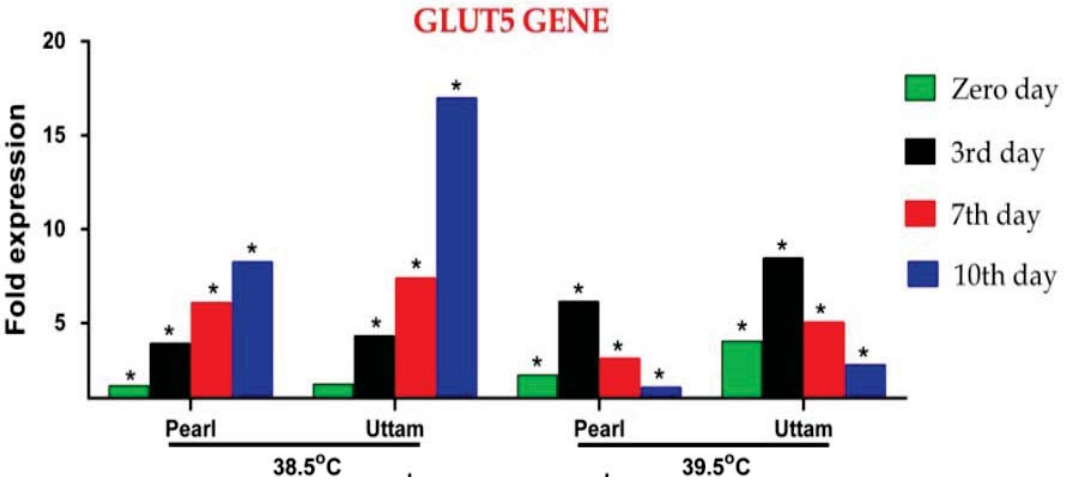


Fig. 8: Effect of elevated incubation temperatures on the relative fold expression of GLUT5 gene in Japanese quail as compared to normal incubation temperature

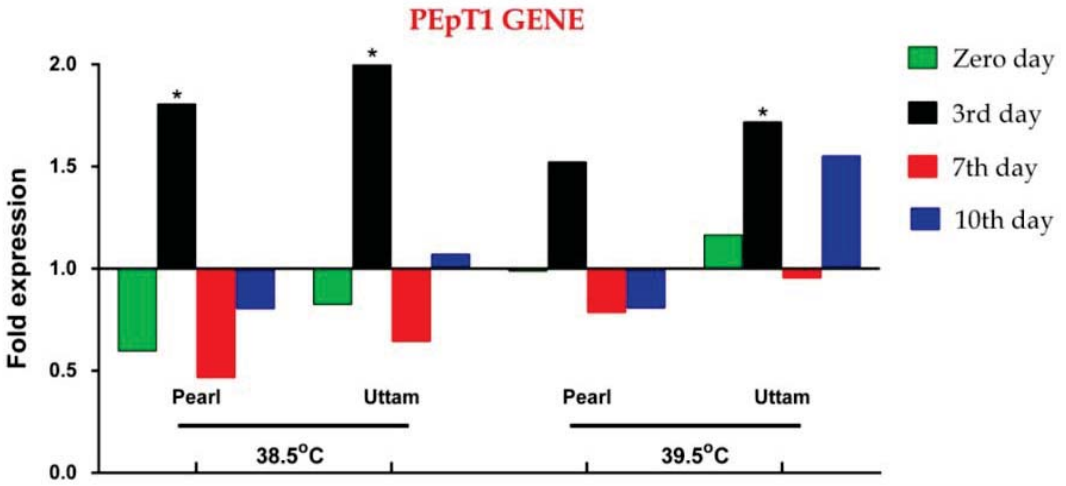


Fig. 9: Effect of elevated incubation temperatures on the relative fold expression of PepT1 gene in Japanese quail as compared to normal incubation temperature

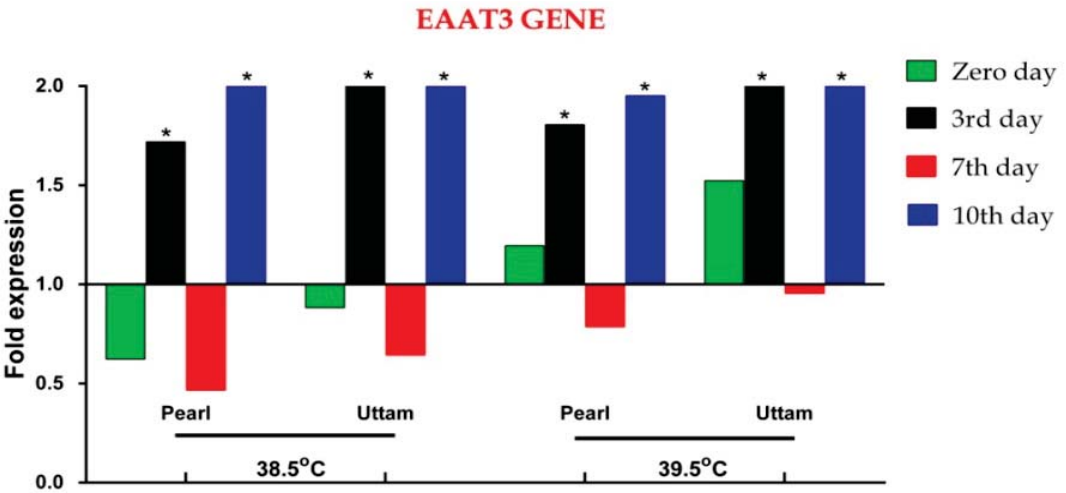


Fig. 10: Effect of elevated incubation temperatures on the relative fold expression of EAAT3 gene in Japanese quail as compared to normal incubation temperature

PHYTOHORMONAL STRATEGIES FOR AUGMENTING REPRODUCTIVE EFFICIENCY OF JAPANESE QUAILS

Development of phytohormonal based interventional strategies for improving reproductive efficiency: Female Japanese quails (n = 120; 10 weeks old) (*Coturnix coturnix japonica*) were used for this study. All the quails were hatched out from a large group of parent stock that was identical in age. After a one week adaptation period, birds were randomly assigned into treatment groups. Birds were fed adult layer diet containing crude protein 19%, ME (kcal/kg) 2700, calcium 3.02% and available phosphorus 0.39%. The basal diet (control) was formulated using conventional feed ingredients but soybean cake was excluded to remove any interference from isoflavones already present in soybean. Aglycone form of soy isoflavones (40% extract), which include Genistein and Daidzein were used as they are absorbed faster and in greater amounts from the feeds. Soy isoflavones (powder form) was blended (Genistein-25% and Daidzein-15%) thoroughly in vegetable oil and incorporated into adult layer diet @ 60 mg/kg. Diets were prepared on a weekly basis and stored in covered plastic containers excluding light and heat to avoid photo-oxidation of active phytoestrogenic components. The diets (control and treatment) and fresh water were all offered *ad libitum* to all the experimental birds. Light was provided continuously (24 h) throughout the trial period. Feed intake and body weight was determined at weekly intervals. Egg production and egg weight of all the eggs laid from treatment groups besides mortality if any, were recorded on a daily basis. Based on these data, hen day (per cent) and hen housed (number) egg production and livability percentage was calculated. Occurrences of abnormal oviposition were also noted.

Isoflavone supplementation resulted in a slight increase of feed intake and a higher body weight, however the differences were non-significant. The analysis of hen day egg production (%) showed significantly ($P < 0.05$) higher rate of lay in supplemented group (83.22 ± 0.59) compared to control (78.05 ± 1.26). Noticeable decrease in incidences of abnormal eggs viz. shell less and double yolk eggs were also observed in treated hens.

SHELTER MANAGEMENT

EVALUATION OF MANAGEMENT PRACTICES TO OPTIMIZE TURKEY PRODUCTION

Performance of white turkey poults was evaluated in different floor space and dietary protein levels. An experiment was conducted (3x3 factorial design) involving three different floor spaces (0.6, 0.8 and 1.0 sq.ft) each with three dietary protein levels (22%, 24% and 26% CP) during pre-starter (0-4 wk) and starter (4-10 wk) phase of age with constant energy levels of 2800 kcal/kg and 2900 kcal/kg during pre-starter and starter phase, respectively. It was found that during pre-starter period (0-4 weeks of age) the turkey poults can successfully be reared with 1.0 sq. ft. floor space and 26% protein with 1.6% lysine, 0.50% methionine and 2800 kcal ME/kg diet for better growth performance. Starter cum grower (4-10 weeks of age) turkey poults require 0.8 sq.ft floor space and diet with 22% protein, 1.5% lysine and 0.45% methionine, 2900 kcal ME/kg for better growth, immunocompetence and for feed-cost efficient production. For better economic return the poults could be reared at 0.6 sq. ft floor space and 22% protein level from 0-10 weeks of age.

POULTRY REARING PRACTICES AT HIGH ALTITUDE

Performance of CARI Debendra (CD) at high altitude: About 312 day-old chicks of dual purpose birds (CARI Debendra) were housed in battery cages at IVRI, Mukteswar at an altitude of > 2000 msl and another batch of 350 birds from the same hatch was reared at CARI (plain) during winter months (Nov.-Feb.) and their performance was compared. During first four weeks there was no difference in the body weight of birds, but at 8th and 12th week birds reared at CARI campus had 365 g and 716 g higher body weight ($P < 0.01$) than those at Mukteswar (Fig. 11).

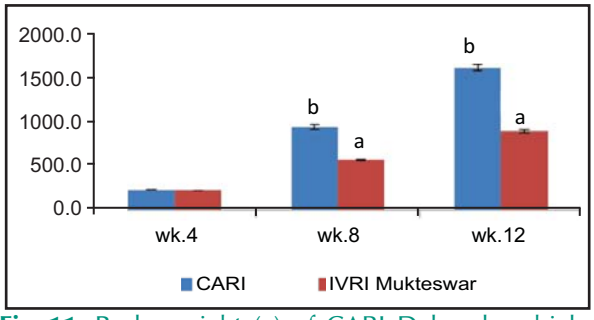


Fig. 11: Body weight (g) of CARI Debendra chicks at CARI and IVRI, Mukteswar

Performance of egg type chickens at high altitude: About 200 egg layer birds (CARI Priya) were distributed in cage and floor system of management and provided iso-nitrogenous (16% CP) diet each having three different level of energy (ME: 2700, 2600 and 2500 kcal/kg) during April to December month at high altitude (>200 msl) of IVRI Mukteswar. During summer months, when reared in cages hen day egg production was significantly higher ($P<0.01$) in birds fed high energy diet (2700 kcal/kg ME) but during winter months, birds fed 2600 kcal/kg ME had egg production comparable to those fed 2700 kcal ME diet. When reared on floor, birds fed 2700 kcal ME diet had higher hen day egg production during summer but birds fed low energy diet (2500 kcal ME) had better production during winter months (Fig. 12-13).

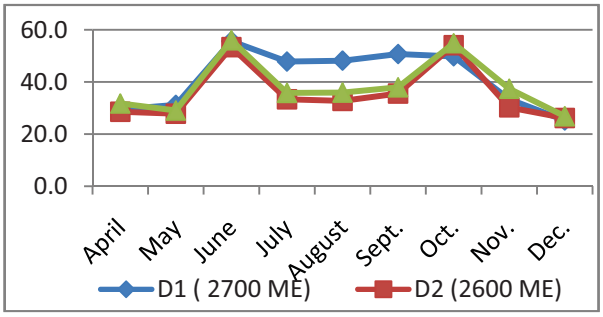


Fig. 12: Hen day egg production (%) of CARI Priya reared on litter

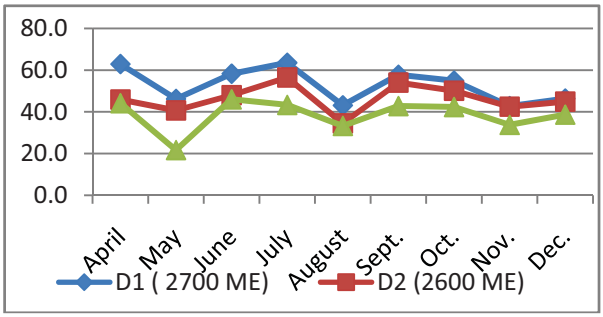


Fig. 13: Hen day egg production (%) of CARI Priya reared in cages

HEALTH MANAGEMENT

SURVEILLANCE AND MONITORING OF POULTRY DISEASES IN POULTRY FARMS OF CARI

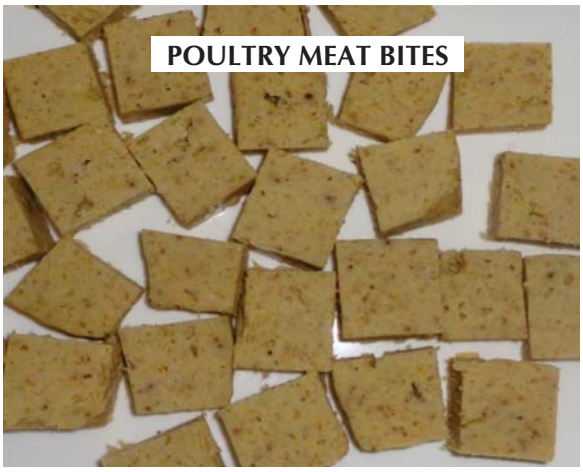
Health management of different poultry species viz. chickens (layer, broiler and desi fowl), quails, turkey, guinea fowl and emu maintained at the Institute was carried out as a regular activity. Health management of poultry birds included both prophylactic as well as therapeutic treatment which was devised from time to time based on sero-surveillance, diagnosis on the basis of post-mortem examination and detection of causative agent(s). Vaccine immunity was also assessed for some important diseases in different poultry species. The vaccine schedule was revised as per the immunity status and species of the poultry birds from time to time. 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. Pathogen profiling for *Salmonella* and Avian Leucosis Virus (ALV) was also carried out as a part of health monitoring programme.

Immuno-modulators supplementation either through feed or drinking water found to be very effective. Hepatotonics, probiotics, gut acting acidifiers, antibiotics, vitamins, minerals anti-coccidial drugs, electrolytes, immuno-modulators and water sanitizers were given to the birds as prophylactic or therapeutic agents to prevent the infection/disease as well as to treat the affected birds. Some of the disease encountered includes colibacillosis, chronic respiratory disease, coccidiosis, etc. and these were effectively controlled using antibiotics, anticoccidial/ antimicrobial drugs along with vitamins including multivitamins, electrolytes and immnuo-boosters. Poultry drinking water and feed samples were assessed for microbiological quality regularly. Assessment of antibiotics sensitivity was carried out to administer the most effective antimicrobial agents so as avoid the problem of development of resistance in bacterial populations. Bio-security measures of all the farm premises as well as all in all the poultry sheds were further strengthened. Disinfection of poultry sheds was carried out regularly in the presence of birds and after completion of the experiment. The waste generated from hatchery, processing plant and dead birds was disposed off hygienically by burning in incinerator as well as by rendering.

PROCESSING, VALUE ADDITION, PRODUCT SAFETY AND QUALITY PARAMETERS

SHELF-LIFE ASSESSMENT OF BAKED EGG

Baked Egg offers a potential market at growing fast food outlets. Most acceptable baked egg was prepared using liquid whole egg, grated cheese and skim milk solids (SMS) at 70, 12 and



5% levels, respectively, as major ingredients, with finely chopped onion, chopped green peppers, ginger paste and salt and its refrigerated (4±1°C) shelf-life was determined in vacuum and aerobic packaging. TBA values, pH and weight loss were significantly ($P<0.05$) affected by storage conditions in both packaging treatments. Significant increase in TBA values was noted on day 4 in both vacuum and aerobic packaging and increased further with storage time. However, rate of increase was slower in vacuum than in aerobic packaging. pH registered significant increase on 4th day in aerobic pack and increased further as the storage advanced, while no significant change was noted in vacuum packaging. Slightly undesirable flavour was noticed in air packed samples on 12th day of storage and hence discarded. Significant increase in counts of aerobic bacteria was found on 4th day in vacuum at on 2nd day in air packaging and increased further as storage progressed, while coliforms and staphylococci were not encountered in any sample during storage. Further, yeast and moulds were occasionally seen in air packed samples only during storage. Sensory evaluation revealed decline in appearance, flavour, texture and overall acceptability scores during storage, yet the baked egg was acceptable for 12 days in vacuum and 10 days in aerobic packs at refrigerated storage.

Optimization of level and type of meat suitable for preparation of poultry meat bites: Several individual trials were conducted for optimization of meat level using spent chicken meat at three levels i.e., 68.5% (T_1), 65.5% (T_2) and 62.5% (T_3). Lean meat along with other ingredients *viz.* ice cubes, refined vegetable oil, textured soya protein, maida, condiments, table salt, sugar, sodium tripolyphosphate, spice mix, boiled eggs and sodium nitrite were mixed properly in a Hobart paddle type mixer for 2 min. The emulsion was filled in aluminium mould and cooked in a pre-heated steam cooker for 1 hr. After keeping at refrigeration temperature, the product was evaluated for physicochemical and sensory attributes. T_1 had highest ($P<0.05$) emulsion stability, cooking yield, moisture and protein contents, however, emulsion and cooked product pH, Lovibond tintometer colour differed non-significantly from T_2. Regarding sensory attributes, all samples were well acceptable by the sensory panel, but T_2 exhibited significantly highest ($P<0.05$) scores for appearance and colour, texture and overall acceptability. So, formulation containing 68.5% lean meat was considered to be most suitable in development of chicken meat bites.

For selection of type of meat suitable in preparation of poultry meat bites, turkey and spent hen meat were used alone and in their 50:50 combinations. A total three treatments were assigned (i) turkey meat 100% (T_1), (ii) spent hen meat 100% (T_2), and (iii) turkey meat 50% + spent hen meat 50% (T_3) and products were prepared and evaluated as mentioned above. Results indicated that protein content was highest but fat content was lowest in T_1 sample. T_2 sample exhibited maximum cooking yield, however, there was no significant difference in emulsion stability and pH value amongst the treatments. Regarding sensory attributes, all samples were well acceptable by the sensory panel, but sensory scores for all attributes were significantly higher for T_2 sample. Finally, it was concluded that use of spent hen meat in development of meat bites is most acceptable.

Standardization of suitable hurdles in development of meat bites: In optimization of suitable hurdle for development of chicken meat bites, meat emulsion containing 68.5% lean chicken along with other seasonings (control) was treated with 0.5M lactic acid, sodium ascorbate, oregano powder, Moringa (*M. oleifera*) leaf powder and makhana @ 0.1, 0.03, 0.05, 0.25 and 1.0%, respectively. Results indicated that during initial days of storage, the pH value of control and treated samples differed significantly, but increased with the increase in storage time. Lipid stability study indicated that control had higher TBARS value on day 5 and at subsequent storage intervals. Lovibond tintometer colour value suggested that treated products were lighter and shown to have lower redness (*a*-value) but higher yellowness (*b*-values) as compared to control. Texture profile analysis revealed that hardness value was more for control products. Treated samples showed lower SPC than control, however bacterial count like total coliforms, *Staphylococcus aereus,* and yeast and molds count were absent throughout the storage. Psychotropic count detected only after 10 days of storage. The treated samples exhibited significantly higher sensory scores for all attributes at each storage interval. The control patties were spoiled on 15th day but treated sample could be well stored up to day 20 indicating the improvement in the shelf-life of chicken bites.

Standardization of suitable hurdles in development of meat finger chips: Hurdles for poultry meat finger chips were developed with citric acid (0.2%), apple peel paste (1.0%) and sodium ascorbate (0.05%) followed by microwave cooking. Two groups of samples were prepared- control (without acidulant/functional ingredients) and treatment (containing 0.2% citric acid + 1.0% apple peel paste + 0.05% sodium ascorbate). Addition of citric acid, apple peel and sodium ascorbate in the product formulation improved cooking yield, emulsion stability and also nutritional value, in particularly, dietary fibre. Lipid oxidation products (PV, TBARS and FFA) were lowest in treated group samples. The treatments also showed positive impact on microbiological quality and sensorial scores. So, it is concluded that apple peel could be used as functional ingredients in development of PMFC and inclusion of citric acid and sodium ascorbate could have potential benefits on extension of shelf-life of products.

Poultry meat finger chips

Hurdle treated poultry meat finger chips

DEVELOPMENT AND QUALITY ASSESSMENT OF POULTRY MEAT WAFER

Effects of apple peel paste (2% APP, T_1), banana peel paste (2.5% BPP, T_2), aloe vera gel (2% AVG, T_3) and drumstick leaf powder (0.5% DLP, T_4) as functional ingredients were studied in development of poultry meat wafer (PMW). Results indicated that addition of APP, BPP, AVG and DLP in the wafer formulations sustained desired cooking yield and emulsion stability besides improving the nutritional benefits. The protein and fat contents were decreased, but fibre and ash contents were increased amongst the treatments. The T_4 sample exhibited highest $ABTS^+$, DPPH and superoxide anion scavenging activity followed by $T_1 > T_3 > T_2$. All the treated samples showed protection against increase in

Poultry meat wafers

lightness (*L*-value) but decrease in redness (*a*) and yellowness (*b*) values during storage. The lipid oxidation products (PV, TBARS and FFA) were lowest in wafers with DLP. The AVG and DLP treatments showed a positive impact on microbiological quality, however, sensory scores were lowest for DLP samples. In general, incorporation of APP, BPP, AVG and DLP in the formulation could improve the product quality and storage stability but DLP has more potential to be used as functional ingredients in poultry meat wafers.

Hurdle treated poultry meat wafers

Development of low-salt poultry meat finger chips: Low-salt poultry meat finger chips (PMFC) were prepared using ingredients such as minced chicken and turkey meat (50:50), chilled water, refined veg. oil, salt (1.5% NaCl), skimmed milk powder, baking powder, spice mix, condiments, rice flour, oat flour, degi mirch and sodium nitrite. Results showed that product yield, pH, moisture content and Lovibond tintometer colour differ non-significantly amongst control and two treatments. Sensory scores for different attributes namely appearance and colour, flavour, crispiness, after taste, meat flavour intensity and overall acceptability differed non-significantly but they were rated as very good to good by the sensory panel members. In conclusion, 40% replacement of NaCl (0.9% NaCl + 0.6% KCl) is best for the preparation of low-salt PMFC.

***Development of low-salt chicken meat bites*:** For optimization of salt levels in development of low salt chicken meat bites a standard formulation was developed using spent hen meat, ice cube, refined veg. oil, textured soy protein, maida, table salt (NaCl), sugar, sodium tri-polyphosphate, spice mix, condiments and sodium nitrite @ 65.5, 10.0, 7.0, 5.0, 3.0, 1.3, 0.2, 1.5, 3.0, 0.3 and 0.01%, respectively (control). For the treatments, sodium chloride (NaCl) is replaced with potassium chloride (KCl) at three different levels viz. 0.9% NaCl + 0.4% KCl (T_1), 0.8% NaCl + 0.5% KCl(T_2), and 0.65% NaCl + 0.65% KCl (T_3). Results indicated that with increase of KCl in the product formulation there was decrease in the emulsion stability and cooking yield but did not affect emulsion and cooked product pH. Regarding sensory attributes, control had highest sensory scores for all attributes but they did not differ significantly from T_1 and T_2 treatments. Finally, it was concluded that replacement of NaCl up to 38% (0.8% NaCl + 0.3% KCl) was found to be well acceptable in development of low-salt/low-sodium chicken meat bites.

Development of low-fat chicken meat bites: The process technique for low-fat chicken meat was standardized with lean meat along with other seasonings. Two products were formulated viz. control (contained 10% added fat) and treated sample (5% added fat). Results indicated that cooking yield and emulsion stability did not vary significantly between the samples, however, as expected protein content was higher for the treatment but fat content was higher in control. Lovibond tintometer colour indicated that control was lighter and exhibited lower redness value than the treatment. Both the samples were well acceptable by the sensory panel members and were rated very good to excellent. In conclusion, formulation containing 5% added fat was considered to be suitable in development of low-fat chicken meat bites.

DETECTION AND QUANTIFICATION OF BACTERIAL PATHOGENS IN CHICKEN MEAT

The chicken meat samples were collected from local markets as well as poultry processing plant of CARI to assess the seasonal occurrence as well as on the level of contamination of *Campylobacter jejuni*. Poultry feed and drinking water were also assessed for tracing the source of this pathogen in poultry environment. Out of 320 chicken meat samples analyzed, 8.4% (27) were found positive for *Campylobacter jejuni* with level on chicken meat surface ranging from $1.20x10^2$ to $1.22x10^4$ cfu/cm^2. Seasonwise, the occurrence of *C. jejuni* was found to be 10, 13.9 and 4.60% in summer, rainy and winter months, respectively.

The level of *Campylobacter jejuni* in chicken meat surface samples in summer, rainy and winter season was in the range of $1.2x10^2$ to $1.0x10^4$ cfu/cm^2, $1.4x10^3$ to $1.22x\ 10^4$ cfu/cm^2 and $2.1\ x\ 10^2$ to $1.6x\ 10^3$ cfu/cm^2, respectively. Source wise, higher number of chicken meat samples (10.6%, 17 out of 160 samples) from local market were found positive as compared to poultry processing plant (6.2%, 10 out of 160 samples). The seasonal occurrence of *C. jejuni* in the samples from processing plant was 7.5, 13.9 and 1.3%, respectively in summer, rainy and winter seasons and the level of this pathogen was in the range from $1.2x10^2$ to $3.5x10^3$ cfu/cm^2. Likewise, the occurrence of *Campylobacter jejuni* in samples from local market was in the range of $1.0x10^3$ to $1.22x10^4$ cfu/cm^2 and occurrence in summer, rainy and winter season was 12.5, 16.2 and 6.5%, respectively. Out of 80 samples each of poultry feed and drinking water samples analyzed, none was found positive for *Salmonella* spp. While *Campylobacter jejuni* was found in 7.5% and 2.5% samples of water and feed. The survivability of *Campylobacter* in chicken meat samples under different storage conditions was assessed. The results indicated higher occurrence of *Campylobacter* in summer months as compared to winter months.

ASSESSMENT OF RESIDUES OF DIFFERENT CHEMICAL CONTAMINANTS IN POULTRY PRODUCTS AND FEED

Residues were determine for heavy metals (lead, arsenic, cadmium and molybdenum i.e., Pb, As, Cd, Mo), pesticides (aldrin, dialdrin, BHC, DDT, chloropyriphos) and veterinary drugs viz. oxytetracycline, tetracycline and enrofloxacin in poultry meat, eggs and tissues collected from certain locations in western India. The samples of poultry feed, egg and meat were collected from farm and market places of Pune, Nashik and Baroda areas of western India. The average residual levels (ppm) of BHC, DDT, aldrin, dieldrin in samples of poultry feed, egg and meat were recorded as follows: poultry feed (0.083, 0.077, 0.025, 0.015 ppm), egg (0.016, 0.015, 0.012, 0.018 ppm), spent hen muscle (0.022, 0.025, 0.017, 0.015 ppm), liver (0.021, 0.032, 0.016, 0.014 ppm) and fat (0.025, 0.024, 0.025, 0.014 ppm), respectively. The occurrence level varied from 6 to 15% with highest for BHC in fat samples collected from Nashik area. Residues of lead, arsenic molybdenum and cadmium in Pune, Nashik and Baroda area revealed that all samples contained these residues and their levels in poultry feed, egg and spent hen tissues viz. muscle, liver and fat were in the range of 0.12-0.3 ppm, which are within the permissible limits. The residues of drugs in samples of poultry feed, egg and tissues were observed to be in the range of 0.015 to 0.025 ppm and their occurrence level varied from 5 to 15%. The levels of residues recorded were within the permissible limit. It was inferred that residues of metallic origin occurred in all samples of poultry feed, egg and tissues of poultry. Occurrence of residues of pesticides was noticed more in BHC and DDT with higher levels found in feed and adipose fat. Drug residues were found at relatively higher levels in liver samples. Among western region, samples collected from Pune contained lower levels of residues. All the samples studied, however, were within the permissible limit.

ASSESSMENT OF POULTRY PRODUCTION AS INFLUENCED BY MARKET DYNAMICS

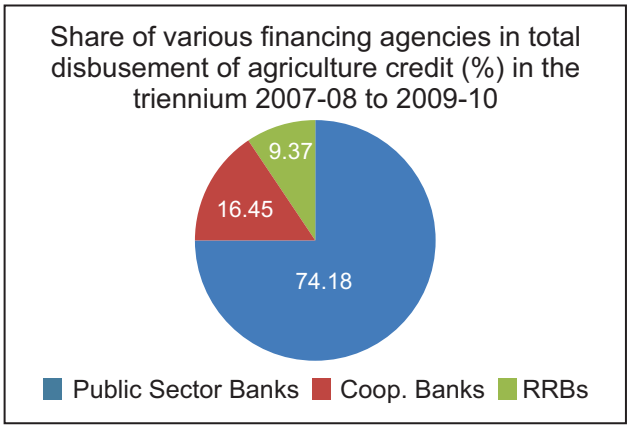
STUDY ON INSTITUTIONAL CREDIT SUPPORT TO POULTRY FARMING IN UTTAR PRADESH

On the basis of the data obtained from secondary sources, the trends in flow of credit to agriculture sector as a whole was analysed (Table 8). The public sector banks and RRBs have been involved more aggressively in financing agriculture during the first decade of the millennium as revealed by high annual compound growth rates of about 32% and 28% respectively as compared to the cooperative

Table 8: Growth of credit flow to agriculture (%/year)

Period	Public Sector Banks	Coop. Banks	RRBs	Total
1992-93 to 2009-10	27.34	12.04	25.97	21.66
1992-93 to 1999-2000	26.24	10.30	21.11	17.53
2000-01 to 2009-10	31.78	12.24	28.34	26.13

banks which have shown to expand agriculture credit at a meagre rate of about 12% (at current prices).



The major share of agricultural credit accounting for 74.18% was borne by the public sector banks followed by cooperative banks (16.45%) and the Regional Rural Banks (9.37%) during the triennium 2007-08 to 2009-10. The total credit disbursed to agriculture sector stood at Rs. 307828 crore during the same period. The absolute share of cooperative banks in the total agriculture credit flow has been almost double that of RRBs, though the RRBs have been able to expand their credit base more aggressively and are fast catching up with the cooperative banks.

HRD AND TECHNOLOGY DISSEMINATION

TRANSFER OF PROVEN POULTRY PRODUCTION TECHNOLOGIES AND THEIR IMPACT ASSESSMENT

An awareness camp was organized at village Dandia, Bithrichainpur development block and the farmers also visited CARI, Izatnagar to become familiar with the various species of poultry.

Scientists briefing the farmers about diversified poultry breeds

A village level exhibition was organized at village panchayat Jasrath pur, Bithrichainpur for dissemination poultry production technologies for the farmers.

Two on-farm demonstrations on Dhanraja broiler were carried out at Benipur and Tirkunia villages with 630 and 945 DOC in the month of October 2013, respectively. Twelve on-farm demonstrations on CARI Debendra were carried out in the month of November 2013 at village panchayat Navadia Harkishan in Bithrichainpur block of Bareilly (U.P.). Three field days were also organized at demonstration sites.

In order to promote backyard poultry and broiler farming in the selected area of Nawabganj development block, an awareness camp on poultry farming and a exhibition on diversified poultry production technology was organized on April 26, 2013 and March 28, 2014, respectively at vill. Kuandonda. Consequently, 17 interested farmers were given layer birds for backyard poultry rearing in the month of March 2014.

POULTRY PRODUCTION IN KUMAON HILLS OF UTTARAKHAND

Under the project, on-farm demonstrations on CARI Debendra were made in the state of Uttarakhand. The CARI Debendra (dual purpose chicken) of two weeks age were provided to the 12 motivated farmers of 7 villages- Khetikhan, Ladoan, Toli, Lada, Jolamail, Bhobadi, Poona kot of Champawat on payment basis.

Three awareness camps-cum-exhibitions on poultry were organized on March 12 and 13, 2014 at Poona kot, Kathad and Chalthi villages of Champawat district of Uttarakhand under the project, in which, farmers of these selected villages were acquainted with improved variety of chicken for backyard and commercial poultry

farming. The farmers of these villages were very much satisfied with the performance of CARIBRO Dhanraja, commercial broiler chicken developed by CARI and they further purchased the chicks.

NAIP SPONSORED PROJECTS

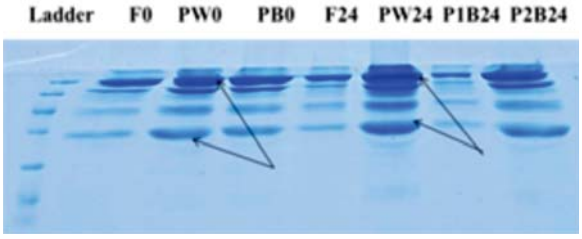
DEVELOPMENTAL POTENCY OF PARTHENOGENETIC GOAT EMBRYOS

***Sub project:* Identification of molecular basis of spontaneous parthenogenesis in Turkey**

Activation of parthenogenetic development in un-fertilized chicken egg through in-ovo injection of mitogen: *In-ovo* injection of mitogens PHA-P was carried out at the broad end of the White Leghorn egg. A standardized concentration of PHA-P was deposited around the blastodermal cells and then incubated. The eggs were broken at periodic intervals to assess the parthenogenetic development. Few eggs developed embryo [Fig 14(a)], out of which two embryos went up to hatching and one fully developed chick was hatched [Fig 14(b)]. Another embryo died before piping. The dead embryo was found male on dissection [Fig 14(c)]. This technique may be attempted for parthenogenetic development in other avian species.

Fig. 14: Parthenogenetic development in WLH chicken

Differential expression of proteins in parthenogenetic turkey embryos: Proteins were extracted from the turkey blastodermal cells and were subjected to 2D gel electrophoresis. Preliminary analysis revealed few differences in protein profiled were shown between fertile and parthenogenetic embryos (Fig. 15).

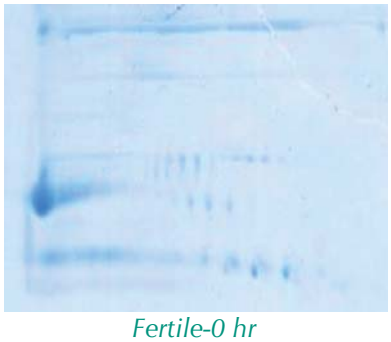


SDS PAGE of 5 micro gram protein/well of turkey embryonic tissues after using clean up and quant kit, F0: Fertile 0h, PW0: Parthenogenetic white 0h, PB0: Parthenogenetic black 0h, F24: Fertile 24 hr, PW24: Parthenogenetic white 24h, P1B24: Parthenogenetic black 24hr-1st & 2nd sample

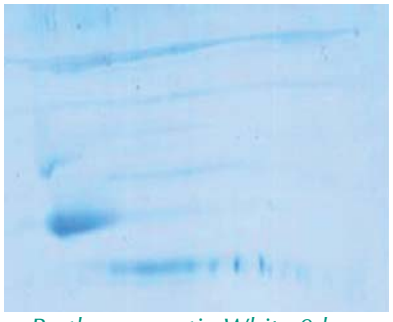
Fertile 0 hr IEF

Parthenogenetic 0 hr IEF

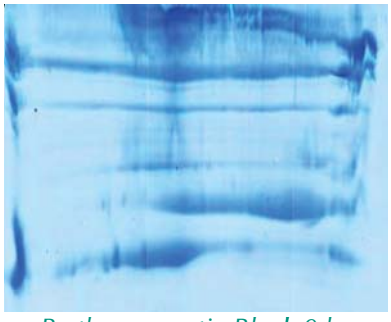
Fertile & Parthenogenetic 24 hr IEF



Fertile-0 hr



Parthenogenetic White-0 hr



Parthenogenetic Black-0 hr

Fig. 15: 2D gel electrophoresis of fertile and partheneogenetic embryos

HOLISTIC APPROACH FOR IMPROVING LIVELIHOOD SECURITY THROUGH LIVESTOCK BASED FARMING SYSTEM IN BARABANKI AND RAEBARELI DISTRICTS OF U.P.

i. ***New cluster:*** M otikpur (Haidergarh) having nine villages were added during this year. A base line survey was completed in the villages of new clusters. Motivation camps and continuous Informal trainings were conducted for creating awareness for rural poultry production system.

ii. A total of 16,404 chicks were distributed/sold to the farmers of the project area. Nearly 70% of the broiler farmers are taking chicks from commercial hatcheries which show the sustainability of the project in the area.

iii. Models for traditional scavenging system integrated with horticulture, azolla harvesting and vermin-compositing were developed, tested are being applied.

   a. ***Model-I*:** Traditional backyard poultry production (25-30 hens with 50% production) with improved housing with supplementary feeding, caters the need of marginal/ small/ landless farmers especially for the women who can earn profit margin of Rs. 17,220 annually while completing all house hold works.

   b. ***Model-II*:** Traditional backyard poultry production (25-30 hens with 50% production) integrated with Horticulture crops and/or azolla and earthworm feeding without feed supplementation: caters the need of marginal/small/landless farmers especially for the women who can earn profit of nearly Rs. 21,900/- as there is no need of supplementary feeding which saves about 30% expenditure.

   c. ***Model-III*:** Small scale Intensive broiler farming: caters the need of marginal/small farmers and can be opted for part time as well as self employment which depends on the number of birds to be reared and number of cycles to be repeated per year. The profit margin ranges from Rs. 10 to 15 per bird per cycle which can be repeated six times a year in one shed. Profit depends on various factors. A farmer with 300 broilers can earn nearly Rs. 4500 per cycle and 6 cycles a year will fetch profit of nearly Rs. 27,000/-. Earning can be increased with increase in number of birds to be reared per cycle which will provide full employment to the unemployed youth.

   d. ***Model IV*:** It is same as the model III but profit can be increased by reducing the cost of feed of broiler/layer farming utilizing the azolla and earthworm in poultry ration as protein source.

EXTERNALLY FUNDED PROJECTS

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

In-vitro silencing of TGFb-4 gene in cultured CEF: Different M.O.I. (multiplicity of infection) of lentivector clone (MSTN and TGFb-4) i.e., 5 and 7 were prepared and transfected into cultured embryo fibroblasts using Hexa di-methrine (@ 8 g/ml). The cells were incubated in CO_2 incubator in growth medium for 24 h; on each second day, the media was replaced with freshly prepared media. On 7th day, the cells in different MOI wells exhibited fluorescence was under fluorescent microscopy (Fig. 16).

Myostatin gene did not exhibit any expression on repeated trials in real time PCR. Lenticlones, TGF b-4-1 and TGF b-4-2 at 5 MOI exhibited 35.47 and 22.80% silencing, respectively. Corresponding silencing values at 7 MOI were 44.78 and 56.87%.

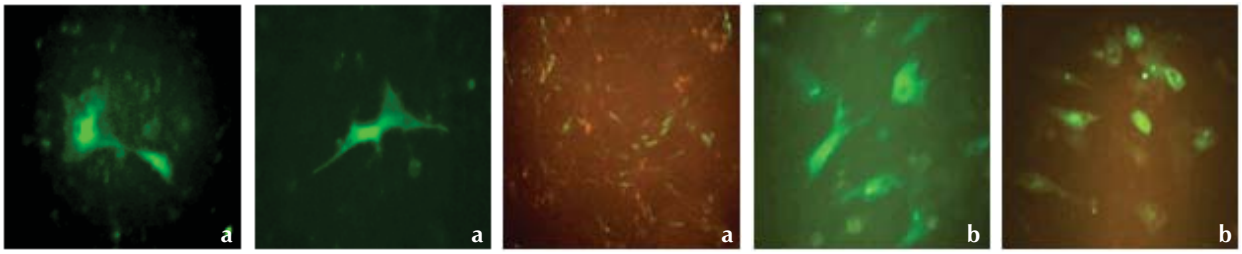


Fig. 16: CEFs transfected with lentivector clones (MSTN (a) and TGFb4 (b) clones) at different MOI

In-vitro silencing of ACC and PPARγ genes in chicken preadipocyte culture: Chicken pre-adipocyte culture was prepared as per the method described by Ramsay and Rosebrough (2003). The cultured pre-adipocytes were transfected with lentivector clones of ACC (ACC-1 and 2) and PPARγ (PPARγ-1 and 2) @ 3 MOI using Hexa-dimetherine (@ 8µg/ml). On 7th day, the cells exhibited fluorescence (Fig. 17). The % knock down as estimated through real time PCR was found to be 40-56% for ACC and 70% for PPARγ, genes.

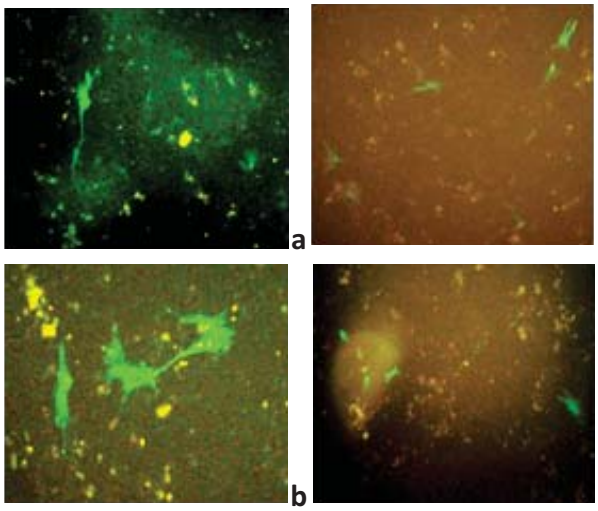


Fig. 17: Pre-adipocytes transfected with lentivector clones (ACC1, ACC2(a); PPARγ1, PPARγ2 (b)at 3 moi

In-ovo silencing of myostatin gene using lentiviral vector (2000 and 4000 TU) at 16th day of incubation: In a repeat trial, the lentivector clones of MSTN1 and MSTN2 @ 2000 and 4000 cells were injected *in-ovo* on 16th day of incubation. The NTC injected and uninjected controls were also kept for comparison. The chicks were reared in battery brooders under uniform management and nutrition. Weekly body weights up to five weeks of age were recorded in each group and subsequently the chicks were euthanized in human manner and disposed as per IBSC guidelines. Tissue samples of 3-4 chicks per group were collected and used for expression analysis of myostatin gene. The hatchability ranged from 67-100%. An improvement in body weight was found at different ages, FCR (0-5 weeks) as well as knock down of myostatin (MSTN) to the tune of 46-58% was also determined in heart and breast muscles tissues of myostatin lenticlones *in-ovo* injected chicks.

In-ovo silencing of PPARγ and ACC genes using lentivector clones: In a preliminary trial, the incubated eggs (ed 16) were injected separately with PPARγ-1(8000 TU), PPARγ-2(8000 TU), ACC-1(4000 TU) + PPARγ-1(4000 TU), ACC-2(TU) + PPARγ-2(4000 TU) lentivectors. Body weights at different ages (weekly up to 5 weeks) were comparable to NTC and uninjected control groups. The % knock down (%KD) of PPARγ gens in liver cells by PPARγ and PPARγ+ ACC lenticlones was found ranging from 25-71%; whereas, the same values in abdominal fat cells ranged from 22-71%. The per cent k nock down of ACC gene in liver ranged from 60-70% whereas in abdominal fat ACC gene was not found to be silenced.

In-vivo silencing of ACC and TGF β4 Lentivcetor clones: The day-old broiler chicks divided in four groups (16 DOCs/group) were intravenously injected with ACC-1 (4000 cells)-Gr1, ACC-2 (4000 cells)-Gr-2, TGFβ4-1 (4000 cells)-Gr-3, TGFβ4-2 (4000 cells)-Gr4, lentivector clones. The NTC (8 DOCs) injected and uninjected control (14 DOCs) were also kept for comparison. Weekly body weights, FCR (0-3 weeks) and (0-5 week) durations were found to be improved in TGF β4 lentivector injected groups as compared to NTC injected and uninjected groups. Serum cholesterol at 5 weeks of age in ACC injected groups were reduced by 14 to 27% as compared to NTC injected and uninjected groups. The ACC gene silencing (28-37%) in liver and TGFβ4 genes silencing (21-45%) in heart and breast muscles were achieved.

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

i. ***Standardization of procedure for MRS culture for Lactobacillus:*** The supernatant of materials from different segments of gut (crop, jejunum, ileum, and caecum) were streaked on MRS agar and incubated 37°C for 48 hrs. The individual colonies were picked and sub-culture in MRS broth 2 times for purification of *Lactobacilli* isolate. The purified cultures will be stored as 50% glycerol stock mixture at -80°C.

ii. ***In-vitro evaluation of lactobacillus isolates for probiotic properties:*** The laboratory tests *viz*. Morphological characterization, Aggregation Test, Cell surface

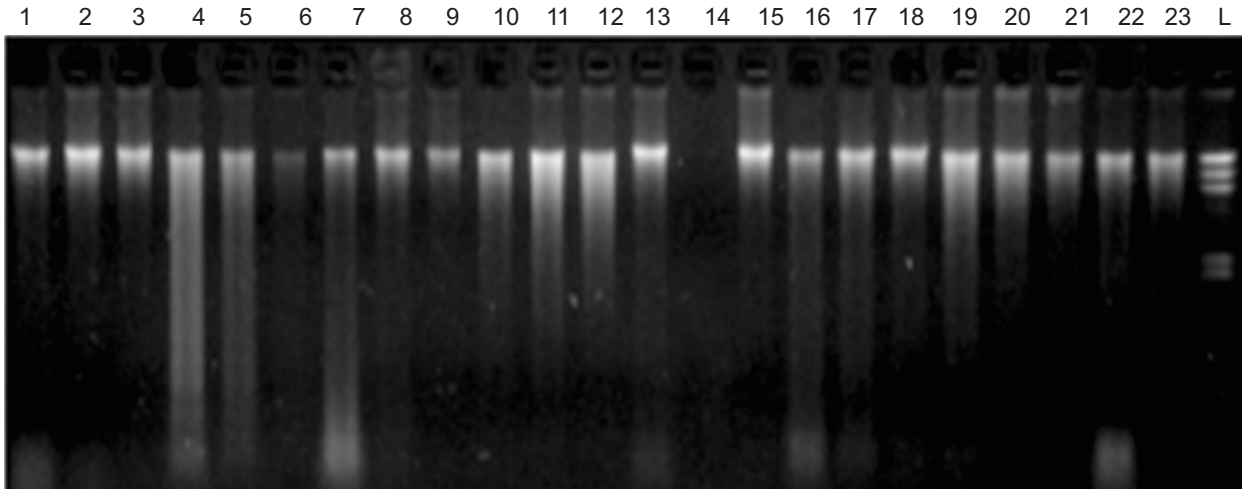


Fig. 18: Gel photos of DNA samples isolated from gut regions of Assam native chicken

hydrophobicity, Bile salts tolerance test, Acidic pH tolerance test, Detection of antagonistic activity, Co-Aggregation Test enzymatic activity tests (Amylase, protease, Lipase) and Molecular Characterization using 16S-23S rRNA Intergenic spacer region primers were standardized.

iii. ***Primmer designing for amplification of 16s rRNA hyper-variable regions:*** The primers were designed from V1-V9 hypervariable regions of 16 S rRNA gene. For metagenomic analysis of poultry gut microbiome, primers were designed from V3, V4 and V4-V6 regions, which have been reported to cover the gut microbial biodiversity almost completely.

iv. ***Metagenomic Analysis of gut microbiome of Assam Indigenous Chicken using NGS analysis:*** A total of 12 gut samples from chick (0-8 week), grower (8-20 weeks) and adult (>20 weeks) stage of Assam indigenous chicken were collected from different segments of gut *viz*. crop, jejunum, ileum, and caecum. DNA were isolated and these samples were checked for their quality on nanodrop and qubit fluorometer. All the samples were of good quality (Fig. 18) for library preparation. The DNA samples were pooled stage and organ-wise. The NGS analysis was outsourced to M/s Genotypic Technology Pvt. Ltd., Bangalore.

v. ***Library preparation:*** Amplicons were generated with the starting amount of 10 ng of DNA and 30 cycles of PCR was performed to amplify the region of interest using specific primers as given above. The amplified products were cleaned up using Agencourt Ampure XP SPRI beads (Beckman Coulter). The equi-molar pooled amplified products were used for next round of PCR. Index barcodes were added using modified primers which had adapter sequences. 10 cycles of PCR was performed and the product was cleaned up. The prepared library was quantified using Qubit florometer and validated by running an aliquot on High Sensitivity Bioanalyzer Chip (Agilent).

The prepared libraries were found suitable for 250 PE sequencing on Illumina platform. Further metagenomic analysis using NGS is in progress.

GENE EXPRESSION ANALYSIS OF THERMO-TOLERANT GENES IN *SALMONELLA* TYPHIMURIUM AND *SALMONELLA* ENTERITIDIS (DBT project)

Salmonella, is the leading cause of food-borne illness of which poultry birds are potential carriers. Environmental stresses exposing Salmonella to sub-lethal heat treatment making them much harder to be killed by subsequent decontamination techniques during poultry processing. Therefore, it is essential to analyze the genes imparting the thermal resistance to Salmonella Typhimurium (ST) and *Salmonella* Enteritidis (SE), the two most important serovars of public health significance.

Differential expression of genes conferring thermal resistance to Salmonella Typhimurium: The differential expression profiles of genes (rpoE, rpoH, rpoS, htrA, uspA and uspB) related to thermotolerance in *Salmonella* Typhimurium

isolate were assessed at different temperatures (42°C and 50°C) while 30°C temperature was kept as control. Incubation temperature and time specific expression profiles of various stress related genes were observed (Fig. 19).

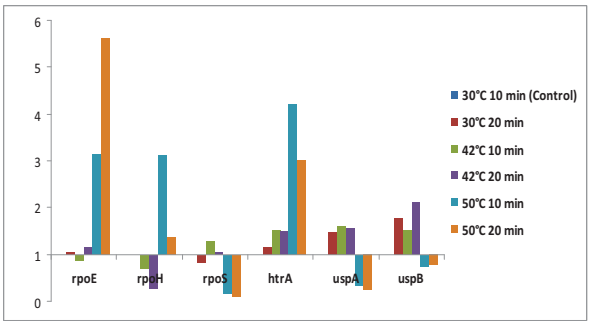


Fig. 19: Gene expression of stress related genes in *Salmonella* Typhimurium at different temperatures

Differential expression of genes conferring thermal resistance to Salmonella Enteritidis: At incubation temperature and times as in above experiment, the expression of similar set of stress related genes was analysed in *Salmonella* Enteritidis. Incubation temperature and time specific expression profiles of various stress related genes were observed which were different from that of ST (Fig. 20).

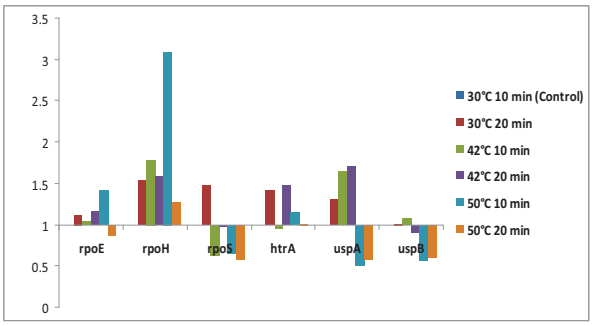


Fig. 20: Gene expression of stress related genes in *Salmonella* Enteritidis at different temperatures

The results of gene expression studies in both serovars indicated that rpoE, rpoH and htrA genes imparting an important role to resist these pathogens from lethal heat stress and the information can be utilized in the development of decontamination regimes during poultry processing.

IDENTIFICATION OF CALPAINS ENZYMES FOR ASSESSMENT OF TENDERIZATION IN POULTRY (DST project)

Tenderization of meat is the single most important attribute because it directly affects consumer acceptability of the products. Micro (μ) and milli (m) calpains are major enzymes which cause post-mortem tenderization of meat. The aim of this investigation was to standardize a method for accurate detection of μ-and m-calpains in blood of broiler birds. Blood samples were collected from chickens and mixed with the lysis buffer (50 mM tris HCl, 10 mM EDTA, 0.05% MCE, 0.2% Tritonx100, 10 mM EGTA) repeated cooling using ice. The content was quantitatively centrifuged at refrigeration temperature and the supernatant was run into a polyacrylamide gel copolymerised with casein, in a tris-glycine buffer containing reducing agent and 1mM EGTA to stabilize calpains. Upon completion of electrophoresis, the gels were washed and incubated in calpain activation buffer containing calcium and reducing agent for 16-24 hr. After staining the casein gels with coomasie blue, μ- and m-calpians were seen as clear bands because of proteolysis of casein against the stained background. The amount of calpain present was proportional to the brightness of cleared bands. For calpains, casein is a good substrate which digest it at multiple sites, producing short peptides which diffuse out of the casein gel causing clearing of background to produce a band at sites where calpains are present.

Regional Centre, Bhubaneswar

RESEARCH ACHIEVEMENTS

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

Four breeds of ducks (viz. Khaki Campbell, White Pekin, Moti and Desi) were maintained and the replacement stock was generated for G-1. Pooled percentages of fertility were 36.91, 27.33, 29.03 and 57.43% for Khaki Campbell, White Pekin, Moti and Desi breeds, respectively. The per cent hatchability on total egg set and fertile eggs transferred basis were 32.35 and 87.65; 20.85 and 76.48; 18.96 and 65.30 and, 48.29 and 84.08% in corresponding breeds. The data recording on juvenile growth traits (i.e., body weight up to 20 weeks of age) for different duck breeds was undertaken.

Reproductive Physiology and Semen Characteristics of Ducks to Augment Fertility and Hatchability

Effect of sex ratio on fertility and hatchability in floor mating: Ducks were maintained on normal wheat based diet (18 per cent CP and 2650 kcal ME) and standard management. Three sex ratio groups of male: female (1:4; 1:5; 1:6) ducks were maintained under deep litter system. It was observed that egg production per cent significantly increased in 1:6 (67.51) ratio over 1:5 (53.85) and 1:4 (50.69) ratio group whereas fertility and hatchability (TES) percentages were significantly higher in 1:4 and 1:5 ratio group. Since, no significant difference was observed between 1:4 and 1:5 mating sex ratio groups for estimated production and reproduction parameters, it may be recommended that 1:5 is the ideal mating sex ratio group in Khaki Campbell ducks for any purpose of multiplication.

Effect of different days of interval A.I. on fertility in ducks breeds: Experiment was conducted in WP and Khaki Campbell laying ducks which were inseminated with 0.1 ml of neat semen at 1 day, 2 days, 3 days and 4 days interval. Eggs collected were incubated and fertility test was carried out on 13th day by candling. Observation revealed significant ($P<0.05$) difference in fertility for insemination interval. Artificial insemination at two days interval yielded highest fertility rate in both the breed of ducks followed by 1 day, 3 days and 4 days interval period. However, no significant difference was observed between 1 day and 2 days insemination interval. Thus, two days insemination interval in ducks may be recommended for better fertility per cent, less stress to bird and optimum labour charge (Table 9).

Table 9: Fertility in ducks

Breed	Fertility per cent of A.I. at different days of interval			
	1 day	2 days	3 days	4 days
White Pekin	81.24^{c}	84.55^{c}	78.06^{b}	63.22^{a}
Khaki Campbell	82.16^{c}	86.08^{c}	76.45^{b}	69.95^{a}

Means with different superscripts in a row differed significantly ($P<0.05$)

Study of fertile period of duck semen in natural mating and artificial insemination: The study revealed that in case of Khaki Campbell ducks the spermatozoa remain viable even up to 11th day of natural mating. However, in A.I. viable spermatozoa found for less days which might be due to less volume of semen deposited in the female reproductive tract.

Effect of dietary protein on female and male reproductive tract of Khaki Campbell:

Female reproductive tract: Iso-caloric diets with 14, 16 and 18 per cent CP were separately offered to three groups of ducklings. Three female birds from each group were sacrificed at 12th and 16th weeks of age. Live body weight dressed body weight length and weight of whole reproductive organ, length (cm) of vagina/shell gland, isthmus, magnum, infundibulum and length, width and weight of left ovary were recorded. Serum total protein and total cholesterol were estimated at 12th and 16th weeks of age. Sexual maturity of adult birds in different groups was recorded by observing the age at first egg.

Observation revealed significant difference ($P<0.05$) of whole reproductive tract length, magnum length and weight of left ovary at 12th weeks of age among three groups of dietary regimen. At 16th week of age no significant

difference was observed in the parameters studied except for width of left ovary ($P<0.05$). However, first egg was laid on 111 days of age in the groups fed with 16 per cent CP against 117 and 121 days for 18 and 16 per cent CP group, respectively.

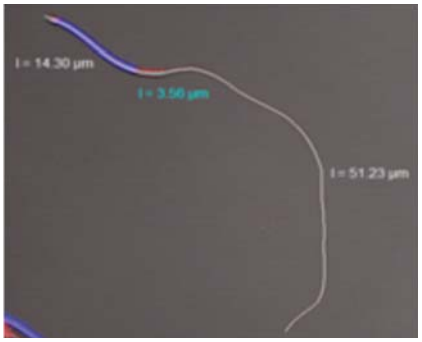
Total protein concentration between different dietary groups differed significantly ($P<0.0.5$) at 12th and 16th weeks age which is corroborating with early sexual maturity in groups fed with 16 per cent crude protein. Therefore 16 per cent CP dietary regimen was optimum for growth of female reproductive organs and certain biochemical parameters under intensive system of management.

Male reproductive tract: Data on live and dressed body wt (g), weight of left and right testes and vas-deference (g), length and width (cm) of testis, phallus and vas deference were recorded. The observation revealed that growth of male reproductive tract and certain serum biochemical profiles are optimum with 14% CP in diet may cause attainment of sexual maturity normally.

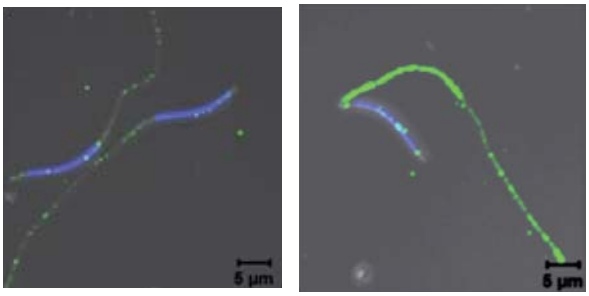
Effect of dietary protein on semen quality in White Pekin ducks: Three groups of male (35 weeks of age) maintained in cage and were fed diet with 14, 16 and 18% CP. After one month of continuous feeding, quality of the semen was found better in drakes offered with 18% CP.

Morpho-metric analysis of White Pekin semen collected: The semen analysis was conducted with the help of National Institute Science Education and Research (NISER), Bhubaneswar. Semen samples from matured were subjected for microscopic study.

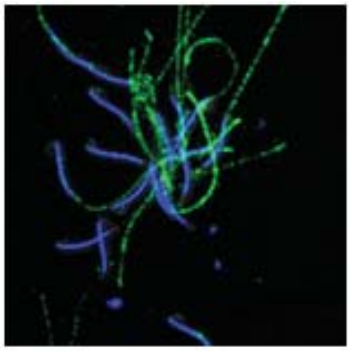
The total length of the sperm was 67.04 ± 2.93 µm. The sperm head is elongated and the size was approximately 13.56 ± 0.67 µm. The principal piece (tail) of sperm is elongated too 50.10 ± 2.71 µm and is at-least three times the length of the head. The mid-piece is coiled in shape, is about 3.37 ± 0.25 µm in length ($N=20$).



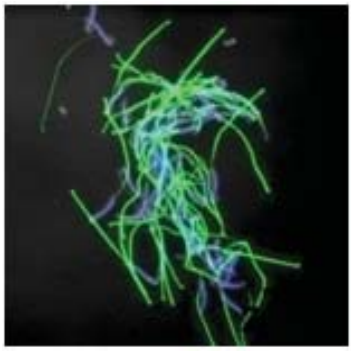
Localization pattern of TRP channels in duck semen: The localization pattern of thermo-sensitive TRP channels varies for heat sensitive as well as for cold-sensitive ion channels. For example, at the mid-piece of duck spermatozoa, heat sensitive ion channel may be absent (a), very high in expression of cold sensitive ion channel (b). The expression of heat sensitive ion channels were diffused in nature while cold sensitive ion channels were more clustered in duck sperm.



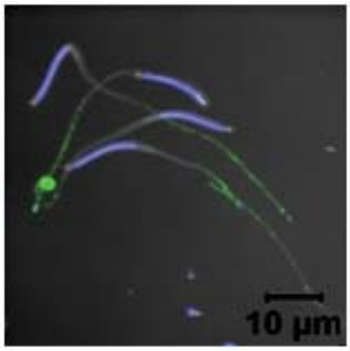
Duck sperm is rich in modified tubulins. Acetylated tubulin is highly intense in the tail of duck sperm. Polyglutamylated tubulin is present in both head and tail of duck sperm, while Tyrosinated tubulin is present diffusely.



Acetylated tubulin



Polyglutamylated tubulin



Tyrosinated tubulin

Nutrient Requirements of Ducks

Protein requirement of Khaki Campbell ducks during starter stage (0-8 weeks): Three dietary groups viz. T_1, T_2 and T_3, containing 18%, 20% and 22% CP, respectively with 108 ducklings/group were fed till 8 weeks of age. There was a significant difference ($P \leq 0.01$) in the body weight of ducklings among different treatments starting from 1st week to 4th week of age. The weekly mean body weight gain was significantly ($P \leq 0.01$) higher in T_3 than T_1 (18% protein diet) during 1st, 2nd and 4th week of age. However, the weekly mean body weight gain of ducks under different treatments was found to be non-significant from 5th to 8th week of age. Weekly feed intake was almost same in all the groups. The apparent metabolizability of dry matter in T_1, T_2 and T_3 were 75.46 ± 0.90, 77.70 ± 0.30 and 79.38 ± 0.89 per cent, respectively. The nitrogen balance as percentage of nitrogen intake was significantly higher in T_3 (79.16 ± 0.85) than T_1 (74.45 ± 0.34) indicating that nitrogen retention was significantly decreased when the protein level in the diet was lowered from 22 to 18 per cent. It was concluded that the diet containing 22% CP during starter stage was optimum for growth and nutrient utilization.

Surveillance and Monitoring of Duck Diseases

The mortality percentages during the period under report in different duck stocks were Desi-pati (1.77%), Khaki Campbell (2.50%), White Pekin (0.75%) and Moti-Muscovy (0.21%). The overall average mortality was 5.23%. Highest mortality was observed in September (13.9%) and lowest in February (0.43%).

Among 26 different causes of deaths, Hypothermia with 1.49% mortality ranked first. Other major mortalities were due to inanition, stampede, debility, enteritis, cannibalism, hepatitis, septicemia, predation, omphalitis, drowning, egg bound, pneumonia, blindness, gout/nephritis, impaction, ascites, internal haemorrhage/rupture, duck cholera and carcinoma with mortality ranging from 0.01 to 0.922%. Age-wise highest mortality recorded in ducklings (3.74%) followed by grower (0.77%) and adult (0.53%). Male:female mortality was almost same. Vaccination for duck plague (2906) and duck pasturellosis (3681) were accomplished.

Timorous growth at head

Sustainable Livelihood Improvement through Integrated Freshwater Aquaculture, Horticulture and Livestock Development in Mayurbhanj, Keonjhar and Sambalpur Districts of Orissa (NAIP project)

Regional Centre, CARI, Bhubaneswar is a consortia partner in the on-going project under NAIP (Component-3) which was initiated during 2009. The project was extended with addition of 1000 more farmers (i.e., 4000 total farmers) in the same clusters. During extended period in 3 districts, 8 clusters and 30 new villages were included in the present study. The project activities were initiated with base line survey, rapport building with farmers, mass vaccination against Ranikhet disease (R2B), PRA activities, sensitization through demonstration/exposure visits/meetings followed by selection of farmers for technology adoption. In the next step the selected farmers were provided with critical inputs and imparted trainings at regular interval to enhance their skills for successful implementation of the programme. The overall operational activities are summarized in Table 10.

Table 10: Operational activities in three districts under NAIP

Activities	*2013-14*
No. of farmers adopted	1,008
Units of backyard poultry initiated	913
Units of ducks initiated	95
Chicks supplied	15,000
Ducklings supplied	1,625
Vaccination (R2B)	~7,000
Vaccination (Lassota)	~14,500
Farmers training conducted	05
SHG adopted	05

Monitoring of the activity of farmers was done by the project personnels. Regular field visits were made and day to day problem of the farmers w.r.t. technology adoption were addressed. RC, CARI introduced its new and existing varieties of germplsm suitable for the field condition. New models were introduced, evaluated, modified and again implemented for better output to the farmers.

Ducks in polythene ponds

CARI model of duck rearing in polythene pond: This is a model aimed towards the farmers having no pond or water body but interested for duck rearing. In the previous years, attempts have been made for implementation of this model in a small way and found encouraging. Therefore, more number of farmers was motivated and involved for adoption of this model in a more scientific way during this year. Marginal farmers can use their small ponds for both fish and duck production; but those having no accessibility to any water bodies can also be guided successfully through a new model of "Duck rearing in polythene ponds". The model has been tested with many farmers (>150 farmers approx) in Sambalpur, Mayurbhanj, Keonjhar and Khurda districts of Odisha. This model can successfully be replicated by the farmers of other parts of the country.

Methods of polythene pond preparation: Rectangular (6 ft x 4 ft) or square (5 ft x 5 ft) pit of 1.5-2.0 ft depth were dug on ground. The inner side of the pit was completely mulched/lined with thick polythene without any joint or overlapping (polythene of 7-8 ft width is most suitable). The outer edge of polythene was fixed at the outer border of the pit. Pits were filled with water from well, tube well or from any other water source (300 lit. approx). Half of the water was changed at every 10 days interval.

Rearing of ducks: Small low-cost duck house (10 ft x 5 ft) constructed with locally available materials and day-old ducklings (25 nos; Khaki Campbell preferably for laying) were brooded inside the house. Duck mash/feed (wheat based) soaked with water was offered and clean water for drinking in small plastic water trough was provided daily. At 3-4th wk of age, the grown up ducklings were allowed to enter into the polythene pond. Leftover food, kitchen waste of the family along with fish scales and vegetable peels etc mixed with water were offered to the ducks daily. In many units boiled broken rice and wheat (1:1 ratio) @ 50-60 g/bird/day were supplemented. Laying were initiated around 5th months of age.

Economics: It was observed that an amount of Rs. 15,000/- (approx) net profit earned by the farmer from a single duck unit reared in polythene pond through sale of adult male birds, eggs and old female ducks which not only gave significant return to a landless/marginal farmer but also nutritional security to the farm family.

Study on performance of backyard chicken production with and without supplemental feed during growing period: A total of 186 backyard chicken units (25 nos. day-old coloured chicks) were initiated in five clusters of operational area out of which 40 units were maintained with partial supplementation of commercial poultry feed. Birds of the supplemental feed group were

allowed to scavenge outside throughout the day and offered feed @ 30 g/bird/day (3-5 wks age) and 60 g/bird/day (6-20 wks of age) before putting them in the shelter house. The observation revealed significantly higher growth rate (combined sex) and significant reduction in mortality per cent in the units offered with supplemental feed, but age at first egg was not differed for both the groups. Therefore, it may be concluded that partial supplementation of commercial feed is beneficial to the birds maintained under free range backyard production system.

Effect of supplemental feed on production performance of ducks under free range: A total of 142 duck units (25 nos. of day-old KC and Native cross ducklings) were developed in three districts of Odisha with scientific brooding practices. All the day-old ducklings were provided with wheat based duck mash during brooding period of 15 days. At about one month of age, ducks were allowed to scavenge in the pond and other water bodies available in the surrounding. From 5th wk of age onwards 53 duck units were supplemented with partial feeding (Rice: Wheat:: 1:1 half boiled, @ 40 g/duck/day up to 8th wk and 70 g/duck/day from 9-20 wks) once before putting the ducks in to the shelter house. Observation revealed significantly higher growth rate in both the varieties for 2nd, 3rd and 4th month of age. No significant difference was found for 5th month body wt, age at sexual maturity and mortality rate. Thus, it may be concluded that partial supplementation of commercial feed is beneficial to the ducks maintained under free range backyard production system for initial period of age.

Egg quality parameters in ducks under rural duck production practice: Two layer varieties of ducks were introduced in more than 450 farm families in eight clusters of three districts of Odisha. Native ducks due to the multi-coloured plumage attracted the farmers even if Khaki Campbell ducks lay more nos. of eggs. Further, certain egg quality parameters were studied for the eggs collected from the farmers' house in both the breeds between 40-43 wks of age. The comparative study revealed significant difference between the breeds for all the parameters except shell thickness (Table 11).

Table 11: Comparative study of egg quality traits of Khaki Campbell and Native ducks

Parameter	*Khaki Campbell (150)*	*Native ducks (150)*
Egg wt. (g)	$57.09^{b} \pm 0.04$	$66.21^{a} \pm 0.02$
Shell wt. (g)	$5.61^{b} \pm 0.01$	$6.7^{a} \pm 0.01$
Yolk wt. (g)	$21.06^{b} \pm 0.04$	$25.83^{a} \pm 0.03$
Albumin wt. (g)	$30.39^{b} \pm 0.03$	$33.68^{a} \pm 0.03$
Yolk height (mm)	$19.02^{a} \pm 0.02$	$17.34^{b} \pm 0.03$
Albumin height (mm)	$8.21^{a} \pm 0.02$	$7.1^{b} \pm 0.02$
Shell thickness (mm)	0.75 ± 0.01	0.74 ± 0.01

Figures in parenthesis indicate no. of eggs

Impact of backyard poultry and duck rearing on the farmers: The impact assessment study of CARI component of the project was conducted through a questionnaire. A total of 350 nos. of adopted farmers were interacted. Thirty questions were asked to each which was relevant to their previous knowledge in backyard poultry and duck production, new technology learned and adopted, economic benefit derived and utilizing for the livelihood improvement. Few salient points observed were as follows.

i) CARI model of backyard poultry production with CARI Debendra (dual purpose variety of chicken) is highly successful for landless and marginal farmers.
ii) Eradication of Ranikhet disease through vaccination developed confidence and inclination of the rural farmers towards scientific poultry production.
iii) Commercial feed provision to growing birds under extensive management may not be having significant role for better productivity.
iv) Training on brooding management of chicks/ducklings imparted significant effect on success rate and continuation of the practice.
v) Duck rearing in village ponds gained highest acceptability by the farmers.
vi) Risk of predator, disease and general mortality pattern in ducks were less in ducks than chicken under backyard practice.
vii) Duck-fish integrated model of practice was better than duck rearing alone.
viii) Duck rearing in polythene pond was one of the biggest innovation which was very much successful in the area other than coastal

districts and highly beneficial for the landless or marginal farmers.

ix) Duck production as a group activity through SHGs was highly successful.

x) Women participation is important for successful backyard poultry production.

xi) Backyard chicken production can never be recommended as a group activity.

xii) Acceptability of duck meat and eggs by tribal farmers was quite high.

xiii) Social conflict was less in duck rearing than backyard chicken production.

xiv) Educating as well as field demonstration was beneficial for backyard chicken and duck rearing.

xv) A dual purpose duck variety with multi-colour plumage need to be developed.

Trainings/Kisan Mela, etc. organized under NAIP: Series of trainings were organized in various villages in different districts of Odisha for sensitization, discussion, demonstration, problem identification, technology dissemination and also impact assessment w.r.t. backyard poultry production and its horizontal expansion.

Workshops organized: Two-days workshop entitled "Backyard poultry production as a tool to augment livelihood of rural and tribal farmers of Odisha" was organized in collaboration with Dept. of Extension Education, OUAT, Bhubaneswar during March 03-04, 2014. A total of 31 SMS from all KVKs of Odisha besides few entrepreneurs and progressive farmers participated in the workshop. Nine deliberations were made and two publications released on this occasion. The participants interacted with the experts and exposed to the protocol of various models developed for backyard poultry and duck production in field condition.

Backyard Poultry and Duck Production as a Tool to Sustainable Livelihood for Rural Women of Khurda District of Orissa (DST project)

Demonstration and trainings were imparted to the women farmers at regular intervals which enhances their skill in poultry and duck rearing practices in a more scientific manner. However, many times it was observed that they always tried to practice their own traditional method of practice. Due to illiteracy, they were unable to read the bulletins and leaflets. Therefore, pictorial presentation in trainings was quite helpful for them to motivate.

Economics and impact assessment: CARI model of backyard chicken rearing, CARI model of duck rearing and Duck rearing in polythene ponds were introduced in different villages of Odisha with improved germplasm and package of practices. It was observed that each women farmer could able to generate at least Rs. 1000/- per month through any of the models. Besides, per-capita availability of egg for consumption in the house is increased to many folds which appeared to improve the general health condition of the children.

Impact of backyard chicken and duck rearing by these women farmers was assessed through the questionnaire which revealed that (1) these women who were not engaged in any productive income generation work could able to utilize their time in a better way, (2) children in each home were happy to get egg daily, (3) though little, but regular income to the family through sale of eggs, (4) they could able to know the rearing of ducks without water body, (5) duck rearing is better practice than that of chicken in backyard.

P.G. Students' Research

Thesis title: **Development and storage quality of functional poultry meat finger sticks**
(Scholar: Dr. P.B. Aswathi, PSC/MVSc/5064; Guide: Dr. C.K. Beura)

Now-a-days, shelf-stable functional meat foods are getting popular in the global market. People are getting more concerned about the incidence of diet related health problems due to consumption of high calorie, fat rich-red meat products. Poultry meat products are less in fat content, easily digestible and various types of functional ingredients can be successfully incorporated to ensure the supply of some selected nutrients. Shelf-stable products do not need cold chain facilities; thereby energy requirement and cost for transportation and storage can be minimized. Such type of products can be stored at room temperature without affecting its qualities for a longer period. Among poultry meat, broiler meat is widely used, where as turkey meat and spent hen meat are under-utilized. A formulation has been standardized to develop shelf stable poultry product for the effective utilization of turkey meat and spent hen meat with the incorporation of fiber rich oat and corn flour in combination with curry leaves, the herb having antioxidant and antimicrobial property as a part of the study. For the preparation of functional poultry meat finger sticks, emulsion was manually extruded and then cooked in microwave oven for 3 minutes. Incorporation of flours increased crude fiber content where as curry leaves improved not only the flavour but also improved the antioxidant and antimicrobial properties of the product. The functional product has shown to have a chemical composition of 31% crude protein, 14% total fat, 7% ash and 3% crude fiber. In regard to storage studies, the developed product can be well stored for a period of 60 days at ambient temperature ($37 \pm 2°C$) without significantly affecting the physico-chemical, microbiological and sensory qualities. Functional poultry meat finger sticks developed with addition of corn flour, oat flour and curry leaves could find their way in food industry as these have health benefits and can be stored for a minimum period of 60 days.

Thesis title: **Effect of floor space vis-a-vis dietary protein supply on growth performance and immunocompetence of growing turkey poults**
(Scholar: Dr. Imtiyaj Ali, PSC/MVSc/5060; Guide: Dr. S. Majumdar)

The proposed study was undertaken to evaluate the response of Beltsvilie White (small white) turkey poults to different floor space and dietary protein levels in terms of growth performance, immune response, carcass quality traits, blood biochemical parameter, nutrient utilization and economics. A biological experiment was conducted (3x3 factorial design) involving three different floor spaces (0.6, 0.8 and 1.0 sq. ft) each with three dietary protein levels (22%, 24% and 26% CP) during pre-starter (0-4 wk) and starter (4-10 wk) phase of age with constant energy levels of 2800 kcal/kg and 2900 kcal/kg during pre-starter and starter phase, respectively. Each biological treatment was replicated four times having 10, 8 and 6 poults per replication according to floor space. Out of four replicate, one replicate was maintained for the replacement of the dead birds, if any so as to keep the effective floor space constant throughout the experimental period. Results indicated that body weight gain (BWG) of poults was significantly ($P<0.01$) higher in 1.0 sq. ft floor space during both the growth phases. The BWG was significantly higher ($P<0.01$) in 26% dietary protein level during 0-4 wk of age but there was no difference in BWG during 4-10 wk of age due to protein levels. The feed intake (FI) during 0-4 wk differed significantly ($P<0.05$), being higher at 0.8 and 1.0 sq. ft floor space with 26% protein level. The FI during 0-4 and 4-10 weeks of age was significantly ($P<0.01$) higher in high floor space (1.0 sq. ft) and higher protein level (26%). The feed conversion ratio (FCR) during 0-4 and 4-10 wk of age did not differ significantly due to different floor space or dietary protein level as well as their interaction. There was no specific pattern of mortality. Performance index (PI) was significantly ($P<0.05$) higher due to floor space in 1.0 sq. ft during 0-4 and 4-10 wk of age while protein level affect PI significantly ($P<0.01$) only during 0-4 wk of age. The humoral (HA titre to sheep red blood cells- SRBC) and cell mediated (foot pad index to PHA-P) immune response did not

differ due to floor space, dietary protein levels as well as their interaction. Similarly, wt. of immune organs also did not differed significantly in all the treatments under study. The various carcass quality traits and organ weights were not affected by different treatments only eviscerated yield was increased significantly in 24% dietary protein level. The breast weight yield was also significantly ($P<0.01$) affected by floor space and dietary protein levels with higher floor space (1.0 sq. ft) and higher protein level (26%). The various blood biochemical parameters did not influenced due to different treatments except for serum total protein and serum uric acid. Significantly ($P<0.01$) lower serum total protein and serum uric acid were observed at 1.0 sq. ft than those observed in 0.8 and 0.6 sq. ft floor spaces. The excreta moisture content, and utilization of calcium and phosphorus did not differ due to different treatments, while nitrogen voided increased with increased level of protein from 22 to 26%. Nitrogen retention were found higher ($P<0.05$) at 22% protein level. Feed cost per kg body weight gain and kg meat production did not differ significantly due to floor space while protein level affect significantly ($P<0.01$). Feed cost per kg body weight gain and meat production was lower at 22% protein level. Profit potential per meter square (PPM) was higher ($P<0.01$) in 0.6 sq. ft floor space than 0.8 or 1.0 sq. ft floor space. Based on the results it is concluded that during pre-starter period (0-4 weeks of age), the turkey poults can successfully be reared on 1.0 sq. ft floor space and 26% protein with 1.6% lysine, 0.50% methionine and 2800 kcal ME/kg diet for better growth performance. However, starter cum grower (4-10 weeks of age) turkey poults require 0.8 sq. ft floor space and diet with 22% protein, 1.5% lysine and 0.45% methionine, 2900 kcal ME/kg for better growth, immunocompetence and for feed cost efficient production. For better economic return the poults could be reared at 0.6 sq. ft floor space and 22% dietary protein level from 0-10 weeks of age.

Thesis title: **Isolation of lactobacillus species from gut microbiome of domesticated Japanese quail, its molecular characterization and evaluation as probiotic**

(Scholar: Dr. Jitendra Kumar Patra, PSC/MVSc/5061; Guide: Dr. Simmi Tomar)

The proposed study was undertaken to isolate and identify lactobacillus from different segments of gastro intestinal tract of domesticated Japanese quail followed by the screening of isolate for its probiotic potency tests. Isolated *lactobacillus* was tested through phenotypic (Gram staining), biochemical (catalase test) and molecular characterization (PCR amplification) and confirmed the presence of *lactobacillus* in the isolate. For proving the efficacy of *lactobacillus* strain as probiotic, screening was carried out through different tests like high cell surface hydrophobicity, aggregation test, co-aggregation, resistance to bile salts acidic conditions, enzymatic test (amylase, lipase and protease test) and lastly antagonistic test. Isolated LAB isolate passed all the tests for its probiotic properties. After isolation, identification and enumeration of LAB isolate basal feed for quail was fermented with 10% of the inoculum at 37°C for 24 hr and feed to domesticated Japanese quail reared for 35 days of duration. In total 8 dietary supplements were used of which first 3 are provided graded level of LAB cfu in contrast to supplementation of multi strain symbiotic at the rate of 0.5, 1.0 and 1.5 g/kg feed. In T-7 and T-8 basal feed (control) and antibiotic at the rate of 1 g/kg feed was provided, respectively. During the entire feeding trial parameters like body weight, FCR, carcass traits, immunity (cell mediated and humoral), microbial count at 14^{th} and 35^{th} day and histomorphological analysis of ileum and caeca was done. The result showed better body weight and FCR values at $3x10^6$ cfu feeding. Similar nature of finding was observed at medium level of cfu (T-2) feeding in terms of carcsss traits and humoral immunity by studying the HI titre level. Low level of cfu resulted better cell mediated immune response measured by foot web swelling upon PHAP injection. Histomorphological analysis revealed higher villi height and higher villi crypt ratio in ileum and caeca indicating better absorbability of nutrients is $3x10^6$ cfu feeding level (T-2) which is in comparable with commercial synbiotic. Bacterial enumeration at 14^{th} and 35^{th} day indicated lower *E. coli* count in crop, ileum and caeca of upon $3x10^6$ cfu (T-2) feeding comparable with commercial probiotics and increased *E. coli* population in T-7 (control) suggesting that isolated *lactobacillus* has competitive exclusion activity. In terms of cfu enumeration of *lactobacillus* at 14^{th} and 35^{th} day there is significant rise in the LAB population indicating that it has beneficial action on production parameters and expulsion of

pathogenic organism like *E. coli* from GI tract thus reducing their number. Based on the result it can be concluded that supplementation of isolated quail specific *lactobacillus* at $3x10^6$ cfu (T-2) has improved production and immuno performances of quail and thus can be a good probiotic candidate in future upon further validation.

Thesis title: **Genetic analysis of growth and immunocompetence in different breeds of ducks**
(Scholar: Dr. Vijay Singh, PSC/MVSc/5063; *Guide:* Dr. S.K. Mishra)

In the present investigation, genetic analyses were conducted to elucidate the inheritance-pattern of various immunocompetence parameters and their correlation with juvenile growth and conformation traits in different breeds of ducks. Under this, humoral immunocompetence (anti sRBC antibodies and its IgG amd IgM fractions), cell-mediated immunity (CMI, via foot-index upon PHA-P injections), total serum proteins and body weight at 4, 6 and 8 weeks of age (BW4; BW6 and BW8), were measured on individual basis, in a total of 562 ducks, belonging to three breeds viz. Indigenous, Khaki Campbell and White Pekin breeds maintained at the CARI Regional Centre, Bhubaneswar, Odisha. Results revealed statistically-significant breed differences ($P<0.05$) for all body-weight traits. Variation due to sex remained non-significant for all the recorded traits. The body conformation traits included: shank length, thigh length, keel length, neck length, body length and bill length at 4, 6 and 8 weeks of age. The Pekins were significantly better than other breeds for shank length and bill length (at 8 weeks age), while they had numerical-superiority for other conformation traits. The differences between the Desi and Khaki were non-significant for most of the conformation traits. The sRBC antibodies were titrated (log2 HA titers) at 5 dpi, following i/v injections of 0.5 ml of 0.5% sheep-RBC to individual ducks at 5 weeks of age. The mean sRBC titer ranged from 6.52 to 6.85, across breeds. The between-breed variance for serum IgG and IgM level (fractionated from anti-sRBC antibodies) was non-significant. The mean Foot Index (CMI) ranged from 0.97 to 1.08 between breeds. The total serum-protein values for Khaki, Desi and Pekin were 5.50 ± 0.08, 5.61 ± 0.06 and 5.34 ± 0.06, respectively. Analyses of heritability (h2) for biweekly body weights showed that estimates were moderate to high in Khaki; low to moderate in Pekin; but, were very-low in estimate (nearing zero) for Desi ducks. Low to moderate h2 values (range: 0.15 to 0.37 for sRBC-HA; 0.15 to 0.35 for CMI) were realized for immunocompetence traits. The h2 for most conformation traits were high across breeds. Positive and high phenotypic-correlation (rp) were evident between different body-weight measures for Desi and Khaki breeds. While the sRBC titer revealed moderate to high rp with CMI, it had significantly-positive ($P<0.01$) correlations with other immunocompetence traits: IgG, IgM for all breeds. Significant rp ($P<0.01$) were also realized between body-weight and both keel length and shank length at 6 weeks of age. The rp between immunocompetence and body weight at 4 and 8 weeks age ranged from low to high, across breeds. The total serum protein as a trait showed low to moderate rp with most immunocompetence traits and it did not appear to be consistently heritable across breeds (very-low to high h2 values). Based on analyses of these results, it can be concluded that ducks appeared as a moderately immune-responsive species like chickens, both for humoral and cell mediated immunity. By possessing moderately-heritable immunocompetence traits, these studied populations can promise satisfactory response to any future selection-programme for improving immune-competence while retaining higher Juvenile growth.

Thesis title: **Interaction of aflatoxicosis with methionine and zinc levels in diet of broiler chickens**
(Scholar: Dr. Mamta Sharma, PSC/MVSc/5058; Guide: Dr. Ram Singh)

The present study was conducted to evaluate the efficacy of zinc and methionine in ameliorating induced aflatoxicosis (250 ppb aflatoxin B_1) in broiler chickens from 0-6 weeks of age. First experiment included six dietary treatments (T_1-control; T_2-T_1 + 250 ppb AFB_1; T_3-T_1 + 20 mg Zn/kg; T_4-T_1 + 40 mg Zn/kg; T_5-T_2 + 20 mg Zn/kg and T_6-T_2 + 40 mg Zn/kg diet), each offered to 5 replicated groups of 8 birds. Addition of AFB_1 at 250 ppb level significantly ($P<0.05$) decreased the body weight gain, feed intake, and impaired feed conversion ratio. Supplementation of zinc at 40 ppm diet level effectively reduced

the adverse effect of aflatoxicosis on such production parameters of broilers. AF increased the relative weights of liver and spleen while decreased in weight of bursa of Fabricius. These effects of AF were ameliorated by supplementation of 40 mg Zn/kg diet. Addition of aflatoxin in the diet decreased the serum protein, cholesterol, uric acid and haemoglobin levels and increased the serum SGPT and SGOT activities and H/L ratio. Supplementation of 40 ppm diet zinc to the AF contaminated diet ameliorated the ill effects on blood biochemical and haematological parameters. Supplementation of 40 ppm diet zinc significantly improved the CMI response as well as humoral immunity, which was reduced because of AF contamination in feed. In histopathological study showed degenerative change in hepatic cells, proliferation of bile ducts along with periportal infiltration of MNCs in liver and degenerative changes, sloughing and focal area of necrosis along with infiltration of inflammatory cells in intestine. Supplementation of zinc reduced the severity of the hepatic and intestinal histopathological changes associated with aflatoxicosis and improved the villus length/crypt depth ratio. In experiment 2, six treatments (T_1-control; T_2-T_1 + 250 ppb AFB_1; T_3-T_1 + 0.05% Met; T_4-T_1 + 0.1% Met; T_5-T_2 + 0.05% Met; T_6-T_2 + 0.1% Met) were formulated and each diet was fed to 5 replicated groups of 8 birds up to 6 weeks of age. Supplementation of 0.1% methionine in AF contaminated diet improved ($P < 0.05$) the body weight gain (BWG). Met supplementation at 0.1% level ameliorated the ill effects of aflatoxin on BWG, feed consumption and feed conversion efficiency. Supplementation of 0.1% Met to the AF contaminated diet ameliorated the ill effects of aflatoxin on relative organ weight, blood biochemical and haematological parameters. Supplementation of 0.1% Met to the AF contaminated diet significantly improved the CMI response as well as humoral immunity. Supplementation of methionine also reduced the incidence and severity of the hepatic and intestinal histopathology changes associated with aflatoxicosis and improved the villus length/crypt depth ratio. It is concluded that supplementation of 80 mg/kg diet zinc or 0.6% Met and 0.48% Met in starting and finishing diets ameliorated the adverse effects of aflatoxin in broiler chickens.

Thesis title: **Effect of varying dietary levels of vitamin A and Zinc on the performance of broiler chickens**

(Scholar: Dr. Nasir Akbar Mir, PSC/MVSc/5056; Guide: Dr. Chandra Deo)

The proposed study was undertaken to evaluate the response of broiler chicken to varying dietary levels of vitamin A and Zinc with reference to the growth performance, immune response, carcass quality traits, haematological and biochemical parameters and skeletal status. A six weeks (0-6 weeks of age) feeding trial was conducted as per 3x4 factorial design involving three Zn levels (40, 60 and 80 mg/kg) each with four vitamin A levels (1500, 3000, 6000 and 10,000 IU/kg diet) during starting (0-3 wks) and finishing (4-6 wks) phase of age in an standard broiler diet. Each dietary treatment was replicated four times having 8 broiler chicks in each replication. The body weight gain (BWG) did not differ significantly due to different dietary Zn levels during all the growth phases. The BWG was higher ($P < 0.01$) at 6000 IU/kg vitamin A than those observed at other dietary levels of vitamin A during all growth phases. The feed intake (FI) during 0-3 wk differed significantly ($P < 0.05$) being higher at 40 and 80 mg Zn/kg diet than that recorded at 60 mg Zn/kg diet. The FI during 4-6 and 0-6 wks remained statistically similar either main effect or due to interaction effect. The feed conversion ratio (FCR) during 0-3, 4-6 and 0-6 wk of age did not differ significantly due to different dietary Zn levels. However, significantly lower and better FCR was observed at 6000 IU/kg vitamin A than other dietary levels of vitamin A during 4-6 and 0-6 wk of age. The humoral (HA titer to sheep red blood cells- SRBC) was significantly ($P < 0.05$) higher at 6000 and 3000 IU/kg vitamin A than other dietary vitamin A levels. Significantly ($P < 0.05$) higher thymus weights was observed at 60 and 80 mg Zn/kg diet than 40 mg Zn/kg diet. The various carcass quality traits and organ weights were not affected by different treatments only per cent shrinkage loss was increased linearly as increasing dietary Zn levels. The per cent shrinkage loss was significantly ($P < 0.05$) higher at 3000 and 6000 IU/kg vitamin A than other dietary vitamin A levels. The few cut-up parts were also significantly affected by dietary Zn and vitamin A levels in the diets but could observed a particular trends. The various haematological parameters did not influence significantly due to

different treatments. Significantly lower serum ALP and serum phosphorus were observed at 40 mg Zn/kg than those observed at 60 and 80 mg/kg diet. Significantly ($P<0.05$) lower ALP activity was observed at 3000 IU/kg vitamin A than those observed at 6000 and 10,000 IU/kg vitamin A. The bone morphometry parameters were found statistically similar due to different dietary Zn and vitamin A levels in the diets. Significant ($P<0.05$) increase on bone ash and bone Zn concentration was observed with increasing dietary Zn levels. However, significant ($P<0.05$) reduction was seen on bone calcium content at 60 mg Zn/kg than 40 mg Zn/kg diet. Significantly ($P<0.05$) higher bone ash was observed at 3000 IU/kg vitamin A than 10,000 IU/kg vitamin A. However, bone ash observed at 1500 and 6000 IU/kg diet was found comparable with that of 3000 IU/kg vitamin A. Significantly ($P<0.01$) higher bone calcium content was observed at 3000 IU/kg vitamin A than those observed at other dietary levels of vitamin A. Based on the results it is concluded that a dietary combination of 40 mg Zn/kg and supplemental vitamin A 6000 IU/kg diet was found adequate to obtain optimum growth performance, carcass quality traits, haematological and biochemical parameters and skeletal health of coloured broiler chicken during 0-6 weeks of age. However, better immune was realized at a dietary levels of Zn (60-80 mg/kg) and 3000 IU/kg vitamin

Thesis title: **Effect of incubation temperatures on the expression of nutrient transporter genes and post-hatch performance in Japanese quail (*Coturnix coturnix japponaca*)**
(Scholar: Dr. Azhar Rashid, PSC/MVSc/5057;
Guide: Dr. J.S. Tyagi)

Temperature during incubation is the most critical factor determining the hatching as well as post hatch performance in poultry. Any deviation from the normal range will adversely affect performance of birds. Elevated incubation temperature causes pre and post natal growth depression. To compensate this growth depression, there occur up-regulation in the expression of various nutrient transporter genes. The information pertaining to elevated incubation temperature and its effects on nutrient transporter gene expression in Japanese quail are not known. An attempt was made in this study to understand the effect of elevated incubation temperatures on the expression of nutrient transporter genes and post hatch performance in Japanese quail. A total of 720 hatching eggs (360 from each variety i.e., CARI Uttam-high body weight and CARI Pearl-low body weight) were obtained from experimental quail farm, Central Avian Research Institute, Izatnagar, India and were randomly divided into three treatment groups. Each treatment having 240 eggs (120 from each variety, which were further divided into 3 replicates with 40 eggs in each replicate). The first treatment group served as control where in the eggs were incubated at 37.5°C, throughout the entire incubation period (17 days). In 2nd and 3rd treatment group, the eggs were incubated at 37.5°C for initial 10 days and thereafter at 38.5°C and 39.5°C, respectively. Eight chicks (4 chicks from each variety) from each treatment group were sacrificed on day of hatch, 3rd, 7th and 10th day of age. Jejunal samples were collected aseptically to study the gene expression of nutrient transporters (SGLT1, GLUT5, PepT1 and EAAT3). The chicks were reared up to 5 weeks of age to study post hatch performance. Results indicated significant ($P<0.01$) up-regulation in the relative expression of nutrient transporter genes at elevated incubation temperatures (38.5°C and 39.5°C) in comparison to control. Over expression of nutrient transporter genes in high body weight variety i.e., Uttam was found comparably higher. The pre and post hatch performance was adversely affected by the elevated incubation temperatures. Elevated incubation temperature reduced ($P<0.01$) hatchability (TES and FES), chick weight, chick to egg weight ratio, spread of hatch whereas moisture loss, malpositions, embryonic mortality were increased. The adverse effects of incubation were more pronounced in high body weight variety of Japanese quail (Uttam). The study revealed that body weight gain, feed intake and feed efficiency were reduced ($P<0.01$) in the treatment group in which the eggs were incubated at elevated temperature of 39.5°C. The post hatch mortality increased progressively with increase in incubation temperature. From this study it may be concluded that elevated incubation temperature caused up-regulation in the expression of nutrient transporter genes. Elevated incubation temperature i.e., 38.5°C and 39.5°C adversely affected pre and post hatch performance in Japanese quail.

Thesis title: **The assessment on the quality of chicken nuggets incorporated with fermented bamboo shoots, cabbage and beet root**
(Scholar: Dr. Kevi Kikhi, PSC/MVSc/5065; Guide: Dr. Sunil Doley)

Poultry is one of the fastest growing segments of the livestock sector in India today and accounts about 0.7% of national GDP. The phenomenal expansion of poultry farming has immensely increased the availability of spent and culled hens which are poorly utilized as meat source because of its toughness and less juiciness. However, this problem could be resolved up to some extent if these tough meats are converted to some value added meat products which will have better acceptability to the consumers. Chicken nugget is one such product which has a better acceptability to the consumers. However, these meat products do not have adequate amount of dietary fibre and the cost of these products are also quite high which limits its consumption. Addition of low cost vegetables which has adequate amount of dietary fibre can be incorporated to these meat products in order to improve its functionality and thereby reduce the cost of these products. Fermented bamboo shoots, beet root and cabbage have many health benefits like antioxidant property and can also provide dietary fibre. Therefore, the present study was undertaken to study the effect of fermented bamboo shoots @ 10%, beet root @ 10% and cabbage @ 15% levels on the qualities of chicken nuggets during refrigerated ($4 \pm 1°C$) and frozen storage ($-18 \pm 1°C$) period. Beet root nuggets were better than all other treated products in terms of sensory attributes. The products could be stored successfully till 14 days under refrigerated temperature without any adverse effect on the microbial quality of the product. Fermented bamboo shoots treated nuggets had lower microbial load than any other treated groups. On frozen storage, the products were comparable to control nuggets in terms of sensory attributes and could be stored up to 90 days without affecting the product quality. Flavour scores of fermented bamboo shoots and cabbage nuggets showed a gradual increase on frozen storage till 90^{th} day. Incorporation of 10% beet root paste was found to be most suitable in development of functional chicken nuggets based on the different physico-chemical and sensory quality parameters. Thus, from the present study, it was concluded that 10% beet root can be incorporated successfully and economically in chicken nuggets formulation without any adverse effect on the physico-chemical, microbial and sensory qualities of product.

Technology Assessed and Transferred

TECHNOLOGY ASSESSED

- Commercial chicks of CARI Nirbheek, CARI Shyama, Upcari and Hitcari birds were supplied to farmers and different organizations of the country.
- Postal information regarding the availability, cost, production potential and characteristics of Aseel and Kadakanath, CARI Nirbheek, CARI Shyama, Upcari and Hitcari were provided through NAIP projects, different organizations and farmers of the country.
- Simple processes for hurdle treated poultry meat wafers and finger chips were developed using lean turkey and chicken meats along with other seasoning, acidulants, humectants and natural antioxidants and/antimicrobials. Both types of products can be stored up to 40 days at ambient temperature ($37 \pm 2°C$) under aerobic packaging conditions.
- Suitable hurdles for shelf-life extension of chicken meat bites were optimized using 0.5M lactic acid, sodium ascorbate, fox nut seed powder and other natural preservatives. The developed product has shelf-life up to 3 wks at refrigeration temperature ($4 \pm 1°C$).
- CARI model of backyard poultry rearing for sustainable income generation by small and marginal farmers was developed at CARI Regional Centre, Bhubaneswar.
- CARI model of duck rearing for sustainable income generation by small and marginal farmers was developed at CARI Regional Centre, Bhubaneswar.
- Duck-Fish integrated farming for farmers having ponds.
- Successful artificial insemination technology in ducks for cross breeding programme.

TECHNOLOGY TRANSFER ACTIVITIES

Farm School on AIR

The XIV Farm School on AIR (Krishi Pathshala) comprising 13 lectures on "*Turkey evam bater palan-Grameenon ke liye labhdayak vyavasay*" was organized by Technology Transfer Section of the Institute through Prasar Bharti, Akashwani Rampur. For the programme, a large number of farmers and other interested people were made their registration on phone and SMS from Bareilly, Budaun, Moradabad, Rampur and Sambhal districts of U.P., and Nainital and U.S. Nagar districts of Uttarakhand. The radio talks for the farm school recorded by the scientists were broadcasted on every alternate day starting from September 21, 2013. The cash prizes worth Rs. 31,000/- sponsored by National Egg Coordination Committee (NECC), Pune were also given to 21 winning farmers.

Field Days Organized

A field day on CARI Priya strain of poultry under semi-scavenging system was organized on September 30, 2013. The Institute supplied germplasm of CARI Priya layer bird to six interested farmers of the village panchayat Nawadia Harkishan for income generation. The scientists showed the performance of CARI Priya layer to other farmers of the village panchayat to adopt this improved breed of poultry for egg production in order to improve the nutritional status of family members of farmers and also get additional income. The group of farmers expressed their satisfaction with the performance of this layer bird.

Field day on CARI Priya

Field days were also organized on demonstration sites to show the results of Dhanraja broiler, CARI Priya layer and CARI Debendra in the Bithrichainpur block under the project "Transfer of proven poultry production technologies and their impact assessment".

A field day on Dhanraja broiler was organized on December 09, 2013 at village Tirkunia to show the performance of Dhanraja broiler of this Institute. The farmers and poultry farmers were shown the result of Dhanraja

broiler in term of growth, birds' activeness, feed consumption and mortality.

Another field day was organized on March 22, 2014 on performance of CARI Debendra (dual purpose chicken) reared under semi-scavenging system at village panchayat Nawadia Harkishan in Bithrichainpur block of Bareilly.

Organization of Awareness Camps

An awareness camp was organized on April 26, 2013 at Kuan Donda village panchayat of Nawabganj block of Bareilly district by Technology Transfer Section of the Institute under an extension project to create awareness and provide technical knowledge about poultry production to the farmers. The scientists acquainted the farmers about various benefits of poultry farming specially backyard poultry production and broiler farming as source of income generation for their family.

Another awareness programme on poultry farming was organized on December 27, 2013 at Dandia village panchayat of Bithrichainpur block of Bareilly district. In this awareness camp, 39 farmers participated in the programme. During the camp, farmers were motivated for adoption of poultry production. The scientists of Technology Transfer Section discussed about poultry breeds such as broiler breeds, layer breeds, desi breeds, and other poultry species such as quails, guinea fowls and turkey breeds etc. in economic terms. The farmers' doubts about poultry farming were also cleared through question-answer session.

Three other awareness camps-cum-exhibitions on poultry were organized on March 12 and 13, 2014 at Poonakot, Kathad and Chalthi villages of Champawat district of Uttarakhand under the project "Promotion of poultry in Kumaon hills of Uttarakhand", in which, farmers of these selected villages were acquainted with promising breeds of chicken for backyard and commercial poultry farming. Keeping in mind the properties of CARIBRO Dhanraja, the farmers purchased 693 day-old chicks from CARI, Izatnagar for trial purpose in the month of April, 2014.

Farmer Field School

A farmer field school was conducted at Rajau village panchayat of Bareilly district, wherein 36 farmers were motivated to adopt poultry farming. The scientists of the Institute provided them the knowledge on backyard poultry for their socio-economic upliftment and assured nutritional security.

Training Programmes for Farmers/State Veterinary Officers

Name of training, date and venue	*No. of beneficiaries*	*Sponsoring agency/Self*	*State*
Short term training on "Poultry production management"			
June 17-22, 2013	19 farmers/ unemployed youth	Self	Chhattisgarh, New Delhi and Uttar Pradesh
September 16-21, 2013	35 farmers/ unemployed youth	Self	Bihar, New Delhi, Uttar Pradesh and Uttarakhand
December 07-12, 2013	12 farmers 20 farmers/ unemployed youth	JEEVIKA, Patna Self	Bihar Rajasthan, New Delhi and Uttar Pradesh
March 03-08, 2014	34 farmers/ unemployed youth	Self	Madhya Pradesh, Rajasthan and Uttar Pradesh
Training course on "Rural poultry production" (Sponsored by Directorate Veterinary Services, Chhattisgarh)			
April 22-27, 2013	17 paravets	State Veterinary Council, Raipur	Chhattisgarh
May 09-14, 2013	18 paravets	State Veterinary Council, Raipur	Chhattisgarh
Training course on "Sustainable poultry production technology" (Sponsored by Directorate Veterinary Services, Chhattisgarh)			
August 19-26, 2013	18 V.O.	State Veterinary Council, Raipur	Chhattisgarh
September 02-09, 2013	17 V.O.	State Veterinary Council, Raipur	Chhattisgarh

Participation in Exhibitions

- Krishi Vasant National Exhibition jointly organized by ICAR, DOE, New Delhi, Maharashtra Govt. and CII at Nagpur from February 09-13, 2014.
- Kisan Mela at IVRI, Izatnagar on February 28, 2014.

DG, ICAR discussing with Director, CARI in the Institute stall at Krishi Vasant, Nagpur

Village Level Exhibitions

In order to expose selected poultry farmers of Kuan Donda poultry producing pocket under Bithrichainpur development block with proven poultry production technologies, a village level exhibition was held at village panchayat Jasrathpur. In the exhibition, the germplasm developed by CARI viz. CARIBRO Dhanraja, CARIBRO Vishal, CARI Priya, CARI Sonali, improved desi chicken-CARI Nirbheek, Quail [CARI Uttam, CARI Pearl, CARI Ujjawal (white breasted quail), CARI Sweta (white feathered quail), CARI Brown (brown feathered quail)], Turkey-CARI Virat, and Guinea fowl (Kadambari, Chitambari and Swetambari) were shown to poultry farmers. Production characteristics and special features of these breeds were explained, which were appreciated by all the participants.

In order to promote backyard poultry and broiler farming in the selected project area of Nawabganj development block, a village level exhibition on diversified poultry production technology was organized at Dandia village panchayat on March 28, 2014. During the exhibition, the germplasm developed by CARI viz. CARIBRO Dhanraja, CARIBRO Vishal, CARI Priya, CARI Sonali, improved desi chicken-CARI Nirbheek were depicted to poultry farmers. Production characteristics and special features of these breeds were explained. Consequently, 17 interested farmers were given layer birds for backyard poultry rearing in the month of March 2014.

Farmer-Scientist Meet

A farmer-scientist meet (sponsored by State Bank of India, CARI Branch, Bareilly) was organized on December 23, 2013. Total 148 poultry farmers from village Dandia, Bhandsar, Kuan Donda and Nawadia Harkishan of Bareilly district participated in the gosthi and their problems and queries were solved on spot by the Scientists of the Institute.

On-Farm Demonstrations

Under the project "Transfer of proven poultry production technologies and their impact assessment", two on-farm demonstrations on Dhanraja broiler were laid out at poultry farmers' farms at Benipur and Tirkunia villages in Bithrichainpur development block of Bareilly district with 630 and 945 day-old chicks in the month of October, 2013, respectively. Both the poultry farmers were practicing broiler farming using white commercial germplasm. They were motivated to test Dhanraja broiler developed by CARI. The poultry farmers paid the cost of chicks to CARI, while CARI supported them technically. Both the poultry farmers were satisfied with CARIBRO Dhanraja performance in terms of feed consumption and mortality.

Under the project, twelve on-farm demonstrations on CARI Debendra (a dual purpose chicken) were conducted in the month of November, 2013 at village panchayat Nawadia Harkishan in Bithrichainpur block of Bareilly (U.P.). Total 360 one week old chicks of CARI Debendra were distributed among 12 farmers of villages Nawadia Harkishan (8), Naugama (2) and Maheshpur (2) for rearing under semi-scavenging system of backyard poultry farming. The Institute supplied each farmer 20 chicks free of cost and rest 10 chicks were purchased by farmer himself. Thus, each farmer got 30 chicks. Farmers find this germplasm superior than pheriwalas, in terms of growth and age at first egg laying.

On-farm demonstration on CARI Debendra was also held in state Uttarakhand under the project "Promotion of poultry in Kumaon hills of Uttarakhand". The CARI Debendra (dual purpose chicken) of two weeks age were provided to 12 motivated farmers of 7 villages- Khetikhan, Ladoan, Toli, Lada, Jolamail, Bhobadi, Poonakot of Champawat on March 12, 2014 on payment basis.

Foundation Day Celebrations

The Institute celebrated its 35th Foundation Day on December 23, 2013 by organizing valedictory function for XIV Farm School on AIR on "Turkey and quail farming-A profitable business for rural masses" aired through Prasar Bharati, Akashwani Rampur. Inaugurating the celebration, the Chief Guest Dr. Gaya Prasad, Director, IVRI, Izatnagar congratulated the staff for the significant progress made by the Institute and distributed the cash prizes worth Rs. 31,000/- (sponsored by NECC, Pune) and certificates to 21 winning farmers of farm school programme. Dr. J.M. Kataria, Director, CARI highlighted the latest achievements made by the Institute. Dr. S. Majumdar, Head, Technology Transfer presented the report on extension activities made during the year. Dr. N.K. Pandey, Head, Post Harvest Technology proposed the vote of thanks.

Supply of Germ Plasm: In order to promote diversified poultry production in the country, high yielding germplasms as parent stocks and commercial crosses were supplied to various agencies in different pockets of the country (Table 12).

Table 12: Supply of germplasm

Germ plasm supplied	*Fertile eggs*		*Day-old chicks*		*Growers*	*Adults*	
	Parent line	*Commercial*	*Parent line*	*Commercial*		*Parent line*	*Commercial*
Layer chicken	11,066	-	-	12,937	-	835	-
Broiler chicken	13,011	7,200	-	38,515	3,815	-	251
Guinea fowl	-	-	-	-	-	782	-
Quail	-	14,700	-	-	-	5,743	-
Turkey	-	-	-	8,227	454	315	-
Vanaraja	-	-	-	1,528	-	-	-
Duckling	-	-	-	39,625	-	-	-

Education and Training

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

Poultry Science Students on Roll

- M.V.Sc. - 32, Ph.D. - 20
- NDPH - 4

Poultry Science Courses Offered

- M.V.Sc./Ph.D. - 97 courses
- NDPH - 24 courses

Poultry Science Degree Awarded

- M.V.Sc. - 8 students (Avian Genetics and Breeding - 3, Avian Nutrition and Feed Technology - 2, Avian Physiology and Reproduction - 1, Post Harvest Technology- 2)

Seminars Organized

- Faculty Seminar-7, ORW Seminar-15, Major Credit Seminar-14, Minor Credit Seminar-8 and Pre-Thesis Submission Seminar-9

Specialized Training Courses

S.No.	*Training courses*	*Duration*	*Trainee*	*Benefactor*
1.	Poultry Hatchery Operation	September 16-28, 2013	1	Sambhal (U.P.)
2.	Poultry Processing and Products Technology	January 13-26, 2014	1	Shrinagar (J&K)
3.	Layer Production	January 15-28, 2014	6	East Champaran (Bihar) Deoria, Faizabad and Gorakhpur (U.P.)
4.	Layer Production	February 10 to March 01, 2014	5	Gorakhpur, Kanpur and Lucknow (U.P.)

International Short Term Training

S.No.	*Training course*	*Duration*	*Trainee*	*Benefactor (Name and Institution)*
1.	Chick Vent Sexing (Sponsored by West Africa Agricultural Productivity Programme (WAAPP) of Agricultural Research Council, Nigeria)	January 20 to February 18, 2014	6	*Nigerian Nationals* Johnmark, Jimmy Angani Namaska, Jacob Ibrahim, Yusuf Ogar, David Ogochukwu Olatunbosun, Ayomide Joy Ogunnaike, Kolawole Joseph

Awards and Recognition

Awards

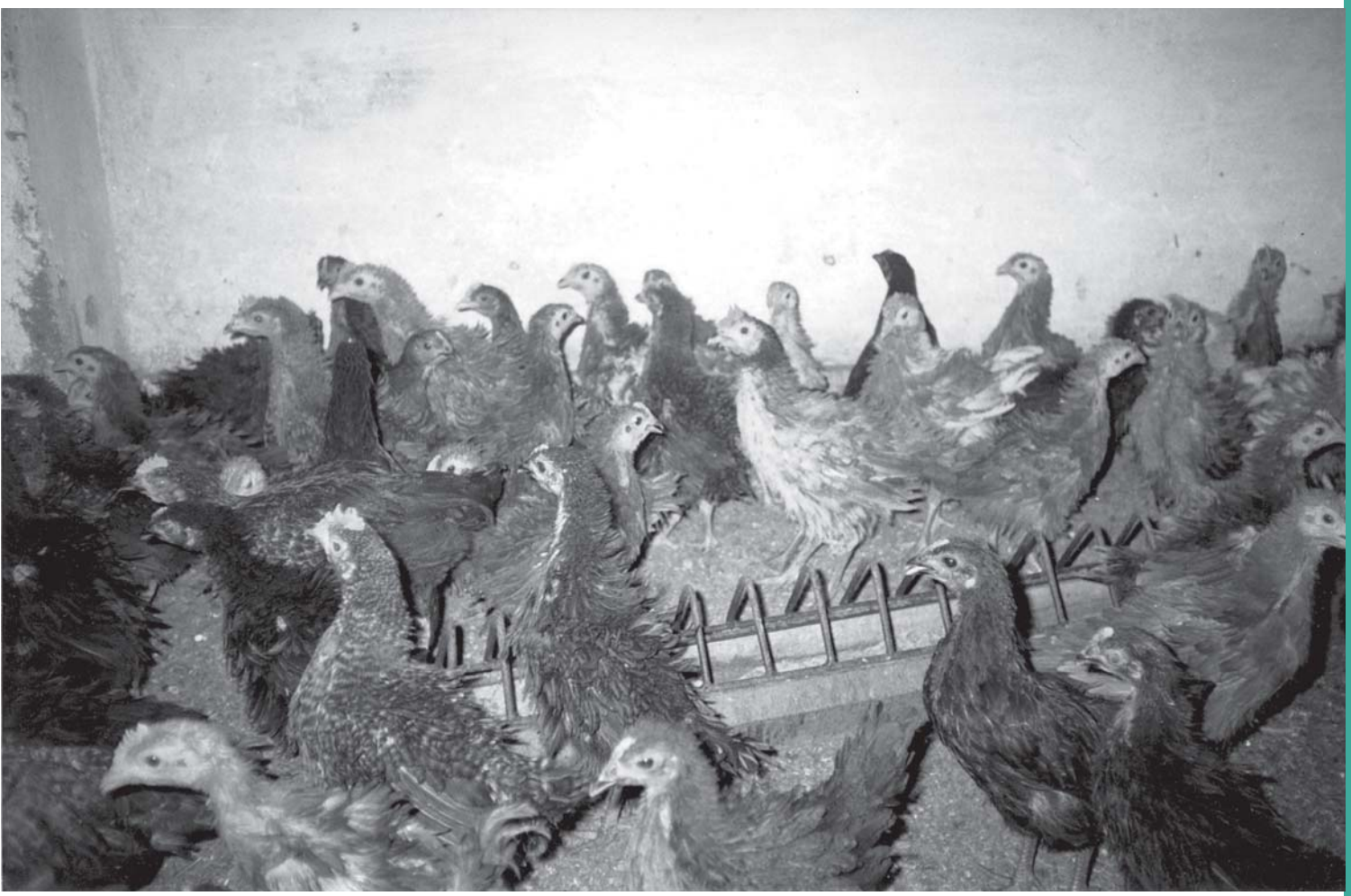
- The Institute received Best Stall Award during Kisan Mela held at IVRI, Izatnagar on February 28, 2014.
- Ayurvet Research Award for Excellence in Avian Research-2012 awarded to the research paper entitled "Standardization of site of *in-ovo* injection, needle length, embryonic age and their effect on hatchability of the egg and hatch weight" authored by A. Bhattacharyya, S. Majumdar, S.K. Bhanja and A.B. Mandal published in Indian Journal of Poultry Science-2012, 47(1): 36-39 during IPSACON-2013 held at CARI, Izatnagar.
- Dr. Sanjeev Kumar, Principal Scientist received Best Poster Award during IPSACON-2013 organized at CARI, Izatnagar during November 2013.
- Dr. Divya, Senior Scientist selected as fellow of Confederation of Horticulture Associations of India (CHAI) on International Conferences on "Water management for climate resilient agriculture" held at Jalgaon, Maharashtra from May 28-31, 2013.
- Dr. Mamta Sharma, M.V.Sc. (Poultry Science) student received IPSA Young Scientist Award 2013 on the research paper entitled "Efficacy of dietary zinc in ameliorating aflatoxicosis in broiler chickens" authored by Mamta Sharma, Ram Singh and A.B. Mandal, 2013 out of her M.V.Sc. (Poultry Science) thesis on November 23, 2013 in XXX Annual Conference and National Symposium 2013 held at CARI, Izatnagar.
- Dr. P.B. Aswathi, M.V.Sc. (Poultry Science) scholar received IPSA Young Scientist Award 2013 for the research paper "Development of functional poultry meat finger stick and assessment of its quality on storage at ambient temperature" authored by Aswathi P.B., Biswas, A.K., Beura, C.K. and Yadav, A.S. (2013) during XXX Annual Conference of Indian Poultry Science Association and National Symposium of IPSA held on November 22-23, 2013 at CARI, Izatnagar.
- Secured Best poster award on paper entitled, "Lactobacillus isolate from GI tract of quail inhibit the growth of Escherichia coli" by Vineetha P.G., Simmi Tomar, J.K. Patra, V.K. Saxena, Sandeep Saran and Adil Khan in XXX IPSACON held on November 22-23, 2013 at CARI, Izatnagar.
- Dr. Ram Kulkarni, Ph.D. scholar (Poultry Science) received Dr. D. Chaudhuri award for best doctoral thesis entitled "Studying efficacy of certain stress alleviating agents on performance and expression of hsp70 in broiler chickens during hot-dry and hot-humid summer" worked under the supervision of Dr. A.B. Mandal, AN&FT Division, CARI (thesis submitted to Deemed University, IVRI).
- Dr. S.K. Sahoo, Principal Scientist received 1st prize in poster presentation in the National Seminar and XXI Annual Convention of Indian Society of Animal Production and Management held at Dept. of LPM, CVS&AH, AAU, Anand during January 28-30, 2014 for the poster entitled "Effect of different levels of protein on the biochemical parameters of Khaki Campbell ducks during starter stage".
- Drs. Chandra Deo, A.B. Mandal and Praveen K. Tyagi received third prize for the research paper on *"Aseel chujo ke anterjhunghika asthi ke akarmity avam khanijeekaran per bibhinn phosphorus tatha justa ke matrao ka prabhav"* during Hindi Pakhwara (September 2013) at CARI, Izatnagar.
- Drs. Divya, A. Biswas, A.B. Mandal, and Pramod K. Tyagi received best poster presentation award for the research paper "Effect of different level of Moringa (*Moringa oleifera*) levels on carcass traits of meat quality of broiler chicks" in XXX Annual Conference and National Symposium of IPSA on November 22-23, 2013 held at CARI, Izatnagar.
- Drs. Jitendra Patra, Simmi Tomar and V.K. Saxena received consolation prize for the research paper on *"Bater antra se prathak lactobacillus ka prakjaivik ankalan uprant labhprad prayogatmak vishleshan"* during

Hindi Pakhwara (September 2013) at CARI, Izatnagar.

- Drs. S.K. Sahoo and D. Mondal received best presentation award (second) under section Avian and Exotic species Medicine, 32nd ISVM Annual Convention and International Symposium at F.V.Sc., SKUAST, Jammu, February 14-16, 2014.
- Drs. Suraj Amrutkar, V.K. Saxena and Simmi Tomar received first prize for the research paper on *"Usrandra vatavarniye pratyaval sahan chamta ke liye vibhinn pakchati prakar ke broileron ka ankalan" d*uring Hindi Pakhwara (September 2013) at CARI, Izatnagar.

Recognition

- Dr. Sanjeev Kumar, Principal Scientist acted as Member, Expert Panel constituted for "Draft code on egg laying hens" by Animal Husbandry, Feeds and Equipment sectional Committee, FAD-5, Manak Bhavan, 9 B.S. Zafar Marg, New Delhi.
- Dr. Sanjeev Kumar, Principal Scientist was elected as PG Faculty Representative to Academic Council of Indian Veterinary Research Institute (Deemed University), Izatnagar for two years (06.11.2013 to 05.11.2015).
- Dr. Sanjeev Kumar, Principal Scientist was elected as Vice-President (Northern Zone) of ARS Scientists Forum, New Delhi (2013-16).



Linkages and Collaborations

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 synthetic broiler sire line	Dr. Simmi Tomar, PI Dr. V.K. Saxena, Co-PI Dr. A.K. Sachdev, Co-PI (till 31.08.2013)	1971	-	Avian Genetics and Breeding Division, CARI, Izatnagar
2.	Development and evaluation of synthetic broiler dam Line	Dr. V.K. Saxena, PI Dr. Simmi Tomar, Co-PI Dr. A.K. Sachdev, Co-PI (till 31.08.2013) Dr. Avishek Biswas (w.e.f. 05.06.2013)	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 *Salmonella* Typhimurium and development of their thermal death time models applicable to poultry processing	Dr. A.S. Yadav, PI Dr. A.K. Sachdev, Co-PI (till 31.08.2013) Dr. V.K. Saxena, Co-PI Dr. J.M. Kataria, Co-PI (w.e.f. 16.01.2014)	19.07.2012 (3 years)	45.1028	Post-Harvest Technology Division, CARI, Izatnagar
NAIP, New Delhi					
1.	Developmental potency of parthenogenetic goat embryos	Dr. S.K. Bhanja, CCPI Dr. S. Majumdar, Co-CCPI	06.01.2009 (3 years) (Extended up to 31.03.2014)	91.3482	Sub centre: CARI, Izatnagar
2.	Sustainable livelihood improvement through integrated freshwater aquaculture, horticulture and livestock development in Mayurbhanj, Keonjhar and Sambalpur districts of Odisha	Dr. S.C. Giri, CCPI Dr.K.V.H. Sastry, Co-CCPI Dr. S.K. Sahoo, Co-CCPI Dr. R.K.S. Bais, Co-CCPI	06.04.2009 (3 years) (Extended up to 31.03.2014)	120.7441	CARI Regional Centre, Bhubaneswar

Sl. No.	Title of the Project	Name of the PI and Associates	Date of Start and Period	Sanctioned Funds (Rs. in lakhs)	Location
3.	Holistic approach for improving livelihood security through livestock based farming system in Barabanki and Raibareli districts of U.P.	Dr. D.P. Singh, CCPI	13.04.2008 (4 years) (Extended up to 30.06.2014)		Avian Genetics and Breeding 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 (up to 23.08.2014)	15.947	CARI Regional Centre, Bhubaneswar

List of Publications

Research Articles

Amrutkar, S.A., Saxena, V.K. and Tomar, S. (2014). m-RNA profiling of HSP-70 under different tropical stress conditions in various broilers. *Vet. World,* 7(2): 100-07 (Foreign journal: Impact factor 5.10).

Bhattacharyya, A., Majumdar, S., Bhanja, S.K., Mandal, A.B. and Dash, B.B. (2013). Comparative response to maternal vaccination, *in-ovo* vaccination and post hatch vaccination on the neonatal growth and feed conversion ratio of turkey poults. *Indian J. Anim. Sci.,* 83(1): 16-19 (Indian journal: Impact factor 6.13).

Biswas, A., Mohan, J. and Sastry, K.V.H. (2013). Effect of dietary supplementation of vitamin E on production performance and some biochemical characteristics of cloacal foam in male Japanese quail. *Anim. Reprod. Sci.,* 140: 92-96 (Foreign journal: Impact factor 7.90).

Divya and Singh, R.P. (2013). Effect of bitter melon as antioxidant in chicken nuggets. *Indian J. Poult. Sci.*, 48(1): 63-67 (Indian journal: Impact factor 5.01).

Divya, Yadav, A.S., Rai, S. and Prasad, N. (2013). Textural and sensory quality of meat nugget containing arabic and guar gum. *Indian J. Poult. Sci.*, 48(1): 58-62 (Indian journal: Impact factor 5.01).

Divya, Yadav, A.S., Swetarai, Beura, C.K. and Prasad, N. (2013). Effect of guar gum and gum arabic addition on functional properties on the quality characteristics of chicken nuggets. *Indian J. Poult. Sci.*, 48(1): 58-62 (Indian journal: Impact factor 5.01).

Goel, A., Bhanja, S.K., Pande, V., Mehra, M. and Mandal, A.B. (2013). Effects of *in-ovo* administration of vitamins on post hatch-growth, immunocompetence and blood biochemical profiles of broiler chickens. *Indian J. Anim. Sci.,* 83(9): 916-21 (Indian journal: Impact factor 6.13).

Jain, P., Singh, R., Saxena, V.K., Singh, K.B., Ahmed, K.A., Tiwari, A.K., Sundaresan, N.R. and Saxena, M. (2013). *In-vitro* rapid clearance of infectious bursal disease virus in peripheral blood mononuclear cells of chicken lines divergent for antibody response might be related to the enhanced expression of proinf ammatory cytokines. *Res. in Vet. Sci.,* 95: 957-64 (Foreign journal: Impact factor 7.77).

Khillare, G.S., Sastry, K.V.H., Singh, R.P., Agarwal, R. and. Mohan, J. (2013). Acid and alkaline phosphatase enzyme activity in sperm storage tubules in Japanese quail. *Indian J. Pout. Sci.*, 48: 128-30 (Indian journal: Impact factor 5.01).

Kulkarni, R.C., Shrivastava, H.P. and Mandal, A.B. (2013). Influence of dietary copper sources and levels on immune-competence, mineral retention and carcass traits in coloured broiler chickens. *J. Poult. Sci. and Technol.,* 1: 1-6 (Indian journal: Impact factor NA).

Majumdar, S., Mandal, A.B., Tyagi, Praveen K., Sahoo, A., Sastry, K.V.H., Das, B.B., Meena, H.R and Sharma, A. (2013). Optimising limiting amino acids profile of broiler chickens at high altitude of Kumaun region. *Anim. Nutr. and Feed Technol.,* 13: 215-22 (Indian journal: Impact factor 6.36).

Mohan, J., Khanday, J.M., Singh, R.P. and Tyagi, J.S. (2013). Effect of storage on the physico-biochemical characteristics and fertility of guinea fowl semen. *Advances in Anim. and Vet. Sci.,* 1(2): 65-68.

Nahak, A.K., Giri, S.C., Mohanty, D.N. and Mishra, P.C. (2014). Seminal characteristics of white pekin duck. *Indian Vet. J.,* 91(02): 39-41 (Indian journal: Impact factor 4.33).

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Mandal, A.B. (2014). Nutrient requirement of egg type chickens. Specialized training programme conducted by CARI, Izatnagar from 15th to 28th January and 10th Feb. to 1st March, 2014.

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Mohan, J. (2013). Importance of artificial insemination in poultry production. In: Training compendium of "Sustainable poultry production technology" held on August 19-26, 2013 and September 02-09, 2013 at CARI, Izatnagar. p. 110-12.

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Narayan, R. (2013). 5 days training programme 20 progressive farmers from gumla Jharkhand on May 06-10, 2013 on topic "Bater palan kaise kare" May 9-10, 2013 organized by J.D. extension, IVRI, Izatnagar.

Narayan, R. (2013). Training on Animal Diseases Control and management from 12-21 June 2013 for Para veterinary staff of department of Animal Husbandry up delivered lecture of topic "Management of chicken and quail farming" on dt 21.6.2013 organized by J.D. extension, IVRI, Izatnagar.

Narayan, R. (2013). 25 progressive farmers 5 days ATMA programme for Kodarma Jharkhand organized from 28.10.2013 to 1.11.2013 delivered lecture on topic "Methods of quail and chicken farming" on dt 1.11.2013 organized by J.D. extension, IVRI, Izatnagar.

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Saxena, V.K. (2014). Poultry production and biotechnology. SVBT National Seminar on "Biotechnological approaches to challenges in animal health and production" held at Veterinary College, Mathura, 6-7 March 2014.

Saxena, V.K. (2013). *Broiler palan: Ek asaan va labhkari rojgar vikalp*. In: Training compendium of "Paarivaarik kukkut utpadan" held on April 22-27, 2013 and May 09-14, 2013 at CARI, Izatnagar. p. 07-10.

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Singh, R., Mandal, A.B., Divya and Lal, N. (2013). *Kukkut ahaar ko vishyukt kavak se bachayen*. In: Training compendium of "Paarivaarik kukkut utpadan" held on April 22-27, 2013 and May 09-14, 2013 at CARI, Izatnagar. p. 37-38.

Tomar, S. (2013). Management of breeding stock of layer chicken. In specialized training on Layer Production w.e.f. 17-30 Oct. 2013 at CARI, Izatnagar.

Tomar, S. (2013). Augmenting guinea fowl meat production. In specialized training course on poultry processing and product technology w.e.f 13- 26 Jan, 2014 at CARI, Izatnagar.

Tomar, S. (2013). Management of breeding stock of layer chicken. In specialized training course on Layer Production w.e.f 10th Feb.-1st March 2014 at CARI, Izatnagar.

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Tyagi, Pramod K. (2013). Milling, compounding, processing and quality control of feeds for poultry species. In: Training compendium of "Sustainable poultry production technology" held on August 19-26, 2013 and September 02-09, 2013 at CARI, Izatnagar. p. 98-105.

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Abstracts/Papers Presented in Conferences/ Symposia

XX Annual Convention of IAAVR and International Conference on "Thrust areas in veterinary research, education, regulatory reforms and governance for quality services to

farmers" held on April 16-17, 2013 at KVAFSU, Hebbal, Bangalore

Aswathi P.B., Beura, C.K., Biswas, A.K. and Sachdev, A.K. Study on acceptability of functional poultry meat finger sticks on incorporation of fiber rich cereals.

International Conference on "Conserving biodiversity for sustainable development (INCCBSD-2013)" organized by Department of Biotechnology and Medical Engineering, NIT Rourkela (India) in association with Postgraduate Institute of Science, University of Peradeniya (Sri Lanka) held on August 16-18, 2013

Das, A.K., Kumar, S., Rahim, A., Kokate, L.S., Mishra, A.K., Kataria, M.C. and Das, D. Microsatellite based genetic diversity estimated after long term selection for egg production in Rhode Island Red chicken. p. 43.

2nd National Conference of Indian Academy of Veterinary Nutrition and Animal Welfare (IAVNAW) held on September 19-21, 2013 at Sher-e-Kashmir University of Agricultural Science and Technology, Jammu

Giri, S.C. and Sahoo, S.K. Calcium supplementation improves mortality rate in free range duck production. p. 635.

Sahoo, S.K., Giri, S.C. and Mondal, D. Optimum level of protein requirement of Khaki Campbell ducks during starter stage. p. 608.

WCAP 2013 held on October 15-20, 2013 at Beijing, China

Saxena R., Saxena, V.K., Tripathi, V., Mandal, A.B., Singh, B.P., Agarwal, R. and Singh, B. Intestinal mucin and cytokines gene expression in naked neck broiler under probiotic and prebiotic feeding.

Workshop on "Opportunities for the development of poultry and dairy genetics for Africa" as a part of 9th annual Grand Challenges Meeting co-hosted by the Ministry of Health of Brazil, Grand challenges Canada, the Bill & Melinda Gates Foundation, USAID and other partners from October 27-30, 2013 at Rio de Janerio, Brazil

Singh, D.P. Indian poultry germplasm development system: CARI experience.

XXII Annual Conference and National Symposium of SAPI held on November 19-21, 2013 at DUVASU, Mathura

Rashid A., Tyagi, J.S., Sharma, S.K., Sirajudeen, M., Mohan, J., Singh, R.P., Narayan R., Mehra, M. and Goel, A. (2013). Incubation temperature affects expression of nutrient transporter genes in Japanese quail. Abstr. No. PFWP-17: 134.

Shinde, A.S., Mohan, J., Singh, R.P., Chouhan, L. and Sastry, K.V.H. Examine fertility in fertile period in Kadakanath chicken using different semen extenders. Abstr. No. PFWP-03:126.

XXX Annual Conference and National Symposium of Indian Poultry Science Association (IPSACON-2013) held on November 22-23, 2013 at CARI, Izatnagar

Ali, H., Singh, D.P. and Rai, R.B. Integration of rural poultry production with agricultural farming system for symbiotic effects. Abstr. No. PGB-029/P: 15.

Ali, I., Majumdar, S., Mandal, A.B., Bhanja, S.K., Goel, A., Mehra, M. and Patra, J.K. Effect of floor space and dietary protein level on carcass quality traits of growing turkey poults in winter season. Abstr. No. DPP-035/O: 152.

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Das, A.K., Kumar, S., Rahim, A., Kokate, L.S. and Mishra, A.K. Reproduction and production profiles of Rhode Island Red chicken strains and its crosses. p. 135.

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Kokate, L.S., Kumar, S., Rahim, A., Das, A.K. and Jagadeesan, K. Immune response to Newcastle disease virus vaccine in Kadakanath native chicken. Abstr. No. 9.O.08: 119.

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Sl. No.	Name of the gene	Amplicon length (bp)	Accession number obtained	Agency	Putitative biological role	Authors
01.	Gallus gallus peptide transporter (PepT1) mRNA,	721	KC594109	NCBI, USA	Nutrient transport	Soren, S.K., Bhanja, S.K., Goel, A., Mehra, M. and Mandal, A.
02.	Gallus gallus brain-derived neurotrophic factor (BDNF) mRNA	629	KC594110	NCBI, USA	Thermoregulatory	Soren, S.K., Bhanja, S.K., Goel, A., Mehra, M. and Mandal, A.
03.	B-cell CLL/ lymphoma 11A (zinc finger protein)	218	KC594099	NCBI, USA	Development related	Bhanja, S.K., Goel, A., Mehra, M., Majumdar, S., Bag, S. and Malakar, D.
04.	Activin A receptor, type IIB [ACVR2B]	215	KC594100	NCBI, USA	Development related	Bhanja, S.K., Goel, A., Mehra, M., Majumdar, S., Bag, S., Malakar, D.
05.	Transmembrane and tetratricopeptide repeat containing 3 [TMTC3]	249	KC594101	NCBI, USA	Development related	Bhanja, S.K., Goel, A., Mehra, M., Majumdar, S., Bag, S. and Malakar, D.
06.	Apolipoprotein A-I [APOA1]	233	KC594102	NCBI, USA	Development related	Bhanja, S.K., Goel, A., Mehra, M., Majumdar, S., Bag, S. and Malakar, D.
07.	Chaperonin containing TCP1, subunit 2 (beta) [CCT2]	220	KC594103	NCBI, USA	Development related	Bhanja, S.K., Goel, A., Mehra, M., Majumdar, S., Bag, S. and Malakar, D.
08.	ADP-ribosylation factor-like 14 effector protein [ARL14EP]	282	KC594104	NCBI, USA	Development related	Bhanja, S.K., Goel, A., Mehra, M., Majumdar, S., Bag, S. and Malakar, D.
09.	Lysophosphatidic acid receptor 2 [LPAR2]	267	KC594105	NCBI, USA	Development related	Bhanja, S.K., Goel, A., Mehra, M., Majumdar, S., Bag, S. and Malakar, D.
10.	T-complex 1 [TCP1]	288	KC594106	NCBI, USA	Development related	Bhanja, S.K., Goel, A., Mehra, M., Majumdar, S., Bag, S. and Malakar, D.
11.	Triosephosphate isomerase 1 [TPI1]	256	KC594107	NCBI, USA	Development related	Bhanja, S.K., Goel, A., Mehra, M., Majumdar, S., Bag, S., Malakar, D.
12.	Thyroid hormone receptor associated protein 3 [THRAP3]	287	KC594108	NCBI, USA	Development related	Bhanja, S.K., Goel, A., Mehra, M., Majumdar, S., Bag, S. and Malakar, D.
13.	Meleagris gallopavo mRNA for sox2 gene	170	HG313862	EMBL, UK	Pluripotent gene	Bhanja, S.K., Goel, A., Mehra, M., Majumdar, S., Bag, S. and Malakar, D.

Sl. No.	Name of the gene	Amplicon length (bp)	Accession number obtained	Agency	Putitative biological role	Authors
14.	Meleagris gallopavo cDNA, clone ChEST128b1	240	HG313862	EMBL, UK	Development related	Bhanja, S.K., Goel, A., Mehra, M., Majumdar, S., Bag, S., Malakar, D.
15.	Meleagris gallopavo mRNA for aldh7a1 gene,	245	HG313863	EMBL, UK	Development related	Bhanja, S.K., Goel, A., Mehra, M., Majumdar, S., Bag, S., Malakar, D.
16.	Meleagris gallopavo mRNA for mtif gene, 5'	268	HG313864	EMBL, UK	Development related	Bhanja, S.K., Goe,l A., Mehra, M., Majumdar, S., Bag, S., Malakar, D.

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News Paper Coverage

Rearing ducks in polythene pond proves rewarding. The Hindu, February 2014.

Rearing ducks in polythene pond proves rewarding. Published in "The Hindu (Farmer's Note book)" on 13.02.14 (All editions).

Muktangan kukuda palana: Eka safala kahani. Oriya article published on October 2013 in "Krusakabandhu Annapurna" monthly Oriya journal for farmers.

Odisara adivasi bahula jilla manankre batak palana prati aagraha. Oriya article published on November 2013 in "Krusakabandhu Annapurna" monthly Oriya journal for farmers.

Duck rearing in Polythene ponds. published in ICAR website, August 2013.

Radio/TV Talks

Radio Talks under XIV Farm School on AIR, Akashwani Rampur

Bhadauria, P. (2013). *Turkey evam bater palan hetu awashyak upkaran*. September 27.

Bhanja, S.K. (2013). *Turkey evam bater palan hetu saste evam tikau awas*. September 23.

Biswas, A.K. (2013). *Mulya-vardhit turkey evam bater utpad kaise banayen?* October 11.

Kataria, J.M. (2013). *Bharatvarsh mein turkey evam bater palan ke kshetra mein Kendriya Pakshi Anusandhan Sansthan ka yogdan*. October 05.

Lal, N. (2013). *Turkey evam bater palan mein mahilayon ki sahbhagita kaise Karen*? October 15.

Majumdar, S. (2013). *Turkey palan-Ek ubharta labhprad vyavasay*. September 21.

Mandal, A.B. (2013). *Santulit turkey evam bater ahaar kaise banayen?* October 01.

Narayan, R. (2013). *Vaigyanik tarike se bater palan kaise karen?* September 23.

Sagar, M.P. (2013). *Turkey evam bater palan ko lokpriya banana mein prachar-prasar madhyamon ki bhoomika*. October 13.

Saran, S. (2013). *Laghu istar par turkey evam bater palan ka aarthik lekha-jokha*. October 09.

Tyagi, Pramod K. (2013). *Turkey evam bater ahaar mishran tatha taiyyar ahaar ka bhandaran*. October 03.

Tyagi, Praveen K. (2013). *Turkey evam bater ahaar sutrikaran*. September 29.

Yadav, A.S. (2013). *Grameen kshetron mein hone wale turkey evam bater rog, lakshan tatha bachav*. October 07.

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Kataria, J.M. (2013). *Kendriya Pakshi Anusandhan Sansthan ke shodh ki gatividhiyan*. AIR Rampur, August 16.

Kataria, J.M. (2013). *Kukkut palakon ke liye CARI ki suvidhayen*. AIR Bareilly, November 18.

Narayan, R. (2014). *Bater palan labhkari*. AIR Bareilly, January 30.

Narayan, R. (2013). *Murgiyo ki dekh rekh*. AIR Rampur, June 02.

Narayan, R. (2013). *Kukkut palan aaj ki awasyakta*. AIR Bareilly, May 18.

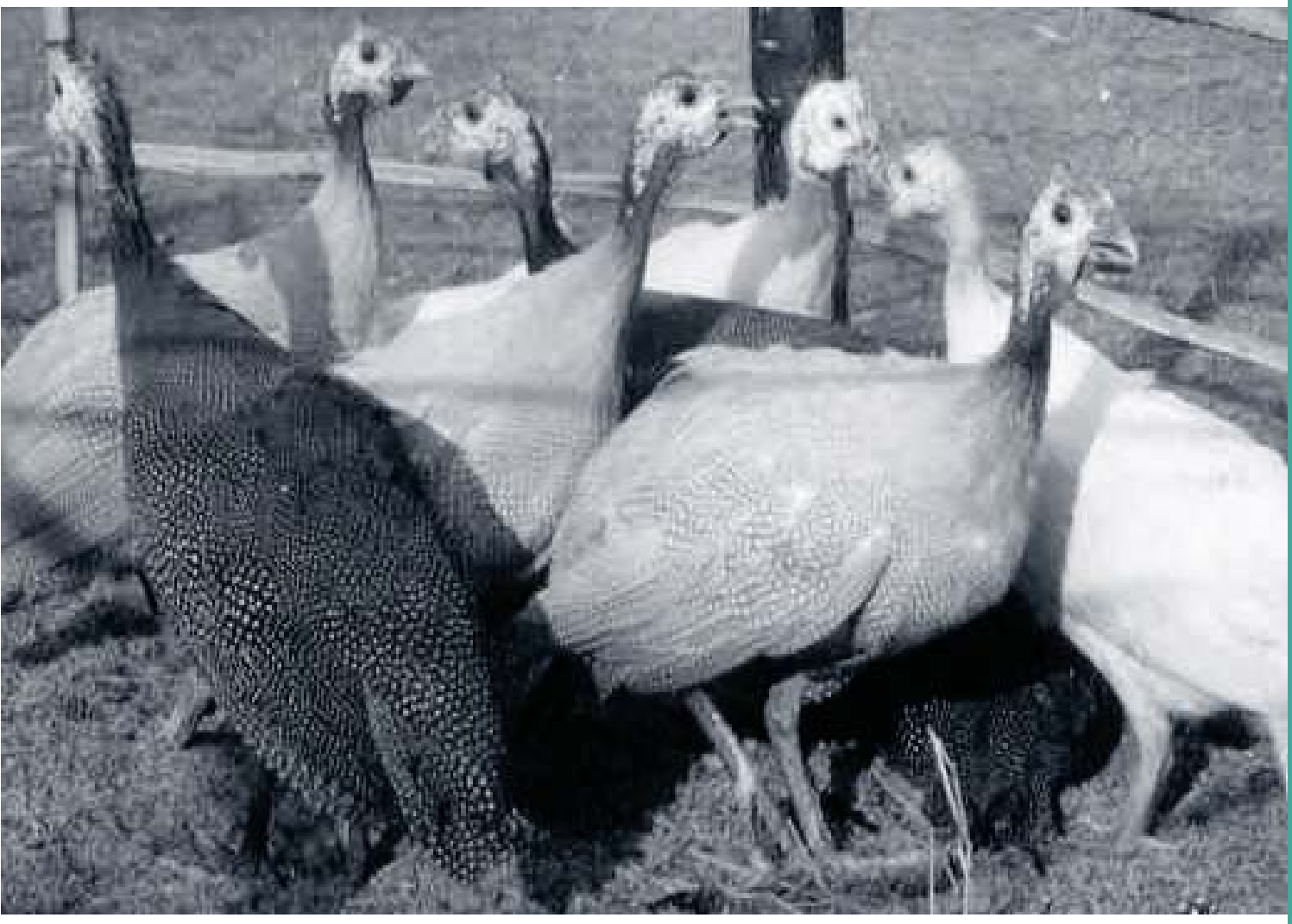
Majumdar, S. (2013). *Kendriya Pakshi Anusandhan Sansthan ki shodh uplabhdhiyan*. AIR Rampur, July 03.

Majumdar, S. (2013). *Kukkut palan atirikt aay ka sadhan*. AIR Bareilly, December 13.

Mandal, A.B. (2014). *Pashu ahaar banate samay savdhaniyan barten*. AIR Rampur, January 21.

Saran, Sandeep (2013). *Kukkut palan: Aaj ki aavashayakta*. AIR Bareilly, April, 29.

Singh, D.P. (2014). *Murgi palan se juri samasyan aur samadhan*. AIR Rampur, January 15.



Participation of Scientists in Conferences, Workshops, Symposia and Trainings

Sl. No.	*Name of the Symposium / Seminar / Workshop / Training*	*No. of Scientists Attended*
1.	XIX Annual Conference and Symposium of Indian Society of Veterinary Immunology and Biotechnology (ISVIB-2013) on "Emerging trends in biotechnology research for sustainable animal health and productivity", IVRI, Izatnagar, April 08-10, 2013	2
2.	Common RAC meeting, PDP, Hyderabad, April 24, 2013.	1
3.	World Veterinary Day (WVD)-2013 programme, IVRI Deemed University, Izatnagar, April 27, 2013	1
4.	Round-table meeting on "Alternative raw materials for poultry feeds", Gurgaon, May 28, 2013	1
5.	International Conference on "Water management for climate resilient agriculture", Jalgaon, Maharashtra, May 28-31, 2013	1
6.	Refresher Course on "Agricultural research management", NAARM, Hyderabad, July 15-27, 2013	2
7.	National Seminar cum Workshop on "Geographical indications (G.I.) for awareness and registration of GI authorized users", BPD unit for Agri-entrepreneurship and Technology Management, NAARM, Hyderabad, July 24, 2013	2
8.	National Workshop on "Repeat study on assessment of post-harvest losses of major horticultural crops, animal and fishery products in India", NASC Complex, New Delhi, August 29, 2013	2
9.	55th National Symposium 2013 of CLFMA on "Facilitating growth of animal husbandry sector", Kempinski Ambience, Delhi, September 26-27, 2013	1
10.	Meeting regarding preparation of DARE/ICAR report 2013-14, ICAR, New Delhi, September 30, 2013	1
11.	Seminar cum Workshop on "Promotion of sweet potato for livelihood and nutritional security in coastal saline soil of Odisha", Regional Station, CTCRI, Bhubaneswar, October 09, 2013	1
12.	Training on "Empowerment of farming communities through hybrid communication tools", Division of Extension Education, IVRI, Izatnagar, October 21- 30, 2013	1
13.	Workshop on "Opportunities for the development of poultry and dairy genetics for Africa", as part of 9th Annual Grand Challenges Meeting organized by Ministry of Health of Brazil, October 27-30, 2013	1
14.	XXX Conference of Indian Poultry Science Association (IPSACON-2013) and National Symposium on "Poultry production: Feed, food and environmental safety", CARI, Izatnagar, November 22-23, 2013	22
15.	ICAR Institute-SAU-State Department Interface Meet, Odisha-2013, CRRI, Cuttack, November 26-27, 2013	1
16.	XII Plan EFC meeting, ICAR, New Delhi, December 11, 2013	2
17.	National Workshop on "Animal welfare education in Indian perspective", IVRI, Izatnagar, December 18-19, 2013	1

Sl. No.	Name of the Symposium / Seminar / Workshop / Training	No. of Scientists Attended
18.	7th International Food Convention on "Nutritional security through sustainable development, research and education for healthy foods", CSRI-CFTRI, Mysore, December 18-21, 2013	1
19.	Workshop technology week for women in agriculture, DRWA, Bhubaneswar, January 22-27, 2014	1
20.	Seminar on "DST-Lockheed Martin India innovation growth programme 2014", Pal Height, Bhubaneswar organized by FICCI regarding patent and successful case study from the India innovation growth performance, January 28, 2014	1
21.	International Conference on Biotechnology and Bioinformatics (ICBB-2014), International Centre for Stem Cells, Cancer and Biotechnology (ICSCCB), Pune, February 01-02, 2014	1
22.	International Conference on "Reproductive health: Issues and strategies under changing climatic scenario", IVRI, Izatnagar, February 06-08, 2014	2
23.	32nd ISVM Annual Convention and International Symposium entitled "The 21 century road map for veterinary practice, education and research in India and developing countries", Division of Veterinary Medicine, SKUAST, Jammu, February 14-16, 2014	1
24.	XVII Annual ADNAT Convention and Symposium on "Genomics in personalised medicine and public health", Rajiv Gandhi Centre for Biotechnology, Thiruvananthapuram, February 23-25, 2014	1
25.	Eastern Zone Agricultural Fair, CRRI, Cuttack, February 26-28, 2014	1
26.	Workshop on "Backyard poultry production as a tool to augment livelihood of rural and tribal farmers", OUAT, Bhubaneswar, March 03-04, 2014	2
27.	National Seminar on "Biotechnological approaches to challenges in animal health and production", DUVASU, Mathura, March 06-07, 2014	1
28.	Training on "Sensitization training programme on data analysis using SAS", Division of Livestock Economics, Statistics and Information Technology, IVRI, Izatnagar, March 24-25, 2014	1

Consultancy, Patents and Commercialization of Technology

Consultancy Services

- Provided low-cost feed formulae to about 50 poultry farmers and small feed industries from different states (Uttar Pradesh, Delhi, Uttarakhand, Haryana, Andhra Pradesh, Madhya Pradesh, Karnataka, Tripura and Bihar) and solving the problems of many farmers from different states through personal contact, telephone call and kisan call centre.
- Least cost feed formulation technology is being disseminated through Makefeed Poultry and Dairy softwares.
- Published extension articles and also disseminating through research news/personal interaction.
- Lectures delivered in two technical seminars on poultry production at Faridpur and Sahipur, Bareilly (U.P.).
- Consultancy granted to following farmers for preparing a bankable project:

  1. Shri Rakesh Kirade, Vill. and P.O. Kunjari, Teh. Niwali, Dist. Badwani (M.P.)
  2. Shri Md. Umar, Vill. and P.O. Muhalla Mirdhan, Faridpur, Bareilly (U.P.)
  3. M/s Rathore Brothers Chicken Farms, Vill. Jalalpur, Bisouli, Block Asafpur, Budaun (U.P.)
  4. Shri Irfan Khan, Vill. and P.O. Muhalla Mirdhan, Khudaganj Road, Block Faridpur, Bareilly (U.P.)

Patent/Technology Submitted to ITMC/ZTMC

- Trademarked Registry by GoI (Trade Mark Act-1999, Trade Mark No.-2312766 dated 10.04.2012 J.No. 1594 and Trade Mark No. 2409823 dated 11.10.2012 J.No. 1614) has been registered in name(s) of CARI, Izatnagar, Bareilly (CARI Uttam Japanese Quail Single firm and CARI PRIYA whitess laying bird, respectively).
- Registration of CARI Dhanraja, the coloured broiler germplasm developed and evaluated at CARI, Izatnagar is under active consideration.
- The patent entitled, "Nucleic acid amplification- Allelic differentiating restriction pattern (NAADRP)-A Novel method for determining the MHC genotype in chicken" has been submitted vide reference number 346/DEL/2009 dated 24.02.2009 (Publication date 03.09.2010). Published in Official Journal of the Patent Office, Issue No. 36/2010; Page 27749 under publication).

Technologies Commercialized and Revenue Generated

- Technology for Salted Chicken Eggs developed at PHT Division was commercialized to M/s GLD Poultry farms, Namakkal and revenue of sum of Rs. 11,000/- was generated.
- Technology for preparation of Quail Egg Pickle developed at PHT Division was commercialized to M/s MPM Japanese Quail Farm and Agro Foods, Tamil Nadu and revenue of sum of Rs. 10,000/- was generated.

Workshops, Seminars and Trainings Organized

Date	*Event*	*No. of Farmers / Beneficiaries*
April 22-27, 2013	Training course on "Rural poultry production" (Sponsored by Directorate Veterinary Services, Chhattisgarh)	17 paravets nominated by State Veterinary Council, Raipur
May 09-14, 2013	Training course on "Rural poultry production" (Sponsored by Directorate Veterinary Services, Chhattisgarh)	18 paravets nominated by State Veterinary Council, Raipur
August 19-26, 2013	Training course on "Sustainable poultry production technology" (Sponsored by Directorate Veterinary Services, Chhattisgarh)	18 veterinary officers nominated by State Veterinary Council, Raipur
September 02-09, 2013	Training course on "Sustainable poultry production technology" (Sponsored by Directorate Veterinary Services, Chhattisgarh)	17 veterinary officers nominated by State Veterinary Council, Raipur
November 22-23, 2013	XXX National Conference of Indian Poultry Science Association (IPSACON-2013) and National Symposium on "Poultry production: Feed, food and environmental safety"	278 participants (Eminent scientists, academicians and persons representing both public and private sectors)
January 20 to February 18, 2014	International training course on "Chick vent sexing" [Sponsored by West Africa Agricultural Productivity Programme (WAAPP) of Agricultural Research Council, Nigeria]	6 Nigerian Nationals

Chief Guest addressing the delegates during IPSACON-2013

Nigerian trainee sharing his views during International Training Course

Distinguished Visitors

Date	*Name*	*Address*
Main Campus, Izatnagar		
April 08, 2013	Dr. R. Prabakaran	Vice Chancellor, TANUVAS, Chennai
May 14, 2013	Dr. S. Dey and Students of 4th Year BVSc & AH	WBUAFS, Kolkata
October 31, 2013	Dr. R.S. Gandhi	ADG (AP&B), ICAR, New Delhi
November 11, 2013	Dr. K. Pradhan	Ex-Vice Chancellor, OUA&T, Bhubaneswar
November 12, 2013	Dr. S. Ayyappan	Secretary, DARE and Director General, ICAR, New Delhi
	Dr. K.M.L. Pathak	DDG (Animal Sciences), ICAR, New Delhi
	Dr. Arvind Kumar	DDG (Education), ICAR, New Delhi
	Dr. Gaya Prasad	Director, IVRI, Izatnagar
November 22, 2013	Shri Arvind Kaushal	Additional Secretary, DARE and Secretary, ICAR, New Delhi
December 07, 2013	Dr. Tri Duong	Assistant Professor, Department of Poultry Science, A&M University, Texas, USA
Regional Centre, Bhubaneswar		
February 10, 2014	Dr. Deoki Nandan Tripathy	Professor Emeritus, Illinois University, USA

DG and DDG (AS), ICAR visiting poultry exhibition at CARI

Director, CARI showing the lay out plan of new CARI complex to Secretary, ICAR

SOME VIEWS OF DIGNITARIES

Had the opportunity to visit CARI Museum today and had been briefed on the achievements of the Institute on poultry breeding, technology, extension and other areas. The achievements are nicely displayed. The awards received are many. Best wishes for more laurels.

Dr. R. Prabakaran
Vice Chancellor, TANUVAS, Chennai

An informative and well designed Museum. Enabled me to know the history and achievements of the CARI since it started in its earlier avatar in March 1939. The Institute is serving an important purpose, which is as relevant today as it was when this was established.

Shri Arvind Kaushal
Additional Secretary, DARE and
Secretary, ICAR, New Delhi

DG and DDG (AS), ICAR visiting poultry exhibition at CARI

Dignitaries visiting poultry science museum

Personnel

DIRECTOR

DR. J.M. KATARIA

(w.e.f. 19.04.2013)

Heads of Divisions/Sections

Division of Avian Genetics and Breeding	Dr. M.C. Kataria (up to 31.07.2013) Dr. D.P. Singh (w.e.f. 01.08.2013)
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.K. Sachdev (up to 31.08.2013) Dr. N.K. Pandey (w.e.f. 01.09.2013 to 28.02.2014) Dr. A.S. Yadav (w.e.f. 01.03.2014)
Poultry Housing and Management Section	Dr. S. Majumdar
Technology Transfer Section	Dr. S. Majumdar
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

Administrative Officer	Shri Ashok Ghosh (up to 20.06.2013) Shri J.L. Sharma (w.e.f. 29.08.2013)
Assistant Administrative Officer	Shri Irfan Ali Khan
Assistant Administrative Officer	Shri B.S. Bisht
Assistant Finance and Accounts Officer	Shri P.K. Singh (up to 23.03.2013) Shri Ashish Shrivastava (w.e.f. 23.03.2013 to 26.05.2013) Shri Kailash Chand (w.e.f. 27.05.2013)

SCIENTIFIC / TECHNICAL STAFF (As on 31.03.2014)

Scientific Staff

1.	Dr. J.M. Kataria	Director	Ph.D.
2.	Dr. A.B. Mandal	Principal Scientist	Ph.D.
3.	Dr. S. Majumdar	Principal Scientist	Ph.D.
4.	Dr. D.P. Singh	Principal Scientist	Ph.D.
5.	Dr. Jag Mohan	Principal Scientist	Ph.D.
6.	Dr. Praveen Kumar Tyagi	Principal Scientist	Ph.D.
7.	Dr. Jagbir Singh Tyagi	Principal Scientist	Ph.D.
8.	Dr. V.K. Saxena	Principal Scientist	Ph.D.
9.	Dr. Sanjeev Kumar	Principal Scientist	Ph.D.
10.	Dr. Sandeep Saran	Principal Scientist	Ph.D.
11.	Dr. C.K. Beura	Principal Scientist	Ph.D.
12.	Dr. Raj Narayan	Principal Scientist	Ph.D.
13.	Dr. Pramod Kumar Tyagi	Principal Scientist	Ph.D.
14.	Dr. A.S. Yadav	Principal Scientist	Ph.D.
15.	Dr. Chandra Deo	Principal Scientist	Ph.D.
16.	Dr. S.K. Bhanja	Principal Scientist	Ph.D.
17.	Dr. M.P. Sagar	Principal Scientist	Ph.D.
18.	Dr. (Mrs.) Simmi Tomar	Senior Scientist	Ph.D.
19.	Dr. Ram Singh	Senior Scientist	Ph.D.
20.	Dr. Divya	Senior Scientist	Ph.D.
21.	Dr. Asim Kumar Biswas	Senior Scientist	Ph.D.
22.	Dr. Avishek Biswas	Senior Scientist	Ph.D.
23.	Dr. Niranjan Lal	Scientist	Ph.D.
24.	Dr. M. Sirajuddin	Scientist	M.V.Sc.
25.	Dr. (Mrs.) Pragya Bhadauria	Scientist	M.V.Sc.
26.	Dr. S.K. Mishra	Principal Scientist (RC)	Ph.D.
27.	Dr. R.K.S. Bais	Principal Scientist (RC)	Ph.D.
28.	Dr. D. Mondal	Principal Scientist (RC)	Ph.D.
29.	Dr. S.K. Sahoo	Principal Scientist (RC)	Ph.D.
30.	Dr. B.K. Swain	Principal Scientist (RC)	Ph.D.
31.	Dr. K.V.H. Sastry	Principal Scientist (RC)	Ph.D.
32.	Dr. S.C. Giri	Senior Scientist (RC)	Ph.D.

Technical Staff

1.	Dr. A. Mishra	T-9 (Medical Officer)	M.B.B.S.
2.	Dr. R.D. Sharma	T-9 (Chief Tech. Officer)	Ph.D.
3.	Shri S. Bhatnagar	T-7-8 (Asst. Chief Tech. Officer)	B.Sc.
4.	Shri B. Arya	T-7-8 (Asst. Chief Tech. Officer)	M.Sc.
5.	Shri R.R. Saxena	T-6 (Sr. Tech. Officer)	M.A.
6.	Shri P.N. Yadav	T-6 (Sr. Tech. Officer)	M.A.
7.	Shri Prem Chandra	T-6 (Sr. Tech. Officer)	M.Sc.
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)	M.Sc.
11.	Shri S.R. Meena	T-6 (Sr. Tech. Officer)	M.Sc.
12.	Shri Lalit Kumar Mishra	T-6 (Sr. Tech. Officer)	M.Sc.
13.	Shri Ravi Prakash	T-6 (Sr. Tech. Officer)	M.Sc.

Expenditure Statement and Revenue Generation

EXPENDITURE STATEMENT (2013-14)

(Rupees in Lakhs)

Ser. No.	Heads of Account	Plan		Non-Plan	
		Allocation	Expenditure	Allocation	Expenditure
1.	**CAPITAL**				
	Works	249.00	249.00	0.00	0.00
	Other	26.00	25.72	2.00	1.99
2.	**REVENUE**				
	Establishment Expenses	0.00	0.00	1350.00	1312.21
	Pension and Retirement Benefits	0.00	0.00	225.00	224.13
	T.A.	8.00	5.90	3.00	3.00
	Research and Operational Expenses	383.75	383.74	165.00	164.89
	Administrative Expenses	25.25	25.35	272.00	264.98
	Miscellaneous Expenses	8.00	5.00	5.00	4.04
	Total	**700.00**	**694.71**	**2022.00**	**1975.24**

REVENUE GENERATION (2013-14)

(Rupees in Lakhs)

Ser. No.	Items	Amount
1.	Disposal of Experimental By-product	134.30
2.	Royalty, Sale of Publications and Advertisement	1.08
3.	Licence Fee	4.33
4.	Interest of Loan and Advances	16.00
5.	Analytical and Testing Fee	0.85
6.	Interest on Short Term Deposits	7.52
7.	Internal Resource Generation	0.75
8.	Miscellaneous Receipts	9.04
	Total	**173.87**
	Loan Recoveries	22.98
	Sale of Assets	4.84
	Grand Total	**201.69**

Other Relevant Information

Institute's Perspective Plan Vision 2050: Vision 2050 prepared by the PME Section was submitted to the Council. Having incorporated the suggestions received from the Council, the same has been finalized. The Vision 2050 document presents the road map to address the challenges currently faced by the Indian Poultry Sector and also the future likely scenario. It outlines future research strategies to overcome the challenges by developing technologies aimed at improving productivity of the poultry production systems as also to focus on qualitative aspects in poultry value chain. This document may be useful for the researchers, policymakers and stakeholders to address the future challenges for growth and development of the poultry sector and to ensure food and income security with a human touch. Vision 2050 is presently available on the Institute's website.

EFC: The XII Plan combined EFC memo for CARI, Izatnagar; DPR, Hyderabad; AICRP on Poultry and the Poultry Seed Project, Hyderabad submitted to the Council was approved in the meeting held in the Council on 11.12.2013. The meeting was attended by Dr. J.M. Kataria, Director and Dr. Sandeep Saran, PS and HD, PME. The EFC for the Institute was approved with a total outlay of Rs. 52.23 crores including Rs. 1.5 crore for NEH and Rs. 0.50 crores for TSP components. The following programmes were approved for the XII Plan:

1. ***Productivity enhancement of selected poultry species***
   - Enhancement of productivity, reproductive efficiency and immune-competence of selected diversified poultry species along with development of improved package of practices.
   - Development of package of practices for rural poultry production system.
2. ***Climate resilient poultry production system and waste management***
   - Impact assessment, adaptation evaluation and amelioration strategies to combat extremes of climate through genetic/ molecular, nutritional, physiological, shelter management and evolving efficient technologies for poultry waste utilization.
3. ***Value addition, food safety, quality assurance and product development***
   - Development of value added poultry feed and poultry products with functional attributes and quality assurance including product development.
4. ***HRD, market intelligence and technology dissemination***
   - Market intelligence, contingency planning and economic implications of emerging issues in poultry value chain.
   - Skill development, capacity building for different stakeholders and transfer of technology.

Institute Research Committee (IRC): The annual IRC meeting of the Institute was held on July 29, 2013 under the chairmanship of Dr. J.M. Kataria, Director, CARI, Izatnagar. Dr. Sandeep Saran, Head, PME and PEAR conducted the meeting in the capacity of Secretary, IRC. The meeting was attended by all scientists of the Institute. He also informed about the Council's directives to conduct next RAC meeting in January 2014 and IRC in February 2014 to publish the Annual Report in time. In the beginning, Dr. J.M. Kataria, Director, CARI presented his welcome address. He 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. Dr. Sandeep Saran presented a brief overview of the Institute research programmes/ projects and the changes that have taken place as a result of O&M reforms at the Council level. 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.

Another IRC meeting for the RC, Bhubaneswar was conducted at Bhubaneswar itself under the chairmanship of Dr. J.M. Kataria, Director. The meeting was conducted by Dr. Sandeep Saran, Secretary, IRC. Dr. V.K. Saxena also attended the meeting as expert breeder. All the existing facilities available at the Centre were reviewed and future needs were assessed.

Research Advisory Committee (RAC) Meeting: The 7th meeting of the Common Research Advisory Committee of Central Avian Research Institute (CARI), Izatnagar and Project Directorate on Poultry (PDP), Hyderabad was held on July 03, 2013 at CARI, Izatnagar under the Chairmanship of Dr. R. Prabakaran, Vice Chancellor, TANUVAS, Chennai. The RAC members attended the meeting include Dr. G. Devegowda, Ex-Professor and Head, Dept. of Poultry Science and Animal Sciences, Agricultural University, Bangalore; Dr. J.L. Vegad, Ex Professor and Head, Department of Veterinary Pathology and Ex Dean, Jawaharlal Nehru Agricultural University, Jabalpur; Dr. Vivek Vinayak Kulkarni, Director, NRC on Meat, Hyderabad; Dr. U.K. Pal, Professor, Department of Livestock Products Technology, RGCOVAS, Pondicherry; Dr. M. Mahender, Professor, Livestock Production Management, College of Veterinary Sciences, Hyderabad; 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.

General recommendations

- The recommendations of 6th RAC on research activities will continue for both the Institutes.
- Updating mycotoxin analytical facilities in both the Institutes for research and services to the farmers and industry.
- Major emphasis should be given on identification of newer alternate feed resources and establishing their feeding value in various poultry species.
- Strengthening transfer of technology and germplasm supply through public-private partnership.

CARI, Izatnagar

- Avian health facilities should be strengthened.
- Research thrust may be given for turkey production with special emphasis to breeding and nutrition including breeder nutrition for more egg production.
- Possibility of investigations on Guinea fowl production under different agro-climatic conditions in collaboration with TANUVAS may be explored.
- The research efforts on environmentally controlled houses may be strengthened.
- Duck breeding should be initiated for its improvement in the regional centre.
- Packaging technology for storage of value-added poultry products at room temperature should be developed.

Institute Management Committee (IMC) Meeting: The 41st Institute Management Committee (IMC) meeting was held on September 13, 2013 under the Chairmanship of Dr. J.M. Kataria, Director, CARI, Izatnagar consisting of Shri J.L. Sharma, Member Secretary; Dr. A.B. Mandal, Dr. S.D. Singh, Dr. Sandeep Saran, Shri Ravindra Kumar, Dr. Sandeep Bhatia and Shri Kailash Chand. The committee was satisfied with the research activities and achievements made by this Institute. Research projects for the year 2012-13 were brought to the notice of all the members and were approved by IMC.

Institute Animal Ethics Committee (IAEC): The IAEC meeting was held under the chairmanship of Dr. J.M. Kataria, Director on June 14, 2013 for examining the proposals for conducting experiments involving poultry birds etc. in various projects during 2013-14 submitted by scientists. The proposals as received by Dr. Sandeep Saran, Secretary, IAEC were examined and cleared by the Committee.

Results Frame-work Document (RFD): Dr. V.K. Saxena and Dr. Sandeep Saran were nominated as Nodal Officer and Co-Nodal Officer, RFD, CARI, Izatnagar, respectively. The RFD 2013-14 of the Institute was finalized and submitted to the Council. The monthly report of RFD was also submitted to the Council regularly. Dr. Sandeep Saran and Dr. V.K. Saxena, PS attended the mid-term review of RDF meeting in Delhi on 22.10.2013.

Right to Information: Dr. Sandeep Saran dispose-off RTI requests pertaining to all scientific matters in the Institute in the capacity of the Central Public Information Officer (Scientific Matters), CARI, Izatnagar. Only three requests were received during the year.

Table 13: MoUs for transfer of technologies

Name of Technology	*Signed with*	*Date of Signing*
MakeFeed Dairy Software	M/s Dr. Sabin George, Asstt. Prof., Deptt. of LPM, College of Veterinary Science, Trichur, Kerala	12.04. 2013
Broiler Parents Stock Fertile Eggs- CARIBRO Dhanraja	M/s Prof. and Head, Department of Animal Genetics and Breeding, LLRUAAS, Hisar, Haryana	16.04.2013
Supply of Adult Breeder Quails (Mixed varieties) Pure Line	M/s Shabnam Poultry Farm, Village Ferozpur Meo, Tehsil Punhana, Mewat Haryana	06.05.2013
Salted Chicken Eggs	M/s GLD Poultry Farms, District Namakkal,Tamil Nadu	22.07.2013
Quail Egg Pickle	M/s MPM Japanese Quail Layer Farm and Agro Foods, 1/255, Moongilpalayam, Vijayamangalam (PO), Perundurai (Tk), Erode (Dt.)	27.09.2013
Broiler Production Technology	M/s Purvanchal Food Industries, Teachers Colony, Village Sabyan, Block Kasia, Kushinagar, U.P.	28.3.2014 (renewal)

Miscellaneous Activities of PME Section:

- RPFs, PIMS-ICAR and PERMISNET of all the scientists/staff were updated regularly as per Council's direction.
- The Monthly Cabinet report, Quarterly Performance report and Scientists' HYPM reports were regularly compiled and submitted to the Council.
- Replies to various Parliamentary questions were promptly submitted through the Council.
- Dr. Sandeep Saran visited Sambhalpur and Bhubaneswar during 11-15.09.2013 in the capacity of the Chairman, Investigating Team constituted by the Director, CIFA, Bhubaneswar to look into the allegations of misuse of resources under the NAIP.
- Dr. Sandeep Saran compiled Institute salient achievement and agenda for the Institute Management Committee meeting and attended the same as a special invitee on for its 40th and 41st meeting held at CARI, Izatnagar.
- Dr. Sandeep Saran, while working as Member, Institute Works Committee; coordinated the ongoing infrastructural development activities on the new site of CARI. The floor space requirements of various experimental poultry farms as well as the Administrative-cum-lab. building was also revised and rationalized

Institute Technology Management Unit (ITMU):

Registration of Trademark: Got Institute's first trademark registered for its commercial broiler quail variety "CARI Uttam" vide no. 2312766 dated 10.04.2012 sealed on January 13, 2014.

Prepared and finalized the MoUs for transfer of technologies between the Institute and various clients (Table 13).

Institute Technology Management Committee (ITMC) Meetings:

Date	*Purpose*
07.06.2013	Review of the prices of various technologies available at the Institute
17.01.2014	Discussed various issues pertaining to transfer of semen extender technology to M/s IMV India Pvt. Ltd., Haryana

Hatchery Operations: With incubation/hatching capacity of about 80,000 eggs at a time, the major responsibilities of the Experimental Hatchery are to hatch out the required number of replacement stock of different pure line/pedigreed 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 and 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

Table 14: Hatching performance of various germ plasm

Type of birds	*Total eggs set*	*Fertile eggs (%)*	*Hatchability on total egg set (%)*	*Hatchability on fertile egg set (%)*	*Number of good chicks hatched*
Layer	44205	65.29 (42.03-80.93)	57.51 (32.70-75.68)	88.09 (75.03-92.10)	25424
Broiler	53158	73.10 (49.03-85.71)	66.36 (42.93-78.84)	90.77 (87.06-100.00)	35275
Quail	78537	63.34 (39.23-86.08)	45.12 (28.88-69.85)	71.24 (50.92-86.90)	35437
Guinea Fowl	9054	56.85 (35.56-89.23)	51.09 (21.11-84.62)	89.88 (59.38-94.83)	4626
Turkey	15547	54.30 (49.51-63.75)	42.93 (28.38-56.76)	79.12 (64.95-89.04)	6679
Desi Fowl	63668	63.19 (44.12-82.02)	55.45 (37.47-75.53)	87.75 (75.37-94.47)	35302
Commercial (TT Section)	59117	70.78 (54.55-80.76)	63.59 (48.03-78.97)	89.84 (78.87-94.98)	37392

Figure in parenthesis denotes minimum and maximum range

Table 15: Activities of experimental hatchery of RC, CARI

Breed name	*Total no. of egg set*	*Fertile eggs*	*Total no. of duckling hatch out*	*Hatchability percentage*		
				Fertility %	*On total egg set*	*On fertile egg set*
Desi	25467	13210	12063	51.87	47.36	91.31
Khaki	33694	16338	14169	48.48	42.05	86.72
WP	21829	8449	7082	38.7	32.44	83.82
DK	20222	12351	11407	61.07	56.4	92.35
KD	16871	9325	8503	55.27	50.4	91.18
Moti	1245	322	184	25.86	14.77	57.14
	119328	59995	53408	50.27	44.75	89.02

government/private personnel. Lectures in short term trainings conducted by Technology Transfer Section and PGE&T Section were delivered. In addition to this, hatching of 37392 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 84.52 per cent during 2013-14. At occasion the highest hatchability (FES) 100.00% was obtained in broiler chicken (Table 14).

The overall activities of experimental hatchery of RC, CARI may be summarized in Table 15.

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 11506.40 qtls. of different types of poultry feed, Detailed break up of feed supplied to different projects is shown in Table 16.

Table 16: Feed supplied to different projects

Project/Division	*Total Quantity (Qtls.)*
Broiler project	2793.5
Layer project	3536.0
Desi fowl	1338.7
Quail farm	1020.0
Guinea fowl unit	497.0
Turkey unit	737.5
AN&FT	92.55
P&R Div.	193.5
PHM	160.4
IVRI	88.95
TT Section	850.5
Bio tech. Lab.	1.0
NAIP	32.0
Emu farm	0.30
Hatchery section	25.5
HAPP Mukteswar	139.0
Total	**11506.40**

Table 17: Quantity of experimental by-products disposed off

Month	Eggs (Nos.)		Processed poultry meat (kg)				
	Chicken	Quail	Chicken	Guinea fowl	Kadakanath	Quail	Turkey
April 2013	160431	73340	1105.75	2.00	9.25	76.00	15.50
May 2013	119108	65000	2399.60	171.00	-	72.50	22.00
June 2013	103737	67240	844.25	263.75	185.75	57.00	39.00
July 2013	115436	67140	1328.50	3.00	105.00	89.00	50.50
August 2013	118862	88530	1381.75	378.25	137.50	95.50	7.00
September 2013	117918	59350	1596.00	318.75	44.75	133.00	17.00
October 2013	127416	62250	1358.50	71.00	-	124.00	5.00
November 2013	128641	45635	1832.50	40.50	-	77.50	21.00
December 2013	111546	46485	996.00	30.50	-	167.50	77.00
January 2014	89196	52850	1733.75	53.75	33.50	178.00	13.00
February 2014	81087	34450	2161.00	-	41.00	88.00	15.00
March 2014	80592	38400	2330.25	60.00	-	59.00	2.00
Total	**13,53, 970**	**7,00,670**	**19067.85**	**1392.5**	**556.75**	**1217.0**	**284**

Table 18: Net revenue generated from the disposal of eggs and poultry meat

Commodity	Revenue (Rs.)
Chicken eggs	50,68,690
Quail Eggs	6,68,865
Chicken meat	19,54,233
Guinea fowl meat	1,39,290
Kadaknath meat	52, 433
Quail meat	5,75,500
Turkey meat	28,610
Total	**84,87,621**

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 2013 to March 2014 is given in Table 17-18.

High Bandwidth Internet Connectivity at Institute: National Knowledge Network (NKN), National Informatics Centre (NIC), New Delhi has provided the 100 Mbps internet speed connectivity on fiber optic cable to this Institute. This high bandwidth internet connectivity is being utilized by all the scientists, officers, PG students and trainees on local area network (LAN) of the Institute. AKMU (ARIS Cell) provides 24x7 internet connectivity to serve the Institute's internet needs. At some of the locations of the Institute, high bandwidth connectivity is also being provided through LAN extender and access points (Wi-Fi connectivity). Currently, Wi-Fi connectivity is available at Library, A-Block, B-Block and Medicine building of the Institute. Network expansion still continues and work is going on for making the whole Institute Wi-Fi by installing more number of access points at different locations. Presently, approximate 100 users are using NKN high bandwidth internet connectivity for their research work.

Library and Information Services: During the period under report, 171 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 5,650 to 5,820. CARI Library subscribed 20 journals out of which 9 were reputed foreign journals. In addition of these, a number of national and international serial publications, annual reports and newsletters were received on gratis. The following activities have been 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 automated, and circulation of books and other publications were also done through LIBSYS-7 software.
- Renewal of journals for the year 2014 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. CARI Library, being a member of Consortium for e-Resources in Agriculture (CeRA), is getting access to more than 2000 online full text journals. Document delivery request (DDR) services are also being exchanged with the member library under CeRA. CARI Library also provides internet, E-mail, information retrieval through CD-ROM database and xerox services to the scientists and students.

Publication Unit: Following Institute publications were compiled, edited and published during the period under report.

- CARI Annual Report (2012-2013) English version
- CARI Annual Report (2012-2013) Hindi version
- The CARI News (December 2012, March, June and September 2013 issues)
- *Turkey evam Bater Palan* - XIV Farm School Book
- 2 Compendium of sponsored trainings

Besides, duplication, xeroxing, binding jobs of ordinary and pakki binding, and photography services were also provided to the scientists and all other divisions/sections of the Institute.

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 for acquainted proficiency in Hindi.

Hindi workshops were organized during the year for the administrative staff to increase use of hindi in the Institute. Acquainted staff with Official Language Act and Rules and trained 55 administrative officials in the workshops in two terms. Beside this, circulars and instructions were issued for compliance of Official Language Act and Rules in the Institute. Scientific, technical and administrative materials were translated and typed the same received from divisions, sections and units of the Institute.

Hindi fortnight was organized during 12-26 Sept., 2013 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, debate, typing on computer, noting/drafting, general knowledge, translation and shabdawali parichaya were conducted in the Hindi fortnight. Research papers writing in Hindi competition was also organized during the reviewing year and total six research papers were received in Hindi and three of them were awarded as First, Second and Third prizes and remains three were consolidated. Prizes were distributed in cash to competitors. A Kavi Gosthi was also organized on this occasion. The Director distributed prizes and mementoes to winners and Kavis.

Renovations at Regional Centre: Renovation of the old and new duck sheds was completed thus ensuring renovation and availability of 12750 sft ideal duck breeder management space for the Centre. Further, a duck cum fish integration pond (5250 sft) was renovated at an expense of Rs. 31.13 lakhs approved by the Council, which is now acting as a bright model for farmers/ entrepreneurs visiting the Centre.

Staff Personalia

Posting/Appointment

- Dr. J.M. Kataria, Joint Director, HSADL, IVRI, Bhopal joined CARI, Izatnagar as Director on 19.04.2013.
- Dr. Pragya Bhadauria, Scientist joined on 15.04.2013 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.
- Shri Mahendra Singh Martolia, S.S.S. promoted to the post of T-1 (Lab Technician) w.e.f. 18.05.2013.

Transfer from other Institutes

- Shri Kailash Chand, AF&AO joined CARI, Izatnagar on 27.05.2013 after transfer from CIRG, Makhdoom.
- Shri J.L. Sharma, Administrative Officer joined CARI, Izatnagar on 29.08.2013 after transfer from DRMR, Bharatpur.
- Dr. B.K. Swain, Principal Scientist joined CARI Regional Centre, Bhubaneswar on 28.10.2013 after transfer from ICAR Research Complex, Goa.

Transfer to other Institutes

- Dr. Lal Singh Gangwar, Principal Scientist transferred to IISR, Lucknow on 22.04.2013.
- Shri Ashok Ghosh, Administrative Officer relieved on 20.06.2013 (F.N.) to join his new assignment as Senior Administrative Officer at IVRI, Izatnagar.
- Shri Tara Kumar, UDC relieved on 12.04.2013 to join his new assignment as Assistant on deputation basis at Project Directorate on Foot and Mouth Disease, Mukteswar, Nainital.

Retirements

- Dr. M.C. Kataria, Principal Scientist and Head, Avian Genetics and Breeding Division superannuated on 31.07.2013.
- Dr. A.K. Sachdev, Principal Scientist and Head, Post-Harvest Technology Division superannuated on 31.08.2013.
- Dr. N.K. Pandey, Principal Scientist and Head, Post-Harvest Technology Division superannuated on 28.02.2014.
- Shri Ram Kishan Singh Rana, T-5 (Tech. Officer) retired on 31.01.2014.
- Shri George Rao, Skilled Supporting Staff retired on 30.09.2013.
- Shri Rajendra Prasad, Skilled Supporting Staff voluntary retired on 09.12.2013.

Demises

- Shri Ayub Khan, Skilled Supporting Staff expired on 19.10.2013.
- Shri Triveni Lal, Skilled Supporting Staff expired on 23.10.2013.
- Shri Rasheed Ahmed, T-2 (Senior Technician) expired on 12.12.2013.
- Smt Omwati, Skilled Supporting Staff expired on 22.12.2013.

Empowerment of Women and the Mainstreaming Gender Issues

- One awareness camp on poultry farming was organized on June 03, 2013 at Faridpur block of Bareilly district with the active participation of the scientists of the Institute, ADOs, aaganwadi ashas, workers and supervisors (ANM). The aim of this women oriented camp was to create awareness about self employment potential and nutritional importance of poultry. In the awareness camp, total 85 aanganwari ladies and asha bahnen (health workers) of different villages actively participated.
- Women SHGs were involved for group activity in various districts of Odisha. All the groups involved in duck production practices by their combined effort. Initially, critical input was supplied to each group and their activities were monitored. However, in the subsequent years almost all women SHGs invested from their own savings for the procurement of housing appliances and chicks etc. Women were mostly house wives and utilized their time in a routine manner for taking the ducks to village ponds/ canals/water channels for scavenging. No supplementary feed were provided. Ducks were kept at one place and the participants collected all the kitchen wastes from their houses to feed the birds there. It was observed that 130-150 ducks can be reared comfortably by each group for better economic return.

Scientists addressing the village women about poultry farming

Approved On-Going Research Projects

Sl. No.	Project Code No.	Project Title	Principal Investigator	Co-Investigator
PROGRAMME-1: PRODUCTIVITY ENHANCEMENT OF SELECTED POULTRY SPECIES				
Sub Programme- (i) Enhancement of productivity, reproductive efficiency and immune-competence of selected diversified poultry species along with development of improved package of practices				
1.	P-1/2007/2-IAV/L10/ 6510 DOS: 01.09.2007 DOC: 01.09.2013	Development and improvement of specialized quail lines using alternate feather colour genes	Dr. Raj Narayan	Dr. D.P. Singh
2.	P-1/2012/1-IAV/L30/ 6600 DOS: 17.10.2012 DOC: 16.10.2015	Improving reproductive performance and immune-competence in turkey through nutritional intervention	Dr. Avishek Biswas	Dr. (Mrs.) Divya Dr. S. Majumdar
3.	P-1/2010/1-IAV/L50/ 6400/6100 DOS: 01.06.2010 DOC: 31.05.2015	Evaluation and improvement of reproductive efficiency in guinea fowl and chicken	Dr. Jag Mohan	Dr. Jagbir Singh Tyagi
4.	P-1/2008/1-IAV/L50/ 6200 DOS: 01.02.2008 DOC: 31.01.2014 (including 1 yr extension)	Investigation into the reproductive physiology and semen characteristics of ducks to augment fertility and hatchability	Dr. S.C. Giri	Dr. K.V.H. Sastry (w.e.f. 23.08.2013)
5.	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
6.	P-1/85/95/1-IAV/L10/ 6100/9705 (Component-AICRP-PB, Hyderabad) DOS: 01.04.1985 DOC: 31.03.9999	Development and evaluation of synthetic broiler sire line	Dr. (Mrs) Simmi Tomar	Dr. V.K. Saxena Dr. A.K. Sachdev (till 31.08.2013)
7.	P-1/85/95/2-IAV/L10/ 6100/9705 (Component-AICRP-PB, Hyderabad) DOS: 01.04.1985 DOC: 31.03.9999	Development and evaluation of synthetic broiler dam line	Dr. V.K. Saxena	Dr. (Mrs) Simmi Tomar Dr. A.K. Sachdev (till 31.08.2013) Dr. Avishek Biswas (w.e.f. 05.06.2013)
8.	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
9.	P-1/2009/2-IAV/L30/ 6000-3790 DOS: 01.04. 2009 DOC: 31.03.2015	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

Sl. No.	Project Code No.	Project Title	Principal Investigator	Co-Investigator
10.	P-1/2010/1-IAV/L34/ 3745/6000 DOS: 01.06.2010 DOC: 31.05.2014 (including the extension period)	Management of mycotoxicosis in poultry	Dr. Ram Singh	-
11.	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
12.	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
13.	*Service Project*	Surveillance and 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	-
14.	*Service Project, CARI Regional Centre*	Surveillance and monitoring of duck diseases and their bio-security measures	Dr. Dayamoy Mondal	Dr. S.K. Sahoo
15.	*Service Project*	Quality assessment of feed stuffs and poultry feed	Dr. A.B. Mandal	-
Sub Programme- (ii) Development of package of practices for rural poultry production system				
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 multi-coloured strains for rural poultry production	Dr. M.C. Kataria (till 31.07.2013) Dr. S.K. Bhanja (w.e.f. 01.08.2013)	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. Jag Mohan Dr. (Mrs) Pragya Bhadauria (w.e.f. 29.07.2013)
3.	P-1/2009/2-IAV/L10/ 6400 DOS: 01.06.2009 DOC: 31.05.2014	Improving Guinea fowl for low input poultry production system	Dr. (Mrs) Simmi Tomar	-
4.	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

Sl. No.	Project Code No.	Project Title	Principal Investigator	Co-Investigator
5.	P-1/2010/1-IAV/L10/ 6100 DOS: 01.06.2010 DOC: 31.03.2015	Evaluation and maintenance of native chicken genetic resources and their utilization	Dr. D.P. Singh	Dr. Raj Narayan Dr. (Mrs.) Pragya Bhadauria (w.e.f. 06.06.2013)
6.	DOS: 01.06.2010 DOC: 31.03.2015	Conservation of elite layer stock*	Dr. Sanjeev Kumar	Dr. Niranjan Lal Dr. S.K. Bhanja (w.e.f. 01.08.2013) Dr. M.C. Kataria (till 31.07.2013)
PROGRAMME 2: CLIMATE RESILIENT POULTRY PRODUCTION SYSTEM AND WASTE MANAGEMENT				
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-1/2009/1-IAV/L10/ L30/6100 DOS: 01.06.2009 DOC: 31.05. 2013	Analysis of gene expression, growth and immunity traits in broilers under pro and pre-biotics feeding	Dr. (Mrs) Simmi Tomar	Dr. V.K. Saxena
2.	P-1/2010/1-IAV/L10/ 6100 DOS: 01.06.2010 DOC: 31.05.2013	Expression profiling of genes related to immunity in Aseel, Kadakanath and WL chickens	Dr. Sanjeev Kumar	Dr. M.C. Kataria (till 31.07.2013)
3.	P-1/2012/1-IAV/L32/ 3790 DOS: 01.07.2012 DOC: 30.06.2016	Utilization of alternate feed resources and wastes in poultry feed	Dr. Pramod K. Tyagi	Dr. Ram Singh Dr. (Mrs) Divya Dr. Avishek Biswas
4.	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
5.	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 K. Tyagi Dr. B.B. Dash** Dr. B. Sahoo**
PROGRAMME 3: VALUE ADDITION, FOOD SAFETY, QUALITY ASSURANCE AND PRODUCT DEVELOPMENT				
Sub Programme- Development of value added poultry feed and poultry products with functional attributes and quality assurance including product development				
1.	P-1/2012/1-IAV/L30/ 9640/6510 DOS: 01.07.2012 DOC: 30.06.2015	Egg cholesterol reduction and nutrient enrichment in quails	Dr. Praveen K. Tyagi	Dr. Pramod K. Tyagi Dr. Chandra Deo
2.	P-1/2009/1-IAV/L34/ 8954 DOS: 01.04.2009 DOC: 31.03.2014	Assessment of residues of chemical contaminants in poultry feed and poultry products in different regions of India	Dr. C.K. Beura	Dr. Ashim K. Biswas
3.	P-1/2006/1-IAV/Q10/ 9690 DOS: 01.04.2006 DOC: 30.09.2013	Processing and shelf-life assessment of egg-based finished products	Dr. N.K. Pandey	Dr. A.S. Yadav

*The project is in operation as per IRC-2013. However, the RPF-I is awaited; **IVRI, Mukteswar

Sl. No.	Project Code No.	Project Title	Principal Investigator	Co-Investigator
4.	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
5.	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	Dr. N.K. Pandey (till 28.02.2014)
PROGRAMME 4: HRD, MARKET INTELLIGENCE AND TECHNOLOGY DISSEMINATION				
Sub Programme- (i) Market intelligence, contingency planning and economic implications of emerging issues in poultry value chain				
1.	P-1/2012/1-IAV/E10/ 6000 DOS: 01.07.2012 DOC: 30.06.2015	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 Dr. L.S. Gangwar (till 22.04.2013)
3.	P-1/2010/1-IAV/E10/ 6000 DOS: 01.06.2010 DOC: 22.04.2013	Economic analysis of poultry production in Kumaon hills	Dr. L.S. Gangwar	Dr. Sandeep Saran
Sub Programme- (ii) Skill development, capacity building for different stakeholders and transfer of technology				
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

NAIP RESEARCH PROJECTS

Sl. No.	Project Code No.	Project Title	Name of CCPI/ Consortium Partner
1.	Sanction order No. NAIP/Comp-4/C-4/ C30016/2008 dated 06.01.2009 DOS: 06.01.2009; DOC: 31.03.2012 (Extended up to 31.03.2014 vide letter No. NAIP/ Comp-4/C30016/2008-09 dated 06.05.2013)	Development potency of parthenogenetic goat embryos	Dr. S.K. Bhanja Dr. S. Majumdar
2.	Sanction order No. NAIP (SRLS-III) 3rd Call-9/2008 dated 06.04.2009 DOS: 06.04.2009; DOC: 30.06.2012 (Extended up to 31.03.2014)	Sustainable livelihood improvement through integrated fresh water aquaculture, horticulture and livestock development in Mayurbhanj, Keonjhar and Sambalpur district of Orissa	Dr. S.C. Giri Dr. K.V.H. Sastry Dr. S.K. Sahoo Dr. R.K.S. Bais
3.	Sanction order No. NAIP (SRLS-III) 3rd Call-6/2008 dated 13.04.2008 DOS: 13.04.2008 DOC: 30.06.2012 (Extended up to 31.12.2013)	Holistic approach for improving livelihood security through livestock based farming system in Barabanki and Raibareli districts of U.P.	Dr. D.P. Singh

EXTERNALLY FUNDED PROJECTS

Sl. No.	Sanction order No.	Title of the project	Name of PI	Name of Co-PI
1.	BT/PR12887/AGR/36/622/ 2009 dated 21.05.2010 (DBT Project) DOS: 21.05.2010 DOC: 20.05.2014	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: 10.01.2011 DOC: 23.08.2014	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 16.07.2012 (DBT Project) DOS: 19-07-2012 DOC:18-07-2015	Thermotolerance gene expression analysis *Salmonella Typhimurium* and development of their thermal death time models applicable to poultry processing	Dr. A.S. Yadav	Dr. A.K. Sachdev (till 31.08.2013) Dr. V.K. Saxena Dr. J.M. Kataria (w.e.f. 16.01.2014)
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 02.05.2013 (DST Project) DOS: 02.05.2013 DOC: 01.05.2016	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.	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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