

# CARI



## वार्षिक प्रतिवेदन Annual Report 2010-2011



केन्द्रीय पक्षी अनुसंधान संस्थान

इज्जतनगर - 243 122 (उ.प्र.) भारत

**CENTRAL AVIAN RESEARCH INSTITUTE**

Izatnagar - 243 122 (UP) INDIA



# CARI

## ANNUAL REPORT (2010-2011)

CENTRAL AVIAN RESEARCH INSTITUTE  
IZATNAGAR, BAREILLY - 243 122 (U.P.)

The Editorial Board acknowledges Dr. R.P. SINGH, Director for providing valuable guidance and suggestions in bringing out this publication.

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## PREFACE

Central Avian Research Institute, ever since its establishment on the 2<sup>nd</sup> November, 1979 has been playing a vital role in providing need-based R&D support for sustained growth in commercial poultry production and also for promoting small scale rural poultry production for meeting the ever-increasing demand of poultry products and for generating employment, upliftment of rural economy and nutritional security. In this endeavour, the R&D focus of the Institute has shifted towards development of improved germplasm, production and processing technology for promoting diversified poultry production. The Institute has not only developed and propagated superior germplasm of different poultry species for and wide in the country but also their feeding, rearing and health care practices, processing of poultry products, apart from post-graduate education and extension services to stakeholders in both public and private sectors.



It gives me immense pleasure in presenting the annual report (2010-11), highlighting mandated activities and achievements of the Institute. During the period, further progress has been made through selective breeding in enhancing the productivity of different breeds/lines strains/of alternate poultry species such as quail, guinea fowl, duck, turkey and desi (indigenous) fowl, apart from chicken layer and broiler as AICRP component. It is worthwhile to mention that two varieties of Nicobari breed of chicken and parent stock of Vanaraja have been added to the existing native fowl gene pool. This apart, considerable work has been done in the area of avian biotechnology, nutrition, physiology, management, poultry products technology, marketing and extension education under four major research programmes. Under NAIPs, the Institute has contributed in improving the livelihood of beneficiaries in target area through diversified poultry rearing as a component of integrated farming systems. In order to promote poultry production in hilly region, trials conducted on the evaluation of the performance of commercial broiler and layer at Mukteswar have been encouraging results.

During the period, five M.V.Sc. and four Ph.D. students were awarded degree in Poultry Science. Under outreach programme, 11<sup>th</sup> farm school on poultry production management was broadcast from AIR, Rampur. Besides, 7 specialized short term training courses in the area of avian biotechnology, broiler and layer production, 3 batches of training of poultry production management covering 95 farmers/entrepreneurs and 6 sponsored training programmes covering over 200 trainees sponsored by the Bihar A.H. Department, ATMA, Madhubani and Army Resettlement Training Unit were organized. Trainings were also imparted on duck and backyard chicken rearing to a number of beneficiaries by the scientists of the Regional Centre, Bhubaneswar.

An MoU between the Institute and M/s Agribusiness Management Centre, Ghaziabad was signed in public-private partnership (PPP) mode for supply of elite quail germplasm and its production technology, apart from commercialization of technology for processed poultry products. Besides, a large number of both parent and commercial stocks of different species of poultry were supplied to beneficiaries in both public and private sectors.

The scientists of the Institute have bagged over half-a-dozen prestigious awards and two of them received advanced training in the area of bio-security and nano-technology abroad.

I am highly indebted to Dr. S. Ayyappan, Secretary (DARE) & DG, ICAR; Dr. K.M.L. Pathak, DDG (As) and ADG (AP&B) for their candid support and able guidance in carrying out mandated activities of the Institute and its overall development. Furthermore, support and cooperation rendered by Dr. C.S. Prasad, former ADG (ANP), Dr. Gaya Prasad, ADG (AH), Scientists and other staff of the Animal Science Division are thankfully acknowledged. I congratulate all the, Scientists and other staff members of the Institute whose contributions are reflected in this report. The Editorial Board deserves high appreciation in bringing out this publication.

June 22, 2011

(R.P. Singh)  
Director

# Introduction

Central Avian Research Institute, the premier Institute of Poultry Research in the country, has crossed the milestone of over three decades since its inception (2<sup>nd</sup> November, 1979) at IVRI, Izatnagar campus under the aegis of the Indian Council of Agricultural Research, as a commodity Institute to provide the need based research, P.G. education, training and extension support in all sub-disciplines of Poultry Science for promoting sustainable productivity and profitability of Indian Poultry Industry and the rural poultry production as well.

Poultry farming occupies an important place in our livestock sector due to its enormous potential to bring about rapid economic growth, particularly, benefiting the weaker sections of the society of the country. It needs low capital investment and ensures quick returns.

The Institute has its main campus at Izatnagar, Bareilly (U.P.) and a Regional Centre at Bhubaneswar (Orissa). The Institute has an administrative building, four blocks accommodating the laboratories of various disciplines, seven experimental farms, hatchery, feed processing unit, semi-automatic poultry processing unit, ARIS cell, central library and trainees' hostel-cum-guest house.

Basic, applied and strategic research through multi-disciplinary approach on diversified poultry species is conducted under Avian Genetics and Breeding, Avian Nutrition and Feed Technology, Avian Physiology and Reproduction, Post Harvest Technology Divisions and Poultry Housing and Management, Technology Transfer and Avian Medicine Sections of the Institute.

## EXPENDITURE STATEMENT (2010-11)

(Rupees in lakh)

Sl. No.	Heads of Account	Non-Plan		Plan	
		Allocation	Expenditure	Allocation	Expenditure
<b>1.</b>	<b>Capital</b>				
a.	Works	0.00	0.00	170.85	170.21
b.	Other	3.00	0.89	51.00	49.88
<b>2.</b>	<b>Revenue</b>				
a.	Establishment Expenses	1256.00	1255.80	0.00	0.00
b.	T.A.	2.75	2.75	3.50	3.50
c.	Research and Operational Expenses	75.00	74.92	264.50	264.42
d.	Administrative Expenses	134.75	134.60	19.00	19.00
e.	Miscellaneous Expenses	3.50	3.50	5.00	4.99
	<b>Total</b>	<b>1475.00</b>	<b>1472.46</b>	<b>513.85</b>	<b>512.00</b>

## MANDATE

### MAIN INSTITUTE

- 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.

**REVENUE RECEIPTS (2010-2011)**

(Rupees in lakh)

<i>Sl. No.</i>	<i>Items</i>	<i>Target 2010-11</i>	<i>Achievements 2010-11</i>
1.	Sale of Farm Produce	111.35	92.46
2.	Income from Sale of Publications		0.50
3.	Licence Fees		2.62
4.	Interest Earned on Loans and Advances		15.80
5.	Analytical and Testing Fees		0.21
6.	Income Generated from Internal Resource Generation		
(a)	Consultancy Services-Income		0.06
(b)	Sale of Technology-Income		0.24
(c)	Training Programmes-Income		3.02
9.	Miscellaneous Receipts		0.73
	<b>Total Revenue Receipts</b>	<b>111.35</b>	<b>115.64</b>

**STAFF POSITION (As on 31-03-2011)**

<i>Categories</i>	<i>No. of Posts</i>	<i>No. of S/C Employees</i>	<i>No. of S/T Employees</i>
<b>Scientific</b>			
Sanctioned	50	-	-
Filled	38 +1 RMP	04	-
Vacant	12	-	-
<b>Technical</b>			
Sanctioned	61	-	-
Filled	48*(4)	08	02
Vacant	13	-	-
<b>Administrative</b>			
Sanctioned	31	-	-
Filled	31*(2)	02	01
Vacant	03**	-	-
<b>Supporting</b>			
Sanctioned	144	-	-
Filled	131*(2)	36	05
Vacant	13	-	-

\*including terminated employees

\*\*due to revised cadre strength

# FORMER DIRECTORS



Dr. B. PANDA  
November 02, 1979 to March 31, 1990



Dr. J.N. PANDA  
March 26, 1992 to August 31, 1992



Dr. S.C. MOHAPATRA  
August 25, 1994 to November 30, 1996



Dr. RAJVIR SINGH  
October 14, 1997 to March 06, 2003  
October 24, 2003 to October 03, 2006  
November 10, 2006 to December 03, 2006



Dr. B.P. SINGH  
July 19, 2007 to January 31, 2010



Dr. R.P. SINGH  
February 08, 2010 to March 18, 2011  
April 13, 2011 till date

## **DIRECTORS (OFFICIATING)**

1. Dr. J.N. PANDA  
April 01, 1990 to March 25, 1992
2. Dr. P.K. PANI  
September 01, 1992 to January 31, 1994
3. Dr. D.C. JOHARI  
February 01, 1994 to August 24, 1994  
December 01, 1996 to October 13, 1997  
March 07, 2003 to October 24, 2003
4. Dr. T.S. JOHRI  
October 04, 2006 to November 09, 2006  
December 04, 2006 to July 18, 2007
5. Dr. A.K. SHRIVASTAV  
February 01, 2010 to February 07, 2010  
March 19, 2011 to April 12, 2011



# Executive Summary

## RESEARCH

- In 30<sup>th</sup> generation, the crossbred of White Leghorn strains showed higher egg production than the purebreds and between crossbreds, three way cross was better than two-way cross for egg production (EP).
- The genetic response for EP 64 week in IWI and IWH strains were 1.11 0.28 and 1.30 0.25, respectively and were highly significant ( $P < 0.01$ ). Average response per generation for various economic traits up to 64<sup>th</sup> wk of age in the control population revealed non-significant changes.
- In 20<sup>th</sup> RSLT Gurgaon, CARI layer cross ranked second for feed efficiency and first for weekly egg production from 17 to 20 wks and 21-24 weeks.
- Under front line demonstration, the CARI PRIYA performed well in the field conditions, maturing at 119 days with an average egg weight of more than 52 g and a body weight of 1350 g at 40 weeks of age.
- Highly significant genetic gains of  $1.09 \pm 0.15$  eggs and  $64.90 \pm 8.67$  g have been realized in S<sub>27</sub><sup>th</sup> generation of RIR selected strain for egg production (EP40) and egg mass (EM40) up to 40 weeks of age, respectively. Significant genetic gains of  $-0.54 \pm 0.21$  days,  $0.10 \pm 0.02$  g,  $12.95 \pm 1.59$  g and  $10.73 \pm 1.53$  g have been realized for age at sexual maturity (ASM), egg weight (EW40), body weights at 20 and 40 weeks of age, respectively.
- Average egg production up to 40 weeks of age was recorded as 99.24, 69.83, 105, 70 and 95.80 eggs in RIR selected strain (RIRs), RIR control (RIC), CARI Sonali and CARI Debendra, respectively. Egg weights at 40 weeks of age in respective populations were 50.54, 48.63, 52.11 and 56.59 g, respectively.
- The egg production and egg mass in CARI Debendra, a multi-colored population developed for rural areas were better than previous generation with an improvement of about 12 eggs and 466 g egg mass.
- The selected lines i.e., CSML and SML showed better fertility percentage (82.24 and 85.26, respectively) than the control (77.36). Hatchability percentage on TES and FES in CSML were 71.6 and 87.15, respectively. Corresponding values in SML were 75.07 and 88.05. In control, lower hatchability on TES (59.01) and FES (76.28) were observed.
- Age at first egg in CSML and SML was 167 and 176 days, respectively. The average egg production up to 40 week was 63.3 and 55 eggs in CSML and SML respectively. Egg quality in both the population was good.
- CARIBRO Dhanraja showed excellent livability in 34<sup>th</sup> RSPPT at Gurgaon. The body weight at 6 and 7 weeks were 1.400 and 1.810 kg, respectively with FCR at 0-6 weeks as 1.90 and dressing percentage of 74.41. The margin of receipt at 6 and 7 weeks were Rs. 18.91 and 19.11, respectively.
- At 34<sup>th</sup> RSPPT at Gurgaon, overall CARIBRO Vishal ranked third, whereas first among government sector entries. The body weights at 6 and 7 weeks were 1.592 and 2.018 kg, respectively with corresponding FCRs of 1.936 and 2.092. The dressing per cent and margin of receipt at 7 week were 74.55% and Rs. 21.25, respectively.
- Aseel (Peela), Kadakanath, CARI Red, Aseel (Kagar) and Ankaleshwar populations were reproduced in pure form. Fertility ranged from 53.78% in Kadakanath to 80.39% in Aseel (Peela). Similarly, hatchability on total egg set ranged from 42.05 (in Kadakanath) to 68.98% (in Aseel Peela) and on fertile egg set from 78.17% in Kadakanath to 85.80 in Aseel Peela.
- Nicobari breed (Brown and Black varieties) was introduced in the Institute. The per cent fertility, hatchability on TES and FES was 76.15%, 56.58% and 74.29%, respectively. Black variety weighed significantly heavier than yellow variety at all the ages in both the sexes. Regarding egg production traits, egg weight seemed to be more in black variety, whereas for egg number, varieties did not seem to differ much.
- The improvement in egg type white plumage naked neck and frizzle lines

were continued. The naked neck population had more body weight, more egg weight and more part period egg production than the frizzle population.

- A 4 x 4 diallel experiment involving four lines viz. CARI Uttam (CU), CARI Ujjwal (CJ), CARI Sweta (CS) and CARI Pearl (CP) revealed that between the two mating systems, crossbreds exhibited significantly higher weight gains than purebreds at all age intervals, in both sexes. Among four purebreds the respective sex corrected body weight gain between 0-4 weeks and 0-5 weeks of age was highest in CARI Ujjwal ( $119.22 \pm 1.23$  and  $150.71 \pm 1.36$  g) and least in CARI Pearl ( $93.51 \pm 1.15$  and  $116.50 \pm 1.33$  g), respectively.
- Effects of genetic group, sire and dam groups were significant on conformation traits viz. shank length (SL), keel length (KL) and breast angle (BA) in quails.
- Over the five generations of mating between CARI Uttam and CARI Sweta, an increasing trend in heritability estimates for body weight was observed in the crosses.
- The CARI Uttam (CU), CARI Ujjwal (CJ), CARI Sweta (CS) and CARI Pearl (CP) lines were characterized by using 44 polymorphic microsatellite (STR) markers. In general, all the markers were informative showing high PIC value. The observed and expected heterozygosity was also high.
- A total of 23 private alleles over 19 loci in CU, 9 private alleles over 8 loci in CJ, 13 private alleles over 12 loci in CP; and 18 private alleles over 13 loci in CS were found. Phylogenetic analysis of data pooled over 44 loci revealed faithful clustering of samples within a population clusters with absolutely no outliers.
- Three improved guinea fowl populations namely Pearl (P), Lavender (L); one cross bred population i.e., Pearl x Lavender (PL) and one indigenous population (IND) were used to produce different purebred and crossbred groups. The populations differed significantly for the body weight among themselves at all weeks of age.
- Among purebreds, Lavender purebred showed maximum 12<sup>th</sup> week body weight, whereas among crossbreds, maximum 12<sup>th</sup> week body weight was observed the crosses from indigenous male and PL

females, followed by PL x L cross and L x PL cross. However, when indigenous populations were used as female with either of the purebred i.e., Pearl or Lavender, body weights were significantly reduced, however in reciprocal combinations, the body weights were comparable to the improved purebreds or crosses of purebreds.

- The chicken specific primers amplified the partial CDS of IL1 $\beta$ , TGF- $\beta$ 4 and TNF- $\alpha$  gene in guinea fowl. The sequences of partial CDS were the first reports worldwide.
- Overall, guinea fowl showed more genetic similarity with the galliformes species in comparison to Anseriformes. Among galliformes, guinea fowl was more close to chicken and different jungle fowls than other galliformes species, which suggest that guinea fowl may be the nearest and most suitable model to study the disease resistance mechanism in commercial chickens.
- Expression of Pro-inflammatory cytokines (IL1 $\beta$ , IL-6 and TNF-  $\alpha$ ) was very high in guinea fowl in comparison to broiler particularly at 1 hr p.i. as well as at 12 hrs p.i., whereas expression of anti-inflammatory cytokines (TGF-  $\beta$ 4) was at lower level in guinea fowl than broiler, particularly at 12 hrs p.i.
- Expression of the IL-10 (Th2) cytokine was exceptionally higher in GF than broiler. Most of the reports indicate that higher expression of IL-10 was negative to resistance, but recent studies suggested that higher expression of IL-10 may be the unexplored factor responsible for higher disease resistance.
- In Kadakanath population, tvb\*<sup>r</sup> (resistant) allele showed a reasonable frequency of 0.07 or 7% while in a long-term selected White Leghorn strain (IWH), relatively lower frequency (0.052 or 5.2%) of resistant allele was observed. Natural frequency of the tvb\*<sup>S1/r</sup> heterozygote is the range of 5 to 10% of the breeders.
- Selective inter-se mating of the tvb\*<sup>S1/r</sup> heterozygote resulted in a small proportion of tvb\*<sup>r/r</sup> and more number of tvb\*<sup>S1/r</sup> progenies in Kadakanath as well as in White Leghorn.

- Progenies from tvb\**r/r* sires and dams showed significantly higher ( $p < 0.05$ ) body weight at 6<sup>th</sup> and 8<sup>th</sup> week of age in comparison to the progenies from tvb\*<sup>S1/r</sup> sires and tvb\*<sup>r/-</sup> dams, which indicates the possible role of 'tvb' locus in influencing higher juvenile growth rates. No significant disadvantages was associated with the TVB\*<sup>r/r</sup> genotypes in terms of fertility and hatchability.
- Birds fed different doses of commercially available probiotic in combination with single dose of prebiotic and only prebiotic showed significantly higher body weight at 5<sup>th</sup> weeks of age in comparison to control group. Birds in all the experimental diets exhibited superior FCR ranging from 1.92 to 1.95 than control (2.18). The HI titres against NDV were significantly higher at different time points in treatment groups in comparison to control. The CMI evaluated through Lymphocyte proliferation assay and Stimulation index was higher in birds fed pre and probiotics in comparison to the control group.
- An advanced inter-cross population segregating for the 'Fm/ fm' gene was generated. The specialty of this population is that it enables the evaluation of the 'Fm' variants without the impact of the 'Id' gene which is present in the WLH layer line. Similar strategic introduction of the 'id' allele into the IWH line, where the 'id' allele has been fixed into a WLH layer base was made.
- The expression of immunity related genes (IL-6, IL-10, iNOS and IFN- was analysed in thymus spleen and lung at 3 and 5 weeks of age using real time PCR SYBERGREEN assay.
- The initial results from analysis of the above resources indicate that the 'id' gene is capable of inducing very low level of pigmentation in the shank of the host and not in the skin. This would then conclude that Fm's role in inducing the pigmentation in host has more distinct role in the host than that of 'id' gene.
- The shRNAs for myostatin and TGF4 genes were designed. The CG content ranged from 40-60% and shRNAs were designed for lentiviral vectors having U6/H1 promoters.
- Primary chicken embryo fibroblasts (CEF) Cultures procedure were standardized.
- Under the "Holistic approach for improving livelihood security through livestock based farming system in Barabanki and Raebareli districts of U.P." project, 621 farmers have started the Traditional Backyard Poultry Farming while the target was for 500 farmers till the end of the project up to March 2012. A total of 445 new farmers were added during the current year. 18 farmers have upgraded their poultry farm from Scavenging chicken to Small Farm Broiler production. Number of birds ranges from 250 to 2000 birds. A total of 21,372 chicks were distributed/sold to the farmers of the project area while only 5688 chicks were distributed during the previous year. Training for the feed formulation and compounding was arranged at CARI, Izatnagar and 17 farmers were trained.
- Under the project "Goat husbandry based integrated approach for livelihood security in disadvantaged districts of Bundelkhand region", a total of 8424 day old chicks of HITCARI, UPCARI, CARI Nirbheek and CARI Debendra were distributed to a total of 338 selected farmers. The income of the beneficiaries was increased due to intervention of "Rearing of improved Germplasm" by 8.5%. Routine health services and technical know-how was provided to the beneficiaries by organizing the camps/personal visits, etc.
- Addition of dried fresh root powder of Sarpagandha (*Rauwolfia serpentina*) 0.1 to 0.3%, ashwagandha (*Withania somnifera*) 0.2% or dried stem powder of geloi (*Tenospora cordifolia*) 0.1% in diet was beneficial to improve performance and welfare (HL ratio, immno-competence, oxidative stress profile) of coloured broiler chickens (0-42 d of age) during extreme summer (May-June, 38°C to 43°C).
- Addition of dried Amla (*Emblica officinalis*) fruit powder 0.2% in diets of coloured broiler chickens (0-42 d of age) was beneficial to improve feed conversion efficiency and cell-mediated immune response during extreme summer (May-June, 38°C to 43°C).
- Addition of dried fresh *Artemisia vulgaris* (mugwort or common wormwood) leaf meal in diet (0.1-0.3%) of growing broilers

- (CARIBRO) did not prove beneficial to improve growth, feed utilization efficiency and carcass yields but improved immune-competence of broilers during extreme winter.
- Addition of excess lysine was beneficial in improving body weight (201, 198 and 190 g), feed conversion ratio (2.74, 2.84 and 2.94) and reduction of feed-cost per kg gain (Rs. 45.21, 46.36 and 47.58 in 17, 15 and 13 g Lys per kg diet, respectively) of meat-type growing Japanese quails. However, additional folic acid in diet did not prove beneficial.
  - Addition of either sodium acetate 0.2% or tartaric acid 0.1% in feed or glacial acetic acid 2.5 ml/liter in drinking water significantly improved body weight gain, feed efficiency and immune-response (cellular and humoral) with decreased microbial load in caecal contents of growing Japanese quails (0-5 weeks).
  - A biological trial to assess the efficacy of sodium acetate in feed (0.1, 0.2 and 0.3%) or glacial acetic acid (2.5 and 5ml/lit) in drinking water indicated that sodium acetate at a concentration of 0.1% in feed or acetic acid 2.5 ml/lit in drinking water was effective for enhancing the egg production performance, feed conversion efficiency and immune response (cell mediated and humoral), and reduction of *E. coli* count in caecal content of laying quails (10-17 weeks).
  - A dietary concentration of 40 mg of zinc and 16 mg of copper per kg diet either organic or inorganic form was sufficient to meet their requirements for growing broiler chickens. However, higher levels of copper (16 mg per kg) and zinc (80 mg per kg) together improved immune response.
  - A level of 200 mg/kg organic copper irrespective of the source did not cause any adverse effect on bone morphometry and mineralization, except reduction in tibia bone zinc concentration. However, copper at this level reduced serum cholesterol significantly.
  - Analysis of 120 each of maize and soybean samples from different locations in India revealed 91% maize (ranged from 0.00 to 1.00 ppm with an overall average of 0.29 ppm) and 87% soybean meal samples (0.00 to 0.67 ppm with an overall average of 0.22 ppm) samples positive for aflatoxins.
  - The aflatoxin production potential of *Aspergillus parasiticus* NRRL 2999 was higher as compared to *A. parasiticus* MTCC 411 and the maximum yield of aflatoxin was obtained at moisture level between 30 and 35%, at 30°C on 7<sup>th</sup> days of incubation for *A. parasiticus* NRRL 2999 and 14<sup>th</sup> days of incubation for *A. parasiticus* MTCC 411.
  - Fumaric acid (evaluated at 0.00 to 0.50%) was effective in complete prevention of aflatoxin production at 0.2% level in feed at 13% moisture level, while fumaric acid partially reduced the aflatoxin production in poultry feed with 15 or 17% moisture.
  - Fungal fermentation of de-oiled rice polish increased its protein content from 14.56 to 18.36% and decreased the crude fibre content from 12.85% to 8.38%, and fungal fermentation of wheat bran increased CP content from 14.89 to 19.78% and decreased the crude fibre content from 13.04% to 10.10%.
  - The incorporation of 5% WB without enzyme supplementation and 7.5 % WB with enzyme supplementation or 7.5% FWB proved effective for growth performance, immune competence and gut health. Beneficial effect of enzyme supplementation can be substituted with fungal fermentation at 5% and 7.5% WB level with better humoral immune response and gut health.
  - A combination of chromium (1000 µg/kg) and Spirulina (2g/kg) in diet of laying hens was effective in reducing egg yolk cholesterol content. Spirulina @ 1g/kg diet was effective in increasing good cholesterol level (HDL) and reducing triglyceride level in the blood of laying hens.
  - The study carried out to determine whether diets prepared with transgenic corn would have any adverse effects on performance of broiler chickens when compared to diets prepared with non-transgenic (isogenic) control and commercial corn indicated that the transgenic corn had no deleterious or unintended effects on production traits of broiler chickens.
  - The transgenic Bt rice grain can be included safely up to 20% in maize- soybean meal based broiler diet up to 0-6 weeks of age.

- Inclusion of poultry slaughter by-product meal at the rate of 5% found to be effective in decreasing feed cost per kg live weight and increasing the weight gain for profitable turkey production.
- For native ducks, a dietary level of 2700 kcal ME/kg+22% CP during starting phase (0-8 wks of age), 2400 kcal ME/kg+16% CP during grower phase (9-16 wks of age) and 2600 kcal ME/kg+18% CP during laying phase has been found optimum for better growth and egg production.
- Semen collection technique in four breeds/varieties of ducks is being standardized at regional Centre of Institute.



*Courtship in White Pekin pair*



*Collection of semen from different breeds of drakes*

- Under NAIP scheme at Regional Centre, Bhubaneswar, a base-line survey was prepared and documented. Series of meetings with the farmers and village committee were also made to discuss about the resource, need and interest of the targeted groups. Subsequently, Participatory Rural Appraisal (PRA) was conducted with the help of Social Science personnel belonging to CENDERET (XIMB, Bhubaneswar). Problems are identified and technological interventions were fixed as per the soil, water and other resources of the farmers.



- Molecular indicator for physiological maturation of infundibulum part of oviduct developed.
- Phytohormone addition in diet of broiler breeding hens @ 30 ppm significantly improved egg number and size in by checking reproductive anomalies (internal laying, double hierarchy and follicular atresia) and restructuring ovarian and oviductal functional development.
- Acute heat stress (40°C for 4 hrs @ 70% of RH) in broiler chicks suppressed digestive enzyme activity (Pepsin, trypsin, amylase and lipase).
- More frequent insemination with 24 hrs stored semen is required as compared to freshly ejaculated semen.
- Organic zinc (20,000 ppm) is effective for induced moulting and welfare friendly comparable to feed withdrawal.
- Experiments conducted to determine the storage quality changes in functional chicken scroll as well as functional chicken meat pellets made with different levels (10, 20 and 30%, w/w) followed by trials with 15, 20 and 25% levels (w/w) of processed soya nuggets (PSN) suggested that incorporation of 20% and 15% supplementary (w/w) levels of PSN were more suitable for processing good quality functional chicken scroll and functional chicken meat pellets, respectively. These products could be safely utilized till 90 days and 4 weeks, respectively, of frozen storage (-18 C). Trials with different supplementary (5, 10 and 15% followed by experiments with 2.5, 5 and 10%) levels of processed barley floor, suggested that functional chicken meat pellets, containing 5% supplementary (w/w) level of barley floor, could be safely utilized till 21 days of refrigerated (4 1°C) and 42 days of frozen storage (-18 1°C).
- Process of preparing egg cutlet was standardized. Egg cutlet prepared with 42% egg and 40% minced chicken meat with 6.7% grated cheese, 6.0% onion paste, 2.0% refined wheat flour, 0.10% mustard powder, 2.0 % spice mix, 0.8% salt and 0.2% each of white vinegar and soy sauce were most acceptable and had a refrigerated shelf life of 14 days in vacuum and 12 days in aerobic packaging with satisfactory microbiological and organoleptic

- quality. The cost of formulating one processed egg cutlet weighing about 125 g was calculated to Rs. 21.70.
- Quantification of *Salmonella* by real-time PCR in chicken eggs collected from selected poultry farms indicated higher level of *Salmonella* with  $1.38 \times 10^3$  cfu per egg as compared to eggs collected from marketing channels where the level of *Salmonella* was in the range of  $1.00 \times 10^5$  to  $1.19 \times 10^6$  cfu per egg indicating multiplication of this pathogen during transport and storage.
  - The samples of poultry feed, egg and muscle tissue collected from different poultry farms and local markets of Gorakhpur, Ludhiana and Barbala areas indicated their average levels of residues of tetracycline as 0.04, 0.02 and 0.015 ppm and the same for enrofloxacin was 0.04, 0.02, 0.03 ppm, respectively. Similarly, the levels of residues of BHC, DDT, eldrin, dieldrin were determined in samples poultry feed (0.16, 0.15, 0.14, 0.13 ppm), muscle (0.015, 0.02, 0.18, 0.17 ppm), liver (0.02, 0.04, 0.13, 0.12 ppm) and abdominal fat (0.22, 0.18, 0.15, 0.16 ppm), respectively. The residues of heavy metals in feed, liver and muscle in sampling areas were found in the order of lead (0.2, 0.15, 0.15 ppm), arsenic (0.2, 0.15, 0.12 ppm), molybdenum (0.13, 0.14, 0.17 ppm) and cadmium (0.13, 0.12, 0.13 ppm), respectively. The levels of residues analysed were within the permissible limit and samples collected from Ludhiana area were containing higher residue levels than those of other two locations.
  - Based on the analysis of expression pattern, the trace elements and fatty acid for growth are zinc, iodine and iron. Expression of humoral immunity genes (IL-6 and TNF ) are enhanced by iron, iodine and linoleic acid, whereas, mRNA expression of IL-2 and IL-12(cell mediated immunity) genes are enhanced by zinc, selenium and iron.
  - Different nutrients modulating growth, cell mediated and humoral immunity have been identified and tried in combination. Growth, CMI and Humoral group chicks had better chick weight at 14 and 42 days post-hatch, but FCR was better in growth group chicks.
  - Humoral group chicks had higher bursa weight and HA titer to SRBC, while CMI group chicks had higher thymus weight and better CMI response.
  - *In ovo* vaccine for ND has been standardized, where it was found that formaldehyde inactivated NDF<sub>1</sub> vaccine can effectively be used as *in ovo* vaccine for better protection against ND in broiler chickens.
  - About 12% increase in parthenogenetic turkey embryo development had been observed by using fowl pox vaccination in breeder hens.
  - Irrespective of age of the embryo, genomic DNA content ( $\mu\text{g}/\mu\text{l}$  sample) was higher in normal fertilized eggs than parthenogenetic egg.
  - Mitogens like PHAP or Con-A can be used for induction of parthenogenetic development in infertile turkey eggs.
  - Karyotyping of parthenogenetic *vis-a-vis* normal fertilized turkey embryos has been standardized.
  - Proportion of haploid or diploid W chromosome decreased after 24 hrs incubation and transition of ploidy from haploid to diploid is observed up to 48 hrs of incubation.
  - Micro-array analysis of parthenogenetic and normal fertilized embryos from turkey revealed few genes very significantly up and down regulated.
  - Some of the important export destinations for the Indian hen-eggs-in-shell were Switzerland, Venezuela, Mongolia, Honduras, Nicaragua, Latvia, Czech Republic, Trinidad and Tobago, Japan, Estonia, Singapore, Hungary, Russian Federation and Canada providing a gross margin of about \$ 14700 to \$75500 per reefer container maintaining a temperature of  $-2^{\circ}\text{C}$  to  $0^{\circ}\text{C}$  with a payload of about 21 t eggs (about 4.13 lakh eggs).
  - Some of the important destinations for poultry meat exports turned out to be Congo, Armenia, Panama, Saint Lucia, Cyprus, Antigua and Barbuda, Switzerland, Cape Verde, Indonesia, Georgia, Albania, Suriname, Ghana, Russian Federation, Venezuela providing a gross margin ranging from over \$1.11 lakh to \$7000 per TEU reefer container maintaining a temperature of  $-28^{\circ}\text{C}$  to  $-23^{\circ}\text{C}$  and 90-95% RH with 21 t payload.
  - Generation of biogas was observed to be the best and most profitable alternative for

- utilizing poultry waste. It also resulted in reduction of green house gases thereby paving way for earning through trading of carbon credits. The next best alternative was observed to be vermi-composting utilizing poultry cage droppings (layer farms) and other organic material (such as dung, dry leaves, straw etc.). Feeding dried poultry droppings to ruminants in the concentrate mix. was the least capital intensive alternative to utilize poultry waste.
- The commercial poultry layer and broiler farms are established in plains of Uttarakhand. The poultry products are supplied from these districts and other production centers to fulfill the demand of Kumaon hill involving transportation cost and other overhead expenses leading to inflated prices in hilly areas.
  - During 2010-2011, 40 students were on roll for different degree courses in Poultry Science discipline of Deemed University, IVRI, Izatnagar and one student of other University under co-guidance system.
  - Five M.V.Sc. and four Ph.D. students were awarded degrees in Poultry Science discipline from Deemed University, IVRI, Izatnagar.
  - Seven specialized short-term training courses were organized on “Application of Biotechnological Techniques”, “Broiler Production” and “Layer Production”.
  - One major credit, 08 minor credit, 08 ORW, 03 pre-thesis submission and one faculty seminars were organized by Post Graduate Education and Training Section of the Institute.
  - The 11<sup>th</sup> Farm School on “Commercial Broiler Farming” was organized through Prasar Bharti, Akashwani Rampur during September 01 to October 13, 2010. During the valedictory function on November 02, 2010, the cash prizes and certificates were distributed to 15 winning farmers. Total 131 farmers participated in the Farm School from 14 districts of U.P. and 2 districts of Uttarakhand.
  - Total 37,351 commercial broiler day-old chicks were supplied to 85 farmers, who have established their farms after getting training from the Institute in consultation with the scientists.
  - Three batches of short-term training on poultry production management were organized; wherein 95 trainees, including 2 selected farmers from the adopted village (Nawadia Harkishan of Bareilly) received certificates on successful completion of the training.
  - Six sponsored training programmes on poultry production management were organized for 57 farmers nominated by Animal Husbandry Deptt., Government of Bihar under Rashtriya Krishi Vikas Yojna; 15 farmers nominated by Agricultural Technology Management Agency (ATMA), Madhubani (Bihar); and 130 army soldiers of Gorkha Resettlement Training Unit, C/O 56 APO.
  - To disseminate poultry production technologies, a village panchayat-Navdia Harkishan was adopted by the Institute. The farmers of the village panchayat were motivated to establish poultry farms through a series of farmer–scientist meets (7 in number) at the village.
  - The Institute organized CARI stall in four Krishi Melas at IVRI, Izatnagar; MPUA&T, Udaipur; NBFGR, Lucknow; and IARI, New Delhi. CARI stall was adjudged as **Best Stall** of the IVRI Mela and received First prize.
  - The technology dissemination was made through releasing various press releases/features in Print media as well as by broadcast of radio features by Akashwani Rampur/Bareilly. Besides, various queries of farmers through Kisan Call Centre were solved on phone.

# Research Achievements

## PROGRAMME-1

### PRODUCTIVITY INCREASE IN SELECTED AVIAN SPECIES

#### SUB PROGRAMME - (I) CONVENTIONAL AND MAS FOR IMPORTANT ECONOMIC TRAITS

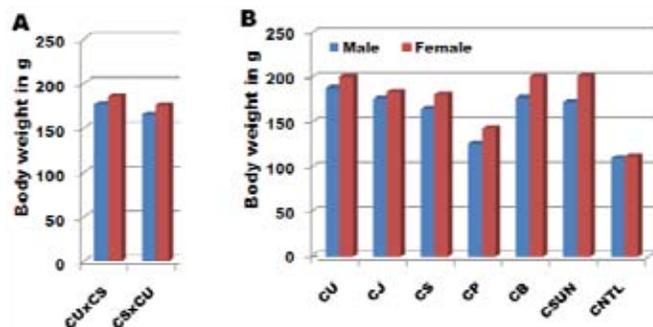
#### 1. DEVELOPMENT AND IMPROVEMENT OF SPECIALIZED QUAIL LINES USING ALTERNATE FEATHER COLOUR GENES

**Diallele Experiment:** Using four quail lines viz. CARI UTTAM (CU), CARI UJJWAL (CJ), CARI SWETA (CS) and CARI PEARL (CP), a complete 4x4 diallel mating was made. Significant differences were observed between various genetic groups, mating systems and sire and dam groups for juvenile body weights at most of the ages from 0 week to 5<sup>th</sup> weeks, except body weight at 1<sup>st</sup> week. Between the two mating systems, cross-breed exhibited significantly higher weight gains than that of purebreds at all age intervals, in both sexes and combined data. Among four purebreds the respective sex corrected body weight gain between 0-4 weeks and 0-5 weeks of age was highest  $119.22 \pm 1.23$  and  $150.71 \pm 1.36$  g in CJ, followed by  $118.04 \pm 1.12$  and  $143.44 \pm 1.16$  g in CS,  $113.24 \pm 1.21$  and  $142.33 \pm 1.40$  g in CU and  $93.51 \pm 1.15$  and  $116.50 \pm 1.33$  g in CP, respectively. Amongst the different crossbred groups, body weight was highest in CU X CS followed by CJ X CU and CJ X CS crosses. Effects of genetic group, sire and dam groups were significant on conformation traits viz., shank length (SL), Keel length (KL) and breast angle (BA). The  $h^2$  estimates for body weight at all weeks of age i.e., from 1<sup>st</sup> to 5<sup>th</sup> weeks and weight gain up to 4<sup>th</sup> as well as up to 5<sup>th</sup> week of age were moderate to high ranging from  $0.32 \pm 0.17$  to  $0.64 \pm 0.13$ .

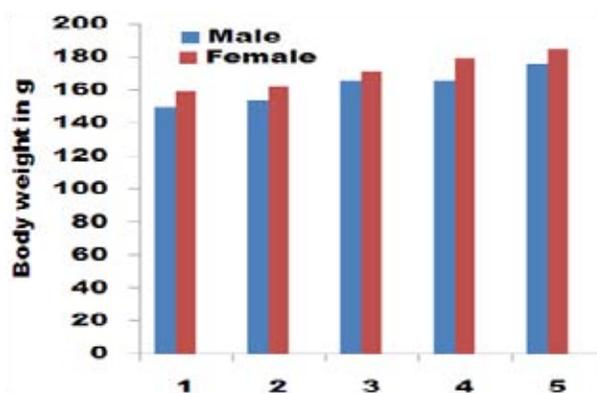
**Improvement of broiler quail lines:** Improved broiler quail lines i.e. CARI Uttam and CARI Sweta were utilized to create large genetic pools for developing specific quail line. Fifth generation of crossing was completed. Among them, CUxCS weighed heavier than the reciprocal cross in both the sexes (Fig. 1a). Overall an increasing trend was observed in both the crosses over number of generations under crossing (Fig. 2).

Among pure lines, highest per cent hatchability was reported in CARI Uttam (68.43),

followed by CARI Brown (68.34), CARI Ujjwal (67.11), CARI Sweta (60.17) and CARI Sunheri (58.46). In the control population, hatchability percentage was lowest i.e., 48.77% only. In pure lines, males of CU weighed heaviest at 5<sup>th</sup> week of age, followed by CB and CSUN, whereas, among females, CU, CB and CSUN weighed more than 200 g. Control line followed by CP, showed lowest body weight in both the sexes (Fig. 1b).



**Fig. 1:** Fifth week body weight in crossbreds (A) and purebreds (B) quail populations. (CU: CARI UTTAM, CJ: CARI UJJWAL, CS: CARI SWETA, CP: CARI PEARL, CB: CARI BROWN. CSUN: CARI SUNHERI and CNTL: Control)

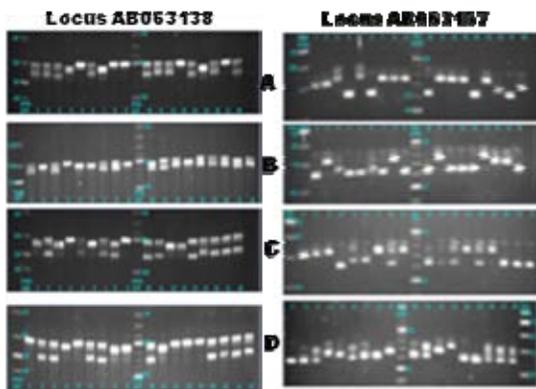


**Fig. 2:** Fifth week body weight in CUxCS cross in different generations of crossing

*To develop unique feather color layer quail to differentiate CARI brand quails from that of wild (pharaoh) quails, we are developing and improving a layer quail (White egg cell line) tagged with a unique feather colour (white/brown) and egg color markers. A total no of 102 birds (Male and Female) were identified with the white egg cell laying. These birds are being maintained for their further utilization.*

## Molecular characterization of quail lines

The CARI Uttam (CU), CARI Ujjwal (CJ), CARI Sweta (CS) and CARI Pearl (CP) lines were characterized by using Microsatellite (STR) markers (Fig. 3). Out of total 50 STR tested, 44 were found polymorphic and used for analysis with a sample size of 18 birds/line. In general, all the markers were informative showing high PIC value. The observed and expected heterozygosity was also high (Table 1). Private alleles were found in all the four strains. A total of 23 private alleles over 19 loci in CU, 9 private alleles over 8 loci in CJ, 13 private alleles over 12 loci in CP; and 18 private alleles over 13 loci in CS were found. While, highest genetic distance (0.631) was found between CU and CS, The CS and CP showed least genetic distance with each other. Genetic distance and Identity analysis determined based on microsatellite analysis showed high correlation with results obtained based on data recorded on heterosis and SCA for weights and weight gains. Phylogenetic analysis of data pooled over 44 loci revealed faithful clustering of samples within a population clusters with absolutely no outliers (Fig. 4).

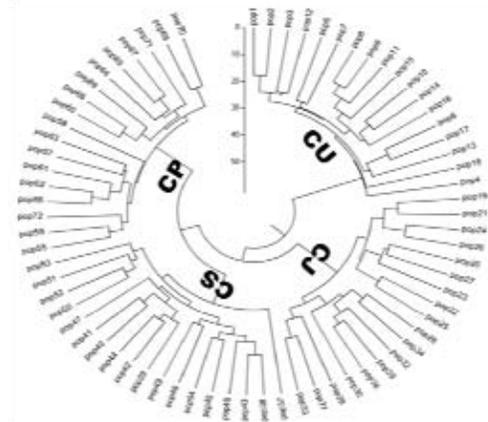


**Fig. 3:** Genotyping of four quail lines viz. a: CARI Uttam, b: CARI Ujjwal, c: CARI Sweta and d: CARI Pearl at different microsatellite locus

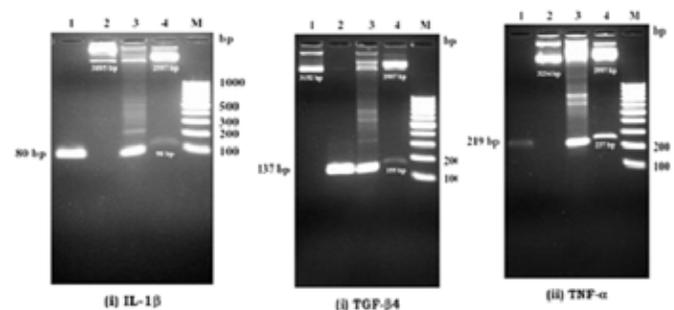
## 2. DIFFERENTIAL EXPRESSION STUDIES FOR SOME IMPORTANT GENES INFLUENCING DISEASE RESISTANCE IN GUINEA FOWL

***In vitro* amplification, cloning, sequencing and sequence homology analysis of CDS of different cytokine/chemokine genes of guinea fowl:** The chicken specific primers amplified the CDS of all the cytokine genes in guinea fowl (Fig. 5). The sequences of partial CDS of IL1 $\beta$ , TGF-  $\beta$ 4 and TNF- $\alpha$  gene of GF were the first reports worldwide. For IL-1 $\beta$  gene,

guinea fowl showed 88.6 to 93.7% (88.5 to 96.2%) identity with galliformes such as chicken, necked neck chicken, jungle fowls, quail, Chinese bamboo partridge, gray partridge etc., while with anseriformes viz. duck, columbiformes viz. pigeon and Zebra Finch, the percent similarity was 84.8% (88.5%), 85.7% (84.0%) and 87.0% (84.0%), respectively. For TGF- $\beta$ 4 gene, guinea fowl showed the genetic similarity of 94.2-94.9% (84.4%) with other galliformes, viz. chicken and necked neck chicken; and 94.9% (86.6%) with duck. For TNF- $\alpha$  gene, while galliformes, viz. chicken and necked neck chicken showed 92.2% (90.4%) identity with Guinea fowl, duck showed 89.5% (86.0%) identity with guinea fowl. Zebra finch showed 84.4% (78.6%) identity with guinea fowl.



**Fig. 4:** Consolidated dendrogram based on pooled data over 44 generations over 44 microsatellite loci. CU: 1-18, CJ: 19-36, CS: 37-54 and CP: 55-72



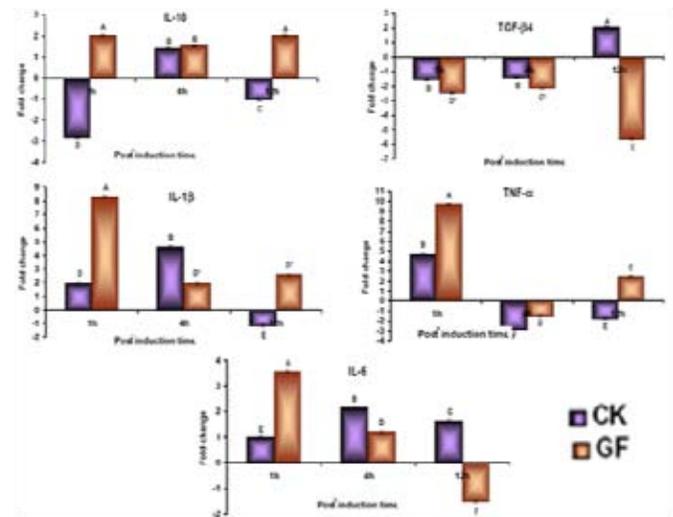
**Fig. 5:** Amplification of partial CDS of different cytokine genes in guinea fowl (1: Gene specific product, 2: Recombinant plasmid, 3: Recombinant plasmid PCR and 4: Recombinant plasmid PCR Restriction enzyme digestion)

**Table 1: Polymorphism in different quail lines estimated by using microsatellite markers)**

Lines	Per cent polymorphic loci	PIC	Number of alleles	Effective number of alleles	Similarity Index	Observed Heterozygosity	Expected Heterozygosity
CU	84%	0.44 ±0.03	3.73 ±0.21	2.34 ±0.16	0.91 ±0.07	0.29 ±0.03	0.48 0.03
CJ	82%	0.46 ±0.03	3.57 ±0.22	2.46 ±0.15	0.94 ±0.07	0.31 ±0.03	0.51 0.03
CS	82%	0.46 ±0.03	3.59 ±0.23	2.41 ±0.14	0.92 ±0.07	0.36 ±0.04	0.50 0.04
CP	86%	0.44 ±0.03	3.45 ±0.23	2.32 ±0.14	0.89 ±0.07	0.34 ±0.03	0.49 0.03
Over-all	88%	0.60 ±0.03	3.59 ±0.11	2.38 ±0.07	0.91 ±0.03	0.33 ±0.02	0.50 0.02

Overall, guinea fowl showed more or less higher genetic similarity with galliformes viz., chicken, jungle fowls, quail, turkey and pheasant etc. based on cytokine genes sequence homology and phylogenetic analysis. Among galliformes, guinea fowl was more close to chicken and different jungle fowls than other galliformes species, which suggest that guinea fowl may be the nearest and most suitable model to study the disease resistance mechanism in commercial chickens.

**Differential expression analysis of different cytokines:** Expression of Pro-inflammatory cytokines (IL1 $\beta$ , IL-6 and TNF- $\alpha$ ) was very high in guinea fowl in comparison to broiler particularly at 1 hr p.i. Expression of pro-inflammatory cytokines interestingly higher than broiler at 12 hrs p.i. Guinea fowl spleenocytes expressed anti-inflammatory cytokines (TGF- $\beta$ 4) at lower level than broiler, particularly at 12 hrs p.i., which may be the cause of the higher expression of pro-inflammatory cytokines at 12 hrs p.i. in GF. Expression of the IL-10 (Th2) cytokine was exceptionally higher in GF than broiler. Most of the reports indicate that higher expression of IL-10 was negative to resistance, but recent studies suggested that higher expression of IL-10 may be the unexplored factor responsible for higher disease resistance (Fig. 6). These differences in the expression of different cytokines may be instrumental for the higher immune response in the guinea fowl against pathogens compared to broiler.



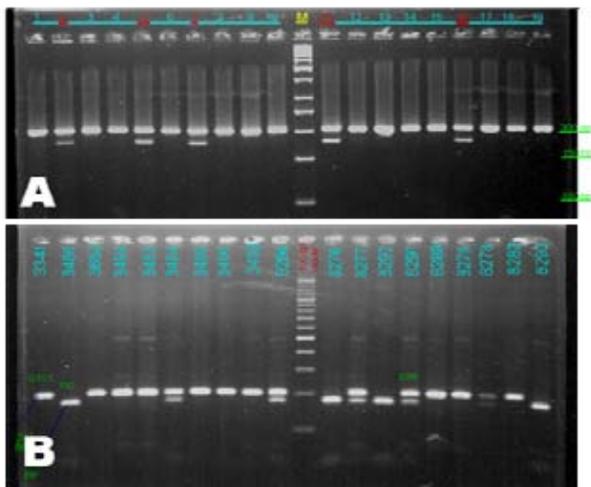
**Fig. 6:** The mRNA expression level (LS mean adjusted 40-CT values) in terms of fold changes estimated in *Salmonella enterica* serovar *Enteritidis* induced *in-vitro* cultured spleenocytes relative to un-induced spleenocytes of broiler and guinea fowl in different p.i. times

### 3. NATIVE FOWL GENOMICS FOR DISEASE RESISTANCE AND MOLECULAR BREEDING FOR HIGH YIELDING CHICKENS

Using two R.E PCR-RFLP by *Xba* I and *Nla* III for discriminating *Tvb*\*<sup>r/r</sup> from *Tvb*\*<sup>S1/r</sup> and *Tvb*\*<sup>S1/S1</sup>, molecular breeding of chickens resistant to ALV-B/D/E subtypes was continued in Kadakanath and WLH chickens. Confirming the earlier trend, it was re-established that: susceptible allele fixed in the said two population was *Tvb*\*<sup>S1</sup> and not the *Tvb*\*<sup>S3</sup>, across the 'Tvb' Locus. It was also proved that KN's frequency for *tvb*\*<sup>r</sup> (resistant) was 0.07 while the same from

IWH was 0.052. The frequency of  $tvb^* S1/r$  heterozygotes remained in the range of 0.05 to 0.07 across both KN and IWH stocks.

Selective inter-se mating of  $tvb^* S1/r$  heterozygotes resulted in giving a small proportion of  $tvb^* r/r$  and more of  $tvb^* S1/r$ , as per expectation of Hardy Weinberg proportion, in 2010-11 within both breeds (of CARI). So, molecular breeding aimed at raising  $tvb^{*r/r}$  genotypes in higher number, along with batches of  $tvb^* S1/r$  and  $tvb^* S1/S1$ , simultaneously, gave rise to ~ 400 progeny within KN-currently which were analyzed for their comparative performance (growth and fitness traits). Analysis for *Tvb* genotyping indicated that 33.1% of the progeny samples were of  $Tvb^{*r/r}$  genotypes. There were increased frequency of  $Tvb^{*r/r}$  homozygotes (Fig. 7B), in contrast to the samples of previous year (Fig. 7A) which are indicated by single PCR-amplicons of 172Bp alleles, visible in many lanes in contrast to the susceptible genotypes, which were indicated either by single amplicons of by 202 Bp alleles ( $Tvb^{*S1/S1}$ ) or heterozygotes ( $Tvb^{*S1/r}$ ) consisting of both 172 and 202 Bp products per each of such lanes.



**Fig. 7:** A: Shows presence of limited number of  $Tvb^* S1/r$  heterozygotes upon screening of previous generation's breeder's comprising of most number of  $Tvb^{*r/r}$  homozygotes. B: Depicts increased frequency of  $Tvb^{*r/r}$  homozygotes, as a sequelae to molecular breeding using  $Tvb^* S1/r$  heterozygote parents

Analysis of juvenile-growth data in KN indicated that progeny from  $tvb^{*r/r}$  sires and dams showed significantly better ( $P < 0.05$ ) 6<sup>th</sup> week (226 g) and 8<sup>th</sup> week (358 g) body weight than progeny from  $tvb^* S1/r$  sires and  $tvb^{*r/-}$  dams (195 g and 310 g, respectively). This indicated probable role of 'tvb' locus in

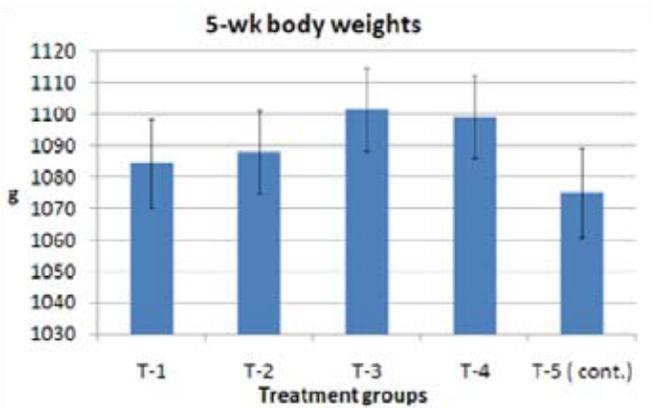
influencing higher juvenile growth rates (better than heterozygotes and  $tvb^{*S1/S1}$  homozygotes) in KN. Thus, from this trial, it could be proven that breeding for enhancing number of  $tvb^{*r/r}$  hosts selectively was possible, without any significant loss of fitness (hatchability) traits. No significant disadvantages was associated with  $Tvb^* r/r$  genotypes, for fertility and hatchability as compared to the ALV-B susceptible chickens. This study also proved the continued feasibility of molecular breeding for ALV-B/D/E resistant chickens into larger stocks which can be combined into any category of high-productive chickens.

#### 4. ANALYSIS OF GENE EXPRESSION, GROWTH AND IMMUNITY TRAITS IN BROILER UNDER PRO AND PREBIOTICS FEEDING

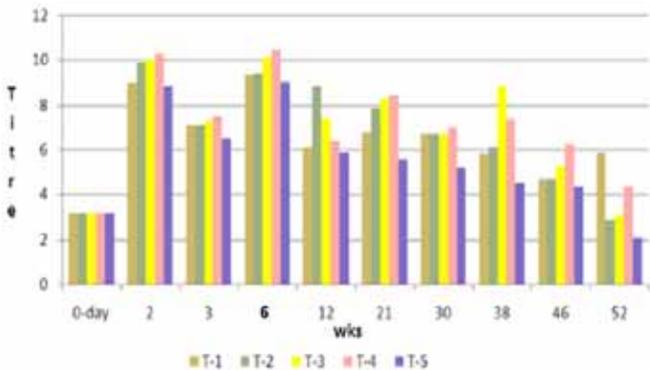
The chicks from coloured synthetic male line (CSML) were fed with different doses of commercially available probiotic in combination with single dose of prebiotic. Day old chicks (60/group) of CSML were utilized. A total of four experimental groups ( $T_1$ ,  $T_2$ ,  $T_3$ , and  $T_4$ ) and one control ( $T_5$ ) with standard diet were fed. Briefly, Group I=Probiotic: 5 g/100 kg feed+prebiotic: 3 ml/litre of water; Group II=Pro-biotic: 10 g/100 kg feed+prebiotic: 3 ml/litre of water; Group III=Probiotic: 15 g/100 kg feed+Prebiotic: 3 ml/litre of water; Group IV=Prebiotic: 3 ml/litre of water; Group V (control)=Standard feed+Antibiotic: 1 g/litre of water. Experimental groups were fed pro and prebiotic from 3 to 7 days of age and then twice till experimental period.

The overall body weight at 5 week in treatment groups viz.  $T_1$ ,  $T_2$ ,  $T_3$  and  $T_4$  were  $1084.37 \pm 14.15$ ,  $1087.94 \pm 13.23$ ,  $1101.57 \pm 13.12$ ,  $1099.156 \pm 13.22$  g, respectively, whereas in control group it was  $1075.14 \pm 14.29$  g (Fig. 8). Birds from the all the experimental diets exhibited superior FCR ranged from 1.92 to 1.95 than control (2.18). At 5 week of age 10 birds of both sexes from each treatment were randomly chosen and sacrificed to analyse the carcass traits. Means of different carcass traits and cut up parts also showed better performance in treatment groups than control. The antibody titer against the NDV was evaluated by HI and ELISA. Chicks and birds were vaccinated with ND vaccine (RD-F Strain) at the day of hatching, booster RDF at 28<sup>th</sup> day,  $R_2B$  at 6<sup>th</sup> wk of age and finally with killed vaccine at 18 week of age

and sera were collected at 1<sup>st</sup> day for maternal, 2<sup>nd</sup>, 3<sup>rd</sup>, 6<sup>th</sup>, 12<sup>th</sup>, 21<sup>st</sup>, 30<sup>th</sup>, 38<sup>th</sup>, 46<sup>th</sup>, and 52<sup>nd</sup> weeks of age. Significant differences among groups were observed in titre values at 2, 6, 12, 21 and 38 weeks (Fig. 9). Highest titres were observed in T4 group and lowest in T5 i.e., control. Highest titre value among all the groups were observed at 6<sup>th</sup> week. ELISA titres were in agreement with HI titre values. Bursa and spleen weights in T4 at 3<sup>rd</sup> and 5<sup>th</sup> weeks of age weighed significantly more than in control (T5). CMI was evaluated through Lymphocyte proliferation assay at 14, 21, 56, 70, and 140 and 154 day of age for the assessment of CMI immune response for RD-F, R<sub>2</sub>B and ND killed vaccine. Birds from pro and prebiotic groups (T2 and T4) showed higher CMI cellular response against the ND vaccine. Stimulation index in trated group ranged between 0.96 and 2.2 at different ages. However, in control then range was 0.92 to 1.4.



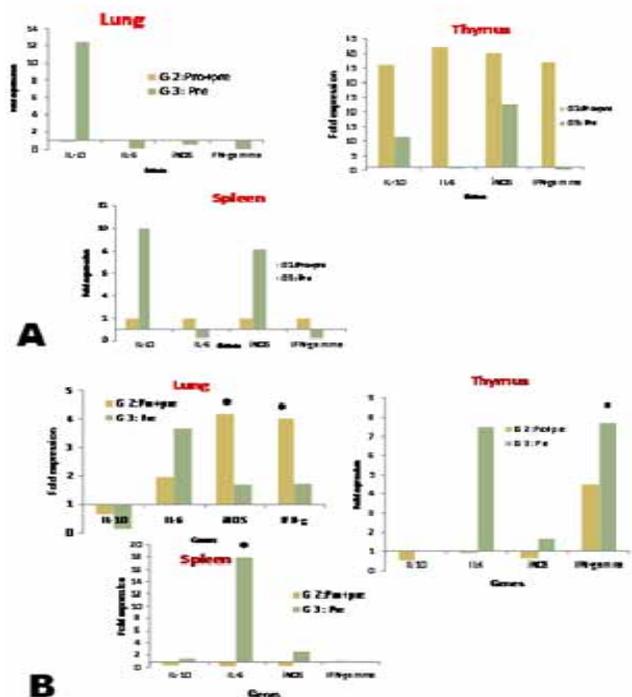
**Fig. 8:** Average 5<sup>th</sup> week body weight in different experimental groups



**Fig. 9:** Mean HI titre against NDV in different experimental groups

**Gene expression analysis:** The expression of immunity related genes (IL-6, IL-10, iNOS and

IFN-g) was analysed in thymus, spleen and lung at 3 and 5 weeks of age using real time PCR SYBERGREEN assay (Fig. 10). At three weeks of age IL-10 was up-regulated whereas at 5 weeks of age it was downregulated in all the organs. Up-regulation of iNOS and IFN-g was observed in spleen and thymus at 3 weeks; the expression profiles of various genes at 3 weeks indicated the involvement of innate immunity and CMI/ non-specific immunity. At 5 weeks of age IL-6 and IFN-g were up-regulated suggesting role of adaptive immunity. At three weeks of age diet containing pre-biotic only resulted into up-regulation of IL-10 and iNOS in lung and spleen whereas in thymus all the genes had higher expression in diets containing pre and pro-biotic both. At five weeks of age most of the genes studied had higher expression under diet containing pre-biotic only. The results suggested that in early age pre and pro-biotic both are required for immunity boosting however at later ages pre-biotic only can help in sustaining higher immune status of the birds.



**Fig. 10:** Expression profile of various immunity related genes in lungs, thymus and spleen under different groups at 3-wks of age (A) and at 5-wks of age (B)

## 5. EXPRESSION PROFILING OF GENES RELATED TO IMMUNITY IN ASEEL, KADAKANATH AND WLH CHICKENS

Sera samples at 0 day and at the age of 1, 2, 3, 4, 5 and 6 weeks were collected from 80 White Leghorn birds. Titration of antibodies against ND vaccine was done using HI (Haemagglutination Inhibition) test in the sera of all experimental birds in all seven collections, i.e. at day 0 to 6 weeks of age. The titres at day 0, week 1, 2, 3, 4, 5, and 6 ranged from 1/20 to 1/40960, 1/20 to 1/81920, 1/10 to 1/81920, 1/10 to 1/81920, 1/20 to 1/40960, 1/10 to 1/40960 and 1/10 to 1/40960, respectively. The averages and standard errors of  $\text{Log}_{10}$  transformed titres at corresponding ages were  $2.49 \pm 0.07$ ,  $2.55 \pm 0.08$ ,  $2.41 \pm 0.09$ ,  $2.49 \pm 0.09$ ,  $2.45 \pm 0.09$ ,  $2.31 \pm 0.08$  and  $2.32 \pm 0.08$ . Sera samples at the age of 1, 2, 3, 4, 5 and 6 weeks have been collected from 100 Kadakanath and 90 Aseel native chicks. Four tissues viz. spleen, bursa, thymus and liver were collected from 2 males and 2 females of White Leghorn chicks at

Debendra (CD) were 87.13, 87.04, 85.64 and 73.78, respectively. The hatchability % on fertile eggs transferred basis was 82.34, 85.18, 87.15 and 81.53 in corresponding strains, which were better than preceding generation.

**Comparative performance of RIR pure strains:** The chicks of selected (RIR<sub>S</sub>) and control (RIR<sub>C</sub>) strains hatched in 27<sup>th</sup> generation were kept for brooding and growing. The females were housed in individual laying cages for recording of economic traits after attaining 16 wks of age. The selected RIR strain had significantly higher egg mass, egg number as well as egg weight at 40 weeks of age as compared to control line as this difference was of 1616 g, 30 eggs and 1.91 g. While the ASM was ~15 day earlier, but the body weight at 20<sup>th</sup> and 40<sup>th</sup> weeks of age were 372 g and 309 g higher in RIRs in comparison to RIR<sub>C</sub> (Table 2).

**Genetic parameters in RIR strains:** With a low heritability for egg production, egg mass and ASM (Table 3) the other economic traits were moderately heritable. Contrary to EW28, the

**Table 2:** Comparative performance of RIR strains and crosses in S<sub>27</sub> generation (2010-11)

Strain	Bw at 20 wk (g)	Bw at 40 wk (g)	Avg age at first egg (d)	Ewt at 28 <sup>th</sup> wk (g)	Ewt at 40 <sup>th</sup> wk (g)	EP up to 40 wk	EM up to 40 wk (g)
RIR <sub>S</sub>	1570.25 4.78	1825.84 6.56	140.58 0.30	46.28 0.08	50.54 0.08	99.24 0.53	5015.55 28.04
RIR <sub>C</sub>	1198.41 7.49	1516.67 10.39	154.22 0.87	44.18 0.13	48.63 0.12	69.83 0.85	3399.35 42.92
HR cross	1447.77 12.59	1681.44 18.66	149.82 0.25	48.89 0.25	52.11 0.24	105.70 1.67	5508.03 70.29
CD cross	2214.36 17.36	2928.39 31.20	154.27 0.87	50.85 0.38	56.59 0.24	95.82 1.50	5422.45 120.27

higher extreme and from equal numbers of chicks at lowest extreme of ND vaccine response, estimated by HI test. Total RNA was isolated from bursa (n=2), liver (n=1), spleen (n=1) and thymus (n=1). cDNA was synthesized using RNA isolated from thymus and spleen and checked on gel. Amplified both cDNA using one housekeeping gene, chicken beta-actin, was optimized.

## 6. IMPROVEMENT OF RIR FOR RURAL POULTRY PRODUCTION

**Reproductive Performance of RIR strains:** The per cent fertility in RIR selected (RIR<sub>S</sub>), control (RIR<sub>C</sub>), CARI-Sonali (HR) and CARI

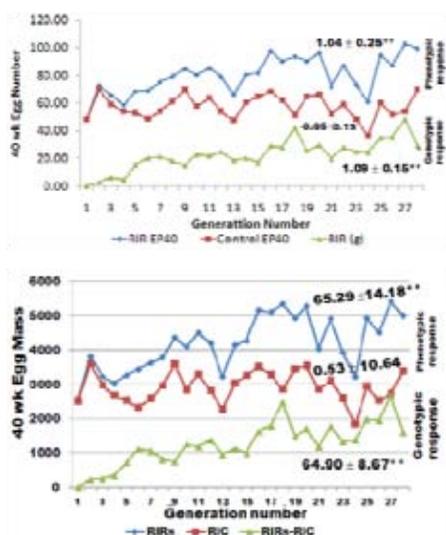
importance of non-additive genetic and/or maternal effect was observed for BW20, BW40 & EW40. The genetic association of 40-wk egg production (EP40) with ASM and egg weight at 28<sup>th</sup> and 40<sup>th</sup> wk. of age were found to be negative in direction and low to high in magnitude. The genetic correlation ( $r_{GS}$ ) of 40-wk egg production with egg mass and body weight at 20<sup>th</sup> & 40<sup>th</sup> week of age were found to be positive in direction and low to high in magnitude. The genetic association ( $r_{GS}$ ) of 40-wk EM with ASM were found to be negative and moderate to high in magnitude. Genetic correlation ( $r_{GS}$ ) of 40-wk EM with egg weight at

**Table 3:** Heritability estimates of various economic traits in RIRs for S27 generation (2010-11)

<i>Component of variance</i>	<i>BW AT 20 WK</i>	<i>BW AT 40 WK</i>	<i>AGE AT FIRST EGG</i>	<i>EW AT 28<sup>TH</sup> WK</i>	<i>EW AT 40<sup>TH</sup> WK</i>	<i>EP UP TO 40 WK</i>	<i>EM UP TO 40 WK</i>
$h^2_s$	0.26 0.09	0.17 0.07	0.07 0.05	0.36 0.11	0.25 0.09	0.07 0.04	0.09 0.04
$h^2_D$	0.28 0.09	0.25 0.09	0.07 0.08	0.30 0.09	0.28 0.09	0	0
$h^2_{S+D}$	0.27 0.05	0.21 0.04	0.07 0.03	0.33 0.06	0.27 0.05	0	0.01 0.02

28<sup>th</sup> and 40<sup>th</sup> wk of age and body weights at 20 and 40 weeks of age was found to be generally positive in direction and low to high in magnitude.

**Response to selection:** The RIR selected strain was maintained, evaluated, selected and regenerated for S<sub>27</sub> generation of selection. Part period egg number upto 40<sup>th</sup> weeks of age was taken as criterion of selection using Osborne selection index. On genetic scale, the average response per generation for 40 wk egg number and egg mass were observed to be highly significant and positive (Fig. 11). Similarly, for egg weight at 40 weeks of age, the response at genetic as well as phenotypic scales were of the tune of 0.10 0.02 and 0.15 0.05 g per generation respectively and were highly significant. In control population, all these traits showed non-significant changes over generations.



**Fig. 11:** Phenotypic and genetic responses per generation in selected RIRs and time trend in RIC for egg number and egg mass

## 7. IMPROVEMENT OF POULTRY FOR EGG PRODUCTION

The S<sub>30</sub> generation of White Leghorn pure strains i.e. IWH and IWI (long term selected strains) and IWC (control strain) were evaluated for economic traits up to 72 weeks of age (Table 4). The two crossbred populations i.e., HI and JHI were also evaluated up to 64 weeks of age. A total of 1389, 1228, 654 pullets of IWH, IWI and IWC and 127 pullets of HI and 72 pullets of JHI strain cross were housed in the individual laying cages after completion of 16<sup>th</sup> wk of age. Both the crossbreds i.e., HI and JHI showed distinctly high hen-housed egg production upto 64 weeks as well as 72 weeks of age as compared to pure lines i.e., H and I. Though hen-day as well as survivor egg production upto 64 and 72 weeks of age were also high in crossbreds, but difference was not so acute. In control population, all the measures of egg production were low, however, egg weight as well body weights were high in control population. Frequency distributions for egg production up to 64 wks of age also revealed the efficiency of index selection where 7.71 to 16.67 % of the pullets laid more than 250 eggs in comparison to only 0.71% in control population.

**Egg quality traits:** The selected pure strains as well as stain crosses qualified the standards of good internal egg quality. Haugh unit of A-grade eggs has been reported to be 70 and above. Haugh unit score of all the pure strains and stain crosses were observed to be above A-grade eggs. The incidence of blood and meat spot were

**Table 4:** Mean  $\pm$  SE for economic traits in different pure lines of White Leghorn and crosses

<i>Traits</i>	<i>IWH</i>	<i>IWI</i>	<i>IWC</i>	<i>HI</i>	<i>JHI</i>
BW-64 wk (g)	1368.63 $\pm$ 3.85	1410.90 $\pm$ 5.02	1638.71 $\pm$ 8.31	1463.85 $\pm$ 11.61	1501.86 $\pm$ 17.17
BW-72 wk (g)	1430.00 $\pm$ 7.32	1460.62 $\pm$ 10.57	1683.87 $\pm$ 14.15	1463.39 $\pm$ 20.79	1496.10 $\pm$ 32.39
EW-64 wk (g)	52.92 $\pm$ 0.10	53.76 $\pm$ 0.10	54.11 $\pm$ 0.12	53.91 $\pm$ 0.30	52.68 $\pm$ 0.36
Hen housed EP-64 wk	188.32 $\pm$ 1.95	190.46 $\pm$ 2.02	150.75 $\pm$ 2.88	201.16 $\pm$ 5.72	210.76 $\pm$ 3.98
Hen Day EP-64 wks	216.49	220.02	183.73	228.09	230.27
Survivors EP-64 wk	221.86 $\pm$ 1.06	222.20 $\pm$ 1.03	195.69 $\pm$ 1.69	224.73 $\pm$ 3.38	220.42 $\pm$ 3.03
Hen housed EP-72 wk	198.61 $\pm$ 1.47	197.36 $\pm$ 5.71	162.88 $\pm$ 6.62	230.68 $\pm$ 6.23	243.03 $\pm$ 6.28
Hen Day EP-72 wk	246.97	245.37	201.27	260.53	265.53
Survivors EP-72 wk	251.17 $\pm$ 3.17	257.19 $\pm$ 3.53	221.79 $\pm$ 5.07	263.58 $\pm$ 3.88	258.49 $\pm$ 3.77

observed to be  $<1\%$ . The internal quality of control line was within normal limits.

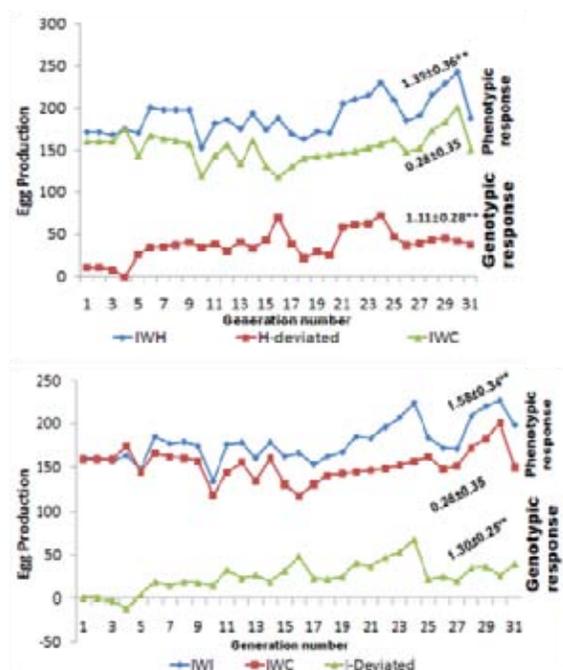
**Feed efficiency:** The feed consumed per dozen of eggs and per kg of egg mass was 2.07 and 3.25 kg for IWH; 2.04 and 3.09 kg for IWI; 2.05 and 3.22 kg for HI and 2.09 and 3.32 kg for JHI, respectively. For control group the corresponding figures were 2.23 and 3.28 kg.

**Genetic parameters:** In general, the heritability estimates were low in both selected strains i.e., H and I. There was no definite trend for type of gene action in various strains (selected and control) except the higher estimates of heritability from dam component in control lines suggesting more influence of maternal effects on all the traits at 64 weeks of age.

Regarding the phenotypic correlation of 64<sup>th</sup> egg production with various economic traits, 64<sup>th</sup> wk egg production showed significant and high positive correlation with 40 wk EP in H as well as in I, whereas in Control line, it was moderate in magnitude. With egg weight and body weight, the correlations were in desired direction, but of low to moderate in magnitude. The genetic correlations did not produce any trend between selected and control lines as also between the traits. Most of the estimates were non-significant or beyond the theoretical range. This trend is indicative of pleiotropic effects of the genes influencing egg production.

**Response to selection:** Egg production (64<sup>th</sup> wk) improved significantly in the both the selected strains with the estimates of 1.11 0.28

and 1.30 0.25 eggs per generation in IWH and IWI strains on genetic scale. This increase in egg production was also associated with non-significant change in 64 wk egg weight in both the strains (Fig. 12). The 64 wk BW showed significant decline in H, whereas in I, though it was negative in direction, but non-significant. In Control, no significant time trend was observed, suggesting the stability of control line for these traits.



**Fig. 12:** Phenotypic and genetic responses per generation in selected WLH strains and time trend in control (IWC) strain for egg number

**Maintenance of other pure lines of long term selected White Leghorn populations:** Two long term selected white leghorn strains i.e., IWG and IWJ were also maintained in minimum number. The egg production in these strains were 112.66 and 107.81 eggs up to 40 weeks of age with an egg weight of 51.30 and 49.61 g. The JG cross showed an egg production of 109.25 eggs up to 40 weeks of age.

## 8. DEVELOPMENT AND EVALUATION OF SYNTHETIC BROILER SIRE LINE

Initially the selection criterion in Coloured Synthetic Male Line (CSML) and Synthetic Male Line (SML) lines was six-week body weight, which was shifted to high body weight at five week of age. So far, nine generations of selection and breeding have been completed. Restricted feeding programme was followed after 5-weeks.

**Incubation and hatchability:** Good per cent fertility ranging from 82 to 85 was observed in both the selected lines, whereas in control line, it was 77.36. Similarly, hatchability percentage on TES and FES ranged from 71.6 to 75.07 and 87.15 to 88.05 in selected lines, while the respective estimates in control line were 59.01 and 76.28.

**Body weights at different ages:** The overall average body weights at 5 weeks in CSML and SML were 1148.78 2.89 and 1126.28 5.49 g. In control, the body weight at 5 week was 760.42 10.24 g. Genetic and phenotypic responses to selection for 5-week body weight in CSML were 13.66 2.77 and 17.77 2.18 g/generation, respectively. Corresponding values for SML were 12.37 4.09 and 14.42 3.18 g/generation.

**Confirmation and carcass traits:** Means of pre-slaughter de-feathered, eviscerated weights, breast, drumstick, thigh weights and dressing percentage were 1140.9±33.06, 965.90±23.21, 795.92±26.79, 169.2±5.32, 110.90±4.02, 106.2±2.9 g and 75.65% respectively in CSML at 5 weeks of age. The conformation traits viz shank length, keel length and breast angle at 5-weeks of age in CSML were 87.1±3.49, 89.98±4.65 and 49.66±0.34, respectively.

**Egg production traits:** Age at first egg in CSML and SML were 167 and 176 days, respectively. The average egg production up to 40 week as 63.3 and 55 eggs/bird, respectively, in CSML and SML respectively. Mean egg weights at 32, 40

and 52 weeks of age were 60.63±0.47, 61.98±0.63 and 66.85±0.72 g respectively. Eggs showed good internal egg quality at all weeks of age.

**Random sample performance test:** The CARIBRO Dhanraja, CARIBRO Vishal and CARIBRO Mritunjay were tested at 34<sup>th</sup> RSPPT, Gurgaon. While CARIBRO Vishal showed maximum body weight of 1592 g and 2018 g at 6<sup>th</sup> and 7<sup>th</sup> weeks of age, the margin of receipt at 7 weeks was maximum in CARIBRO Mritunjaj (Rs. 24.53). The feed efficiency upto 7 weeks was maximum in CARIBRO Dhanraja (1.90 kg of feed per Kg of body weight). No difference was observed for dressing percent among them.

## 9. DEVELOPMENT AND EVALUATION OF SYNTHETIC BROILER DAM LINE

Initially, selection criterion in Coloured Synthetic Female Line (CSFL) and Synthetic Dam Line (SDL) lines was six-week body weight, which was revised to high body weight at five week of age. So far, nine generations of selection (high body weight at 5 weeks) have been completed. The birds having conformational deformities and showing coloured feathers were culled. Mild culling was also employed for egg production and age at sexual maturity.

**Incubation and hatchability:** The good chicks produced in CSFL and SDL were 4538 and 2251, respectively. The fertility percentage was 81.94 and hatchability percentage based on TES and FES were 69.43 and 84.74, respectively in CSFL. Corresponding values in SDL were 85.56, 77.80 and 90.92 per cent, respectively.

**Body weights at different ages:** The overall average of body weight at 5 in CSFL and SDL were 1135.08±3.128 g and 1091.68±4.56 g, respectively. Genetic and phenotypic responses to selection for 5-week body weight in CSFL were 15.58±3.00 and 19.67±2.31 g per generation, respectively and were significant (P>0.01). Corresponding values for SDL were 13.93±5.04 and 15.98±4.68 g per generation and were also significant. The phenotypic response in control was 4.11±2.15 g per generation.

**Egg weight and shape index in CSFL:** Age at first egg in CSFL was 166.7 days with egg production up to 40 week and 52 weeks in CSFL were 65.6 and 96.7 eggs/bird. In SDL the ASM, and EP 40 weeks were 175 days and 57 eggs. The egg weights at 32, 40 and 52 weeks of age in CSFL were 58.30 0.50, 59.80 0.84 and

63.74 0.61 g, respectively. The Albumin height of 8 mm, Yolk height of 15.63 mm, Yolk index of 4.0 and HU of 88 suggest very good internal egg quality in CSFL.

### Random bred control population

A random bred control was also developed for estimation of environmental deviations. In Control line, a total of 932 eggs were set out of which 541 good chicks were hatched with per cent fertility of 77.36 and hatchability per cent based on TES and FES were obtained as 59.01 and 76.28. The body weight at 5 was 760.4210.24 g, respectively. The estimates of heritability in control line at 5 week of age were observed as 0.230.11, which indicated that random mating is effective in maintaining the additive genetic variance in the control population. The phenotypic response for 5-week body weight in the control population was non-significant (4.10 2.15 g/generation) showing that the control population was fairly stable. The phenotypic gains for fertility and hatchability (FES) percentages were 0.11 0.34 and 0.62 0.35 which were non-significant. Frequency distribution of control population for 5-week body weight appeared almost normal distribution.

**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.

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 CARIBRO Tropicana. Besides two other parent stocks namely IC3 and IR3 are also maintained in the Experimental Broiler Farm. The fertility, hatchability (TES) and hatchability (FES) percentages ranged from 77 to 91; 61 to 76; and 78 to 88, respectively. The mean body weight at 5-week of age in IR-3, IC-3, CARIBRO Tropicana, Naked neck coloured and naked neck white were 1062.122.20, 834.91±3.10, 987.6±6.24, 1147.09±4.10 and 1079.85±2.68 g, respectively.

## SUB PROGRAMME – (II) NUTRIENT BALANCING USING CONVENTIONAL AND ALTERNATE FEED RESOURCES

### 1. NUTRITIONAL MANIPULATION OF THE GASTRO-INTESTINAL TRACT TO CONTROL

## INTESTINAL PATHOGENS AND THEIR EFFECTS ON THE UTILIZATION OF NUTRIENTS AND IMMUNE RESPONSE IN POULTRY

Comparative efficacy of acetic acid as feed or water acidifier vis-a-vis tartaric acid on the performance of broiler quails

A biological trial of five week duration was conducted involving eight dietary treatments, which included a practical corn-soya basal quail starter diet, basal diet supplemented with three levels (0.1, 0.2 and 0.3%) of sodium acetate, two levels (0.1 and 0.2%) of tartaric acid in feed and two levels (2.5 and 5 ml/lit) of acetic acid in drinking water. Four replicate groups of 20 quail chicks each were assigned to each of the eight dietary treatments from 0 to 5 weeks of age. The chicks were reared in electrically heated battery brooders throughout the experimental period. Individual chick weight and group feed intake were recorded at weekly intervals. A nutrient balance trial was carried out for a period of 3 days at the end of third week in order to study nitrogen (N), calcium (Ca) and phosphorus (P) retention. On 22<sup>nd</sup> day of experimental feeding, two birds from each replicate of all the treatments were injected with PHA-P mitogen (1 mg/ml PBS) intra-dermally to monitor the in vivo cell mediated immune response by measuring the foot pad index. At the end of 5 week 6 birds from each treatment group were taken randomly for determining the dressing yield and organ weights. Cecal contents from four birds per treatment group were collected for total microbial load and presence of *E. coli* pathogens. For humoral immune response, on 29<sup>th</sup> day of experiment, 0.2 ml of 10% (v/v) of SRBC (sheep red blood cell) suspension was injected intravenously and about 2 ml blood was collected on 5th day of post injection from wing vein for antibody titre detection. The data were subjected to statistical analysis as per standard procedures.

The results of growth performances of broiler quails at 5 weeks of age revealed a significant increase in body weight gain, feed efficiency and retention of nitrogen and calcium due to dietary supplementation of sodium acetate, tartaric acid in feed or acetic acid in drinking water over control with maximum response on 0.2% sodium acetate, 0.1% tartaric acid in feed or 2.5 ml/lit acetic acid in drinking water. Feed intake, phosphorus retention and the carcass traits as measured by dressing yield and relative weight of certain organs as liver, spleen,

bursa, thymus and caeca showed no significant difference amongst various treatments. Footpad index against PHA-P mitogen as an index of in vivo cell mediated immunity, the humoral immune response as assessed with antibody titre to sheep RBC increased whereas, the load of organisms ( $10^4$ ) in caecal contents reduced significantly with the supplementation of sodium acetate, tartaric acid in feed or acetic acid in drinking water. Based on the results it was concluded that addition of either sodium acetate at 0.2% or tartaric acid at 0.1% in feed or acetic acid 2.5 ml/liter in drinking water have promising effects on enhancing the growth, feed conversion efficiency, nutrient retention and immune response with reduction of cecal microbial colonization in broiler quails.

### **Efficacy of acetic acid as feed or water acidifier on the performance of layer quails**

A biological trial of eight weeks duration was conducted to assess the efficacy of lactic acid as feed or water acidifier on the performance of laying quails. Six dietary treatments included a practical corn-soya basal quail layer diet, basal diet supplemented with 0.1, 0.2 and 0.3% sodium acetate in feed and 2.5 and 5 ml/lit acetic acid in drinking water. The results of egg production performances of layer quails revealed that supplementation of acetic acid as feed or water acidifier significantly increased the hen-day egg production, feed efficiency, egg mass and protein retention of laying quails. No significant difference within levels of sodium acetate in feed (0.1 to 0.3%) and levels of acetic acid in water (2.5 to 5 ml/lit) or between the levels of acetic acid in feed or water could be observed. Feed, protein, energy intake and energy retention were not influenced by dietary treatments. Egg quality characteristics as measured by shell weight; albumen and yolk indices were not influenced by the dietary treatments. Egg weight increased significantly and remained comparable between treatment groups. The cell mediated immune response as measured by foot pad index although increased with supplementation of acetic acid in feed or water remained statistically non-significant. Humoral immune response, as determined by RD-HI antibody titre against RDF at 15 days of post immunization, increased significantly by dietary supplementation of acetic acid in feed or water at all the levels. Microbial status of cecal contents indicated a significant decrease of microbial load with complete absence of *E. coli* in all treatment groups. Based on the

results it is inferred that acetic acid at a concentration of 0.1% in feed or 2.5 ml/lit in drinking water can be used effectively for enhancing the gut health and thereby increasing the production performance and immune response of laying quails.

## **2. STUDIES ON NUTRITIONAL AND PHARMACOLOGICAL LEVELS OF COPPER FOR POULTRY**

Response of feeding different sources and concentrations of copper on serum cholesterol, skeletal status and retention/utilization of minerals in broiler chickens

Twelve dietary treatments comprising three copper sources (copper sulphate-CuS, copper chloride-CuCl and copper propionate-CuP) each with four copper levels (8, 100, 150 and 200 mg/kg diet) in a factorial (3 x 4) manner was tested in broiler chickens from 0-6 wks of age. At the end of feeding trial 6 birds from each dietary treatment (2 birds/replicates) making a total of 72 birds were selected randomly and slaughter after 12 hrs fasting with ad lib drinking water. Blood and tibia bone samples were collected to study serum cholesterol and skeletal status. Skeletal status with respect to bone morphometry traits (length and width of tibia bone), bone mineralization traits (dried bone weight, bone ash, bone calcium, phosphorus, copper, zinc, manganese and iron) contents were evaluated. During the feeding trial, last three days (40-42 days) a metabolic trial were also conducted to study the minerals retention/utilization in broiler chickens.

Results indicated that the significant ( $P < 0.01$ ) reduction in serum cholesterol was observed at 200 mg Cu/kg diet than other dietary copper levels. Bone morphometry traits such as tibia bone length, bone width (proximal, mid shaft and distal) did not differed significantly ( $P > 0.05$ ) due to either main effect or interaction between different sources and concentrations of copper in the diet. Bone mineralization traits such as dried bone weight, bone ash, bone calcium, phosphorus and manganese content remained statistically unchanged due to either main effect or interaction between different sources and concentrations of copper in the diet. The tibia bone Zn differed significantly due to main effect and interaction between different sources and levels of copper in the diet. Significantly ( $P < 0.05$ ) higher tibia bone Zn content was observed in CuP than CuS supplemented diet. However, the diet

supplemented with CuCl the tibia Zn content was found intermediary. Significantly ( $P<0.01$ ) higher tibia Zn concentration was recorded at lower levels (8 and 100 mg Cu/kg) diet than those recorded at higher levels (150 and 200 mg Cu/kg) diet. Significantly ( $P<0.05$ ) higher tibia Zn concentration was observed at 8 mg Cu from CuCl or 100 mg Cu from CuP or 8 mg Cu from CuS or 8 mg Cu from CuP than other dietary combinations. Significantly higher tibia Cu ( $P<0.05$ ) and Fe ( $P<0.01$ ) concentrations were noticed in CuP than CuS and CuCl supplemented diet. Tibia Cu and Fe concentrations remained statistically unchanged due to Cu levels in the diet. Concentrations of calcium (Ca), phosphorus (P), copper (Cu), zinc (Zn), manganese (Mn) and iron (Fe) in excreta samples did not differ significantly due to interaction between different Cu sources and levels. As increasing the dietary Cu concentration, significantly ( $P<0.01$ ) increased excreta Cu concentration with dose response. Excreta Cu concentration did not differ significantly due to different Cu sources. Significantly ( $P<0.01$ ) higher excreta Mn content was observed in CuCl than CuS supplemented diet and lowest excreta Mn content was recorded in CuP supplemented diet. Excreta Mn concentration was significantly ( $P<0.01$ ) higher at (150 and 200 mg Cu/kg) diet than its lower dietary Cu levels. Significantly lower excreta Zn and Mn concentrations were observed in CuP than CuS and CuCl supplemented diets. Excreta Zn and Fe concentrations did not alter significantly due to different Cu levels. Concentrations of Ca and P in excreta did not change significantly due to different sources and levels of Cu in the diet. Based on the results, it may be concluded that dietary copper concentration up to 200 mg/kg diet irrespective of different copper sources did not bring any adverse effect on bone morphometry and mineralization traits except reduction of tibia zinc concentration. However, at 200 mg/kg copper level significantly reduced serum cholesterol. Further, increasing dietary copper concentrations linearly increased copper and manganese concentrations in excreta.

Response of feeding different sources and concentrations of zinc and copper on growth, immune response and carcass quality traits in broiler chickens

An experiment was undertaken to evaluate the response of broiler chicken to supplementary sources and concentration of zinc

(Zn) and copper (Cu) on growth, immune response and carcass traits. A six weeks (0-6 weeks) feeding trial was conducted involving two Zn levels (40 and 80 mg/kg) each with two Cu levels (8 and 16 mg/kg) and again each with two mineral sources (organic/chelated and inorganic) in the form of Zn propionate and Cu propionate (organic/chelated) and Zn sulphate and Cu sulphate (inorganic) through a 2x2x2 factorial experiment. Accordingly eight test diets were prepared separately for starting (0-3 wks) and finishing (4-6 wks) phase.

The study indicated that the body weight gain was significantly ( $P<0.01$ ) higher at 16 mg Cu/kg than that recorded at 8 mg Cu/kg diet during all growth phases. There was no significant effect on body weight gain due to Zn levels, mineral sources and interaction among Zn, Cu and mineral sources. During 4-6 wks of age, significantly ( $P<0.05$ ) higher feed intake was observed at 16 mg Cu/kg than 8 mg Cu/kg diet. However, during 4-6 wks feed intake remained unchanged statistically due to Zn levels, mineral sources and interaction among Zn, Cu and mineral sources. Feed intake did not change due to main effect and interaction among Zn, Cu and mineral sources during 0-3 and 0-6 wks of age. Significantly better feed conversion ratio was observed during 0-3 ( $P<0.01$ ), 4-6 ( $P<0.05$ ) and 0-6 ( $P<0.01$ ) wks of age at 16 mg Cu/kg diet as compared to 8 mg Cu/kg diet. However, no significant effect was observed on feed conversion ratio due to Zn levels, mineral sources and interaction among Zn, Cu and mineral sources. Mortality of broilers did not influence by dietary treatments. The humoral immune response (HA titre to SRBC) and cellular immune response (foot pad index to PHAP) were significantly ( $P<0.01$ ) higher at higher levels of Zn as compared to lower levels of Zn in the diet. The HA titre to SRBC did not change due to Cu levels, mineral sources and interaction among Zn, Cu and mineral sources. The cellular immune response (foot pad index to PHAP) was significantly higher at 16 mg Cu/kg diet with organic source as compared to 8 mg Cu/kg diet with inorganic source. No significant effect was observed on foot pad index to PHAP due to interaction among Zn, Cu and mineral sources. Most of carcass quality traits did not differ significantly due to different dietary treatments. However, the relative organ weight (giblet, heart and liver) were significantly higher at 40 mg Zn and 16 mg Cu/kg diet as compared

to 80 mg Zn and 8 mg Cu/kg diet. It is concluded that a dietary combination of 40 mg zinc and 16 mg copper/kg diet either in organic or inorganic forms of minerals was found optimum for satisfactory growth performance and carcass quality traits in broiler chickens. However, better immune response was realized in a dietary combination of 80 mg zinc and 16 mg copper with organic source.

### **3. NUTRIENT REQUIREMENTS OF DUCKS**

#### **Determination of optimum level of metabolizable energy for native ducks during starter stage**

Optimum level of metabolizable energy during starter age of ducklings was studied. At the 8<sup>th</sup> week of age, the final body weight recorded was 634.78±25.12, 693.93±7.46 and 706.90±18.77 in 2500 kcal, 2700 kcal and 2900 kcal ME/kg fed group, respectively. Significantly ( $P\leq 0.05$ ) poor FCR was observed in 2500 and 2700 kcal fed group than 2900 kcal ME/kg fed group. However no difference was observed between 2700 and 2900 kcal/kg fed groups. No significant difference was observed between the treatment groups with respect to their DM, and OM metabolizability and also in CF and EE digestibility. The nitrogen balance (g/d) in different groups was determined by taking into consideration of nitrogen intake through feed and its out go in faeces. No significant difference was observed between the groups with respect to their nitrogen intake, nitrogen out go, nitrogen balance and also in nitrogen balance when calculated as percentage of nitrogen intake. From this experiment it was concluded that a diet containing 2900 kcal ME/kg diet with 22% CP was optimum for growth and nutrient utilization of native ducks during starter stage.

#### **Determination of optimum level of metabolizable energy for native ducks during grower stage (9-16 weeks)**

The optimum level of metabolizable energy for native ducks during grower stage (9-16 weeks) was determined. From the experiment it was observed that no significant difference was there with respect to their weekly body weight throughout the experimental period. The final body weight at 16<sup>th</sup> weeks of age was 1140.77±62.63, 1187.67±22.84 and 1146.80±28.51 g in 2400 kcal, 2600 kcal and 2800 kcal ME/kg fed group, respectively. No significant difference was observed between the

groups with respect to their DM and OM metabolizability and in EE digestibility. However, significantly ( $P\leq 0.05$ ) higher CF digestibility was observed in 2600 kcal and 2800 kcal/kg fed group than 2400 kcal/kg fed group. No difference was observed between the groups with respect to their nitrogen intake, nitrogen out go and nitrogen balance per day. From this experiment it was concluded that a diet containing 2400 kcal ME per kg diet along with 16% CP was optimum for growth and nutrient utilization for native ducks during grower stage.

#### **Study of the performance of native ducks with different levels of metabolizable Energy during layer stage**

A study was conducted to study the performance of native ducks during layer stage from 20-40<sup>th</sup> weeks of age with three different levels of metabolizable energy (ME) i.e., 2450 kcal, 2600 kcal and 2750 kcal per kg diet. The overall feed intake from 20-40<sup>th</sup> week was 138.69±1.04, 140.55±2.50 and 138.81±3.61 g/d in ducks fed at 2450 ( $T_1$ ), 2600 ( $T_2$ ) and 2750 ( $T_3$ ) kcal/kg diet, respectively. The metabolizability of DM and OM was 74.48±0.58, 75.92±0.77 and 77.37±1.44 and 78.46±0.82, 80.32±0.63 and 81.45±1.13 in  $T_1$ ,  $T_2$  and  $T_3$ , respectively. The differences observed between the groups with respect to their DM and OM metabolizability and CF and EE digestibility were not statistically significant. Significantly ( $P\leq 0.05$ ) higher nitrogen balance (g/d) was observed in  $T_1$  and  $T_2$  than  $T_3$ . The egg weights of the ducks within the groups were compared between 20<sup>th</sup>, 30<sup>th</sup> and 40<sup>th</sup> week and found statistically significant ( $P\leq 0.05$ ) difference. The egg weight at 30<sup>th</sup> and 40<sup>th</sup> weeks were significantly ( $P\leq 0.05$ ) higher than 20<sup>th</sup> week, but no significant difference was observed between 30<sup>th</sup> and 40<sup>th</sup> week. Significantly ( $P\leq 0.05$ ) higher egg production on duck house basis was observed in  $T_2$  and  $T_3$  than  $T_1$ . From this experiment it was concluded that a diet containing 2600 kcal ME/kg with 18% CP was optimum for nutrient utilization and egg production for native ducks during layer stage.

### **4. AUGMENTING NUTRIENT UTILIZATION OF ALTERNATE FEED RESOURCES IN POULTRY**

Procurement and maintenance of microbial culture and optimization of conditions for fermentation of wheat bran (WB) and de-oiled rice bran (DORB)

The lyophilized culture of *Aspergillus niger* (MTCC ACC No. 281) was reconstituted and subculture was made by agar plating technique using potato dextrose agar (PDA). The inoculated subculture was kept at 37°C for 48 hrs and washed with 15 ml of 0.01% Tween-80. Autoclaved water (15 lbs for 15 min.) was used for spore suspension preparation and further dilution. Spore suspension was prepared at the concentration of one lakh spore per ml. Thus, *Aspergillus niger* spores was harvested by tapping. Spore count was determined using a haemocytometer according to the Fuchs-Rosenthal technique. The spores was preserved at 4°C until the organisms was used for solid medium inoculation.

An in-vitro trial was conducted in order to optimize the conditions for *Aspergillus niger* growth on wheat bran and de-oiled rice bran. Wheat bran and de-oiled rice bran were soaked in water at three different ratios of (WB/DORB and water) 30:70, 70:30 and 50:50, respectively and incubated at 37°C for 72 hrs. Thus, each three treatments were used in triplicate to get best suitable combination of different level of WB/DORB and water ratio on the basis of chemical analysis; dry matter (DM) loss, aflatoxin screening and visual inspection for growth of *Aspergillus niger* fungus.

Optimum conditions for the best visual growth of *Aspergillus niger* has been found in group having WB and water ratio (70:30) for 72 hrs incubation at 37°C. CP increased was highest in group WB and water (70:30) ratio. In all three groups CP content and NFE did not differ significantly ( $P>0.05$ ) to each other. However, DM loss was significantly ( $P<0.05$ ) lowered ( $16.98\pm 0.21\%$ ) in group WB and water ratio (70:30) as compare to ( $18.74\pm 0.52\%$ ,  $20.44\pm 0.42\%$ ) in group WB and water ratio (60:40 or 50:50). Therefore, group having WB and water (70:30) ratio incubated at 37°C for 72 hrs. has been selected for final fermentation.

Fungal fermentation of DORB significantly increased the CP content from 14.56 to 18.36% decreased the crude fibre content from 12.85% to 8.38%. Optimum conditions for the better visual growth of *Aspergillus niger* has been found in group having DORB and water (50:50) for 72 hrs incubation at 37°C. CP increased was highest in group DORB and water (50:50) which did not differ significantly ( $P>0.05$ ) to each other and NFE also did not differ significantly ( $P>0.05$ ) in

same group, however DM loss was significantly ( $P<0.05$ ) lowered ( $21.13\pm 0.31\%$ ) in group WB and water (50:50) as compare to ( $25.41\pm 0.62\%$ ,  $24.37\pm 0.37\%$ ) group WB and water ratio (70:30 or 60:40). Therefore group having WB and water (70:30) ratio incubated at 37°C for 72 hrs has been selected for final fermentation. It was concluded that the nutritional value of WB and DORB can be enhanced by fungal fermentation with *Aspergillus niger*.

Effect of different level of wheat bran (WB) with or without enzyme supplementation and fungal fermented wheat bran (FWB) on growth performance, immunocompetence and carcass traits in broiler chickens

Eight experimental diets were prepared by incorporating WB at 0, 5 and 7.5% levels (Diets- $D_1$ ,  $D_2$ ,  $D_3$ ); enzyme supplemented WB at 0, 5 and 7.5% levels ( $D_4$ ,  $D_5$ ,  $D_6$ ) and fermented WB at 5 and 7.5% levels ( $D_7$  and  $D_8$ ), respectively. All diets had been kept isocaloric and isonitrogenous in nature while CP was maintained 23% and 21%, ME 2800 and 3000 kcal/kg of feed for starting phase i.e., 0-21 days and finishing phase i.e., 21-42 days of age in broiler chickens diet, respectively as per BIS (1991).

Wheat bran employed in this study was analyzed to contain moisture 8.87%, DM 91.13%, CP 14.89%, EE 2.36%, CF 13.04%, TA 5.07%, NFE 64.64%, AIA 0.61%, Ca 0.36%, P 1.44% and GE 4607 kcal/kg. Fermented wheat bran (FWB) obtained by *Aspergillus niger* fermentation contained moisture 2.69%, DM 97.31%, CP 19.78%, EE 1.96%, CF 10.1%, TA 6.14%, NFE 62.02%, AIA 1.15%, Ca 0.28%, P 1.45% and GE 4560 kcal/kg. WB and FWB were also analyzed for aflatoxin which was found 0.004 ppm. The results of feeding trail showed that feed intake increased significantly ( $P<0.05$ ) in diet containing 7.5% WB without enzyme and in control as compared to 7.5% FWB. However, enzyme supplemented and unsupplemented group at 5%WB did not differ significantly ( $P>0.05$ ) other than 7.5% FWB group. Diet containing 5% WB without enzyme and control group showed significantly ( $P<0.05$ ) lowered body weight gain as compared to and other test diets. However, enzyme supplemented and FWB group did not differ significantly ( $P>0.05$ ) with each other. In starter phase (0-3 wks.) birds feed diet containing control and 5% WB without enzyme supplementation showed significantly ( $P<0.05$ ) poor FCR as compared to other test

diets. Over all 0-6 wks of age all test diets showed better FCR as compared to control.

## **5. DIETARY MANIPULATION OF EXTERNAL AND INTERNAL EGG QUALITY**

To study the effect of dietary chromium picolinate and Spirulina supplementation on egg production, egg quality and serum and egg cholesterol profile of laying hens

The experimental diet included three levels of dietary supplementation of chromium picolinate (0, 1000 and 2000 µg/kg diet) and three levels of Spirulina (0, 1.0 and 2.0 g/kg in diet) were fed to laying hens. The results of the study indicated that the organic form of chromium is effective in lowering yolk as well as liver cholesterol as well as serum lipid components. A combination of chromium (1000 µg/kg) and spirulina (2 g/kg) was best among all other dietary combinations of chromium and spirulina in reducing yolk cholesterol content in laying hens. Dietary supplementation of spirulina @ 1 g/kg diet was effective in increasing good cholesterol level (HDL) and reducing triglyceride level in the blood of laying hens.

## **6. MAXIMIZING NUTRIENT UTILIZATION AND WELFARE OF POULTRY THROUGH PRECISE NUTRIENT SUPPLY AND APPLICATION OF BIOTECHNOLOGY**

### **Effect of Ashwagandha (*Withania somnifera*) root powder in diet on welfare of coloured broilers during extreme summer**

In the process of understanding pathophysiology and developing packages for mitigation of heat stress, the welfare aspects of broiler chickens during extreme summer (May–June, Max temp. 38°C-43°C) on feeding diets with addition of ashwagandha (*Withania somnifera*) was studied. The fresh roots were collected, washed with distilled water, air dried under shed, powdered and stored in air tight container at room temperature till further use. Four dietary treatments were prepared by adding different levels of dried root powder (0, 0.1, 0.2 and 0.3% of diet) in broiler starting (0-3 wk) and finishing (3-6 wk) diets and each diet was fed to four groups of 8 birds each. The humoral immune response (HA titre to SRBC) of the experimental broiler chicks were analyzed (28<sup>th</sup> to 34<sup>th</sup> day of age). The cell mediated immune (CMI) response (foot web index to PHAP) was studied on 21<sup>st</sup> day. A total of 32 chicks (8 chicks/ treatment) were selected for cell mediated and humoral

immune-response. Packed cell volume, haemoglobin, differential leucocyte count, reduced glutathione and lipid peroxide level was measured. Oxidative stress factors (LPO and GSH were multiplied and then divided by PCV) were then calculated.

There was no significant difference in body weight gain (BWG) among dietary treatments during starting phase but there was significant (P<0.05) improvement in BWG during finishing phase with 0.1 or 0.2% ashwagandha in diet leading to statistically (P>0.05) improved BWG during overall growth phase (0-6 weeks) compared to control. Feed intake during overall growth phase was significantly lower (P<0.01) in diets with any level of ashwagandha than that of control. The feed conversion ratio during overall growth phase was significantly better (P<0.01) in 0.1% or 0.2% ashwagandha diet compared to control. Carcass traits remain comparable among different dietary treatments but breast yield was significantly higher in diet with ashwagandha compared to control with highest yield observed at 0.2% level. There oxidative stress factor (LPOxGSH/PCV) reduced significantly (P<0.01) on addition of ashwagandha in diet at any level. The cellular immune response did not differ but there was significant (P<0.01) improvement in humoral (SRBC) immune response on addition of ashwagandha at any level. Similarly, there was decrease (P<0.05) in H:L ratio at 0.1% level though the birds fed 0.2 or 0.3% ashwagandha had similar H:L ratio to that of control. The HSP 70 expression was significantly (P<0.01) up regulated in liver and down regulated in bursa, while no difference was observed in spleen. Addition of dried fresh root powder of ashwagandha (*Withania somnifera*) 0.1 to 0.2% was beneficial to improve performance and welfare (HL ratio, immuno-competence, oxidative stress profile) of coloured broiler chickens (0-42 d of age) during extreme summer (May-June, 38°C to 43°C).

### **Response of coloured broilers to dietary addition of geloi (*Tinospora cordifolia*) during extreme summer**

Performance of coloured broiler chickens fed diets with or without addition of Geloi (*Tinospora cordifolia*) during extreme summer (May-June, 38°C to 43°C) was assessed. Fresh plant stems were collected, washed, dried and then powdered. Dried powder of geloi (0, 0.1, 0.2 and 0.3% of diet) was mixed in practical broiler

starting (0-3 wk) and finishing (3-6 wk) diets. The immune response, packed cell volume, haemoglobin concentration, differential leucocyte count (DLC), reduced glutathione (GSH), lipid peroxide level were analyzed.

There was no significant difference in body weight gain during starting phase but the broilers fed diet with 0.1% geloi had higher ( $P<0.001$ ) gain during finishing and overall growth phases. Feed intake was lower ( $P<0.001$ ) and FCR improved ( $P<0.05$ ) on addition of geloi at any level. The yields of breast ( $P<0.05$ ) and drum stick ( $P<0.05$ ) increased with reduction of back yield ( $P<0.001$ ) on Geloi addition. The cell-mediated immune response, relative weight of immune organs, haemoglobin level, lipid peroxidase activities and oxidative stress factor did not differ among dietary treatments but humoral immune response against SRBC improved ( $P<0.001$ ) on addition of geloi at any level. Lower levels of reduced glutathione ( $P<0.05$ ) and H:L ratio ( $P<0.08$ ) were lowest at 0.3% level. The HSP 70 expression was significantly ( $P<0.01$ ) up regulated in spleen, while no difference was observed in liver or bursa. It was concluded that addition of dried fresh geloi (*Tinospora cordifolia*) stem powder in diet (0.1%) of growing coloured broilers is beneficial to improve growth, feed utilization efficiency, breast yield and welfare aspects of birds during extreme summer months.

#### **Welfare aspects of coloured broilers fed Sarpagandha (*Rauwolfia serpentina*) root powder through diet during extreme summer**

The welfare aspects of broiler chickens during extreme summer (May–June, 38°C–43°C) on feeding diets with addition of Sarpagandha (*Rauwolfia serpentina*) was studied. The fresh roots were collected, washed with distilled water, air dried, powdered and stored. Four levels of dried root powder (0, 0.1, 0.2 and 0.3% of diet) were mixed in broiler starting (0-3 wk) and finishing (3-6 wk) diets. The immune response was studied. The blood samples were collected after six weeks of age. The different parameters like total protein, alkaline phosphatase, heterophill to lymphocyte ratio (H:L), total cholesterol, haemoglobin, lipid peroxidase, reduced glutathione peroxidase and oxidative stress factor were studied.

There was no significant difference in body weight gain at any growth phase. Feed intake

was lower ( $P<0.001$ ) and FCR improved ( $P<0.001$ ) on addition of sarpagandha at any level. The haemoglobin level remained higher ( $P<0.05$ ) in broiler chicken fed sarpagandha at any level being highest at 0.3% level. Lipid peroxide level remained comparable but lower levels of reduced glutathione ( $P<0.05$ ) and oxidative stress factor ( $P<0.05$ ) were estimated in broiler chickens fed diets with any level being lowest at 0.3% level. The total protein, H:L ratio, triglycerides, total cholesterol, alkaline phosphatase and HL ratio did not differ statistically on addition of sarpagandha root powder. The HSP 70 expression was significantly ( $P<0.01$ ) up regulated in spleen, while down regulated in bursa and liver. Therefore, the results indicated that addition of Sarpagandha root meal in diet at 0.1 to 0.3% level improved feed utilization and welfare aspects of growing coloured broiler chickens (0-42 d of age) during extreme summer (May-June, 38°C to 43°C).

#### **Response of heat stressed coloured broilers to dietary addition of Amla (*Emblica officinalis*) during extreme summer**

Performance of coloured broiler chickens fed diets with or without addition of amla (*Emblica officinalis*) fruit powder during extreme summer (May-June, 38°C to 43°C) was assessed. Fresh fruit pulps were collected, air dried, and stored for use. Four diets were prepared by adding different levels of dried powder (0, 0.1, 0.2 and 0.3% of diet) in practical broiler starting (0-3 wk) and finishing (3-6 wk) diets. The cellular and humoral immune response, packed cell volume, haemoglobin concentration, differential leucocyte count (DLC), reduced glutathione (GSH), lipid peroxide level were analyzed.

The body weight gain due to dietary addition of *Emblica* fruit powder during 0-3, 3-6 and 0-6 wk of age remained statistically unchanged. Feed intake was lower ( $P<0.001$ ) in the broilers fed diet containing *Emblica* fruit powder at any level in comparison to control. The feed conversion ratio during 0-3 wk, 3-6 wk and 0-6 wk phase was better ( $P<0.001$ ) in diet with 0.2% *Emblica* fruit powder compared to control and other dietary treatments. The giblet, liver, gizzard, eviscerated yield and dressed yield differed among various treatments. The yields of breast ( $P<0.01$ ) was better on 0.1% *Emblica* fruit powder addition. The humoral immune response against SRBC, relative weights of bursa and spleen remained comparable, but cell-mediated

immune response improved ( $P < 0.01$ ) on addition of *Emblica* fruit powder at any level. The haemoglobin level, lipid peroxide and oxidative stress factor and H:L ratio remained comparable but lower levels of reduced glutathione ( $P < 0.01$ ) was estimated in broiler chickens fed diets with *Emblica* fruit powder being lowest at 0.1% level. The HSP 70 expression was significantly ( $P < 0.01$ ) up regulated in spleen as well as in liver. Addition of *Emblica* fruit powder in diets of broiler chickens (0-42 day of age) at the rate of 0.2% was beneficial to improve feed conversion efficiency and cell mediated immune response while addition of *Emblica* fruit powder at the rate of 0.1% was beneficial for reduction of reduced glutathione in extreme summer.

#### **Effect of feeding *Artemisia vulgaris* (mugwort or common wormwood) to broiler chickens during extreme winter**

Performance of broiler chickens fed diets with or without addition of *Artemisia vulgaris* (mugwort or common wormwood) leaf powder during extreme winter (Dec.-Jan., Min.  $6.6 \pm 0.48^{\circ}\text{C}$  to Max.  $19.4 \pm 0.65^{\circ}\text{C}$ ) was assessed. Fresh leaves were collected, air dried, powdered in an electrical grinder and stored in air tight container for use. Four dietary treatments were prepared by adding different levels of dried leaf powder (0, 0.1, 0.2 and 0.3% of diet) in practical broiler starting (0-3 wk) and finishing (3-6 wk) diets. The performance and cellular and humoral immune response were recorded.

Addition of *Artemisia* leaf meal reduced body weight ( $P < 0.01$ ) significantly during starting period but no significant difference was observed during finishing or overall growth phase. Feed intake reduced significantly ( $P < 0.01$ ) during all the phases on inclusion of *Artemisia* leaf meal at any level. Feed conversion efficiency, however, did not alter. The carcass traits and cut-up body parts did not change due to *Artemisia* inclusion in diet. The immune organs did not differ but cellular as well as humoral immune response improved significantly ( $P < 0.01$ ) in broilers fed any level of *Artemisia* leaf meal.

#### **Effect of feeding lysine and folic acid dense diets on growth performance and immune-competence of Japanese quails**

The performance of growing quails fed lysine (13, 15 and 17 g Lys/ kg diet) and folic acid (1, 2 and 3 mg/kg diet) dense diets was studied. Cell mediated immune (CMI) response

(PHAP) was studied on 21<sup>st</sup> day. The humoral immune response (HA titre to SRBC) of the experimental quails were analyzed (28<sup>th</sup> to 34<sup>th</sup> day of age), each on 8 quails per treatment. At the end carcass traits were recorded.

Addition of excess lysine was beneficial in improving body weight (201, 198 and 190 g) at 35 d of age or body weight gain during 0-21 days of age, feed conversion ratio (2.74, 2.84 and 2.94) and reduction of feed-cost per kg gain (Rs. 45.21, 46.36 and 47.58 in 17, 15 and 13 g Lys per kg diet, respectively) during 0-35 days of age of meat-type growing Japanese quails. However, additional folic acid in diet did not prove beneficial rather body weight gain decreased ( $P < 0.01$ ) with increased level of folic acid during 21-35 days of age. Folic acid or lysine dense diets did not influence eviscerated and breast yield. The cellular immune response did not differ but humoral immunity improved significantly ( $P < 0.05$ ) in lysine dense diets (15 g or 17 g Lys/kg).

### **7. MANAGEMENT OF MYCOTOXICOSIS IN POULTRY**

#### **Amelioration of aflatoxicosis in broiler chickens by BHT**

The effect of dietary BHT on the performance of broiler chickens was studied from 0-6 weeks of age. The birds were fed six experimental diets viz. (control, T<sub>1</sub>; 1 ppm aflatoxin (AF), T<sub>2</sub>; 1000 ppm BHT, T<sub>3</sub>; 2000 ppm BHT, T<sub>4</sub>; 1 ppm AF+1000 ppm BHT, T<sub>5</sub> and 1 ppm AF+2000 ppm BHT, T<sub>6</sub>).

During first week of age, the body weight gain in control (T<sub>1</sub>) remained comparable to those of other treatment groups however, the values were numerically lowest in AF fed group. During second week of age, the BWG in T<sub>1</sub> was significantly ( $P < 0.05$ ) higher than that of T<sub>2</sub> and remained almost similar in rest of the treatment groups. This indicated that the AF started depressing body weight gain in the second week itself. During third week of age, the BWG in T<sub>1</sub> was significantly ( $P < 0.05$ ) higher than those of T<sub>2</sub>, T<sub>4</sub>, T<sub>5</sub> and T<sub>6</sub> whereas, it was numerically higher than that of T<sub>3</sub>. During fourth and fifth weeks, the BWG in T<sub>1</sub> was comparable to those of T<sub>3</sub>, T<sub>4</sub>, T<sub>5</sub> and T<sub>6</sub> however, it was significantly ( $P < 0.05$ ) higher than that of T<sub>2</sub>. During sixth week, the BWG was comparable among various treatment groups except in T<sub>4</sub> where it was significantly ( $P < 0.05$ ) higher than those of other

treatment groups. In the case of overall BWG (1-6 weeks), the BWG in T<sub>1</sub> was significantly (P<0.05) higher than those of T<sub>2</sub>, T<sub>5</sub> and T<sub>6</sub> whereas, the BWG in T<sub>1</sub> was statistically comparable to those of T<sub>3</sub> and T<sub>4</sub>. Therefore, the BWG in non-AF fed treatment groups was significantly (P<0.05) higher than those of AF fed groups. In this study, 1 ppm total aflatoxins resulted in significant reductions in BWG however, this reduction was partially improved by the addition of 1000 and 2000 ppm dietary BHT. However, the addition of dietary BHT at these levels could not bring the BWG reductions equivalent to that of control. Also, the BWG in birds given either level of BHT alone, did not differ statistically however, the values were numerically higher than that of control. With regard to FC, during first week of age, the FC in T<sub>1</sub> was significantly (P<0.05) lower than that of T<sub>5</sub> and remained comparable to those of other treatment groups. However, during second and third weeks of age, no significant difference in FC of various treatment groups was recorded. During fourth week, FC in T<sub>1</sub> was significantly (P<0.05) higher than that of T<sub>2</sub> and remained comparable to those of other treatment groups. During fifth week, FC in T<sub>1</sub> did not differ significantly with those of other treatment groups. During sixth week, the FC in T<sub>1</sub> was significantly (P<0.05) higher than that of T<sub>5</sub> however, it remained comparable to rest of the treatment groups. In case of cumulative FC (1-6 week), the FC in T<sub>1</sub> was significantly (P<0.05) higher than those of T<sub>2</sub> and T<sub>5</sub> whereas, it was almost similar in rest of the treatment groups. Thus, the FC in non-AF fed treatment groups was higher than those of AF fed treatment groups. In this study the FC in T<sub>6</sub> was numerically less but did not differ significantly compared to control, indicating that the BHT supplementation along with AF fed groups tended to improve the FC. With regard to FCR, during first and second weeks of age, the FCR in T<sub>1</sub> was statistically (P<0.05) lower than that of T<sub>2</sub> and it was comparable to rest of the treatment groups. This indicated that AF contamination deteriorated feed efficiency from the first week itself. During third week, the FCR in T<sub>1</sub> was comparable to that of T<sub>3</sub> and significantly (P<0.05) lower than those of other treatment groups. However, during fourth, fifth and sixth weeks, no significant difference among FCR of various treatment groups was recorded. In case of cumulative FCR (1-6 week), the FCR in T<sub>1</sub> differed significantly (P<0.05) from that of T<sub>2</sub> and T<sub>3</sub> whereas, it remained

comparable to those of T<sub>4</sub>, T<sub>5</sub> and T<sub>6</sub>. Thus, AF contamination deteriorated the feed efficiency and these adverse effects on feed efficiency were reversed by BHT supplementation. With regard to biochemical parameters, the serum total protein concentration in T<sub>1</sub> was significantly (P<0.05) higher than those in T<sub>2</sub> and T<sub>5</sub> and remained comparable to those in T<sub>3</sub>, T<sub>4</sub> and T<sub>6</sub>. The protein concentration in T<sub>2</sub> was the lowest as compared to other treatment groups. Cholesterol content in T<sub>1</sub> were significantly (P<0.05) higher than that of T<sub>2</sub> and comparable to rest of the treatment groups. Uric acid content did not differ significantly among various treatment groups. BHT supplementation in AF contaminated groups reversed these parameters significantly and the values were almost comparable to that of control. The ASAT and ALAT activities in T<sub>1</sub> were statistically lower than that of T<sub>2</sub> and remained almost comparable to T<sub>3</sub>, T<sub>4</sub>, T<sub>5</sub> and T<sub>6</sub>. Significantly highest activities of these enzymes were recorded in T<sub>2</sub>. BHT supplementation in AF contaminated groups reversed these parameters significantly and was comparable to that of control group. It is thus concluded that dietary supplementation of BHT at 1000 and 2000 ppm levels provided intermediate alleviation in the adverse effects of 1 ppm total AF in terms of investigated parameters in broiler chickens.

### **Use of fumaric acid as mould inhibitor in poultry feed**

The effect of various concentrations of fumaric acid (0.00, 0.05, 0.10, 0.15, 0.20, 0.25, 0.30, 0.35, 0.40, 0.45 and 0.50 per cent) at four moisture levels (11, 13, 15 and 17 per cent) on aflatoxin production was studied for a period of one month. 50 g broiler feed was taken in 250 ml conical flask at above mentioned fumaric acid concentrations and moisture levels. The flasks were charged with spores of *Aspergillus parasiticus* NRRL 2999 and kept for a period of one month.

At 11% moisture level, none of the aflatoxins (B<sub>1</sub>, B<sub>2</sub>, G<sub>1</sub> and G<sub>2</sub>) were recorded at any of the fumaric acid concentrations including control indicating that moisture level is the first limiting factor for the production of aflatoxin.

At 13% moisture level, the biosynthesis of AFB<sub>1</sub> reduced from 0.04 ppm (control) to 0.030 ppm at 0.15% fumaric acid, whereas, the biosynthesis of AFB<sub>2</sub> reduced from 0.025 ppm (control) to 0.020 ppm at the same concentration of fumaric acid. Neither AFB<sub>1</sub> nor AFB<sub>2</sub> was

recorded at 0.20% fumaric acid. The biosynthesis of AFG1 and AFG2 decreased from 0.010 and 0.015 ppm to 0.005 ppm at 0.10 fumaric acid. Biosynthesis of total AF decreased from 0.090 ppm (control to 0.050 ppm at 0.15% fumaric acid. Complete inhibition of aflatoxins production at 13% moisture level was recorded at 0.20% fumaric acid concentration.

At 15% moisture level, the biosynthesis of AFB1 reduced from 0.392 (control to 0.175 ppm and that of AFB2 0.218 (control) to 0.035 ppm at 0.50% fumaric acid. Whereas, AFG1 and AFG2 biosynthesis reduced from 0.195 (control) to 0.035 ppm and 0.182 (control to 0.030 ppm, respectively at 0.35% fumaric acid concentration. Complete inhibition of AFG1 and AFG2 biosynthesis was recorded at 0.40% fumaric acid. In case of total AF, the biosynthesis of total AF reduced from 0.987 ppm (control) to 0.200 ppm at 0.50% fumaric acid. Therefore, for complete inhibition of AFs production, higher concentration of fumaric acid is required.

At 17% moisture level, the biosynthesis of AFB1 decreased from 0.539 to 0.302; AFB2, 0.005 to 0.160; AFG1, 0.219 to 0.068 and AFG2, 0.200 to 0.057 ppm at 0.50% fumaric acid concentration. The total AF biosynthesis reduced from 1.293 to 0.587 ppm at 0.50% fumaric acid concentration. Therefore, none of the AFs biosynthesis was inhibited completely at 15% moisture level and 0.50% fumaric acid concentration. For complete inhibition of AFs biosynthesis higher than 0.50% concentration of fumaric acid is required. It is thus concluded that at 13% moisture level, complete inhibition of AFs was achieved at 0.20% concentration of fumaric acid, however, at 15 and 17% moisture level, more than 0.50% concentration of fumaric acid is required for complete inhibition of AFs biosynthesis.

## **SUB PROGRAMME - (III) PHYSIOLOGICAL INTERVENTIONS TO ENHANCE AND SUSTAIN PRODUCTIVITY UNDER NORMAL AND STRESSED CONDITIONS**

### **1. STUDIES ON REPRODUCTIVE SYSTEM REMODELLING, STRESS RESPONSE AND AMELIORATION STRATEGIES DURING FORCED MOULTING IN WHITE LEGHORN HENS**

#### **Alternative welfare friendly method of moulting to feed withdrawal**

Forty eight healthy White Leghorn hens (72 weeks of age) from the same hatch and nearly similar body weight were taken randomly and were divided into three groups. The birds of group 1, group 2 and group 3 were force moulted by different concentrations of dietary organic Zinc (10,000 ppm, 15,000 ppm and 20,000 ppm) for 8 days. Four hens from each group were sacrificed on day 2, 4, 6, 8 days after zinc feeding. Organ weight i.e., ovary, magnum, isthmus and uterus were excised and weighed. Initial body weight and pre-slaughter weight was also recorded to determine the percent body weight regression. Results are summarized as follows:

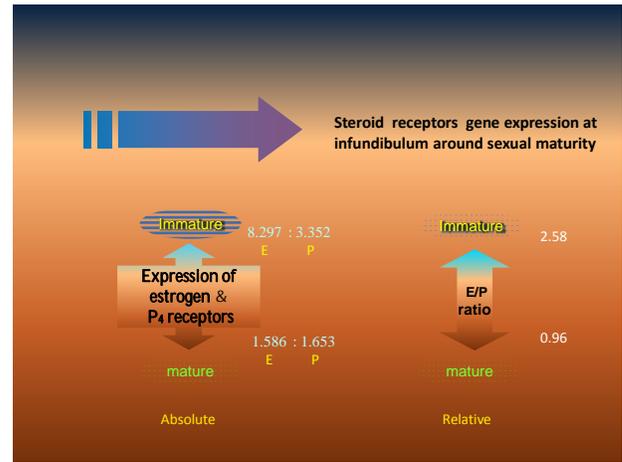
1. A higher (20%) body weight reduction was observed in birds allowed to feed with high zinc (20,000 ppm) as compare to other zinc concentration tested.
2. A similar pattern of reduction of weight in ovary, magnum, uterus and isthmus was also observed in the same group.

### **2. MOLECULAR MECHANISM OF OVA CAPTURING AND INTERVENTIONS TO IMPROVE EGG SIZE AND NUMBER DURING EARLY LAYING PHASE IN BROILERS**

#### **Multi-level causal factors identified**

Phytoestrogen induced predominance of progesterone over estrogen receptor expression (Progesterone-1.653 folds and estrogen-1.586 folds, with Estrogen (E): Progesterone (P) ratio being 0.96) at infundibulum indicating functional maturity of high body weight birds of infundibulum with respect to improved engulfing/capture of ovulated follicles in Fig. 15. In contrast estrogen receptor expression occurred several folds greater than that of progesterone receptors (estrogen-8.297 folds and progesterone-3.352 folds, with E: P ratio being 2.58) in infundibulum of immature low body weight birds broiler breeder hens in Fig. 16. A similar pattern was also reflected in the serum steroidal hormonal profile of breeder hens. Phytoestrogen resulted in lowered thyroidal status in broilers of high body weight and a reverse trend was induced in birds of low body weight, possibly because heavier birds have matured earlier and thereby reduced necessity for pro-metabolic hormones like thyroxin. On the other hand T3/T4 ratio is elevated in low body weight birds upon drug supplementation as there exists a need in them for attainment of

reproductive maturity. Dietary phytoestrogen significantly reduced serum cholesterol level to 109 mg/dl and 107 mg/dl, respectively as against controls of heavy body weight group (134 mg/dl). Additionally significant drop in serum total lipids was noticed in drug treated group. A non significant reduction in abdominal fat pad resulted due to the above treatment in heavy and low body weight birds. Taken together drug induced reduction in body fat composition could translate into better reproductive efficiency. Based on the results obtained on the gene expression of steroidal hormones, the maturation mechanism of infundibulum is presented in Fig. 17.



**Fig. 17:** Infundibulum maturity regulation at molecular level

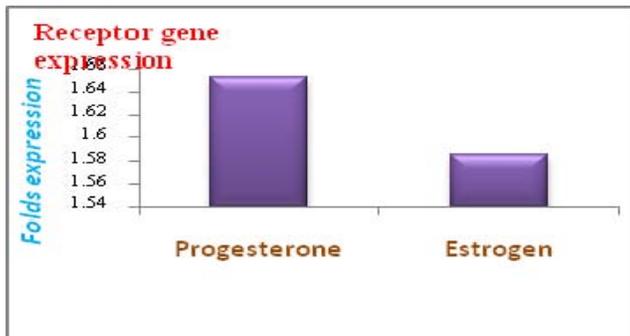
### Phytohormone induced remedial outcome on ovarian state of broiler hens

Phytoestrogen drug induced significant reduction in ovary weight of heavier full fed birds (HFD) thus minimizing the potential for excessive follicular growth and development which was significantly reflected in reduced presence of hierarchical yellow follicles as that of control (8.17 vs 11.33). Treatment of birds with phytoestrogen minimized internal laying (16.6% vs 50.0%) which was mainly occurring in birds of heavy body weight only. Besides, double hierarchy which was prevalent up to 58% in controls was lowered to 25% by drug supplementation.

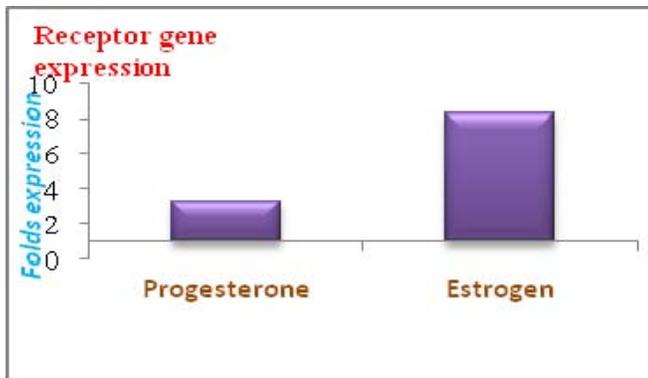
(HFC- High body full fed control, HFD- High body full fed Drug, LFC- Low body full fed control, LFD- Low body full fed Drug)



**Fig. 18:** Phytohormone induced reduction of abnormal hierarchical follicles in broiler breeder hens



**Fig.15:** Steroid receptor gene expression in infundibulum of mature in broiler breeder hens (HFD)



**Fig. 16:** Steroid receptor expression in infundibulum of immature in broiler breeder hens (LFD)

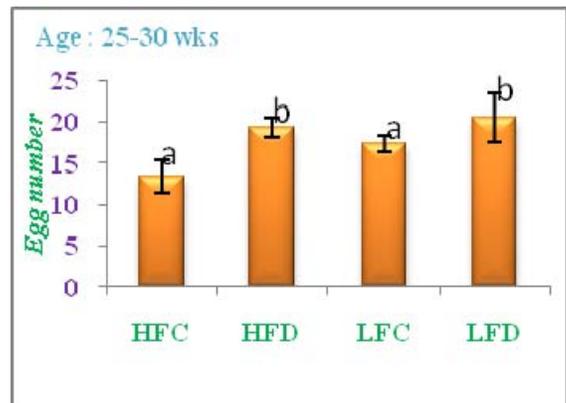
**Table 7: Impact of phytoestrogen on ovarian and abdominal fat pad status**

Groups	HFC	HFD	LFC	LFD
Ovary weight (Without yellow follicles) (g)	16.18 <sup>c</sup> ±1.71	9.47 <sup>ab</sup> ±1.03	12.43 <sup>b</sup> ±1.11	10.22 <sup>ab</sup> ±1.12
Oviduct weight (g)	65.92 ±3.18	80.87 ±2.57	77.77 ±1.95	76.41 ±1.52
No. of yellow follicles	11.33 <sup>bc</sup> ±0.80	8.17 <sup>a</sup> ±0.48	12.50 <sup>c</sup> ±0.67	9.67 <sup>ab</sup> ±0.42
Abdominal fat pad (g)	214.33 ±78.59	142.3 ±15.15	156.00 ±17.84	141.33 ±11.44

Thus rampant reproductive anomalies (Fig. 18) prevalent at the phase of initial laying period were checked by phytoestrogen supplementation. Also, follicular atresia in yellow ovarian follicles was observed at 58% in control was reduced to 16% by phytoestrogens as well as feed restriction irrespective of body weight of birds.

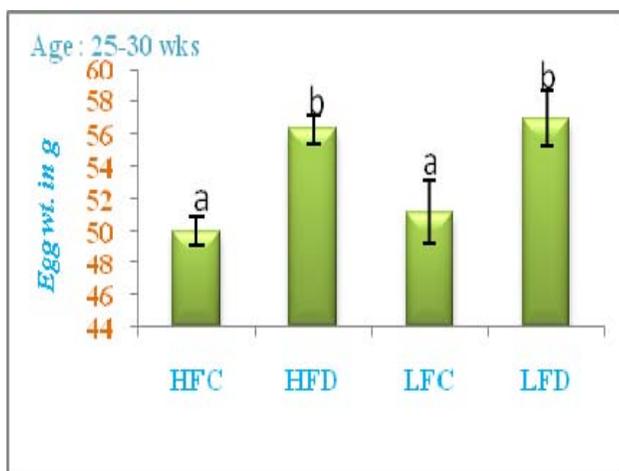
**Corrective impacts on egg production parameters of broilers**

Phytoestrogen treatment (HFD and LFD) advanced first egg earlier than control on the other hand feed restriction delayed in case of high body weight birds. Interaction between treatment and feed restriction has no apparent difference on age at sexual maturity.



**Fig. 20:** Effect of phytoestrogen on egg number of high and low body weight birds (25-30 wks)

Phytoestrogen feeding had beneficial impact on both egg size and number in both heavy and low body weight broilers (Fig. 19 and 20). Hen day egg production increased in treatment groups (HFD and LFD) in both high body weight and low body weight groups as compared to control groups (HFC and LFC). Feed restriction in high body weight group (HRC) increased hen day egg production as compared to control (HFC) but feed restriction in low body weight group (LRC) decreased hen day egg production as compared to control (LFC). Per cent egg production increased significantly in phytoestrogen (30 ppm) supplemented groups (HFD and LFD) as compared to control groups (HFC and LFC).



**Fig. 19:** Effect of phytoestrogen on egg weight of high and low body weight birds

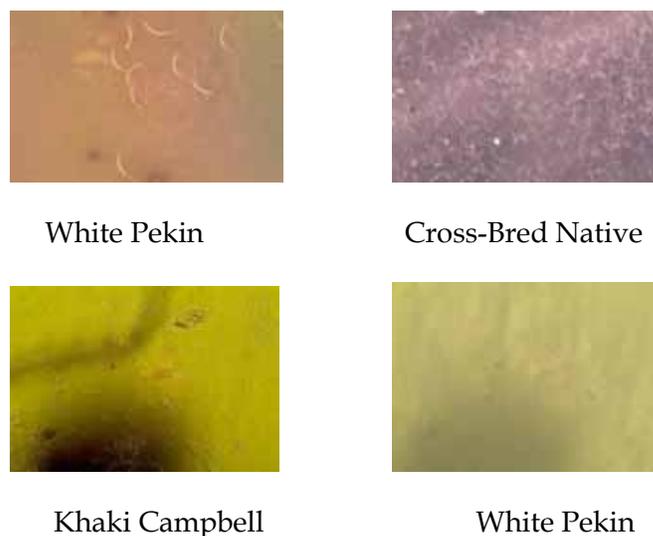
**Table 8:** Physical evaluation of semen

<i>Breed</i>	<i>Reaction time</i>	<i>Volume</i>	<i>pH</i>	<i>Mass activity (0-5 scale)</i>	<i>Conc.</i>	<i>Live %</i>	<i>HOST</i>
Khaki Campbell	4.86 (3.6-6.3)	0.38 (0.15-0.58)	7.23	4.78	254x10 <sup>8</sup>	92.45	83.65
White Pekin	3.12 (2.5-5.8)	0.68 (0.46-1.00)	7.41	4.55	222x10 <sup>8</sup>	94.66	76.54
Moti	3.45 (2.6-5.2.8)	0.72 (0.28-1.25)	7.36	4.60	267x10 <sup>8</sup>	89.33	74.32
Native	7.56 (5.2-10.8)	0.25 (0.15-0.55)	7.18	4.72	231x10 <sup>8</sup>	92.68	81.33

A multiple level (endocrinal, biochemical and molecular) basis for the lapses in attaining functional oviductal maturity of broilers was identified. These shortfalls were found to be favorably amenable by exogenous phytohormonal interventions showing better functional maturation of reproductive tract which in turn improves the production traits by checking the reproductive anomalies in breeding broiler hens. This study has paved way to fetch significantly more hatchable eggs of better size in broiler hens.

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

Comparative study of seminal attributes (Table 8) for Khaki Campbell, White Pekin, Moti (Muscovy type) and Native drakes were made under intensive system of rearing with two hours of swimming facility in water channel. Reaction time was recorded prior to semen collection to ascertain the sexual activeness of the breed/variety. Further, Hypo-osmotic swelling test (HOST) was conducted to ascertain the fertilizing ability of the spermatozoa (Fig. 21).



**Fig. 21:** Live and dead sperm (Vital staining)

### 4. EVALUATION AND IMPROVEMENT OF REPRODUCTIVE EFFICIENCY IN GUINEA FOWL AND CHICKEN

#### Normal reproductive indices of guinea fowls

One hundred healthy adult female guinea fowl from the same hatch and nearly similar body weight were taken randomly from the same flock. For the fertility and hatchability studies 45 male guinea fowl were also reared and maintained under uniform husbandry conditions in individual cages. They were allowed to get the normal / breeder ration and water *ad libitum* with 14 hr light per day. Estrogen hormone, various production traits and egg quality characteristics were examined. Results of this study are summarized as follow:

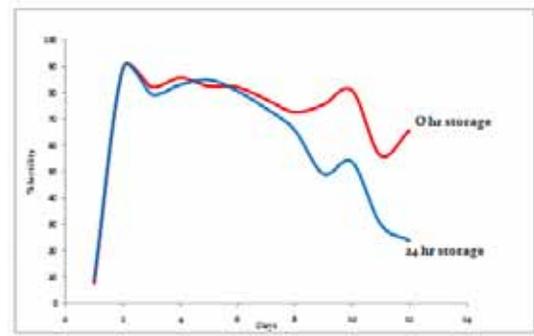
1. Body weight of day old keet, adult male and female pearl guinea fowl was observed  $24.22 \pm 1.11$ ,  $1620 \pm 55$  and  $1525 \pm 47$  g, respectively. This indicated nearly similar body weight in male and female guinea fowl.
2. Egg weight and body weight ratio was found 2.76%.
3. In guinea fowl sexual maturity ( $286 \pm 21$  days) was found very late as compare to chicken.
4. During the period of study (41-50 wk of age) egg production was found nearly similar in white (29.54 eggs) and lavender (28.69 eggs) variety of guinea fowl, whereas comparatively less egg production was recorded in pearl (23.55 eggs) variety.
5. A rapid increase in egg weight was found during first 10 days of egg production. During this period egg weight reached from  $32.23 \pm 0.65$  to  $40.00 \pm 1.10$ g. Nearly, similar pattern was followed by shape index, shell thickness, shell weight, yolk weight and albumen weight.
6. Yolk albumen ratio was found nearly constant (50-54%) throughout the study.
7. The shell, yolk and albumen percent were recorded  $13.19 \pm 0.07$ ,  $29.72 \pm 0.37$  and  $57.00 \pm 0.65$ , respectively.
8. Estrogen profile in plasma was found more than double in breeding season than non breeding season in all the three varieties of guinea fowl.

#### **Fertile period with stored and freshly ejaculated semen in WLH**

Twenty healthy cocks and 45 hen of WLH were taken from the same hatch and maintained in individual cages in the uniform husbandry condition. They were allowed to get the normal / breeder ration and water *ad libitum* with 14 hr light per day. Semen samples were collected during study period by abdominal massage method. Fertility of fresh and 24 hrs stored semen ( $3^{\circ}\text{C}$ ) was determined using A.I technique. Hens were inseminated once in 2 week with 100 million spermatozoa per insemination after diluting the semen with CARI diluent. Fertility of birds was assessed by incubating the eggs ( $99.5^{\circ}\text{F}$  temperature and 55-60% relative

humidity) layed by hens 2 to 14 days after intra-vaginal insemination. The eggs were examined after 9 days of incubation to determine fertilization. The per cent fertility was determined by the ratio of numbers of fertile eggs to the number of total egg set in the incubator. Sperm motility was recorded as per standard method. Following observations were recorded.

Using freshly ejaculated diluted (1: 3) and stored semen, maximum fertility (nearly 80% and above) was noticed between 3-7 days. Subsequently, reduced pattern was recorded between 8-15 days of the study. This reduction of fertility was comparatively more prominent in stored semen than fresh as apparent from the following Fig. 22.

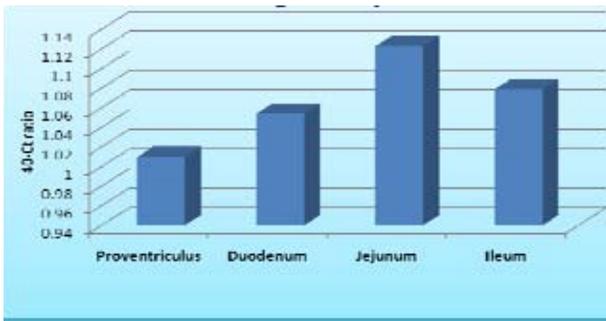


**Fig. 22:** Fertile period in WLH using fresh vs. 24 hour stored semen

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

#### **Heat shock protein 70 gene expression in GIT of chicken**

To study HSP 70 gene expression in GIT of non-stressed chickens, tissue samples from proventriculus, duodenum, jejunum and ileum were collected and processed. Total RNA was isolated from the tissue by TRIzol method. cDNA was prepared and stored at  $-20^{\circ}\text{C}$ . HSP 70 gene expression was standardized by employing real time PCR,  $\beta$  actin and GAPDH were taken as reference genes. The gene expression level of hsp 70 was observed highest in jejunum than ileum followed by duodenum and lowest in proventriculus in non-stressed broiler chicken as depicted in Fig. 23.



**Fig. 23:** HSP 70 expression in gastrointestinal segments of broiler chicks

### Digestive enzymes in broiler chickens under normal and heat stressed condition

The estimation of digestive enzymes viz pepsin, trypsin, amylase and lipase showed depletion in their activities in acutely heat stressed birds.

### SUB PROGRAMME - (IV) DEVELOPMENT OF HEALTH, SHELTER AND OTHER MANAGEMENT PACKAGES

#### 1. REARING AND MANAGERMENTAL PRACTICES OF TURKEY UNDER TROPICAL CLIMATE

##### Utilization of poultry slaughter byproduct meal (PSBM) in diets of growing turkey poults

The present study was conducted to assess the feeding value of poultry slaughter byproduct meal (PSBM) and its growth performance, immune response, mortality, carcass traits, blood biochemical and cost economics in growing Belts Ville White turkey poults. 0% (T<sub>1</sub>), 2.5% (T<sub>2</sub>), 5% (T<sub>3</sub>), 7.5% (T<sub>4</sub>) and 10% (T<sub>5</sub>) PSBM, replacing the soybean meal, were taken. Each dietary treatment was fed *ad lib* in two phases i.e., starter (0-4 wk, 28% CP and 2800 kcal ME/kg) and developer (4-8 wk, 26% CP and 2900 kcal ME/kg).

The poults fed 7.5% or 10% PSBM had significant less body weight (P<0.01), feed intake (P<0.01) and poorer feed conversion (P<0.001) compared to 0% PSBM (T<sub>1</sub>) diet at 8 wk of age, but these parameters did not differ among the diets containing 0% to 5% PSBM (Table 9).

Results on biochemical parameter indicated that with the increase in PSBM there was decrease in plasma protein level significantly (P<0.001). Plasma uric acid level in birds, at 8 weeks of age, fed 10% PBPM (T<sub>5</sub>) was

significantly (P<0.001) more than in other groups and was least at 0% PSBM fed birds. There was no significant difference (P<0.001) in total plasma cholesterol, HDL cholesterol, plasma glucose, alanine amino transferase (ALT) in between treatment groups. There was no significant difference in the immune response, weigh of immune organ (Table 10) and carcass traits among the different treatment groups. Studies on humoral and cellular immune response revealed that there was no adverse effect of feeding of PSBM on the immuno-competence of growing turkey poults. No mortality was observed in any of the treatment group throughout the experiment. Therefore, it indicated that the PSBM had no toxic effect. These observations suggested that inclusion of poultry slaughter byproduct meal (PSBM) up to 5% in diet replacing soybean meal had no adverse effect on body weight, feed intake and feed utilization efficiency but at .higher levels (7.5 or 10%) of inclusion of PSBM as a source of protein decreased the body weight gain of growing turkey poults. Therefore, poultry slaughter byproduct meal can safely and effectively be incorporated up to 5% level without adverse effect on immuno-competence. Inclusion of PSBM was at the rate of 5% found to be effective in decreasing the feed cost per kg live weight gain, and thereby will be economic for profitable turkey production.

#### 2. POULTRY REARING PRACTICES AT HIGH ALTITUDE

##### To study the rearing systems of commercial broilers (Dhanraja) at the altitude of about 8000 ft during rainy season

Result of the present investigation showed that there was significant improvement in biweekly body weight, body weight gain, FCR and survivability of Dhanraja (commercial broiler of CARI) birds when reared under cage system (Table 11) during rainy season. However, litter and cage systems of rearing did not influence carcass yield, cut-up parts and yield of various organs during rainy season (Table 12). It is concluded that commercial broiler can be reared under cage system for better growth and survivability at high altitude during rainy season.

**Table 9:** Effect of feeding of poultry slaughter byproduct meal at various levels on growth performance of growing (0 to 8 wk) turkey poult

<i>Treatments</i>	<i>T<sub>1</sub></i>	<i>T<sub>2</sub></i>	<i>T<sub>3</sub></i>	<i>T<sub>4</sub></i>	<i>T<sub>5</sub></i>
<i>Biweekly body weight</i>					
0 wk	50±0.27	51±0.41	51±0.38	51±0.32	50±0.23
2 wk**	239 <sup>c</sup> ±0.96	239 <sup>c</sup> ±0.92	240 <sup>c</sup> ±0.81	230 <sup>b</sup> ±0.90	224 <sup>a</sup> ±0.67
4 wk**	633 <sup>d</sup> ±2.02	631 <sup>cd</sup> ±1.88	628 <sup>c</sup> ±1.58	619 <sup>b</sup> ±1.25	592 <sup>a</sup> ±1.79
6 wk**	1072 <sup>d</sup> ±5.13	1062 <sup>d</sup> ±8.17	1045 <sup>c</sup> ±5.22	1012 <sup>b</sup> ±4.57	981 <sup>a</sup> ±3.99
8 wk**	1703 <sup>c</sup> ±5.33	1697 <sup>c</sup> ±7.75	1694 <sup>c</sup> ±7.75	1659 <sup>b</sup> ±8.57	1609 <sup>a</sup> ±6.19
<i>Body weight gain (wk)</i>					
0 to 4**	583 <sup>d</sup> ±2.61	580 <sup>cd</sup> ±2.48	577 <sup>c</sup> ±2.59	558 <sup>b</sup> ±2.4	542 <sup>a</sup> ±2.3
4 to 8**	1072 <sup>b</sup> ±7.39	1067 <sup>bc</sup> ±14.2	1075 <sup>bc</sup> ±12.42	1038 <sup>bc</sup> ±14.41	987 <sup>a</sup> ±8.59
0 to 8**	1655 <sup>b</sup> ±10	1647 <sup>bc</sup> ±16.68	1652 <sup>bc</sup> ±15.01	1593 <sup>bc</sup> ±16.92	1529 <sup>a</sup> ±10.89
<i>Feed intake</i>					
0 to 4**	918 <sup>b</sup> ±1.59	918 <sup>b</sup> ±1.05	916 <sup>b</sup> ±1.07	915 <sup>b</sup> ±1.56	847 <sup>a</sup> ±2.12
4 to 8**	2741 <sup>b</sup> ±0.73	2738 <sup>b</sup> ±1.98	2739 <sup>b</sup> ±0.8	2737 <sup>b</sup> ±1.1	2589 <sup>a</sup> ±1.48
0 to 8**	3660 <sup>b</sup> ±2.32	3655 <sup>b</sup> ±3.03	3656 <sup>b</sup> ±1.87	3652 <sup>b</sup> ±2.56	3437 <sup>a</sup> ±3.6
<i>FCR</i>					
0 to 4**	1.57 <sup>a</sup> ±0.01	1.58 <sup>a</sup> ±0.01	1.58 <sup>ab</sup> ±0.05	1.60 <sup>c</sup> ±0.01	1.62 <sup>c</sup> ±0.01
4 to 8**	2.53 <sup>a</sup> ±0.10	2.54 <sup>ab</sup> ±0.02	2.55 <sup>ab</sup> ±0.02	2.59 <sup>c</sup> ±0.010	2.61 <sup>c</sup> ±0.02
0 to 8**	2.19 <sup>a</sup> ±0.01	2.23 <sup>a</sup> ±0.005	2.21 <sup>a</sup> ±0.01	2.25 <sup>b</sup> ±0.01	2.31 <sup>c</sup> ±0.01

Values bearing different superscripts in a row differ significantly (P<0.01)

**Table 10:** Effect of feeding of poultry slaughter byproduct meal at various levels on immunocompetence and weight of immune organ of growing turkey poult at 8 weeks

<i>Treatments</i>	<i>T<sub>1</sub></i>	<i>T<sub>2</sub></i>	<i>T<sub>3</sub></i>	<i>T<sub>4</sub></i>	<i>T<sub>5</sub></i>
<i>Wt. of immune organ (g)</i>					
Bursa	246±3.8	250±3.7	249±2.5	241±4.8	239±5.3
Thymus	225±3.7	227±3.4	227±3.2	219±4.4	218±4.9
Spleen	219±3.8	218±3.2	218±2.2	211±4.2	203±4.7
<i>Humoral immune response (response to SRBC)</i>					
5 <sup>th</sup> DPI	9.14±0.59	9.14±0.40	9.42±0.29	9.14±0.40	9.28±0.47
10 <sup>th</sup> DPI	4.28±0.60	3.85±0.34	4.42±0.52	4.14±0.26	3.85±0.45
<i>Cell mediated immunity</i>					
Foot web index (mm)	0.31±0.05	0.31±0.03	0.31±0.04	0.30±0.08	0.30±0.07

**Table 11:** Body weight, body wt. gain, feed intake, feed conversion ratio and survivability of CARIBRO Dhanraja under two different systems of rearing at high altitude

<i>Parameter</i>		<i>Litter system</i>	<i>Cage system</i>
Biweekly body wt. (g)	0 wk	44.93±0.34	44.3±0.30
	2 wk**	266.4±3.87	308.3±6.22
	4 wk**	740.8±6.20	879±7.65
	6 wk**	1387.2±11.63	1476.3±13.60
	8 wk**	1693.2±17.45	1895.6±12.60
Body wt. gain (g)	0 - 4 wk**	697.4±6.61	834.7±7.61
	4 - 8 wk**	952.4±17.49	1016.7±14.06
	0 - 8 wk**	1649.8±17.59	1851.4±12.63
Feed intake (g)	0 - 4 wk	868.6±5.2	880.7±3.15
	4 - 8 wk**	2708.9±23.47	2655.8±47.7
	0 - 8 wk**	3577.2±39.23	3536.6±48.05
Feed conversion ration	0 - 4 wk**	1.25±0.11	1.15±0.01
	4 - 8 wk**	2.89±0.55	2.64±0.62
	0 - 8 wk**	2.18±0.25	1.91±0.23
Mortality percentage	0-8 wk	4	7

\*Correlation is significant at P<0.0

Values are mean ± SE of sixty observations

**Table 12:** Carcass quality parameter, cut up parts and organ mass of CARIBRO Dhanraja under two different systems of rearing at high altitude

<i>Traits</i>		<i>Cage system</i>	<i>Litter system</i>
Carcass quality parameter	Defeather yield	82.21±1.12	81.92±1.4
	Evisceration %	66.35±0.64	64.21±0.43
	Thigh %	9.34±0.25	9.48±0.31
Cut-up parts	Drumstic %	9.61±0.41	9.72±0.31
	Breast %	15.34±1.32	14.38±1.36
	Back %	15.67±0.34	15.3±0.24
	Neck%	4.35±0.25	4.52±0.27
	Wing %	6.1±0.23	6.3±0.24
Organs mass	Heart	0.54±0.03	0.53±0.06
	Liver	1.82±0.04	1.72±0.05
	Gizzard	2.25±0.07	2.24±0.04
	AFP %*	0.66±0.3	0.47±0.1

\*Abdominal fat pad

Results on biochemical parameter indicated that with the increase in PSBM there was decrease in plasma protein level significantly (P<0.001). Plasma uric acid level in birds, at 8 weeks of age, fed 10% PBPM (T<sub>5</sub>) was significantly (P<0.001) more than in other groups and was least at 0% PSBM fed birds. There was no significant difference (P<0.001) in total

plasma cholesterol, HDL cholesterol, plasma glucose, alanine amino transferase (ALT) in between treatment groups. There was no significant difference in the immune response, weigh of immune organ (Table 10) and carcass traits among the different treatment groups. Studies on humoral and cellular immune response revealed that there was no adverse

**Table 13: Hen housed egg production (%) and average egg weight (g) in different cage system**

<i>Treatments</i>		<i>18-20 wk</i>	<i>20-22 wk</i>	<i>22-24 wk</i>	<i>24-26 wk</i>	<i>26-28 wk</i>	<i>28-30 wk</i>
Hen house egg production (%) **	Litter system	77.64±1.26	73.50±5.21	75.71±4.47	76.07±1.17	74.07±0.93	69±4.79
	Cage system	84.52±1.45	83.92±10.17	80.07±3.95	78.35±.83	80.92±2.55	78.25±0.82
Egg weight	Litter system	54.4±0.3	53.21±0.3	53.78±0.5	52.6±0.4	52.2±0.3	52.6±0.3
	Cage system	54.1±0.3	53.51±0.3	53.38±0.5	52.02±0.4	51.2±0.3	51.1±0.3

\*Correlation is significant at P&lt;0.001

Values are mean ± SE of hundred observations

**Table 14: FCR for kg of egg and FCR for dozen of egg produced in different cage system**

<i>Treatments</i>		<i>18-20 wk</i>	<i>20-22 wk</i>	<i>22-24 wk</i>	<i>24-26 wk</i>	<i>26-28 wk</i>	<i>28-30 wk</i>
FCR/kg eggs**	Litter system	3.14±0.54	3.08±0.23	3.01±0.30	2.79±0.27	2.98±0.23	2.90±0.48
	Cage system	2.72±0.35	2.89±0.33	2.71±0.23	2.56±0.29	2.36±0.24	2.61±0.14
FCR/dozens of eggs**	Litter system	2.1±0.33	2.07±0.41	2.02±0.30	1.88±0.20	2.02±0.15	1.95±0.12
	Cage system	1.84±0.25	1.94±0.60	1.82±0.16	1.72±0.23	1.70±0.10	1.75±0.50

\*Correlation is significant at P&lt;0.001

Values are mean ± SE of hundred observations

effect of feeding of PSBM on the immuno-competence of growing turkey poults. No mortality was observed in any of the treatment group throughout the experiment. Therefore, it indicated that the PSBM had no toxic effect. These observations suggested that inclusion of poultry slaughter byproduct meal (PSBM) up to 5% in diet replacing soybean meal had no adverse effect on body weight, feed intake and feed utilization efficiency but at higher levels (7.5 or 10%) of inclusion of PSBM as a source of protein decreased the body weight gain of growing turkey poults. Therefore, poultry slaughter byproduct meal can safely and effectively be incorporated up to 5% level without adverse effect on immuno-competence. Inclusion of PSBM was at the rate of 5% found to be effective in decreasing the feed cost per kg live weight gain, and thereby will be economic for profitable turkey production.

## 2. POULTRY REARING PRACTICES AT HIGH ALTITUDE

### To study the rearing systems of commercial broilers (Dhanraja) at the altitude of about 8000 ft during rainy season

Result of the present investigation showed that there was significant improvement in biweekly body weight, body weight gain, FCR and survivability of Dhanraja (commercial broiler of CARI) birds when reared under cage system (Table 11) during rainy season. However, litter and cage systems of rearing did not influence carcass yield, cut-up parts and yield of various organs during rainy season (Table 12). It is concluded that commercial broiler can be reared under cage system for better growth and survivability at high altitude during rainy season.

## **To study the rearing systems of commercial layer at the altitude of about 8000 ft.**

Hen housed egg production in cage system was significantly higher ( $P < 0.05$ ) than those housed on litter system (Table 13). However, no difference was observed in the egg weight of those birds. FCRs for kg of egg or for dozen of eggs produced were significantly better in cage system of rearing (Table 14). It is concluded that commercial layer can be reared under cage system for better hen housed egg production and feed conversion ratio at high altitude.

### **3. SURVEILLANCE AND MONITORING OF POULTRY DISEASES AND IMPLEMENTATION OF BIO-SECURITY MEASURES INCLUDING VACCINATION FOR ACHIEVING BETTER SURVIVABILITY AND PRODUCTIVITY IN CARI BIRDS (Service Project)**

Poultry species such as chickens (layer, broiler, desi fowl), turkey, quail and guinea fowl maintained at this institute were provided preventive as well as therapeutic health treatment. The health programmes for different poultry species were formulated based on regular monitoring and sero-surveillance of diseases, diagnosis of disease based on clinical signs, post-mortem findings and identification of pathogens. Depending upon the sero-surveillance and immunity status of the birds, the health programme for different species of poultry was redesigned from time to time after taking into account the prevailing disease/infection, extrinsic as well as intrinsic factors and other factors affecting disease incidence. Biosecurity measures were evaluated regularly and efforts were made to augment these measures from time to time as per the need.

Therapeutic and preventive treatments were administered based on to prevent or to control the prevailing disease/infection which was designed keeping in view immunity status of the birds. Deworming was carried out in different poultry species as per the schedule and birds were administered vitamins, electrolytes and immunostimulants before and post-deworming periods to relieve the stress of deworming. Hepatotonics, gut acidifiers, antibiotics, vitamins, minerals, probiotics, anti-coccidial drugs, dewormers, electrolytes, immuno-modulators and water sanitizers were given to the birds as therapeutic or prophylactic agents to prevent the infection/ disease. Besides, vaccine programme

was monitored regularly by assessing antibody titre against a particular disease and after assessing the vaccinal immunity, the vaccine programme was re-designed from time to time. To avoid the problem of bacterial resistance development and to prevent residual effect of antibiotics in poultry egg and meat, the use of antibiotics especially in feed was reduced both from human health point of view as well as for environmental safety.

Surveillance of *Salmonella* in poultry birds was carried out regularly with conventional PCR as well as by real-time PCR techniques using genus specific primers of *invA* gene of *Salmonella*. Besides, poultry drinking water and feed samples were also screened regularly for assessment of microbiological quality. In addition, bio-security measures of the farm premises as well as all in all the poultry sheds were augmented keeping in view the threat of emerging diseases/ disease causing agents which included provision foot dips at the entrance of main gate of the experimental farm as well as different poultry sheds. Besides, poultry wastes generated from hatchery, processing plant and dead birds was disposed off hygienically by burning in incinerator which has helped in breaking host-microorganisms-environment cycle so as to prevent the spread of any infectious disease causing agents and to protect the environment. Disinfection of all the poultry sheds was carried out regularly during presence of birds and a complete disinfection procedure was put in place to destroy the disease causing agents after the termination of productive cycle of a particular batch of poultry species. Regular disinfection procedures were in place in areas surrounding experimental sheds, experimental hatchery, processing unit, post-mortem unit and marketing centre. Coccidiosis, colibacillosis and chronic respiratory disease were encountered sporadically and these were controlled effectively using effective anticoccidial/antimicrobial drugs along with multivitamins, immune-modulators and electrolytes.

### **4. SURVEILLANCE AND MONITORING OF DUCK DISEASES AND THEIR BIOSECURITY MEASURES (Service Project CARI Regional Centre)**

A total of 736 duck and ducklings (adult duck-173, grower-163 and duckling-400) died during this period. Total yearly population of the 12 months was 7879. The birds day round the

year at risk was 238514. The overall mortality revealed to be 9.34% (Equivalent average death rate per 1000 duck days at risk, EADR=3.085) of which majority death in duckling (up to 5-7 weeks of age) 5.08% (EDAR=1.6770), grower up to 18 weeks 2.07% (EADR=0.6833) and adult 2.19% (EADR=0.7253). Month wise highest mortality observed in April (38.74%, EDAR 12.8811), followed by November (12.45%), May (12.36), October (7.08%), January (6.25%), December (5.8%), June (4.98%), February (1.76%), August (1.75%), July (1.35%), September (1.01%), March (0.39%). Breed wise, highest mortality was observed in Khaki duckling in April (195, 48%) also in Khaki grower highest mortality was found in April (70, 17.5%). The Khaki birds were more susceptible to death during early ages. Age wise, highly susceptible group found to be duckling followed by adult and least to grower ducks.

Of the total deaths, highest deaths were due to gastrointestinal disorders followed by predation (132, 17.93%), debility (110, 14.94%), septicemia (104, 14.13%), inanition (83, 11.27%), pneumonia (35, 4.75%), lesion obscured (28, 3.80%), hepatitis (20, 2.71%), egg band (14, 1.90%), corneal opacity (13, 1.76%), cannibalism (12, 1.63%), stampede (11, 1.49%), heat stress (6, 0.81%), drowning (5, 0.67%), organ rupture (5, 0.67%), impaction, nephritis (3 each, 0.40%) and other (6, 0.81%).



*Moti ducks*



*White Pekin duck at RC, CARI*



*Pericarditis on septicemia*



*Hepatitis with pus formation*

**Isolation and identification of bacteria:** A number of 15 samples of fecal and internal organ like kidney, liver samples from dead and ailing ducks were found *Proteus mirabilis* by microscopical, cultural, biochemical and molecular characterization (sequencing).

**Seroprevalence of duck salmonellosis:** A total of 188 sera samples of ducks were screened by agglutination test against Salmonella antigen (*Salmonella pullorum*) and 12 samples were found positive (6.38%).

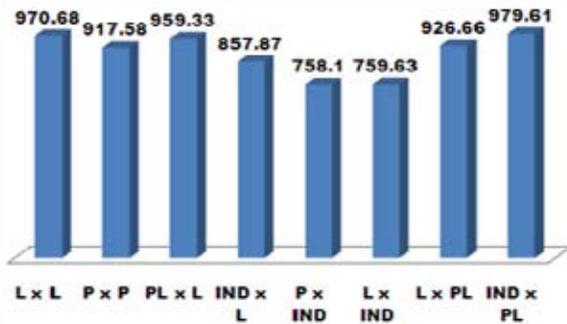
### **SUB PROGRAMME - (V) DEVELOPMENT OF POULTRY GERMLASM AND PACKAGE OF PRACTICES FOR RURAL POULTRY**

#### **1. IMPROVING GUINEA FOWL FOR LOW INPUT POULTRY PRODUCTION SYSTEM**

An indigenous guinea fowl population was introduced in the experimental guinea fowl unit by collecting the fertile eggs from one of the guinea fowl rearing pocket of Uttar Pradesh i.e., District Allahabad. This population was maintained and evaluated under intensive system along with the existing improved guinea fowl varieties. During the period under report, three improved populations namely Pearl (P), Lavender (L) and White (W); one cross bred population i.e. Pearl x Lavender (PL) and one indigenous population (IND) were used to produce different purebred and crossbred groups. All the populations were reared on deep litter under uniform conditions of feeding, management and disease control.

A total of 7459 eggs were set and 5975 eggs were found to be fertile giving an average fertility of 80.10%. A total of 3950 keets were hatched and the overall hatchability was 52.96% and 66.11% on total eggs set and on fertile eggs set basis, respectively. The populations differed significantly for the body weight among themselves at all weeks of age. Lavender purebred showed significantly higher body

weight than Pearl purebred for 12<sup>th</sup> week body weight (Fig. 24).



**Fig. 24:** Twelfth week body weight in different purebreds and crossbreds guinea fowl populations

Among crossbreds, maximum 12th week body weight was observed in crosses from indigenous male and PL females, followed by PL x L cross and L x PL cross. However, when indigenous populations were used as female with either of the purebred i.e. Pearl or Lavender, body weights were significantly reduced, however in reciprocal combinations, the body weights were comparable to the improved purebreds or crosses of purebreds. A total of 126 guinea fowl birds from different genetic groups were used to study the carcass yield between 13<sup>th</sup> to 14<sup>th</sup> weeks of age. Genetic groups did not differ significantly for total per cent eviscerated yield as well as total per cent loss.

## 2. EVALUATION AND MAINTENANCE OF NATIVE CHICKEN GENETIC RESOURCES AND THEIR UTILIZATION

Evaluation and maintenance of native breeds: A total of 1010 Aseel (Peela), 972 Kadakanath, 2952 CARI Red, 220 Aseel (Kagar) and 509 Ankaleshwar were hatched and reared. The fertility ranged from 53.78% in Kadakanath to 80.39% in Aseel (Peela). Similarly hatchability on total egg set ranged from 42.05 (in Kadakanath) to 68.98% (in Aseel Peela) and on fertile egg set from 78.17% in Kadakanath to 85.80 in Aseel Peela. Production performance of the Aseel (Peela), Kadakanath, CARI Red Aseel (Kagar) and Ankaleshwar (Table 15). A total of 9066 CARI Nirbheek, 11677 Hitcari, 4120 CARI Shyama and 3528 Upcari chicks were produced and supplied to various NAIP projects and KVK's for rural poultry production. In addition 891 fertile eggs

and 2843 day old chicks of parent lines were supplied.

Nicobari breed (Brown as well as Black variety) was introduced in Experimental Desi Fowl unit of CARI from Port Blair (A&N). The fertility was 76.15%, whereas hatchability on TES and FES were 56.58 and 74.29%, respectively. In black variety, body weight at day old, 8, 16, 20, 24, 32, 36 weeks of age were 31, 509, 1153, 1532, 1761, 2021 and 2078 g, respectively in males and 29, 464, 889, 1145, 1389, 1511 and 1523 g in females. Similarly, in yellow variety, corresponding weights were 29, 392, 957, 1288, 1504, 1821 and 1896 g in males and 29, 380, 761, 990, 1233, 1380 and 1412 g in females. Black variety weighed significantly heavier than yellow variety at all the ages in both the sexes. Regarding egg production traits, egg weight seemed to be more in black variety, whereas for egg number, varieties did not differ much (Table 16).

**Improvement of egg type white plumage Naked neck and Frizzle lines:** The egg type white plumage naked neck and frizzle lines were continued to be improved. A total of 641 chicks of Naked neck and 695 chicks of Frizzle line were hatched and evaluated. The fertility and hatchability on TES and FES were 71.16, 46.78 and 65.64 % respectively for Naked neck and the corresponding figure for Frizzle line were 78.79, 59.65 and 75.70 %. The naked neck population had more body weight, more egg weight and more part period egg production than the frizzle population (Table 17).



**Table 15:** Production performance of native breeds of chicken

<i>Breed</i>	<i>ASM (Days)</i>	<i>20 WK BW (g)</i>	<i>40 WK BW (g)</i>	<i>EP 40 (Number)</i>	<i>40 WK EW (g)</i>
Aseel (Peela)	193.73 ± 1.43	1070.42 ± 10.83	1791.30 ± 18.06	53.77 ± 1.20	48.87 ± 0.87
Kadakanath	191.30 ± 0.97	1023.03 ± 16.37	1366.74 ± 17.72	60.32 ± 1.44	43.10 ± 0.37
Ankaleshwar	166.51 ± 1.32	1039.23 ± 25.09	1419.36 ± 36.75	72.34 ± 2.01	43.75 ± 0.53
CARI Red	186.25 ± 1.93	1201.52 ± 22.19	1721.11 ± 19.18	55.31 ± 1.22	52.89 ± 0.59

**Table 16:** Production performance of Nicobari chicken

<i>Variety</i>	<i>ASM (Days)</i>	<i>20 WK BW (g)</i>	<i>32 WK BW (g)</i>	<i>40 WK BW (g)</i>	<i>EP 40 (Number)</i>	<i>40 WK EW (g)</i>
Brown	174.60 ± 2.55	1051.00 ± 36.69	1472.30 ± 53.03	46.95 ± 1.13	47.95 ± 0.97	66.70 ± 2.62
Black	164.80 ± 1.58	1159.27 ± 21.91	1568.39 ± 30.22	47.24 ± 0.63	47.44 ± 0.84	73.96 ± 2.51

**Table 17:** Production performance of Naked neck (NN) and Frizzle birds

<i>Genetic group</i>	<i>ASM (days)</i>	<i>BW 20 (g)</i>	<i>BW 40 (g)</i>	<i>BW 72 (g)</i>	<i>EW 40 (g)</i>	<i>EW 72 (g)</i>	<i>EP 40 (no)</i>	<i>EP 72 (no)</i>
NN	153.42 ± 0.78	1004.56 ± 12.12	1365.72 ± 18.51	1503.75 ± 27.83	51.67 ± 4.78	54.08 ± 6.03	99.63 ± 2.07	216.86 ± 7.22
Frizzle	160.71 ± 2.32	903.65 ± 23.51	1235.94 ± 28.70	1352.17 ± 34.15	52.85 ± 11.17	52.09 ± 20.13	89.23 ± 3.41	219.00 ± 7.36

## **Molecular characterization of important candidate genes hosted in native fowl breeds including their functional genomics, mapping and sequence characterization**

The Kadakanath chicken breed has been utilized as the source for generating a resource population involving the WLH and WR breeds, for mapping of the 'Fm' gene using DNA markers. Under the work done in 2010-11, a distinct advanced inter-cross population has been generated which is segregating for the 'Fm' gene and its alternate allele 'fm'. The speciality of this population is that it enables the evaluation of the 'Fm' variants without the impact of the 'Id' gene which is present in the WLH layer line.

Similar strategic introduction of the 'id' allele into the WLH line; 'IWH' has been accomplished during the year: 2010-11, where the 'id' allele has been fixed into a WLH layer base, which can be used specifically to evaluate the impact of 'id' gene on the Dermal melanin deposition in the host, *vis a vis* the impact of 'Fm' gene, both individually as well as in combinations. The initial results from analysis of the above resources indicate that the 'id' gene is capable of inducing very low level of pigmentation in the shank of the host and not in the skin. This would then conclude that Fm's role in inducing the pigmentation in host has more distinct role in the host than that of 'id' gene.

### **PROGRAMME 2**

#### **PROCESSING, VALUE ADDITION, PRODUCT SAFETY AND QUALITY PARAMETERS**

##### **SUB PROGRAMME – (I) STANDARDIZATION OF PROTOCOLS OF PRODUCTS/BY-PRODUCTS HANDLING AND PROCESSING IN UNORGANIZED SECTOR**

##### **1. PROCESSING AND SHELF-LIFE ASSESSMENT OF EGG-BASED FINISHED PRODUCTS**

###### **Formulation and processing methodology**

Several trials were conducted to standardize the formulation and processing methodology of egg cutlet. Based on the organoleptic evaluation results of initial trails, 3 blends were finally formulated which contained egg and minced chicken meat at 42 and 40 (blend I), 38.5 and 43.5 (blend II), and 32 and

50% (blend III), respectively. Grated cheese, onion paste, spice mix, refined wheat flour, mustard powder, salt, white vinegar and soy sauce were used at 6.7, 6.0, 2, 2, 0.10, 0.8, 0.2 and 0.2% levels, respectively in all formulations. Minced chicken meat was mixed with salt and pressure cooked until they were tender. Yolk was removed from the boiled egg, cooked albumen mashed and mashed albumen, yolk, onion paste, soy sauce, white vinegar, grated cheese, refined wheat flour, mustard powder and spice mix were mixed with cooked chicken minced meat. A medium size ball was made from mixed ingredients; a half piece of one boiled egg albumen was placed in the middle of the ball and made a ball again. Liquid contents of one egg was beaten well and kept aside. The ball was dipped in the beaten egg mixture and deep fried on both sides at 205°C oil temperature for 2-3 minutes or until golden brown in colour and served with tomato or chilli sauce. For analysis the fried cutlets were allowed to cool for 10 minutes, wrapped in aluminum foil and kept in refrigerator.

###### **Quality evaluation of egg cutlets**

All three blends of egg cutlets were analyzed for physico-chemical, microbiological and sensory properties. Cooking yield ranged from 81.47-83.63% with no differences between blends. Moisture, protein and ether extractives did not differ significantly ( $P < 0.05$ ) between blends and ranged from 65.04-65.35, 15.92-16.94 and 7.32-8.43%, respectively in three formulations. pH ranged from 6.77-6.91 and was significantly higher in blend I than other groups. Sensory evaluation results indicated that the egg cutlets prepared with 42% egg and 40% minced chicken meat, among other ingredients (blend I) was preferred over other blends for appearance, flavour, texture and overall acceptability. Microbiological analysis showed that all groups had low aerobic counts (log 1.60 to 1.70 cfu/g) with complete absence of coliforms, Staphylococci and yeast and moulds.

###### **Shelf-life assessment of egg cutlets**

Refrigerated ( $4 \pm 1^\circ\text{C}$ ) shelf-life of most acceptable blend of egg cutlet (blend I) was determined in vacuum and aerobic packaging. Effect of storage was significant ( $P < 0.05$ ) for TBA values, pH and weight losses in both packaging groups. TBA values increased significantly on day 4 in vacuum and increased further as storage progressed, while in aerobic packaging there was

a significant progressive increase in TBA values as storage advanced. However, the rate of increase was slower in vacuum than in aerobic packaging. pH registered significant progressive increase in aerobic pack from 4<sup>th</sup> day onward, while in vacuum pack the increase was significant only on 12<sup>th</sup> day of storage. Slight off-flavour was noticed on 13<sup>th</sup> day in air packed and on 15<sup>th</sup> day in vacuum packed samples and hence discarded. Changes in moisture, protein and ether extractives were not significant either due to storage or packaging treatments. Significant increase in counts of aerobic bacteria was noted on 6<sup>th</sup> day in both packaging groups and increased further as storage progressed, however increase in counts was slower in vacuum than in aerobic packs. Coliforms and staphylococci were not encountered in any sample, while yeast and moulds were occasionally seen only in air packed samples during storage. Sensory evaluation indicated decline in appearance, flavour, texture and overall acceptability scores during storage, yet the egg cutlets were organoleptically acceptable for 14 days in vacuum and 12 days in aerobic packs at refrigerated storage with satisfactory microbiological and sensory quality.

### Ingredients cost

Based on the market price of ingredients used, the cost of formulating one kg of processed egg cutlet was calculated to Rs 173.70 and for one egg cutlet weighing about 125 g was estimated to Rs. 21.70.

## 2. DETECTION AND QUANTIFICATION OF BACTERIAL PATHOGENS IN POULTRY PRODUCTS AND POULTRY ENVIRONMENT

Quantification of bacterial pathogens of public health importance from chicken eggs and poultry environment is important in quantitative risk assessment and identification of source of these pathogens both at farm level as well as in marketing channels which can be utilized in devising strategy to reduce the level or to eliminate occurrence of such pathogens ensuring safety of poultry products. *Salmonella* is one of the most important bacterial pathogen of human health significance with chicken eggs as important source. The study, therefore, has been carried out to generate data base for assessment of *Salmonella* level on chicken eggs and poultry environment with real-time PCR technique targeting *invA* gene of *Salmonella*.

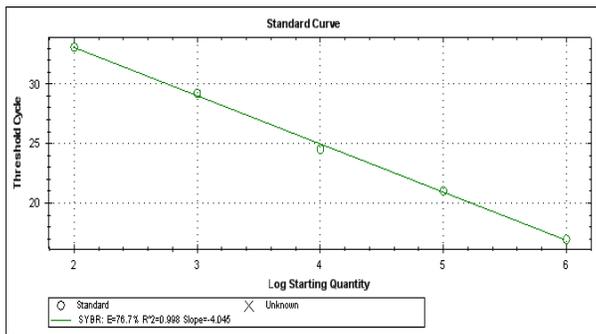
Real-time PCR being a sensitive and less cumbersome technique can detect and quantify bacterial pathogens rapidly with much more specificity as compared to conventional culture methods. Quantification and detection of *Salmonella* by real-time PCR involves standardization of annealing temperature including melt curve analysis, establishment of standard curve and finally, quantification of *Salmonella* in unknown chicken egg and poultry environment (poultry drinking water and feed) samples which has been summarized as below.

### **Determination of annealing temperature:**

Simple PCR reaction on gradient thermal cycler was standardized to determine annealing temperature which is a critical step in quantification of pathogen using real-time PCR technique. The annealing temperature standardized for *invA* gene of *Salmonella* was 50°C while preventing nonspecific annealing and primer-dimer formation. The specificity of the reaction was checked by analyzing the PCR product using melt curve analysis. The melt curve displayed a single sharp peak at a temperature of 82°C indicating specific amplification of target gene. The sample was also run on 1.4% agarose gel which yielded an amplicon of *invA* gene of *Salmonella* with a size of 286 bp.

### **Setting up of standard curve:**

Protocol for setting up the standard curve was developed for determining the primer efficiency and log starting quantity corresponding to the bacterial concentration producing a 10-fold dilution series starting from the point of most concentrated DNA sample. Standard *Salmonella* strain was used for standard curve set up, ensuring that the standard curve obtained in the study covers all potential template concentration that were encountered during the quantification of *Salmonella* on chicken eggs and poultry environment samples. The standard curve was constructed by plotting log starting quantity of the template (*Salmonella* cells numbers) against the C(t) (threshold) value obtained during real-time PCR reaction. The range of C(t) values obtained from the standard curve was 16.97 to 33.09. The coefficient of determination ( $R^2$ ) in the reaction was >0.99 which indicated that the experimental data fit the regression lines (Fig. 25).

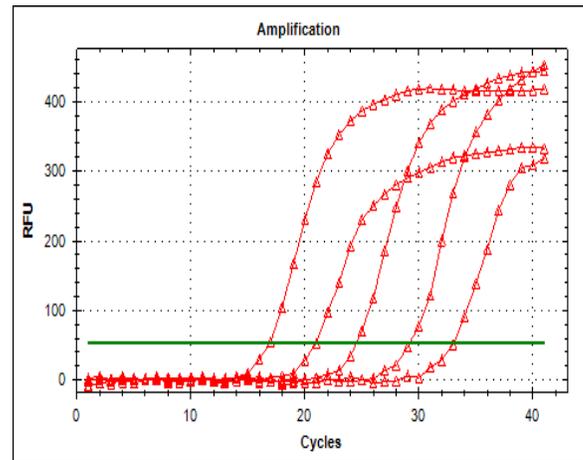


**Fig. 25:** Standard curve for quantification of *Salmonella* by real-time PCR

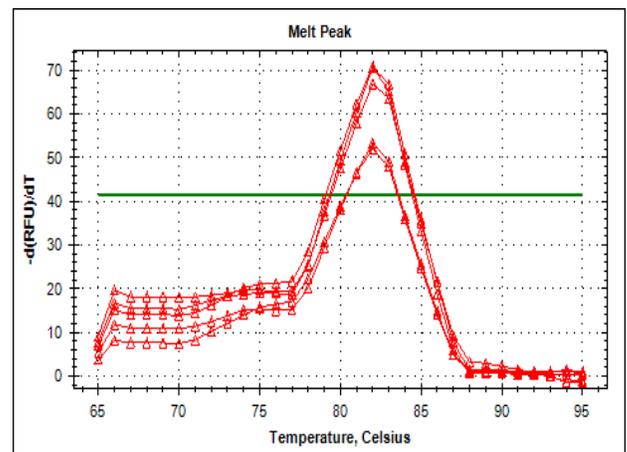
**Quantification of *Salmonella* on chicken eggs and poultry environment samples:**

Two hundred chicken eggs, 100 each from selected poultry farms and marketing channels in and around Bareilly were collected for detection and quantification of *Salmonella* by real-time PCR. The egg surface was swabbed with normal saline solution (NSS) and then processed for DNA extraction using DNA extraction kit. A known quantity of extracted DNA was used as template for real-time PCR. Real-time PCR reaction was set up with optimized conditions which amplified *invA* gene (Fig. 26) and C(t) (threshold) value was obtained. The melt curve analysis of all the amplified products was also obtained which indicated a sharp peak at a temperature of 82°C (Fig. 27). A total of 4 eggs were found positive for *Salmonella* presence in which one egg represented poultry farms and 3 eggs representing marketing channels. The log starting quantity for respective threshold cycle C(t) value of unknown sample was calculated by prism 3.0 software. The concentration of *Salmonella* on chicken egg shell surface was calculated. The level of *Salmonella* on chicken egg from poultry farm was  $1.38 \times 10^3$  cfu while the level of *Salmonella* in chicken eggs was in the range of  $1.00 \times 10^5$  to  $1.19 \times 10^6$  cfu per egg. Out of 50 drinking water samples collected from the poultry environment, 2(4.0%) were found positive for the presence of *Salmonella* and the level of *Salmonella* in the positive samples was 5.6 to  $6.4 \times 10^3$  cfu/ml. Out of 50 poultry feed samples none was found positive for *Salmonella*.

The results of quantification of *Salmonella* indicated that eggs collected from marketing channels were found to have higher level of *Salmonella* as compared to fresh farm eggs.



**Fig. 26:** Amplification of *invA* gene of *Salmonella* by real-time PCR



**Fig. 27:** Melt curve analysis of *invA* gene of *Salmonella* by real-time PCR

**3. ASSESSMENT OF RESIDUES OF CHEMICAL CONTAMINANTS IN POULTRY FEED AND POULTRY PRODUCTS IN DIFFERENT REGIONS OF INDIA**

The samples of poultry feed, egg and muscle tissue collected from different poultry farms and local markets of Gorakhpur, Ludhiana and Barbala areas indicated their average levels of residues of tetracycline as 0.04, 0.02 and 0.015ppm and the same for enrofloxacin was 0.04 0.02, 0.03ppm, respectively. On an average, only 5% of samples contained residues of drugs analyzed. The occurrence of residues of heavy metals was observed in all samples. The

## **SUB PROGRAMME – (II) VALUE ADDITION TO DIFFERENT POULTRY PRODUCTS AND BY-PRODUCTS**

### **1. DEVELOPMENT OF POULTRY PRODUCTS BASED FUNCTIONAL FOODS**

#### **(i) Effect of different supplementary levels of processed soya nuggets on the quality of functional chicken scroll**

Independent trials were undertaken to evaluate the performance of different supplementary levels (w/w)-10, 20 and 30% (Groups A, B and C, respectively) followed by further refining through use of 15, 20 and 25% levels (Groups I, II and III, respectively) of processed soya nuggets in functional chicken scrolls subjected to hot air oven cooking before eating. Observations were recorded, on the parameters-pH, TBA (Thiobarbituric acid value, malonaldehyde, mg/100 g), per cent Moisture, Crude Protein (CP) and total lipids/Ether Extract (EE), microbial estimates ( $\log_{10}$ cfu/g) for Total Plate Counts (TPC), Coliforms, Staphylococci, Yeast and Moulds and sensory evaluations on 7-point hedonic scale for appearance, flavor, juiciness, tenderness, texture and overall acceptability.

Results of the trials indicated an increase in pH, TBA and moisture of the samples containing higher levels of processed soya nuggets. Group C had significantly ( $P < 0.05$ ) higher values than other experimental groups (insignificant differences between groups A and B). Coliforms and Streptococci were not found in any of the experimental groups. Microbial loads were also significantly ( $P < 0.05$ ) high in group C. Sensory evaluations also revealed lowest ranks allotted, particularly for flavour, tenderness, texture and oval acceptability to group C. However, no significant differences for all these traits were observed between groups-A and B. So, it was evident from this study that supplementation of processed soya nuggets at 20% (w/w) level helped in processing good quality chicken scroll. Storage studies conducted up to 21 and 90 days of refrigerated ( $4 \pm 1^\circ\text{C}$ ) and frozen ( $-18 \pm 1^\circ\text{C}$ ) storage, respectively, revealed relatively fastest increase in pH, TBA, CP, EE and microbial counts in samples containing 30% PSN as compared to other experimental groups. Sensory determinations also evinced lowest ranks assigned to the group C. Viewing at insignificant variations among the groups containing 10 and 20% supplementary

mean residue levels of heavy metals in poultry feed, liver and muscle in sampling areas were found to be in the order such as: lead (0.2, 0.15, 0.15 ppm), arsenic (0.2, 0.15, 0.12 ppm), molybdenum (0.13, 0.14, 0.17 ppm) and cadmium (0.13, 0.12, 0.13 ppm), respectively. There was no marked variation in occurrence of metallic residues among samples collected from certain locations of northern region i.e., Gorakhpur (U.P.), Ludhiana (Punjab) and Barbala (Haryana). Among pesticidal residues, the average levels of residues of BHC, DDT, eldrin, dieldrin were determined in samples of poultry feed (0.16, 0.15, 0.14, 0.13 ppm), muscle (0.015, 0.02, 0.18, 0.17 ppm), liver (0.02, 0.04, 0.13, 0.12 ppm), egg (0.02, 0.015, 0.14 ppm) and abdominal fat (0.22, 0.18, 0.15, 0.16 ppm), respectively. BHC level in muscle ranged from 0.04–0.26 ppm whereas in liver, adipose fat, poultry feed and egg it was in the range of 0.01–0.05 ppm; 0.1–0.3 ppm, 0.14–0.26 ppm and 0.01–0.03 ppm, respectively. The samples collected from Gorakhpur had lower occurrence (6.5%) of residues of pesticidal chemicals than those of Ludhiana and Barbala. In Ludhiana area, comparatively higher levels of contamination were observed. The level of DDT was recorded to be 0.01–0.1 ppm in muscle, 0.02–0.1 ppm in liver, 0.1–0.2 ppm in adipose tissues, 0.002–0.02 ppm in egg and 0.1–0.2 ppm in poultry feed. Occurrence pattern of DDT showed that it was more (30%) in adipose tissue collected from Ludhiana market. As observed earlier, samples from Barbala and Gorakhpur had similar pattern of residue level of DDT. The market samples had higher levels of residues as compared to that of the farm samples. The residue of eldrin and dieldrin occurred in the pattern similar to that of BHC. The residual level of chloropyrifos was found to be 0.02–0.05 ppm in egg, liver and fat and its distribution varied (5–8%) among samples from all locations. Dichlorovous and monocrotophos residues were detected in very low level in few tissue samples only.

It was concluded that residues of metallic origin occurred in all samples of poultry feed, egg and tissues of poultry. Occurrence of residues of pesticides in poultry tissues were within respective MRLs. Among the locations of northern region studied, samples collected from Ludhiana appeared to contain more residues than those of Gorakhpur and Barbala and market samples had higher occurrence of residues.

levels of processed soya nuggets and considering economics of formulating recipe, the 20% level of PSN was considered better, for preparing functional chicken scroll.

Further experimentation with 15, 20 and 25% levels also showed similar trends for pH, TBA and moisture. However, CP and EE were insignificantly ( $P < 0.05$ ) different between the treatment groups. Coliforms and Streptococci were not found in any of the experimental groups. Total plate counts, anaerobes, Yeast and molds were also significantly ( $P < 0.05$ ) high in group III. Organoleptic estimates for the studied parameters, also indicated significantly ( $P < 0.05$ ) poor acceptability for group III with insignificant differences between groups I and II. Storage studies conducted up to 21 and 90 days of refrigerated and frozen storage, respectively, revealed significantly higher pH, TBA, CP, EE and microbial counts with fast deterioration in the sensory qualities of the group made with 25% level of processed soya nuggets (PSN). Nevertheless, the groups made with 15 and 20% level had lesser microbial counts with better sensory properties. Hence, it was concluded that inclusion of processed soya nuggets (PSN) at 20% level (w/w) rendered good quality experimental functional chicken scroll storable till 21 days (three weeks) of refrigerated ( $4 \pm 1^\circ\text{C}$ ) and 90 days of frozen ( $-18 \pm 1^\circ\text{C}$ ) storage, respectively.

#### **(ii) Effect of supplementary levels of processed soya nuggets on the quality of functional meat pellets**

Separate experiments were undertaken to evaluate the performance of different supplementary levels (w/w)-10, 20 and 30% (Groups A, B and C, respectively) followed by further refining through use of 15, 20 and 25% levels (Groups I, II and III, respectively) of processed soya nuggets in functional meat pellets, subjected to cooking in hot air oven before consumption. Observations were recorded, on the parameters as indicated above at (i).



An increase in pH, TBA and moisture was observed with the rising levels of PSN. The group C, containing 30% PSN, had significantly ( $P < 0.05$ ) higher pH, TBA and moisture than other experimental groups (insignificant differences between groups A and B). Coliforms and Streptococci were not found in any of the experimental groups. Microbial loads were also significantly ( $P < 0.05$ ) high in group C. Sensory evaluations also revealed poorest ranks, particularly for flavour, tenderness, texture and oval acceptability, assigned to group C. However, no significant differences for all these traits were observed between groups-A and B. So, it was evident from this study that supplementation of processed soya nuggets at 20% (w/w) level could be useful in processing good quality functional meat pellets. Further, experimentation with 15, 20 and 25% levels also revealed similar trends for pH, TBA and moisture. However, %-moisture, CP and EE were insignificantly ( $P < 0.05$ ) different between groups I and II. Coliforms and Streptococci were not found in any of the experimental groups. Total plate counts, anaerobes, Yeast and molds, being minimum in group I, were also significantly ( $P < 0.05$ ) high in group III. Organoleptic estimates also indicated poor preferences for group III with relatively better ranks assigned to group I suggesting that functional meat pellets processed with 15% PSN were better acceptable. Studies conducted up to two and four weeks of refrigerated ( $4 \pm 1^\circ\text{C}$ ) and frozen ( $-18 \pm 1^\circ\text{C}$ ) storage, respectively, revealed increase in pH, TBA, CP, EE and microbial counts with decline in sensory quality of the groups made with the increasing levels of PSN. However, the proximate, microbial and sensory qualities of group I was comparatively superior than the other experimental groups. So, it was inferred that inclusion of processed soya nuggets (PSN) at 15% level (w/w) rendered good quality experimental functional chicken meat pellets safely consumable till two and four weeks of refrigerated ( $4 \pm 1^\circ\text{C}$ ) and frozen ( $-18 \pm 1^\circ\text{C}$ ) storage, respectively.

#### **(iii) Effect of supplementary levels of processed barley floor on the quality of functional meat pellets**

Experiments were undertaken to evaluate the performance of different supplementary levels (w/w)-5, 10 and 15% (Groups A, B and C, respectively) followed by further refining through 2.5, 5 and 10% levels (Groups I, II and III, respectively) of processed barley floor in

functional meat pellets, subjected to hot air oven cooking before consumption. Observations were recorded, on the parameters as indicated above at (i).

Observations showed significantly ( $P < 0.05$ ) low-pH, TBA and moisture content with relatively higher values of CP and EE in the group made with 5% supplementary level (Group A) of barley flour. TPC, Yeast and Mould counts were also significantly ( $P < 0.05$ ) low in group A as compared to other groups. Coliforms, Anaerobes and Staphylococci were not present in any of the experimental samples. Sensory evaluations also revealed significantly ( $P < 0.05$ ) higher preferences for group A. It was evident from the results that the quality of functional meat pellets processed with 5% supplementary level of barley flour was better than the other experimental groups. In other trials using 2.5, 5 and 10% levels of barley flour confirmed the trends showing insignificant differences between groups I and II for pH, TBA, %-moisture, CP and EE. The sensory determinations also showed insignificant differences between groups I and II with significantly poor ranks for group III. Therefore, it was concluded that 5% (w/w) level of barley flour could be used to process good quality functional meat pellets.

Trials conducted to evaluate shelf life of functional meat pellets kept under refrigeration ( $4 \pm 1^\circ\text{C}$ ) and frozen ( $-18 \pm 1^\circ\text{C}$ ) temperatures, evinced fast deterioration in quality of samples containing 10 and 15% levels of barley flour. Despite, increase in TPC, yeast and molds with the prolonged storage, specifically under refrigeration over the frozen samples, the Coliforms, Anaerobes and Staphylococci were not present in any of the experimental samples. Based on the proximate, microbial counts and sensory determinations, it was inferred that functional meat pellets made with 5% supplementary level of barley flour could be safely consumed till 21 and 42 days of refrigerated ( $4 \pm 1^\circ\text{C}$ ) and frozen ( $-18 \pm 1^\circ\text{C}$ ) storage, respectively.

### **PROGRAMME 3**

#### **ASSESSMENT OF POULTRY PRODUCTION AS INFLUENCED BY MARKET DYNAMICS**

##### **SUB PROGRAMME – (I) MARKET INTELLIGENCE GATHERING AND CONTINGENCY PLANNING**

## **1. INTERNATIONAL TRADE AND EXPORT OPPORTUNITIES FOR INDIAN POULTRY SECTOR**

On the basis of available data on average ad-velorum applied duties faced by Most Favoured Nations (MFN) under the WTO, producers' price in various countries for chickenmeat and eggs (hen-egg-in shell) for the year 2008 and freight charges from India to various countries obtained from some of the shipping companies in India, the landing cost of Indian poultry eggs and meat at the destination port per one TEU reefer container having full container load (FCL) was estimated along with the gross margins so as to find out the most lucrative export destinations.

### **Export destinations for poultry eggs**

It is evident from Table 18 that India ranks 6<sup>th</sup> lowest in the world as far as producers' price of poultry eggs are concerned. Therefore, India has distinct cost advantage in the export market due to the fact that the countries having lower producers' prices than those in India are not the major producers of poultry eggs. Hence, it can be concluded that among major producers (and hence exporters) of poultry eggs, India's cost of production of poultry eggs is actually the lowest in the world as per 2008 figures.

Some of the important destinations for the hen-eggs-in-shell were Switzerland, Venezuela, Mongolia, Honduras, Nicaragua, Latvia, Czech Republic, Trinidad and Tobago, Japan, Estonia, Singapore, Hungary, Russian Federation and Canada providing a gross margin of about \$ 14700 to \$75500 per reefer container maintaining a temperature of  $-2^\circ\text{C}$  to  $0^\circ\text{C}$  with a payload of about 21 t eggs (about 4.13 lakh eggs).

### **Export destinations for chicken meat**

Producers' price-wise, India ranks 50<sup>th</sup> in the world in respect of chicken meat. Therefore, India has to face stiff competition from major exporting countries of chicken meat (Table 19). The countries having higher producers' prices than those in India were not considered competitors in export market for obvious reasons.

**Table 18:** Producers' price for poultry eggs in increasing order

<i>Country</i>	<i>Producers' Price (US \$/t)</i>	<i>Total Egg Production (000 t)</i>
Ecuador	76.7	88
Belarus	77.8	184
Croatia	147.9	47
Costa Rica	608.9	52
Lao People's Democratic Republic	697.9	15
<b>India</b>	<b>723.8</b>	<b>3060</b>

**Table 19:** Producers' prices for chicken meat in increasing order

<i>Major Exporting Countries</i>	<i>Producers' Price (US \$/t)</i>
No major exporters	< 1000
USA, Uruguay	1000-1500
Denmark, Netherlands, Ireland, Korea, Brazil, Czech Republic, UK, Australia, Thailand, Belgium, Germany, Chile, Finland, Poland, Belarus,	1500 - 1996 (India)
<b>India</b>	<b>1996.6</b>

Some of the important destinations for poultry meat exports turned out to be Congo, Armenia, Panama, Saint Lucia, Cyprus, Antigua and Barbuda, Switzerland, Cape Verde, Indonesia, Georgia, Albania, Suriname, Ghana, Russian Federation, Venezuela providing a gross margin ranging from over \$1.11 lakh to \$7000 per TEU reefer container maintaining a temperature of -28°C to -23°C and 90-95% RH with 21 t payload.

## 2. ECONOMIC ANALYSIS OF POULTRY PRODUCTION IN KUMAON HILLS

The Uttarakhand state is comprised of 13 districts of two regions; Garhwal and Kumaon. The districts in Kumaon region are Nainital, Almora, Pithoragarh, Udham Singh Nagar, Champawat and Bageshwar. Out of 6 districts in Kumaon region, two districts (Udham Singh Nagar and some part of Nainital) have area in the plains, whereas the other four districts totally comprised of hill areas. The livestock and poultry rearing provides subsidiary livelihood to population in hills where crop production may not be remunerative. The contribution of agriculture, livestock and poultry to the state economy was 16.87% of total state GDPs during 2007-08. The annual egg production in Uttarakhand was 254 million and it accounted for 0.4% of egg

production in India during 2009-10. Further, more than 85% of total poultry population of Kumaon region is concentrated in plains of Udham Singh Nagar and Nainital districts. Therefore, poultry egg and chicken is supplied from these areas as also from other production centres in neighboring states to fulfill the demand of hill region involving transportation and overhead expenses leading to inflated prices in hill areas.

The survey schedules have been developed to carry out primary survey in two selected districts of Kumaon hills having maximum poultry population. Based on analysis of secondary data, following conclusions were drawn.

- The per capita availability of egg and poultry meat in Uttarakhand was 25 egg/annum and 1.12 kg/annum in 2009-10. It was low as compared to per capita availability at national level (48eggs/annum and 2.28 kg/annum). As per NSSO 61<sup>th</sup> Round survey data, the average per capita consumption of poultry products was 0.67 and 1.45 eggs; 0.015 and 0.031 kg chicken in rural and urban Uttarakhand, respectively.

- The total layer population in Uttarakhand has increased from 4.43 to 12.87 lakhs during 2001-10. However, the desi layer population reared as backyard poultry in hills has decreased from 2.09 to 1.53 lakhs and improved layer population has increased from 2.35 to 11.33 lakhs during 2001-10 in Uttarakhand. It reveals that the share of backyard poultry in total egg production in Kumaon hills has declined drastically whereas the share of commercial/improved poultry has increased from 61 to 93% during past decade.

## EXTERNALLY FUNDED PROJECTS

### A. NAIP SPONSORED PROJECTS

#### 1. HOLISTIC APPROACH FOR IMPROVING LIVELIHOOD SECURITY THROUGH LIVESTOCK BASED FARMING SYSTEM IN BARABANKI AND RAIBAREILI DISTRICTS OF UP

The "Holistic approach for improving livelihood security through livestock based farming system in Barabanki and Raibareili districts of U.P" project is an integrated approach having various components to improve Livelihood Security. Various consortia partners are assigned different components. We are concerned for improvement in poultry production through family poultry production. The project area is spread over 21 villages under two clusters viz. Trivediganj and Haidergarh of Barabanki districts and 21 villages under two clusters viz Sareni and Lalganj of Raibareili districts of U.P. Regular informal training were conducted to motivate the farmers for poultry farming. Some of the farmers were motivated to shift from traditional scavenging system of poultry production to small scale commercial broiler production. 621 farmers have started the Traditional Backyard Poultry Farming while the target was for 500 farmers till the end of the project up to March 2011-12. 445 new farmers were added during the current year. 18 farmers have upgraded their poultry farm from Scavenging chicken to Small Farm Broiler production. Number of birds ranges from 250 to 2000 birds. A total of 21,372 chicks were distributed/sold to the farmers of the project area while only 5688 chicks were distributed during the previous year. Training for the feed formulation and compounding was arranged at CARI, Izatnagar and 17 farmers were trained.



*High yielding chicken germplasm in operation area*

#### 2. GOAT HUSBANDRY BASED INTEGRATED APPROACH FOR LIVELIHOOD SECURITY IN DISADVANTAGED DISTRICTS OF BUNDELKHAND REGION

Under another project "Goat husbandry based integrated approach for livelihood security in disadvantaged districts of Bundelkhand region" improved chicken varieties showed good adaptability in the harsh climatic conditions of Bundelkhand region. The day old weight was 30.53 g. The chicks showed large variation for their growth and this variation might be due to different type of managerial practices adopted by the villagers. The body weight at 8<sup>th</sup> weeks of age ranged from 315 g to 425 g with an average weight of 369.54 g. The adult body weight (at 6-7 months of age) ranged from 975 g to 1370 g with an average weight of 1190.37 g and 120-140 eggs (132.45) annually under scavenging system with little feed supplementation. The eggs were tinted in colour and overall egg weight ranged from 48 to 54 g with an average of 50.89 g. All the four varieties did not differ for their adaptability and production performance; however CARI Nirbheek showed better survivability against predation under foraging conditions due to their aggressive behaviour. The income pattern after adoption of low input technology chicken has been presented in Table 3. The increase in monthly income of beneficiaries due to chicken rearing ranged from 3.25 % to 13.75 % with an average increase 8.11%.



*High yielding germplasm under scavenging system*

Health care was provided through health camps and regular personal visits. The regular health camp and personal visits generated faith in the farmers to rear the scavenging chicken in a profitable way. The overall mortality was 38.22%. Though there was a difference in mortality estimates in different villages, but no definite trend could be found. The major cause of death was predation in which the backyard poultry flocks were attacked and killed by cats, dogs, and mongooses etc.

### **3. DEVELOPMENTAL POTENCY OF PARTHENOGENETIC GOAT EMBRYOS.** *(Lead Centre: Indian Veterinary Research Institute, Cooperating Centre: Central Avian Research Institute)*

#### **IDENTIFICATION OF MOLECULAR BASIS OF SPONTANEOUS PARTHENOGENESIS IN TURKEY (NAIP sponsored)**

##### **Genomic DNA content of normal and Parthenogenetic blastoderm/embryo**

Amount of genomic DNA increased with advancement of time of incubation (e.g. 0, 12, 24, 36, 48, 60, 72, 84 and 96 hrs). In freshly laid fertilized egg DNA content was significantly ( $P < 0.05$ ) higher as compared to parthenogenetic egg, however, at 12 and 24 and 48 hrs of incubation the difference was not significant and the DNA content was approximately 4.45-6.85 times higher in normal fertilized eggs. 60 hrs onward significantly higher ( $P < 0.01$ ) DNA content was estimated in normal fertilized egg as compared to parthenogenetic egg (Fig. 28).

##### **Determining ploidy and sex of parthenogenetic embryo at different stages of development**

The relative length of 10 largest chromosomes of diploid genome (male and female) was measured and compared. The

largest chromosome had a relative length of 23.03% and significantly varied from all the chromosomes. The size of 2<sup>nd</sup> and 3<sup>rd</sup> largest chromosomes significantly vary ( $P < 0.01$ ) from the 4<sup>th</sup> and Z chromosome. However, there was no difference in the size of 4<sup>th</sup> and Z chromosome. 5<sup>th</sup>, 6<sup>th</sup>, 7<sup>th</sup> and W chromosomes also had higher relative length than 8<sup>th</sup> and 9<sup>th</sup> chromosome.

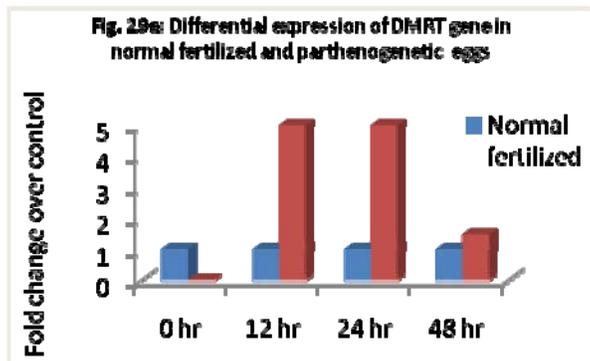
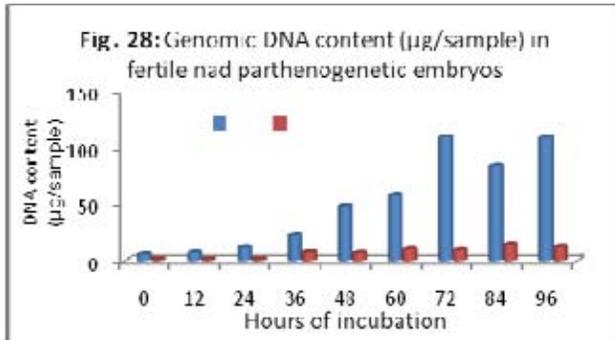
No significant difference in relative length, size and morphology of chromosomes in parthenogenetic, normal fertilized embryos and PBMC cultured cells were found. With advancement of age % of haploid cells decreased (38.7 to 20.4%) while % of diploid cells increased (21 to 33%). The proportion of other ploidy also decreased with advancement of embryonic age. The proportion of W chromosome containing cells was higher at the initial level but significantly decreased with the advancement of age, while a reverse trend was observed in Z chromosome. No ZW combination was observed at any point during the whole experiment in parthenogenetic embryos. No haploid cells in normal fertilized embryos were observed while proportion of haploid cells was significantly higher in parthenogenetic embryos.

##### **Expression of Sex specific genes**

Expression level of male sex specific gene (DMRT) was compared between normal fertilized and parthenogenetic turkey embryo at different stages of development. The level of expression was very low at 0 hr (before incubation). Then the expression level increased significantly at 12, 24 and 48 hrs of incubation and maximum level was observed at 24 hr of incubation (Fig. 29a). The expression level of anti-müllerian hormone (AMH) in parthenogenetic eggs was also lower at 0 hr as compared to normal fertilized embryo. However, the expression level was significantly higher in parthenogenetic egg/embryo at 12 and 24 hrs of incubation. At 48 hrs the expression level in parthenogenetic eggs/embryos was lower than the normal fertilized egg/embryo.

The expression profile of ASW (avian sex specific w-linked) a candidate ovary determining gene revealed significantly higher expression in freshly laid parthenogenetic eggs. However, the expression level decreased in parthenogenetic eggs/embryos at 12, 36 and 48 hrs of incubation. At 24 hrs of incubation, like that of male specific gene expressions (DMRT and AMH) higher level of ASW gene (female specific) was also observed

in parthenogenetic eggs than normal fertilized egg. At 0 hr expression level of female specific P450 gene was lower in parthenogenetic embryo. Whereas, the expression level increased many fold in parthenogenetic embryo at 12 and 24 hrs of incubation as compared to normal fertilized embryo. 36 hrs onward parthenogenetic embryo had also significantly lower expression than their normal fertilized counterparts (Fig. 29b).



### Chemical agents to induce parthenogenetic development

A preliminary study was conducted to induce/increase parthenogenetic development in parthenogenetic eggs collected from virgin females. *In ovo* injection of chemical agents like mitogen, phytohaemaagglutinins (PHAP) and concavalin-A (Con-A), ethanol, phosphate buffer saline (PBS) and normal saline were done in freshly laid eggs at broad the end of the egg (just above blastodermal cells) and set in incubator. After 48 hours of incubation the eggs were broken and parthenogenetic development was assessed. Eggs injected with PHAP, Con-A and PBS had higher number of parthenogenetic development than other treatments and uninjected parthenogenetic eggs.

### Differential expression of global turkey genes in parthenogenetically and normal fertilized embryo by micro-array analysis

Blastodermal/embryo cells from freshly laid, 12 and 24 hours incubated eggs of parthenogenetic and normal fertilized were collected and subjected to RNA isolation subsequent micro-array hybridization. Data were analyzed and comparisons were done between parthenogenetic and control samples at different stages of embryodevelopment. At 0 hr total 2188 genes showed more than two fold change in the expression pattern, where 752 genes were UP-regulated and 1436 genes were down regulated. However, at 12 hours of embryo development 1541 genes showed more than two fold change with 942 genes UP-regulated and 599 genes down regulated. At 24 hours of incubation 1632 genes showed more than two fold changes out of which 589 genes were UP-regulated and 1044 genes were down regulated.

### 4. 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 adopted 1172 farm families of eight clusters. Since, most of the lands are non-irrigated and failure of crop production was intermittent, therefore, livestock production was targeted for upliftment of social and economic status of farmers. Further, availability of water bodies either individual or village panchayat ponds attracted the project personnel to introduce duck production, a new component to meet the goal.



## Backyard poultry production

The activities of Regional Centre, CARI spread up with 1172 farm families of eight clusters (Table 20). Mass vaccination programme with R<sub>2</sub>B against Ranikhet disease was conducted for more than 10,000 birds before supply of inputs. Farmers are sensitised through meeting and audio-visual aids. Also training are imparted regarding brooding, management, health coverage, production and marketing aspects of the programme. Twenty number of day old chicks (CARI Debendra), 10 kg of initial chick mash, one feeder and one drinker is the input supplied to each unit of backyard poultry. Vaccination with 'Lasota' nasal drop (within 7 days) and R2B at 3 month of age was the scheduled programme. Poultry houses were constructed by the farmers with the technological support of the project personnel. Day to day activities with respect to brooding, feeding and management were guided and monitored regularly. Monthly body weight, mortality percentage, onset of laying, body weight at first laying and prevalence of parasitic infestation was recorded. In almost all the cases between 5-6 months of age, egg laying was initiated and farmers are advised to sell their adult male birds for one time bulk income. Female birds are continued with laying and supplemental therapy with calcium and vitamin preparation was provided. Egg production performances were recorded and economic status of the unit was calculated. The whole process was named as "CARI Model of Backyard Poultry Farming".

## Duck rearing in village ponds

Regional Centre, CARI has introduced improved varieties of duck for egg purpose which is integrated with aquaculture in farmers' pond and community ponds.

Initially, the perennial ponds of the villages in all the eight clusters were identified. Ponds were prepared for scientific aquaculture. Simultaneously, day old ducklings (Khaki Campbell and crossed native variety) with initial feed, feeder and drinker were introduced to the selected farmers for brooding. After 15 days of brooding, they were offered kitchen wastes, left over rice of the family and other wastage materials of the house. Ducklings above 4 wks of age were allowed to go to the pond and to collect the feed. Data on body weight in every month and weight at first egg was recorded. It was observed that laying of egg was initiated between

4-5 months of age. Male birds were disposed by the farmers in the same month of initiation of laying and able to earn onetime income of Rs 2500-3000/- from a unit of 20 ducks. Female ducks are in laying stage and 60-70 per cent egg production is found in every flock.

In 16 village community ponds, duck rearing have been initiated through SHG mode where the flock size was fixed as per the available water area i.e. 100 ducks per acre of water area. One hundred sixty five farm families have been adopted duck rearing successfully besides 16 SHGs.

The effort will be continuing till the end of the project during which there will be horizontal expansion of the technology and farmers will be involved in successful implementation of the technology so as to generate a substantial amount of return throughout the year which will decide the sustainability of the project.



## Training

Farmers' training was organized in each village where detailed discussions were made for problems and prospects of the technology. Exposure visits of the selected farmers were made to the campus of Regional Centre, CARI

where scientific management of poultry and ducks, hatchery management and availability of inputs are demonstrated.

## Linkages

An effort was made to establish linkages between farmer, field veterinarian, technocrats, business groups and executive heads of the State government line department. For this purpose, one day workshop was organised on 10<sup>th</sup> March 2011 in the campus of Regional Centre, CARI where personnel of all the groups participated. The farmers express their desire to overcome the problem of non-availability of inputs at village level for the success of backyard poultry production system. To this, business groups responded positively and assured them about availability of chicks and other inputs in time. Officers of Government line department also promised to take up the health coverage programme in the cluster to reduce mortality. Accordingly, during the month of April and 1<sup>st</sup> part of May, mass vaccination programme in almost four clusters is covered by the local veterinary officers. State government is going to supply the chicks for backyard poultry at their level. This sort of concern and linkage is showing a bright path for the sustainability of the programme even after termination of the project. Again, the farmers are encouraged to open saving accounts in Post offices or local banks, which is a part of the programme for creation of sustainability fund. It is expected that the CARI model of backyard poultry and duck farming will be expanded horizontally to nearby districts and the main objectives of the project will be fulfilled in due course of time.

## B. DBT SPONSORED PROJECTS

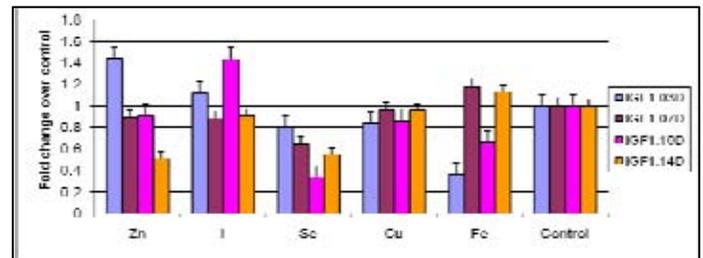
### 1. ENHANCEMENT OF POST-HATCH IMMUNOCOMPETENCE AND GROWTH OF BROILER CHICKENS THROUGH *IN OVO* APPROACHES (DBT sponsored)

#### Effect of *in ovo* injection of trace elements and fatty acids on differential expression of growth and immunity related genes

##### *Differential expression of chicken growth related genes as influenced by trace elements*

During embryonic stage (18 and 20<sup>th</sup> day) chicken growth hormone (cGH) mRNA expression did not differ between control and trace element injected groups. However, Zn and I injected

chicks showed apparently higher expression than that of control group. On the day of hatch cGH expression was significantly lower in Zn, I and Se treated groups, whereas in other treatments it did not differ from control group. During post hatch, at 3<sup>rd</sup> day Zn and Se injected chicks showed significantly lower expression when compare with control chicks. Lower expression in Se group was observed at 7<sup>th</sup> day post hatch. By the 10<sup>th</sup> day of age no significant differences were observed among trace element and control chicks, though Zn and I had higher cGH expression over control. At 14<sup>th</sup> day I injected chicks had significantly higher expression but in other trace element injected chicks it did not differ from that of control group.



**Fig. 30:** Expression of hepatic IGF1 during post-hatch period

On 18<sup>th</sup> and 20<sup>th</sup> day of incubation *in ovo* trace element treated embryos did not show any significant difference in mRNA expression of insulin like growth factor-1 (IGF-1) in comparison to un-injected embryos. On the day of hatch I treated embryos exhibited higher expression ( $P < 0.05$ ) over control and their other counterparts except Cu injected embryos. Though no significant differences were observed between un-injected control and trace element treated chicks on 3<sup>rd</sup> and 7<sup>th</sup> day but Zn and I showed higher IGF1 expression. Correspondingly, I injection showed higher IGF1 expression on 10<sup>th</sup> day post hatch (Fig. 30).

The present study also revealed that on 18<sup>th</sup> day of incubation Zn and I injected embryos showed higher expression ( $P < 0.05$ ) of insulin like growth factor-2 (IGF-2) mRNA than un-injected control group, however it did not differ on 20<sup>th</sup> day of incubation and on the day of hatch. During post hatch, on 3<sup>rd</sup> and 7<sup>th</sup> day significantly higher expression was observed in Zn and Fe injected embryos, respectively when compared with control group. Se treated chicks showed lower

expression of IGF-2 than control and other counterparts throughout the post hatch period.

Expression of mucin gene was significantly higher in Zn, I and Fe injected embryos compared to control embryos during pre hatch period. However, during this period Se showed lower expression of mucin gene ( $P < 0.05$ ). On the day of hatch and at 3<sup>rd</sup> day post hatch trace element injected chicks had lower mucin gene expression as compared to control chicks. On 7<sup>th</sup> day post hatch significantly higher mRNA expression of mucin gene was observed in Zn injected chicks whereas Se injected chicks had lower expression during post natal development. On 14<sup>th</sup> I exhibited higher mRNA expression of mucin gene than the control chicks.

Based on the above observation and analysis, the trace elements which enhanced the expression of the genes of interest (cGH, IGF-1, IGF-II and mucin gene) related to growth during pre-hatch and post-hatch periods are Zinc, Iodine and Iron.

#### ***In ovo injection of Linoleic acids***

*In ovo* injection of linoleic acid showed lower expression of cGH and IGF-1 during embryonic and early post hatch period. However, higher cGH expression was observed at 14<sup>th</sup> day of age. Expression of IGF-2 and mucin gene was significantly higher at 20<sup>th</sup> day of incubation and 3<sup>rd</sup> day post hatch period. Its role in the growth of chicken needs more studies (Fig. 32).

#### ***Expression of immune function genes in trace element and fatty acids treated broiler chickens***

The relative expression of IL-6 in chicks was highly enhanced ( $P < 0.01$ ) by *in ovo* feeding of I and Fe in comparison to control chicks. The expression of TNF was significantly higher ( $P < 0.01$ ) in linoleic acid and Fe injected chicks than that of control chicks. However, Zn, Se and Cu injected chicks had significantly lower expression of IL-6 and TNF compared to control chicks. Based on the above observation it can be postulated that the linoleic acid, Iron and Iodine modulate the humoral immunity genes in chickens.

Though there was no significant difference, the relative IL-2 expression was higher in Zn and Fe treated chicks compared to un-injected control chicks. Similarly higher ( $P < 0.05$ ) expression of IL-12 was also observed

in the chicks *in ovo* injected with Zn and Fe than that of control group chicks. Though, expression of IL-12 was apparently higher in Se and I injected chicks it did not reach to significant level. Linoleic acid and Cu injected chicks had significantly lower expression of IL-2 and IL-12 compared to control chicks.

#### **Development of *in ovo* intervention-based nutritional packages for specified functions during post-hatch period in broiler chickens**

Based on the results of all the nutrients enhancing gene expressions for specified functions (growth, humoral immunity and cell-mediated immunity) combination of nutrients were tried so as to develop an *in ovo* nutritional packages. The effect of *in ovo* injection of these nutrients was assessed through their pre-hatch and post-hatch growth performances and immune responses for humoral as well as cell-mediated immunity.

Though there was no difference in the weight of eggs received *in ovo* injections, growth group had higher ( $P < 0.01$ ) chick weight than other treatment groups and control groups. At 14 day post hatch higher ( $P < 0.01$ ) body weight was recorded in Growth, CMI and Humoral group than sham control and un-injected (control) chicks. However, at 21 days around 20 grams body weight difference was recorded in those groups compared to control chicks. Percent hatchability and livability was comparable with that of sham control and un-injected control. Significantly better ( $P < 0.01$ ) FCR was noticed in the growth group compared to other treatments and control groups. The same trend was maintained till 21 d of post-hatch but the difference was not significant.

#### **Lymphoid and digestive organ weight**

There was no significant difference in the weight of digestive organs in *in ovo* treated and control groups, however, liver and intestine weight was apparently higher in growth and CMI group compared to un-injected control chicks. Weight of bursa was significantly higher in Humoral group, whereas, thymus weight was higher in CMI group compared to other treatments and control groups. Though there was no significant difference, spleen weight was apparently higher in growth CMI and humoral group than un-injected control group.

Though there was no significant difference in the humoral immune response (response to SRBC injection and HA tite), humoral group chicks had apparently higher tier values than other treatment groups and controls. However, cell mediated immunity (foot web index, response to PHAP injection) was significantly better ( $P < 0.01$ ) in CMI and humoral group than un injected control group (Table 21).

### **Superiority assessment of *in ovo* vaccination for ND and or IBD as compared to conventional vaccination and feasibility of packaging *in ovo* feeding and *in ovo* vaccination for better post-hatch performance in broiler chickens**

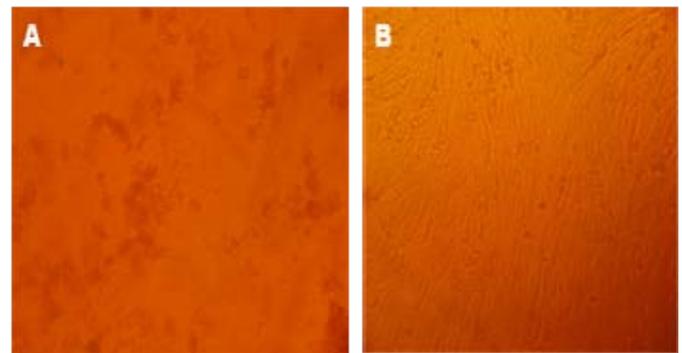
Fertile eggs ( $n=240$ ) from broiler breeder were distributed in to three groups and set in a force draft incubator. On 18<sup>th</sup> ED, first group was injected with Newcastle Disease (ND) F<sub>1</sub> vaccine inactivated by formaldehyde treatment ( $10^3$  titer), the second group with live attenuated NDF<sub>1</sub> vaccine and third group was vaccinated with NDF<sub>1</sub> on day old by conventional method (Occulo-nasal drop). The hatchability on fertile egg set basis was 80, 70 and 87.3% for the above three groups, respectively. All the chicks hatched from the experiment were kept in battery brooders following standard managerial practices. Blood was collected from 10 chicks on 0, 4, 7, 14 and 21 day of age and antibody titer ( $\log_2$  values) against NDF<sub>1</sub> was estimated by haemaagglutination inhibition test (Allan and Gough, 1976). *In ovo* vaccinated chicks maintained significantly ( $P < 0.01$ ) higher titres values than conventional vaccinated group up to 21 days of age.

There was no significant variation in the titre values between formaldehyde treated and live attenuated ND vaccine, however during first 4 days of chick life the formaldehyde treated group maintained the superiority and hatchability was also better in this group. Throughout the experimental period the *in ovo* vaccinated chicks maintained higher titre values than conventional vaccinated birds. It is concluded that formaldehyde inactivated NDF<sub>1</sub> vaccine may effectively be used as *in ovo* vaccine for better protection against ND in broiler chickens.

## **2. APPLICATION OF RNAi TECHNOLOGY FOR AUGMENTING BROILER PRODUCTION (DBT sponsored)**

**Designing shRNAs for individual gene:** The shRNAs for myostatin and TGF 4 genes were designed. The CG content ranged from 40-60% and shRNAs were designed for lentiviral vectors having U6/H1 promoters. The shRNAs designed were matched through BLAST for specificity. Top ranking shRNA were chosen from the list.

Primary chicken embryo fibroblasts (CEF) cultures preparation was standardized (Fig. 34). Preliminary trials were also conducted to standardize the needle length and site of injection in the fertilized eggs. Injection with 24 mm needle at broad end of egg, either on 7th or 14th day of incubation resulted in deposition of ink in the yolk sac of the embryo in majority of cases. Whereas, with 11 mm needle, when injected at broad end, either on 7th or 14th day of incubation the ink was deposited partly in the air cell and chorio-allantoic cavity. When injected with 24 mm needle at narrow end, ink was deposited in yolk sac and seemed to have injured the embryo. When injected at narrow end of egg with 11 mm needle the ink was deposited in the albumen of the egg with minimum contact to embryo.



**Fig. 34:** A: Primary chicken embryo culture, B: Monolayer after sub culture of CEF

**Table 22:** Body weight at different weeks of age in naked neck as well as normally feathered population

<i>Age in weeks</i>	<i>Sex</i>	<i>Naked Neck</i>	<i>Normally feathered</i>
3	Male	448.81 ± 03.69 <sup>a</sup>	450.50 ± 8.44 <sup>a</sup>
	Female	431.27 ± 02.92 <sup>b</sup>	429.00 ± 7.59 <sup>b</sup>
	Combined sex	438.01 ± 02.32	438.65 ± 5.72
5	Male	1071.28 ± 05.54 <sup>a</sup>	1080.92 ± 18.25 <sup>a</sup>
	Female	925.07 ± 05.66 <sup>b</sup>	932.88 ± 15.37 <sup>b</sup>
	Combined sex	0999.84 ± 04.49	994.29 ± 13.33
6	Male	1431.46 ± 09.39 <sup>a</sup>	1427.85 ± 37.74 <sup>a</sup>
	Female	1268.16 ± 09.74 <sup>b</sup>	1269.96 ± 31.34 <sup>b</sup>
	Combined sex	1352.82 ± 07.49	1334.41 ± 26.74
20	Male	4488.19 ± 77.43 <sup>a</sup>	
	Female	2993.51 ± 75.98 <sup>b</sup>	
	Combined sex	3740.85 ± 54.24	

**Note:** Figures bearing the same superscript in a column within weeks of age did not differ significantly in each type of birds.

### 3. AUGMENTATION OF PRODUCTION IN NAKED NECK WHITE POPULATION USING CONVENTIONAL BREEDING AND NANOTECHNOLOGICAL APPROACHES (Emeritus Scientist Scheme)

In naked neck white population, average percent fertility was 88.09%, whereas hatchability on total egg set and fertile egg set was 73.62% and 83.63%, respectively. Naked neck male birds weighed were significantly heavier than female birds at all weeks of age. Similarly, significant sex differences were also observed in normally feathered birds and the males were heavier than female (Table 22). Body weight gains during 0 to 3, 3 to 5 and 0 to 5 weeks of age were 390.40 g, 505.55 g and 912.85 g, respectively, while corresponding FCR values were 2.80, 2.11 and 2.50. The per cent mortality in chicks (0-8 weeks of age), growers (9-20 weeks of age) and adult (21-39 weeks of age) were 6.5, 9.7 and 17.37, respectively. Egg production stated during 22<sup>nd</sup> weeks of age and in 22<sup>nd</sup> weeks of age, it was 7.55%, whereas it achieved ~ 40% production in 26<sup>th</sup> weeks of age and thereafter up to 39<sup>th</sup> weeks of age, same level of egg production was maintained. The dressing percentage in male, female and combined sexe of white naked neck white birds at 6<sup>th</sup> weeks of age was 69.81±1.79, 70.69±1.79 and 70.25±1.27, respectively. The per cent cutup parts i.e., breast, back, neck,

thigh, drumstick and wing were 25.43±7.29, 15.10±0.91, 3.35±0.28, 10.19±0.47, 10.10±0.54 and 9.34±0.39 in males; 15.41±7.29, 13.37±0.90, 3.71±0.27, 9.97±0.47, 9.49±0.54 and 9.05±0.39 in females; and 20.42±5.15, 14.24±0.64, 3.534±0.19, 10.082±.33, 9.80±0.38 and 9.2±0.27 in combined sex, respectively.

### C. CONTRACT RESEARCH PROJECTS

#### 1. COMPARISON OF CHICKEN PERFORMANCE WHEN FED DIETS CONTAINING MON 89034 x NK 603 CORN

A growth performance trial was conducted to compare the feeding value of MON 89034 x NK603 corn, its counterpart hybrid without MON 89034 x NK 603 corn trait and three other commercial varieties of corn on growing broiler chickens. Five diets were formulated; each diet having maize a sole source of cereal:

1. Test corn (MON 89034 x NK 603)
2. Control corn, a counterpart corn hybrid with a genetic background that is similar to test corn but does not contain the MON 89034 x NK 603 trait
3. Reference corn A, a commercial conventional corn variety
4. Reference corn B, a commercial conventional corn variety
5. Reference corn C, a commercial conventional corn variety

By 21 day of age, sex effects became evident with the males weighing significantly more than the females. These effects were also observed at 42 d. There were no significant interactions between corn source and sex at any age on FCR. It is well established that males exhibit better FCR than do females, as found in this study. Corn source had no significant effect on FCR during the starter period (0 to 21 d), finisher period (35 to 42 d), and cumulatively (0 to 42 d). There were no significant differences in percentage survivors for birds that received the Bt corn diets and those that received the non Bt and commercial corn diets on an overall basis at any age. The yield of carcass parts as a percentage of live BW for males and females at 42 d of age had no effect of corn source. The diets containing MON 89034 x NK 603 corn supported normal broiler chicken growth with mortality and FCR that were similar to that supported by the non Bt MON 89034 x NK 603 corn isolate and the commercial corn without significant differences among treatment groups in carcass yield. Therefore, it revealed that the transgenic corn had no deleterious or unintended effects on production traits of broiler chickens.

## **2. EVALUATION OF NUTRITIONAL VALUE OF DIETS CONTAINING Bt RICE GRAINS IN BROILER CHICKENS**

Three types of rice grains i.e., transgenic Bt and non-Bt and one commercial, procured from Maharashtra Hybrid Seeds Company Ltd. (Mahyco), Mumbai were incorporated in broiler chicken diets and compared on broiler chicken performance and carcass yield in a six weeks feeding trail. Seven experimental diets (iso-nitrogenous-23.35% and 21% CP and iso-caloric-2900 and 3000 kcal ME/kg for 0-3 and 4-6 weeks for starting and finishing phases, respectively) were formulated. Diet D1 was a typical corn-soybean meal based control diet. Six more diets were prepared by incorporating 10 and 20% each of Bt. rice grain (D2 and D3), non-Bt rice grain (D4 and D5) and commercial rice grain (D6 and D7) in the control diet. Each dietary treatment was offered to six replicated groups of birds from day old to 6 weeks of age. The birds were reared in battery cages with group wise brooding, feeding and watering facilities. Birds were weighed at weekly intervals and data of feed intake were also recorded simultaneously. At the end of 6<sup>th</sup> week of age, 12 birds per treatment (2 birds/replicate) were sacrificed to study the effect of feeding rice grain types on different carcass

traits and development of digestive and immune organs.

The results of the study revealed that the body weight gain and feed conversion efficiency did not differ statistically ( $P>0.05$ ) either during starting phase (0-3 wks), finishing (4-6 wks), and overall (0-6 wks) phases. However, in starting phase (0-3 wks), the feed conversion efficiency was found to be significantly ( $P<0.05$ ) improved in control and 20% Bt. rice grain groups. The feed intake was found to be significantly ( $P<0.05$ ) higher during starting (0-3 wks), finishing (4-6 wks), and overall (0-6 wks) phases in chicks fed control diet as compared to Bt., non-Bt rice grain and commercial rice grain groups. The Protein and energy efficiencies of experimental diets fed to broiler chicken also remained statistically similar at finishing (4-6 wks), and overall (0-6 wks) phases, however, in starting phase (0-3 wks) the energy efficiency was better in commercial rice grain group as compared to control, Bt. and non Bt. Rice grain groups. The carcass traits (% of live weight) of broilers (blood loss, feather loss, dressed yield, eviscerated yield ready to cook yield and abdominal fat), cut up parts (breast, drum stick, thigh, back, neck, wings) and digestive and immune organs weights (heart, liver, gizzard, spleen, bursa) also remained statistically ( $P>0.05$ ) similar due to various dietary treatments. It is concluded that the transgenic Bt rice grain can be included safely up to 20% in maize-soybean meal based broiler diet up to 0-6 weeks of age.

## **INTER - INSTITUTIONAL PROJECTS**

### **1. RECYCLING OF ANIMAL AND FARM WASTE AND APPLICATION OF THEIR VALUE ADDED PRODUCTS IN SUSTAINABLE CROP PRODUCTION AND ANIMAL HUSBANDRY: HAZARD ANALYSIS OF POULTRY WASTE AND TECHNO-ECONOMIC EVALUATION OF ITS ALTERNATIVE USES (Component B-CARI, Izatnagar)**

In order to find out the most suitable method of poultry waste utilization, the following three alternatives were evaluated for their economic feasibility. The technical data in respect of these alternatives were obtained from primary as well as secondary sources.

#### **Generation of bio-gas**

The economics of biogas generation utilizing commonly recommended size of gas chamber, i.e., 2.4 cu m was worked out. On an

average, a 2.4 cu m biogas plant requires 34 kg of poultry litter (from about 350 birds) and 68 liters of water (or 65 kg of cow dung and an adequate amount of water) daily to function properly. About 2.11 cu m of biogas containing 60% methane is produced which provides 5–6 hours of continuous gas supply for lighting and cooking daily. Smoke-free fuel reduces indoor air pollution, which adversely affects health, particularly of women. Biogas plant results in saving of time since food is cooked more quickly with biogas than with traditional fuels. Moreover, one to two hours are also saved per day in terms of fuel collection time and relief from drudgery involved in the process. It also produces 80–90 kg of slurry, which can be used as compost. The use of organic manure from poultry litter to grow vegetables in farmhouse areas enhances income by 30–50% and provides vegetables to supplement the household diet.

The total cost of construction of 2.4 cu m capacity gas plant turned out to be Rs. 21,415/- including all material and labour costs (Table 23). This biogas plant results in a saving of over Rs. 37,000/- per year. The savings accrued on account of fuel (worked out in terms of equivalent value of LPG) and compost (valued in terms of available N: P: K equivalent to chemical fertilizers) in the form of slurry. The payback period of the investment was estimated to be less than a year by proper eco-friendly utilization of poultry litter. It is estimated that from a 2.4 cu m capacity plant producing 2.11 cu m biogas/day, approx. 4.25 t carbon credits can be earned (1 cu m CH<sub>4</sub> = 9.18 kg carbon).

**Table 23:** Economics of biogas plant with a chamber capacity of 2.4 cu m per day

<i>Cost</i>	<i>Amount (Rs.)</i>
Material cost for biogas plant 2.4 cu m /day capacity	15495/-
Labour cost	5920/-
Total cost of construction	21415/-
<b>Returns or savings</b>	<b>Amount (Rs.)</b>
Value of biogas slurry used as compost @ 90 kg /day (1.6%:1.55%:1% :: N:P:K)	82.05
Biogas @2.11 cu m /day equivalent to 0.43 kg LPG /cu m Biogas per day	20.08
<b>Total annual returns or savings</b>	<b>37277/-</b>
Payback period	Approx. 7 months

## Economics of vermi-composting

Vermi-composting as an alternative for utilization of poultry waste (particularly cage droppings) was evaluated in terms of economic feasibility. Vermin-compost can be prepared by utilizing poultry droppings along with other organic waste such as cow dung, dried leaves, and other bio-waste material in a ratio of 1:4. Therefore, this option is more suitable for crop-livestock-poultry mixed farming system. Broiler litter is not suitable for vermi-composting since it also contains poultry feed which in turn results in rodents' menace. While making vermin-compost, the moisture level has to be maintained at about 60%. Vermiculture gets ready in 20-25 days duration which can also be sold @ Rs. 200-250 per kg commercially. However, the economic analysis carried out (Table 24) does not take into account commercial production of vermin-culture. Here, the economic analysis has been carried out to indicate cost and returns from production of vermin-compost for on-farm use. During summers, special care should be taken to protect worms against extreme temperatures which result in high mortality of earth worms. The duration of cycle is shorter in summers as compared to winters. Jai Gopal strain of Indian earth worms is considered hardier and heat tolerant.

**Table 24:** Economic analysis of vermin-composting

<i>Particulars</i>	<i>Quantity</i>	<i>Rate (Rs.)</i>	<i>Total Amount (Rs.)</i>
Capital investments - For a tank 10'x6'x1' including thatched house	-	-	8880
Operational costs (one cycle) - B	-	-	986
Total capital requirement for 1st cycle C = (A+B)			9866
Total operational cost per year (7 cycles) D = B x 7			6902
Overheads @ 10% of capital cost (A) - E			888
Total production cost per year - F=(D+E)			7790
Annual production of bio-manure (360 Kg x 7 cycle in a year) (Gross Income) - G	2520 Kg	5/kg	12600
Net Profit H=(G-F)			4810
B:C Ratio (G/F)			1:1.62
Payback period (Years) (C/H)			2.05

### **Poultry dropping as ruminants' feed**

Feeding of sun dried and ground poultry droppings as an ingredient of cattle concentrate @ 20-25% results in a saving of about 3.0-4.0 quintals of basal concentrate mixture worth Rs. 3600-4000 per year per cattle head without affecting overall performance. Higher levels of poultry waste up to 70% can be used for replacement herds and maintenance periods of cattle in general. Prior to feeding, poultry wastes must be processed by either drying, ensiling, chemical treatment or other processes to reduce the microbial count and eliminate pathogens. Poultry waste based rations need to be carefully balanced, in view of low energy content and high ash contents especially in layer droppings.

### **Conclusion**

Generation of biogas appeared to be the best and most profitable alternative for utilizing poultry waste. It also resulted in reduction of green house gases thereby paving way for earning through trading of carbon credits. The next best alternative was observed to be vermi-composting utilizing poultry cage droppings (layer farms) and other organic material (such as dung, dry leaves, straw etc.). Feeding dried poultry droppings to ruminants in the concentrate mix was the least capital intensive alternative to utilize poultry waste.

# Technology Assessed and Transferred

## TECHNOLOGY ASSESSED

- The window based computer softwares “MAKEFEED POULTRY and MAKEFEED DAIRY” developed for efficient balanced formulation of feed for a wide variety of poultry birds like layer and broiler chickens, quails, guinea fowls, turkeys etc. were updated and revised for making it more user-friendly. These softwares are being sold @ Rs 1500/- and Rs. 2,000/- per package in CD, respectively.
- Formulation of low cost feed to the farmers rearing backyard poultry.
- Technology for preparing egg cutlets, a nutritious and versatile snack food has been standardized. Process of preparation included mincing of chicken meat with salt and pressure cooking until they were tender. Yolk was removed from the boiled egg, cooked albumen mashed and mashed albumen, yolk, onion paste, soy sauce, white vinegar, grated cheese, refined wheat flour, mustard powder and spice mix were mixed with cooked chicken minced meat. A medium size ball was made from mixed ingredients; a half piece of one boiled egg albumen was placed in the middle of the ball and made a ball again. Liquid contents of one egg was beaten well and kept aside. The ball was dipped in the beaten egg mixture and deep fried on both sides at 205°C oil temperature for 2-3 minutes or until golden brown in colour. Egg cutlet prepared with 42% egg and 40% minced chicken meat with 6.7% grated cheese, 6.0% onion paste, 2.0% refined wheat flour, 0.10% mustard powder, 2.0 % spice mix, 0.8% salt and 0.2% each of white vinegar and soy sauce were most acceptable and had a refrigerated shelf life of 14 days in vacuum and 12 days in aerobic packaging with satisfactory microbiological and organoleptic quality. The cost of formulating one processed egg cutlet weighing about 125 g was calculated to Rs. 21.70.

- Popularization of backyard poultry and duck farming among rural landless and marginal farmers.
- Integrated farming of poultry and duck with aquaculture and horticulture as a sustainable livelihood.

## TECHNOLOGY TRANSFER ACTIVITIES

### Farm School on Akashwani

During the period under report, 11<sup>th</sup> Farm School on “Commercial Broiler Farming” was organized through Prasar Bharati, Akashwani Rampur during September 01, 2010 to October 13, 2010. Total 131 farmers belonging to 14 districts of U.P. and 2 districts of Uttarakhand had been registered for the programme. More than 50% registered farmers took active participation in the Farm School. During the Foundation Day of the Institute on November 02, 2010, the cash prizes and certificates were distributed to 15 winning farmers on the basis of evaluation. The cash prizes worth Rs 25,000/- were sponsored by the courtesy of National Egg Coordination Committee (NECC), Pune.

The prize winning farmers of XI farm school were Smt Raj Kumari, village Bonda, Moradabad—First Prize (Rs. 5000/-); Shri Arif Ali Idrisi, village Sahanpur, Budaun and Shri Kamal Kant Singh, village Firozpur, Moradabad—Second prize (Rs. 3000/- each); Shri Mohd. Akil Idrisi, village Sahanpur, Budaun and Shri Urman Ali Idrisi, village Paira Rafatpur, Moradabad—Third prize (Rs. 2000/- each); and ten consolation prizes of Rs. 1000/- each to Shri Rakesh Kumar, village Begamabad, Rampur; Shri Prem Pal, village Udra, Bareilly; Shri Ravi Kant Maurya, Bilaspur, Rampur; Shri Kunwar Sen, village Saijani, Bareilly; Shri Vaibhav Saran, Civil Lines, Rampur; Shri Bhanu Pratap, village Udra, Bareilly; Shri Ram Prakash Singh, village Kalyanpur, Budaun; Shri Surya Prakash Saxena, Milak, Rampur; Shri Raghvendra Kumar, PO Shahi, Bareilly; Shri Pankaj Kumar, village Nawadia, Rampur.

## **Organization of Short Term Trainings**

### **Regular Training Programmes**

Three batches of short-term training on poultry production management were organized at the Institute during April 12-17, 2010; August 16-21, 2010; and October 26-November 01, 2010. Total 93 trainees belonging to Aligarh, Azamgarh, Barabanki, Bareilly, Budaun, Bulandshahar, Devaria, Fatehpur, Hardoi, Kanshi Ram Nagar, Lucknow, Meerut, Moradabad, Orayya, Pilibhit, Ramabai Nagar, Rampur, Sant Ravidas Nagar, Shahjahanpur, Sitapur, Sultanpur and Varanasi districts of Uttar Pradesh; Nainital and U.S. Nagar districts of Uttarakhand; Madhepura district of Bihar; and New Delhi including 2 selected farmers of adopted village Nawadia Harkishan of Bareilly participated in the above training programmes and received certificates.



### **Sponsored Training Programmes**

Six batches of sponsored training programme on poultry production management were organized at the Institute during August 30-September 04, 2010; October 26-November 01, 2010; January 10-15, 2011; February 14-19, 2011; February 21-26, 2011; and March 14-19, 2011 for 57 farmers of Bhagalpur, Patna, Kishanganj and Poorena districts sponsored by Animal Husbandry Department, Government of Bihar under Rashtriya Krishi Vikas Yojna; 15 farmers sponsored by Agricultural Technology Management Agency (ATMA), Madhubani (Bihar); and 130 army soldiers sponsored by Gorkha Resettlement Training Unit C/O 56 APO. After successful completion of the training, the trainees were awarded with the certificates.

### **Training Programmes at Regional Centre**

A series of farmers' trainings were conducted in Keonjhar, Mayurbhanj and

Sambalpur districts of Orissa where hundreds of landless and women farmers were given training on various aspects of backyard poultry and duck farming. Farmers were sensitized by exposure visit to the Regional Centre, CARI, Bhubaneswar campus for live demonstration of farm and hatchery activities. Besides, the scientists of Regional Centre have attended as resource persons for livestock development in eight farmers' training programmes conducted by Directorate of Water Management (DRM) for Eastern Region, Bhubaneswar under watershed management programme. The trainings were conducted at the village level. Also, the scientists delivered talks in the training programme organized by CPDO, Bhubaneswar for the progressive farmers of different parts of the country.



### **On-Farm Survey of CARI Commercial Broilers**

The performance of CARI commercial broiler (CARIBRO Dhanraja) supplied to the farmers from Technology Transfer Section is being continuously monitored.

### **Commercial Poultry Farms Established**

A total of 85 farmers started poultry farming by adopting CARI germplasm and other technologies after getting proper training provided by Technology Transfer section. Besides, women self help groups of five villages in Khurda district of Orissa were organized and adopted for backyard poultry and duck production under the ongoing DST project entitled "Backyard poultry and duck farming as a tool to sustainable livelihood of rural women of Khurda district of Orissa".

## Consultancy Services

Consultancy services were provided to the farmers and other poultry entrepreneurs from all over the country. About 225 postal/E-mail and more than 800 consultancies in person on various aspects of poultry farming were provided. Institute free publications in large number were issued to the visiting farmers, students and other poultry entrepreneurs, during the period under report.

A large number of queries from farmers, related with poultry training, supply of germ-plasm and the role of CARI for the betterment of poultry production in rural areas, received on phone and also through Kisan Call Centre (Toll free number 1551) were addressed to their satisfaction.

## Kisan Gosthi

A kisan gosthi was organized on November 02, 2010 on the occasion of Foundation Day of the Institute. This event was given wide publicity in and around Bareilly district through farm visits, broadcasting on AIR and telephonic contact. During this kisan gosthi, lectures on commercial broiler farming, preparation of balanced broiler feed, disease management of poultry, quail farming and desi breeds for backyard poultry were delivered by the scientists of the Institute. In order to get feedback from poultry farmers on various problems of poultry, a questionnaire was distributed to the poultry farmers and collected back. The problems enumerated by them were replied in detail by the experts. A total number of 114 poultry farmers from different district of U.P., Bihar and Uttarakhand participated in this gosthi.



## Adoption of Village Panchayat

In order to disseminate poultry production technologies developed by CARI, a village panchayat-Navdia Harkishan was adopted by this Institute in consultation with Block Officials, Pradhan and Dept. of Soil Conservation. The farmers of the village panchayat were motivated through a series of farmer-scientist meets (7 in number) at the village. As a result of continuous efforts, one farmer Shri Rupesh Kumar R/O Navdia, has established a small poultry farm of 1000 birds capacity. He is happy with the progress of the farm and planning to expand it to 3000 birds capacity.



## Participation in Exhibitions

- Kisan Mela and Pashu Vigyan Pradarshini held on November 01-03, 2010 at Indian Veterinary Research Institute, Izatnagar.
- Agricultural Exhibition held on December 22-24, 2010 at Maharana Pratap University of Agriculture and Technology, Udaipur (Rajasthan) on the occasion of 5<sup>th</sup> National Conference on KVK-2010.
- Agricultural Exhibition "AGRIVISION 2011" held on February 10-12, 2011 at National Bureau of Fish Genetic Resources, Lucknow on the occasion of 10<sup>th</sup> Agricultural Science Congress.
- Pusa Krishi Mela held on March 03-05, 2011 at Indian Agriculture Research Institute, New Delhi.



### Foundation Day Celebrations

The 32<sup>nd</sup> Foundation Day of the Institute was celebrated on November 02, 2010 with great zeal and enthusiasm. The valedictory function of XI Farm School on AIR aired through AIR Rampur and the plenary session of short term training on poultry production management was organized on the occasion.

The Chief Guests of the function Dr. S.N.S. Gaur, Prof. and Head (Retd.), GBPUA&T, Pantnagar and Dr. R.M. Acharya, Ex-DDG (AS), ICAR distributed the cash prizes, mementoes and certificates to 15 winning farmers of Farm School programme. The cash prizes worth Rs. 25,000/- were sponsored by the courtesy of National Egg Coordination Committee (NECC), Pune. The Director along with the Guest of Honour distributed the certificates to 32 trainees, who have successfully completed the short term training on poultry production management. Besides, Shri Anirudh Tiwari of district Devaria (U.P.), one of the poultry farmer, who had started and running his poultry farm successfully with CARI technologies was also felicitated with a shawl and certificate.



### Communication through Mass media

Several news features and press releases on the activities of the Institute were released to local and national dailies and journals, besides Doordarshan Bareilly and Akashwani Bareilly and Rampur. A number of advertisements to popularize latest breeds developed by the Institute were also released to various magazines, souvenirs and newspapers.

#### Radio Talks under XI Farm School on AIR

- Bhanja, S.K. (2010). *Vyavasayik broiler palan hetu sthan ka chunav tatha avas nirman*. All India Radio, Rampur. September 11.
- Majumdar, S. (2010). *Vyavasayik broiler palan ka badhta mahatva*. All India Radio, Rampur. September 04.
- Mandal, A.B. (2010). *Vyavasayik broiler palan hetu kam lagat ke santulit aahar*. All India Radio, Rampur. September 22.
- Narayan, R. (2010). *Vibhinn mausamon mein Vyavasayik broiler ki dekhbhal*. All India Radio, Rampur. September 25.
- Sachdev, A.K. (2010). *Vyavasayik broiler se tayyar vibhinn up-utpadon ki prodyogiki*. All India Radio, Rampur. October 13.
- Saran, S. (2010). *Vyavasayik broiler palan hetu poonji vyavastha, sarkari yojnayan evam bima*. All India Radio, Rampur. September 08.
- Saxena, V.K. (2010). *Vyavasayik broiler ka kushal farm prabandhan*. All India Radio, Rampur. September 29.
- Singh, D.P. (2010). *Ghar ke pichware vyavasayik broiler palan ka prabandhan*. All India Radio, Rampur. October 02.
- Singh, R.P. (2010). *Kisanon ko vyavasayik broiler palan ki or unmukh karne hetu CARI ka yogdan evam labhdayak prajatiyan*. All India Radio, Rampur. September 01.
- Tomar, S. (2010). *Vyavasayik broiler chuje farm par lane se purv ki jane wali tayyariyan*. All India Radio, Rampur. September 15.
- Tomar, S. (2010). *Vyavasayik broiler mein rog nidan evam tikakaran*. All India Radio, Rampur. October 09.
- Tyagi, Pramod K. (2010). *Vyavasayik broiler palan hetu avashyak ahar srot, ahar tayyar karne ki vidhi evam uchit bhandaran*. All India Radio, Rampur. September 18.

Tyagi, Praveen K. (2010). *Vyavasayik broiler mein ahār ki kami se hone wale rog*. All India Radio, Rampur. October 06.

#### Other Radio Talks

Gangwar, L.S. (2010). *Kukkuṭ palan vyavasay aur arthik drishtikone*. All India Radio, Bareilly. December 23.

Narayan, R. (2010). *Visahsagya ki rai- Uttam tarike se batter palan*. All India Radio, Bareilly. June 28.

Narayan, R. (2010). *Bater palan aaj ki awashkayata*. All India Radio, Bareilly. December 15.

Narayan, R. (2010). *Murgi palan kaise karen*. All India Radio, Rampur. August 16.

Narayan, R. (2011). Kisan Gosthi (Radio Kisan Divas) organized by AIR, Bareilly on February 15. (Sponsored by IFFCO, Aonla).

Sandeep S. (2010). *Kukkuṭ palan ke liye poonji vyavastha tatha sarkari youjnaye*. All India Radio, Bareilly. November 26.

Sandeep S. (2011). *Kukkuṭ palan hetu poonji vayastha ki aavshayakta tatha sarkari yojnayan*. All India Radio, Rampur. March 06.

Tomar, S. (2011). *Kukkuṭ palan mein ane wali samasayen wa samadhan*. All India Radio, Bareilly. March 24.

#### Video Film

Dr. Sandeep Saran and Dr. R.P. Singh conceptualized, scripted, coordinated videography and edited the Institute video film entitled "Poultry Passion" highlighting salient accomplishments and technologies developed by the Institute. The 10 minutes documentary film was submitted to the Council on July 16, 2010 during the Directors' Conference.

#### MOU SIGNED

MoU was signed between the Institute and M/s Agribusiness Management Centre, Ghaziabad for transfer of quail production technology.

#### TV Talks

Mandal, A.B. (2010). Feeding and management of broiler during summer. Doordarshan Bareilly. May 2010.

Mandal, A.B. (2010). Feeding and management of broiler during winter. Doordarshan Bareilly. December 2010.

#### Supply of Germ Plasm

In order to uplift the standard of living of the people and to make the country self-sufficient in high yielding germplasm, the pure line parent stocks and commercial crosses were supplied to various agencies in different pockets of the country. A brief account of the supply of germplasm (species-wise) is given in Table 25.

**Table 25:** Supply of germplasm

<i>Germ plasm supplied</i>	<i>Fertile eggs</i>		<i>Day-old chicks</i>		<i>Growers</i>	<i>Adults</i>
	<i>Parent line</i>	<i>Commercial</i>	<i>Parent line</i>	<i>Commercial</i>		
Layer	2,025	-	3,787	-	-	-
Broiler	32,190	-	13,893	37,351	1,320	891
Desi fowl	891	-	2,483	28,766	-	37
G. fowl	-	-	-	500	-	25
Quail	17,311	-	-	-	-	17,050
Turkey	-	-	-	5,040	-	741

# Education and Training

The Post Graduate Education and Training (PGET) 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 coordinated PG education leading to M.Sc., M.V.Sc. and Ph.D. degree in Animal Genetics and Breeding/Animal Science/Biotechnology/Microbiology/Poultry Science.

## Post Graduate Students on Roll

During the year 2010-11, the Institute has enrolled 23 students for M.V.Sc. degree, 15 students for Ph.D. degree, and 2 students for NDPH programme under the IVRI Deemed University. Under co-guidance system of education in collaboration with other Universities, the Institute has enrolled one Ph.D. student.

## Degree Awarded

Under the IVRI Deemed University, five M.V.Sc. and four Ph.D. students have completed their degree in Poultry Science guided by the scientists of the Institute (Table 26).

**Table 26:** Degree awarded from the IVRI Deemed University, Izatnagar

<i>Sl. No.</i>	<i>Scholar</i>	<i>Thesis title</i>	<i>Supervisor</i>
<b>M.V.Sc. degree</b>			
1.	Dr. P. Avinash PSC/4663	Evaluation of recombinant chicken IFN- $\gamma$ as vaccine adjuvant and growth promoter	Dr. V.K. Saxena
2.	Dr. N.S. Tomar PSC/4664	Developmental potency of parthenogenesis in turkey bird ( <i>Meleagris gallopavo</i> )	Dr. S.K. Bhanja
3.	Dr. Sivabala PSC/4665	Production and quality evaluation of rendered poultry by-product meal	Dr. C.K. Beura
4.	Dr. V.B. Awachat PSC/4666	Utilization of poultry slaughter by product meal in diets of growing turkey poult	Dr. S. Majumdar
5.	Dr. S. Iqbal PSC/4669	Effect of supplementary sources and concentrations of zinc and copper on performance of broiler chicken	Dr. Chandra Deo
<b>Ph.D. degree</b>			
1.	Dr. D.K. Hajra PSC/1047	Value addition of chicken egg through dietary means	Dr. Praveen K. Tyagi
2.	Dr. Nonigopal Shit PSC/1106	Molecular approaches for the evaluation of stress and its amelioration on ovarian functions in japans quail( <i>Coturnix coturnix japonica</i> )	Dr. K.V.H. Sastri
3.	Dr. Girraj Goel PSC/1108	Molecular characterization of differential cytokines and their differential expression analysis in guinea fowl( <i>Numida meleagris</i> )	Dr. Deepak Sharma
4.	Dr. Azmat Alam Khan PSC/1179	Evaluation of genetic diversity among different quail lines using quantitative and molecular genetic approaches	Dr. D. Chaudhuri

## Specialized Training

During the year, the PGE&T Section of the Institute has organized 7 training programmes. In all, 13 personnel imparted trainings. The detail of the training programmes is given in Table 27.

## Scientific/Technical/Faculty Organized

The PGE&T Section of the Institute organized 01 major credit, 08 minor credit, 08 ORW, 03 pre-thesis submission and 01 faculty seminars on various researchable issues/topics by the M.V.Sc. and Ph.D. students and scientists of the Institute (Table 28).

## Seminars

**Table 27:** Specialized training courses

Sl. No.	Training courses	Duration	No. of trainees	Benefactor (Name and Institution)
1.	Application of Biotechnological Techniques	17.05.2010 to 15.06.2010	02	1. Ms Noopur Upadhyay MSc (Biotechnology) Amity University, Lucknow Campus (U.P.) 2. Shri Prateek Sukumar B Tech (Biotechnology) Maulana Azad National Institute of Technology Deemed University, Bhopal (M.P.)
2.	Application of Biotechnological Techniques	01.6.2010 to 30.6.2010	03	1. Ms Enakshi Johri, MTech (BT), Amity Institute of Biotechnology, Amity University, Noida (U.P.) 2. Ms Shalini Srivastava, MSc (BT) Amity University, Lucknow (U.P.) 3. Shri Musharraf Hussain MSc (BT) Indian Institute of Technology, Roorkee (Uttarakhand)
3.	Application of Biotechnological Techniques	15.6.2010 to 14.7.2010	01	Shri Chandan Sagar, B Tech (Biotech.) VIT University Vellore (Tamil Nadu)
4.	Application of Biotechnological Techniques	17.06.2010 to 16.07.2010	03	1. Ms Bipeno Tsopoe BSc Biotech. 2. Ms Pragya Pandey BSc (Biotech.) Sam Higginbottom Institute of Agriculture, Technology & Sciences, Allahabad (U.P.) 3. Ms Manju B Tech (Biotech) College of Biotechnology, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (U.P.)
5.	Application of Biotechnological Techniques	01.07.2010 to 30.07.2010	01	Ms Pooja Srivastava BTech-M-Tech (Dual Degree) Biotechnology Lovely Professional University, Lovely Campus, (NH-1), Phagwara (Punjab)
6.	Broiler Production	01.06.2010 to 21.06.2010	01	Shri Pamit Kumar MBA Kishanganj (Bihar)
7.	Layer Production	03.08.2010 to 23.08.2010	02	1. Shri Nimesh Shrivastava, Gominagar, Lucknow (U.P.) 2. Shri Rajeev Kumar Singh Jaunpur (U.P.)

**Table 28:** Scientific/technical/faculty seminars organized

<b>Sl. No.</b>	<b>Date of seminar</b>	<b>Topic of the seminar</b>	<b>Speaker</b>
<b>Major Credit</b>			
1.	09.02.2011	Major abiotic stress factors in poultry and mitigation strategies under present scenario of global warming	Dr. Suraj A. Amrutkar PSC/PhD/1256
<b>Minor Credit</b>			
1.	29.12.2010	Biosecurity measures	Dr. Maosami EXT/MVSc/4936
2.	29.12.2010	Control broiler farming	Dr. Dhanoj Patil EXT/MVSc/4937
3.	04.01.2011	Artificial insemination in poultry	Dr. Dileep Kumar EXT/ MVSc/4933
4.	04.01.2011	Designer egg	Dr. Jyoti Yadav EXT/MVSc/4934
5.	04.01.2011	Poultry waste management	Dr. Arbind K. Verma EXT/MVSc/4935
6.	13.01.2011	Ventilation system for modern poultry house	Dr. Deepak Upadhayay LPM/MVSc/4907
7.	13.01.2011	Winter management in chicken	Dr. Shilpi Kerketta LPM/MVSc/4909
8.	13.01.2011	Poultry nutrition and feeding	Dr. Praveen Bharti LPM/MVSc/4910
<b>ORW</b>			
1.	16.12.2010	Protein profiling of melanotic meat in crosses of Indian native chicken: Kadakanath	Dr. Anuj Kumar PSC/MVSc/4789
2.	16.12.2010	Augmentation of reproductive functioning by feed restriction and phytoestrogens in broiler pullets	Dr. Madnurkar A.D. PSC/MVSc/4792
3.	23.12.2010	Physico-biochemical characteristics of semen and serum sex steroid hormonal profile of guinea fowl ( <i>Numida meleagris</i> )	Dr. J.M. Khandey PSC/MVSc/4791
4.	23.12.2010	Detection and quantification of salmonella in chicken egg	Dr. Lakhanpal Singh
5.	23.12.2010	Molecular and biochemical events in sperm storage tubules of oviduct during natural and artificial insemination in japans quail ( <i>coturnix japonica</i> )	Dr. Killare G.S. PSC/MVSc/4795
6.	30.12.2010	Efficiency of diatomaceous earth, sodium bentonite and zeolite as aflatoxin absorbents in broiler chickens	Dr. S. Silambarasan PSC/MVSc/4793
7.	30.12.2010	Evaluation of growth and immunocompetence in indigenous chicken breed: Ankaleshwar	Dr. S. Sharmila Devi PSC/MVSc/4794
8.	10.01.2011	Biometrical genetic analysis of an improved guinea fowl population in different cross combinations for growth rate and genetic variability	Dr. Anand Prakash PSC/MVSc/4790
<b>Pre-Thesis Submission</b>			
1.	29.09.2010	Molecular approaches for the evaluation of stress and its amelioration on ovarian functions Japanese quail ( <i>Coturnix coturnix japonica</i> )	Dr. Nonigopal Shit PSC/PhD/1106
2.	29.01.2011	Molecular characterization of different cytokines and their differential expression analysis in guinea fowl ( <i>Numida meleagris</i> )	Dr. Girraj Goel PSC/PhD/1108
3.	11.3.2011	Evaluation of genetic diversity among different quail lines using quantitative and molecular genetic approaches	Dr. Azmat Alam Khan PSC/PhD/1179
<b>Faculty Seminar</b>			
1.	05.01.2011	Biosecurity (Animal Science)	Dr. A.S. Yadav Sr. Scientist

## Revenue Generation

During the period under report, a revenue of Rs 1,23,700/- (Rupees one lakh twenty three thousand seven hundred only) has been generated from the different courses of poultry production/avian biotechnology as a course fee.

## POST GRADUATE RESEARCH HIGHLIGHTS

*Title of thesis:* **Evaluation of recombinant chicken IFN- $\gamma$  as vaccine adjuvant and growth promoter** (*Scholar:* Dr. Pange Avinash, Roll No. PSC/MVSc/4663; *Guide:* Dr. V.K. Saxena)

Interferon (IFN) represents a family of cytokines that share the capacity to inhibit viral replication and to modulate immune function, making them prime candidates as therapeutic agent. Considering these properties of interferon, the present investigation was carried out for evaluation of recombinant chicken IFN- $\gamma$  as vaccine adjuvant and growth promoter. For assessing the immunoadjuvant effect of recombinant ChIFN- $\gamma$  with conventional ND vaccine birds were divided into four groups with different treatments viz. NDV, NDV+IFN- $\gamma$ , IFN- $\gamma$  and NSS. The humoral and cell mediated immune(CMI) responses were evaluated through ELISA and MTT assay respectively, revealed significant improvement in immune responses, exhibiting role of recombinant IFN- $\gamma$  as vaccine adjuvant. Growth promoting effect of recombinant ChIFN- $\gamma$  was evaluated through various performance traits in different treatment groups viz. NDV, NDV+IFN- $\gamma$  and IFN- $\gamma$ . Analysis of data revealed most of performance traits were significantly affected in recombinant IFN Production and quality evaluation of rendered poultry by-product meal treatments, indicating that rChIFN- $\gamma$  can be effectively used as growth promoter. mRNA expression profiling various growth related genes viz. IGF-1, IGF-R, GH, GHR, myostatin, TGF-B2 by Real time PCR with SYBR green assay was estimated in liver and breast muscles from NDV and NDV+IFN- $\gamma$  treated groups. Analysis revealed that various genes under study were influenced with treatment of rChIFN. Significant up-regulation of major growth axis genes i.e., IGF1-IGR-R and GHR is an important finding, may open new vista of cytokine versus growth factor interaction at molecular level. Further it explains the possibility of genetic mechanism involved in rChIFN- $\gamma$  growth enhancement. From present study it can be concluded that may be used as an effective

immunoadjuvant and growth promoter for optimization of production land immune capacities of birds. It further highlighted the interaction of rChIFN- $\gamma$  and growth factors and receptors genes in recombinant rChIFN-mediated enhanced growth, however further confirmations with larger sample size are warranted.

*Title of thesis:* **Developmental potency of parthenogenesis in turkey bird (*Meleagris gallopavo*)** (*Scholar:* Dr. N.S. Tomar, Roll No. PSC/MVSc/4664; *Guide:* Dr. S.K. Bhanja)

Parthenogenesis is a form of a sexual reproduction which involves formation of the new organism from an unfertilized egg and so represents a modification of the normal sexual process. Parthenogenesis is found in many animal groups, including insects, crustaceans, rotifers, nematodes (Roundworm) molluscs, and non-mammalian vertebrates. Parthenogenesis in turkey occurs through spontaneous activation of haploid eggs. Hatched parthenogenetic poult have invariably been conducted on turkey to determine the mechanism of the parthenogenetic development, that was only studying the ploidy of the parthenogenetic turkey, but there was no conclusive information. Hence the present study was designed to understand the phenomenon of parthenogenesis by comparing parthenogenetic and normal fertilized embryo development in turkey eggs, determining ploidy and sex of parthenogenetic embryo at different stages of development and to study the differential expression of some developmental related and pluripotent specific genes in parthenogenetic via a vis normal fertilized turkey embryos. The result of the macroscopic examination revealed, 23.99% positive development in parthenogenetic egg leading to 4.70% embryo development. At 72 hrs of incubation blood ring formation was seen in normal fertilized egg, whereas in parthenogenetic egg such development was observed at 96 hrs of incubation. Genomic DNA content was significantly higher in normal fertilized eggs as compared to parthenogenetic egg. Karyotyping using PBMc culture of male and female turkey revealed Z chromosome as 4<sup>th</sup> largest metacentric and w chromosome lines between 6<sup>th</sup> and 7<sup>th</sup> chromosome. No difference was observed in the relative length, size and morphology of chromosomes in parthenogenetic, normal fertilized embryos and PBMc cultured cells. With the advancement of incubation period, % of haploid cell decreased (38.7 to 20.4%) while % of diploid cell increased (21 to 33%).

The proportion of other ploidy also decreased with advancement of embryonic age. The proportion of W chromosome containing cells was higher at the initial stages of development but significantly decreased with the advancement of age, while reverse trend was observed in Z chromosome. No ZW combination was observed in parthenogenetic embryos at any point during whole experiment. The expression of male specific genes, DMRT and AMH were very low at 0 hr (before incubation), then expression increased significantly at 12, 24 and 48 hrs of incubation and maximum level was observed at 24 hr of incubation. The expression profile of ASW (avian sex specific WS linked) candidate ovary determining gene was higher in freshly laid parthenogenetic eggs, however, the expression level decreased in parthenogenetic eggs at 12, 36 and 48 hrs of incubation. Expression of GH gene was higher beyond 72 hours, while the expression of IGF2 was higher up to 36 hours of incubation in parthenogenesis eggs. Expression of POU-v was significantly higher in freshly laid eggs and after 72 hrs of incubation in parthenogenetic embryo than that of normal fertilized embryo. Expression of GATA-4 in parthenogenesis embryo was significantly higher at all the periods except 48 hrs of incubation. Differential expression SOX2 in parthenogenetic eggs was lower up to 12 hrs of incubation, while at 24 hr, 36 hr expression level increased several fold in parthenogenetic embryo. It may be concluded from the above study that parthenogenetic development is significantly low until 60 hours of incubation. Percentage of Haploid or diploid w chromosome decreases after 24 hours incubation in parthenogenetic embryo. Transition of ploidy from haploid to diploid is observed up to 48 hours of incubation. Expression of male specific genes DMRT and AMH is higher in parthenogenetic embryo after 24 hours of incubation. GATA-4 IGF2 may act as marker gene for parthenogenetic in turkey.

*Title of thesis:* **Production and quality evaluation of rendered poultry by-product meals** (*Student:* Dr. S. Sivabala, Roll No. PSC/MVSc/4665; *Guide:* Dr. C.K. Beura)

The present investigation was conducted to assess the processing parameters and yields of various inedible by-products of broilers, comparison of yields of by-product meals (feather meal, offal meal and mixed by-product meal) prepared both by conventional and rendering process and to determine the

nutritional and microbiological characteristics of those meals. The conventional method of preparation involved autoclaving (1 kg/cm<sup>2</sup> for 30 min) and drying (70°C for 12-16 h) while a higher steam pressure of 2.5–4 kg/cm<sup>2</sup> for 45 min (digestion) and vacuum drying were followed in rendering process. The processing conditions maintained in both the methods (conventional and rendering) appeared to be optimal for producing good quality meals. The results revealed that the total yield of by-products was found to be 27.38% in broilers. The per cent yields of feather meal, offal meal and mixed by-product meal in conventional and rendering method revealed that meals made from both methods do not differ statistically in proximate principles (dry matter, crude protein, ether extract, nitrogen free extract, total ash, acid insoluble ash) and gross energy content. The quality of by-product meals was assessed from their amino acid and fatty acid composition. The meals produced in conventional method showed better composition of amino acids (methionine, tryptophan and lysine) and fatty acids (C<sub>16</sub>, C<sub>18</sub>, C<sub>18:2</sub> and C<sub>18:3</sub>) possibly due to low temperature during operation. However, rendered meals were found to contain higher levels of macro minerals (calcium and phosphorus) and micro minerals (copper, zinc, manganese and copper). The microbiological study indicated there was substantial reduction in aerobic plate count in meals prepared following rendering technology. In all, the rendering operation was quick, less cumbersome, involved less labour and generated good quality feather meal, offal meal and mixed by-product meals compared to conventionally prepared meals.

*Title of thesis:* **Utilization of poultry slaughter byproduct meal in diets of growing turkey poults** (*Scholar:* Dr. V.B. Awachat, Roll No. PSC/MVSc/4668; *Guide:* Dr. S. Majumdar)

The present study was conducted to assess feeding value of poultry slaughter by product meal (PSBM) for growing turkey poults. In the present experiment the PSBM was tried at four inclusion levels along with one control i.e., T<sub>1</sub> (0%), T<sub>2</sub> (2.5%), T<sub>3</sub> (5%), T<sub>4</sub> (7.5%) and T<sub>5</sub> (10%) replacing primarily soybean meal. The PSBM was analyzed for proximate composition and was found to be a good source of protein, fat, and minerals. Biological study revealed that body weight gain in T<sub>3</sub> group was comparable to control T<sub>1</sub>. However it was significantly lower in T<sub>4</sub> and T<sub>5</sub> at 8 weeks of age. Feed consumption

was significantly lower ( $P < 0.001$  in  $T_4$  and  $T_5$  as compared to control but feed conversion efficiency was significantly better in  $T_1$ , though no significant difference observed in  $T_1$ ,  $T_2$ ,  $T_3$ . Plasma total protein, plasma albumin, plasma protein were significantly more ( $P < 0.001$ )  $T_1$  than  $T_5$  where as plasma uric acid was significantly higher in  $T_5$  than other treatment groups. There were no significant differences in total plasma cholesterol, HDL cholesterol, plasma glucose, alanine amino transferase (ALT) in between treatment groups.

There was no significant difference in pre slaughter shrinkage % in live wt, dressing % eviscerated carcass% between the treatment groups. Similarly no significant differences were found in the yields of various cut-up parts among the treatments. There was no significant difference in the mass of liver, spleen, gizzard among the treatment rations. Abdominal fat percentage of the growing turkey pout at 8 weeks was significantly ( $P < 0.001$ ) increased as level was increased as level of PSBM. No mortality was observed in any of the treatment group throughout the experiment. Therefore, it indicated that the PSBM had no toxic effect. No adverse effect of PSBM feeding was noticed in the weight of immune organs. Proximate analysis of meat at 8 weeks of age revealed that there was no significant difference ( $P < 0.001$  found in proximate analysis i.e. moisture%, dry matter, Crude protein % ether extract % in both breast and thigh meat. Feeding PSBM did not cause any adverse effect on the immune response of growing turkey poults. Significant decrease in feed cost per kg live weight gain was observed as replacement level of PSBM increased at 8 weeks. Hence, it may be concluded that PSBM can be incorporated in turkey diet up to 5% without affecting their production performance and meat quality for profitable rearing of turkey.

*Title of thesis:* **Effect of supplementary sources and concentrations of zinc and copper on performance of broiler chicken**  
(*Scholar:* Dr. Shariq Iqbal, Roll No. PSC/MVSc/4669; *Guide:* Dr. Chandra Deo)

The proposed study was undertaken to evaluate the response of broiler chicken to supplementary sources and concentration of zinc and copper with reference to the growth minerals. A six week (0-6 weeks of age) feeding trial was conducted as per 2x2x2 factorial design involving two Zn levels (40 and 80 mg/kg each

with two Cu levels (8 and 16 mg/kg and again each with two mineral sources (organic and inorganic) in the form of Zn propionate and Cu propionate (organic) and Zn sulphate and Cu sulphate (inorganic) during starting (0-3 wks) and finishing (4-6 wks) phase of age in a standard broiler diet. Each dietary treatment was replicated four times having 8 broiler chicks in each replication.

Results indicated that the body weight gain (BWG) was significantly ( $P < 0.001$ ) higher at 16 mg Cu/kg than that recorded at 8 mg Cu/kg diet during 0-3, 4-6 and 0-6 wks of age. There was no significant effect on BWG due to Zn levels and mineral sources. The feed intake (FI) did not differ significantly due to different levels of Zn and mineral sources. However, it was significantly ( $P < 0.05$ ) higher at 16 mg Cu/kg than 8 mg Cu/kg diet during 4-6 wks of age. Significantly better feed conversion ratio (FCR) was observed during 0-3 ( $P < 0.01$ , 4-6 ( $P < 0.05$  and 0-6 ( $P < 0.01$ ) wks of age a 16 mg Cu/Kg diet as compared to 8 mg Cu/Kg diet. Whereas, no significant effect was observed on FCR due to Zn levels, mineral sources and interaction among Zn, Cu and mineral sources. Mortality of broiler was not altered due to sources and concentrations of Zn and Cu. The HA titre to SRBC and foot pad index to PHAP was significantly ( $P < 0.01$ ) higher at both higher levels of Zn and Cu with organic source as compared to their lower levels with inorganic sources of minerals. The various carcass quality traits of broiler were not affected by different treatments. However, the relative organ weight (liver and heart) was significantly higher at lower level of Zn and higher level of Cu. Bone morphometry parameters did not change due to different dietary regimens. However, bone length was significantly higher at 80 mg Zn/kg than 40 mg Zn/kg of diet. Bone weight Ca, Cu and Zn contents were significantly higher at 16 mg Cu/kg than 8 mg Cu/kg of diet. Increased dietary Zn levels increased tibia Zn concentration and reduced tibia Cu concentrations. Retention of Ca and P was not affected by different dietary regimens, but Cu was better retained at higher level than too organic sources as compared to lower level with inorganic sources. Zn retention was significantly ( $P < 0.01$ ) higher with organic source as compared to inorganic source.

Based on the results it may be concluded that the dietary concentration of 40 mg Zn and 16 mg Cu per kg diet were found sufficient to

obtain optimum growth performance, carcass quality, bone morphometry, mineralization and utilization of Zn and Cu in the broiler chicks during 0-6 wks of age. Further, higher dietary Zn and Cu concentration (80 and 16 mg/kg), respectively gave better immune response, and a nutritional approach that is by lowering Zn and Cu supplementation through organic sources may reduced the risk of phytotoxicity in the soil, resulting from excessive Zn and Cu concentrations in manure.

*Title of thesis:* **Value addition of chicken egg through dietary means** (*Scholar:* Dr. D.K. Hajra, Roll No. PSC/PhD/1047; *Guide:* Dr. Praveen Kumar Tyagi)

The value addition of chicken egg with respect to ameliorating (1) poor egg shell quality, a serious problem faced by egg producers during summer months leading to heavy economic losses, and (2) high egg yolk cholesterol content, a cause of concern to persons suffering with cardiovascular diseases (CVD) along with enrichment with health benefiting nutrients had been attempted by nutritional meals. Out of total five experiments, first three dealt with the first aspect i.e., amelioration of poor egg shell quality during summer and remaining two were aimed at reducing the yolk cholesterol along with enrichment. The first two experiments were carried out to compare the influence of dietary manipulation/supplementation of certain nutrients/additives/homeopathic drugs and time of feeding on performance, egg shell quality and allied parameters during hot and humid summer months in laying hens. Both the experiments were similar in all aspect except that one was conducted in hot and dry summer months and other was conducted in hot and humid (rainy) summer months. The third experiment was carried out to study the effect of supplementation of certain trace minerals (Zn, Cu, Mn and Se) in organic and inorganic forms in diet of laying hens on performance, egg shell quality and immuno-competence. The forth experiment was made to study the effect of organic chromium (as chromium picolinate) and blue-green algae (spirulina) on serum and egg cholesterol profile of laying hens. The last experiment was aimed at cholesterol reduction and enrichment of chicken egg through dietary supplementation of suitable nutrients/additives.

The results of the study revealed that sodium bi-carbonate, methionine hydroxyl

analogue, early morning feeding (5.00 AM) and homeopathic medicines were effective in improving various egg quality parameters as well as performance of birds at various point of time. No single treatment was found optimum in respect to all the parameters, mainly related to egg shell quality. Hence, a package of all these treatments could be more beneficial in combating poor egg shell during dry as well as humid summer conditions. It was observed that during hot and humid conditions, kali-phos was more beneficial than calcaria carb. On the other hand, MHA-FA was most efficient during dry heat period. Also, inclusion of fish meal in the layer ration was found beneficial during summer to supply quality protein, minerals especially calcium and available phosphorus and various unidentified substances which are supposed to have synergistic effect. The dietary supplementation of trace minerals (Zn-24.0, Cu-12.0, Mn-24.0 and Se-0.17 mg/kg diet) in organic amino acid-trace mineral chelate complex form in layer ration have been found beneficial to combat the problem of low productivity and poor egg shell quality during summer months. Organic form of chromium is effective in lowering yolk as well as liver cholesterol as well as serum lipid components. A combination of chromium (@ 1000 ug chromium picolinate/kg) diet and spirulina (@ 2 g/kg diet) was best among all other dose combination of chromium and spirulina in reducing yolk cholesterol. Spirulina @ 1 g/kg diet was effective in increasing good cholesterol level (HDL) and reducing triglyceride level in blood. A combination of 0.02% Atorvastatin, 0.25% EDTA, Niacin-375 mg/kg, a-tochopherol-250 mg/kg and 1.5% fish oil in diet was highly effectively in reducing total yolk cholesterol. Another combination of chromium (1000 ug/kg along with a-tochopherol-250 mg/kg and 1.5% fish oil had similar effect in reducing total cholesterol but unlike former it took time (effect found on 30<sup>th</sup> day after dietary supply) to become effective. Overall, 19% reduction in total cholesterol was achieved (166.97 mg against 2010 in control). Atorvastatin combination had more pronounced effect in reducing liver cholesterol compared to combination of chromium. The addition of fish meal layer diet resulted in increase in n-3 fatty acids in egg without adversely affecting its sensory attributes. The linolenic acid (C18:3) content of egg was increased significantly by the supplementation of spirulina in layer diet. Hence, fish oil and/or

spirulina can be included in the laying hen ration to increase n-3 fatty acid in yolk.

**Title of thesis: Molecular approaches for the evaluation of stress and its amelioration on ovarian functions in Japanese quail (*Coturnix coturnix japonica*)** (Scholar: Dr. Nonigopal Shit, Roll No. PSC/PhD/1106; Guide: Dr. K.V.H. Sastry)

Japanese quail is susceptible to stress which through the activation of HPA axis alters neuro-endocrine balance in reproductive system. The negative effects of stress cause ovarian dysfunction which culminates to regression and follicular atresia. Vitamin C and E, either alone or in combination, is able to ameliorate the adverse effect of stress on reproduction. However, their effect on the endocrine and molecular events associated with ovarian functions as still unknown. Therefore, to understand some of the physiological and molecular events involved in reproductive system functions during maturation, stress and its amelioration, three experiments were carried out. The first experiment was designed understand the role of hormones and certain genes in the ovary and hierarchical follicles of Japanese quail during maturation (6<sup>th</sup> to 10<sup>th</sup> weeks of age). Four birds sacrificed every time on days 1, 3, 7, 11, 13, 16, 19, 22, 25 and 28. Serum and tissues (ovary and hierarchical follicles) samples were collected for biochemical and gene expression studies, respectively. In the hierarchal follicles, the expression of LH-R and PR-R gene increased while the expression of IGF-1 and surviving genes decreased with the advancement of age. Serum estrogen, progesterone and T<sub>3</sub> increased while corticosterone decreased as the bird matured. The second experiment was conducted to examine changes in expression profile of certain genes in the ovary and hierarchal follicles and serum parameters while the birds are under stress. A total 72 Japanese quail hens (10 wks) were divided into three groups i.e., Gr-1/control: Gr-II/feed withdrawal and Gr-III/immobilization (2 h/d) for a period of 10 days. There was a significant reduction in body weight, reproductive organs weight and no. of Y fs in treatment groups. The expression of IGF-1, LH-R and PR-r decreased significantly while Caspase-2 and surviving increased in both treatment groups. The serum glucose, T4 and corticosterone levels were increased significantly (P<0.05) both the treatment groups while decrement was noticed in estrogen, progesterone and T<sub>3</sub> concentration. The

third was undertaken to examine the stress ameliorate effects of vitamin C and E reflected on reproductive system, expression patterns of some genes in hierarchal follicles and serum hormonal profiles. Ninety six Japanese quail hens (10 wks) were equally divided into four groups. Birds from Gr-I served as control and offered quail layer ration. Gr-II,-III and -IV received vitamins (250 ppm each L-ascorbic acid and a-tocopherol).

*Ad libitum* quail ration was provided to both Gr-II and -IV while Gr III and -IV exposed to feed withdrawal and immobilization (2 h/day) stress, respectively for a period of 10 days. The reduction in different serum parameters and reproductive organ weights appeared to be less drastic in the vitamin supplemented groups than the un-supplemented counterparts during stress. The variation in mRNA expression profile of different genes was relatively similar in both supplemented and un-supplemented birds.

**Title of thesis: Molecular characterization of different cytokines and their differential expression analysis in guinea fowl (*Numida meleagris*)** (Scholar: Dr. Girraj Goel, Roll No. PSC/PhD/1108; Guide: Dr. Deepak Sharma)

Molecular characterization and differential expression analysis of different cytokine genes in guinea fowl may provide significant information for better understanding of the mechanism for disease resistance in poultry. Therefore, the aim of present study was to clone and sequence the different cytokine genes and their differential expression in guinea fowl and chicken. In vitro amplification, cloning and sequencing of CDS of various cytokine/chemokine genes was done. Sequence homology analysis between GF-cytokine nucleotide sequence and other avian and mammalian species was performed. The sequences of complete CDS of IL08 and partial CDS of IL1B, IL-6, IL-10, IL-12, IL-18 TGF-B4 TNF-a gene of GF were the first reports worldwide. Guinea fowl showed more or less higher genetic similarity with galliformes viz. chicken, jungle fowls, quail, turkey and pheasant etc. ducks and goose showed very high genetic similarity with each other, but much lower similarity with other poultry species including guinea fowl. Columbiformes viz. pigeon was found on the other lineage. Zebra finch was found to be the most distant bird to domesticated poultry species. These all results are indicative of the evolutionary segregation of the various avian

orders in different lineages from common ancestor. Guinea fowl may have the significant polymorphic sites, associative to disease resistance/susceptibilities. Therefore, guinea fowl may be a suitable model for candidate gene analysis to generate resistant birds by marker-assisted selection. Expression of Pro-inflammatory cytokines (IL-1B, IL-6 and TN-a) was very high in guinea fowl in comparison to broiler particularly at 1 and 12 hrs p.i. in contrast, Guinea fowl spleenocytes expressed anti-inflammatory cytokines (TGF-B4) at lower level than broiler, particularly at 12 hrs p.i. which may be the cause of the higher expression of pro-inflammatory cytokines at 12 hrs p.i. in GF. Expression of the IL-10 (Th2) cytokine was exceptionally higher in GF than broiler. These differences in the expression of different cytokines may be instrumental for the higher immune response in guinea fowl against pathogens compared to broiler. Apoptosis analysis suggested that guinea fowl spleenocytes were more resistance to apoptosis in control as well as in induced conditions, which is a physiological indicator survivability and better resistance mechanism. In vitro pathogen induction studies revealed that guinea fowl was more responsive than broiler chicken in terms of expression of immune molecules and pathophysiological changes occurred in cell culture. The unique responses of the guinea fowl was in contrast to the broiler which has the history of intense genetic selection for the increase growth or reproduction, a process which may leads to reduced or suppressed inflammatory responses. Finally, the results of the present investigation are encouraging for the establishment of guinea fowl as a model for the disease resistance studies.

**Title of thesis: Evaluation of genetic diversity among different quail lines using quantitative and molecular genetic approaches** (Scholar: Dr. Azmat Alam Khan, Roll No. PSC/PhD/1179; Guide: Dr. D. Chaudhuri)

A study was carried out on four specialized lines of quails developed at CARI, Izatnagar: CARI Uttam (CU), CARI Ujjwal (CJ), CARI Sweta (CS) and CARI Pearl (CP) to elucidate genetic diversity through estimation of population parameters using quantitative and molecular genetic approaches. Quantitative genetic study involved studying phenotypic and economic traits in progeny derived from a complete 4x4 diallel

cross employing above lines. Effects of various genetic groups (crosses) and mating systems (Pure-bred vs Cross-bred) were analyzed. The genetic parameters viz. heritability and correlations for various growth traits were estimated for all the four lines. Cross breeding parameters viz. General combining ability (GCA), Specific combining ability (SCA) and Reciprocal effects (RE) were estimated using Griffing's approach. Molecular genetic study was carried out on 18 randomly selected individuals from each of the four lines using quail-specific micro satellites. The micro satellite genotyping data generated from 44 polymorphic loci were analyzed to arrive at various population parameters like allele distribution, Polymorphic information content (PIC), Heterozygosity, F-statistics, Genetic distance, Genetic Identity and Phylogenetic distribution of the four lines. Extent of convergence between various population parameters derived from quantitative and molecular genetic analyses was also attempted. Differences between these lines were quite evident for most of the phenotypic traits studied. The inheritance of plumage colours PH, WB and W (fixed in CU, CJ and CS respectively) could be explained on basis of two independent loci, i.e., 'Wb' (white breasted) and 'ss' (Panda) whose mode of inheritance were established to be dominant and recessive gene action respectively. The CU and CJ were found to be associated with better fitness through display of higher hatchability and lower mortality as compared to CS and CP. For growth trait, crossbreds had significantly better body weight and weight gain as compared to pure-breds. Among purebreds, the CJ was leading followed closely by CU and CS while CP lagged far behind. These differences could be ascribed to the past selection and breeding history of these lines. Among crossbreds, significantly-better growth was realized in crosses involving CJ, CS and CU. Heritability for most measures of growth traits remained medium to high indicating effectiveness of mass selection in improving growth performance. Higher heritability for body weight and corresponding weight gain at 4 weeks of age compared to that at 5 weeks together with higher genetic and phenotypic correlations between later age body weights and weight gains indicated selection for increased body weight was likely to yield more response if practiced on basis of 4<sup>th</sup> week body weight. Significance of both GCA and SCA were indicative of the fact that both additive and non-additive gene actions were important for

various growth traits. SCA estimates indicated better nicking ability of CJ with CU and (or) CS. Perusal of results for fitness traits, growth traits, plumage-colour inheritance and cross-breeding parameters led to suggestions that the best cross-bred commercial broiler quail could be produced by using CJ and CU as respective sire and dam lines. Population parameters derived from micro satellite analyses were indicative of ample genetic diversity existent within and

between in all four lines. It was concluded that a panel of 27 or more polymorphic micro satellites could be sufficient to delineate population parameters between different quail lines including diversity-indices, effectively. Convergence between pair-wise population parameters derived from both quantitative and molecular genetic approaches reveal the possibility of accurately predicting heterosis and (or) cross-combining ability from potential line-crosses, using micro satellite data of the parents.

# Awards and Recognitions

## NAAS Recognition Award

- Dr. A.B. Mandal, Principal Scientist received "NAAS Recognition Award" in Animal Sciences (2009-10) on February 10, 2011 during X Agricultural Science Congress held at NBFGR, Lucknow.

## Dr. P.K. Pani Research Award

- Drs. P.K. Singh, Neha Sharma, U.B. Singh and Deepak Sharma received Dr P.K. Pani Research Award for best research article award by Indian Poultry Science Association in 2010 for their paper "Genetic polymorphism and estimation of parental genomic proportion in a chicken population developed for marker assisted introgression of naked neck gene" published in Indian Journal of Poultry Science (Volume 44, p. 177-180).

## Young Scientist Award

- The research paper entitled "Molecular detection of *Campylobacter* spp. in poultry carcasses and their decontamination using organic antimicrobials" written by Drs. R.S. Rajkumar, A.S. Yadav, R.P. Singh, R.S. Rathore and B.D. Sharma received AVITECH Young Scientist Award-2010 during IPSACON 2010 held at Madras Veterinary College, Chennai.
- Dr. V. Vasanthi, MVSc (PSC) student received Young Scientist Award-2010 of Indian Poultry Science Association during XXVII IPSACON.

## Ayurved Research Award

- Drs. R.K. Sharma, A.V. Elangovan, A.B. Mandal, Praveen K. Tyagi and A.K. Shrivastav received Ayurved Research Award-2009 for their research paper "Response of White Leghorn hens to certain herbs in diets on production performance, blood and egg cholesterol" published in Indian Journal of Poultry Science (2009) in XXVII IPSACON on September 16, 2010 in MVC, Chennai.

## Dr. C.M. Singh Award

- Dr. S.K. Bhanja, Senior Scientist received Dr. C.M. Singh Award-2003 for best Ph.D.

thesis entitled "Feasibility of in ovo amino acid injection for embryonic growth and optimizing total and digestible amino acid requirement for meat production and immunocompetence of broiler chicken" in the convocation held in 2010 at IVRI Deemed University, Izatnagar. (Major Advisor-Dr. A.B. Mandal)

## Best Teacher Award

- Dr. A.B. Mandal, Principal Scientist received University Level Best Teacher Award (2007-08) from IVRI Deemed University (presented in convocation 2010).

## Best Student Award

- Dr. V. Vasanthi received Best M.V.Sc. student Award-2008 (IVRIDU), awarded in 2010 (Major Advisor-Dr. A.B. Mandal).

## Best Paper Award

- Drs. S. Tomar, V.K. Saxena, A.K. Sachdev and Shri Ram Gopal received First prize for research paper on "*Vyavsayik broiler CARIBRO Dhanraja ka vibhinn parivesh mein utpadakta moolyankan*" during Hindi Saptah-2010 at CARI, Izatnagar.
- Drs. A.K. Mishra, M.C. Kataria, R.K.S. Bais, Raj Narayan, Shri Ram Gopal, S.K. Johari, and Dr. R.D. Sharma received Second prize for research paper on "*Anskalik anda utpadan ke adhar per chaynit safed leghorn murgion ke aarthik visheshako ka aanuvanshik evam drashya rupee adhayan*" during Hindi Saptah-2010 at CARI, Izatnagar.
- Drs. Deepak Sharma, Udai Bir Singh and Giriraj Goel received Third prize for research paper on "*Guinea fowl mein dirgh kalin chayan dwara prarambhik sharirik vikas dar mein sudhar*" during Hindi Saptah-2010 at CARI, Izatnagar.

## Best Poster Award

- Drs. S.O. Pratap, S.K. Mishra, Y. Prasad, A.A. Khan, G. Arora, B.J. Khan, S.P. Singh and D.P. Singh received award for best poster presentation on "Significant genotype effect on immune-competence estimated in indigenous chickens Kadakanath *vis a vis*

WLH chickens” during October 22-23, 2010 at National Symposium on “Conventional and modern breeding technologies for genetic improvement of livestock and poultry in India” organized at G.B. Pant University for Agriculture and Technology, Pantnagar.

### Recognition

- Dr. Deepak Sharma, Principal Scientist received the Fellow of Indian Poultry Science Association during XXVII IPSACON in Chennai in view of his outstanding contribution in the area of poultry research.
- Dr. Sanjeev Kumar, Principal Scientist and Dr. R.K.S. Bais, Senior Scientist were elected as PG Faculty Representative to Academic Council of Deemed University, Indian Veterinary Research Institute, Izatnagar.
- Dr. Sanjeev Kumar and Dr. V.K. Saxena, Principal Scientists received “Appreciation Letter” from District Magistrate, Farrukhabad for significant contribution made in the training programme under National Agriculture Development Yojna at Farrukhabad.
- Dr. S. Majumdar, Dr. V.K. Saxena and Dr. S.K. Mishra, Principal Scientists were chosen as panelist for SAPI Silver Jubilee Conference held during November 11-13, 2010 at IVRI, Izatnagar.
- Dr. Sanjeev Kumar, Principal Scientist received honour as Special Guest in a Closing ceremony of Inter-DPS Cricket Tournament held at Delhi Public School, Bareilly on December 06, 2010.
- Dr. D.P. Singh, Principal Scientist was assigned to work as Moderator by the FAO to conduct the E-conference for International Network for Family Poultry Development (INFPD) I. Opportunities of poultry breeding programmes for family production in developing countries: The bird for the poor which was coordinated from CARI, Izatnagar (U.P.), India held from January 23 to February 18, 2011.
- Dr. Sanjeev Kumar, Principal Scientist received honour as Chief Guest in the Valedictory Function of “One-month Seminar and Poster Competition on Biotechnology” held on February 04, 2011, organized by Department of Biotechnology, Bareilly College, Bareilly.
- Dr. S.K. Mishra, Principal Scientist was invited and sponsored by the Department of President’s affairs, Abu Dhabi, UAE to represent India and participate in the 1<sup>st</sup> International Symposium on “Propagation of endangered species of birds” during February 08-10, 2011 held at Emirates Palace Hotel, Abu Dhabi, UAE.
- Dr. D.P. Singh, Principal Scientist was invited and sponsored by FAO to attend the meeting for International Network for Family Poultry Development (INFPD) members from Asia during 7<sup>th</sup> International Poultry Show and Seminar (IPSS) 2011 on March 26, 2011 organized by WPSA–Bangladesh Branch, Dhaka, Bangladesh.

# Linkages and Collaborations

<i>Area</i>	<i>Project</i>	<i>Agency/Organization</i>
Poultry Breeding	Improvement of Poultry for egg and meat production	All India Coordinated Research Project
Poultry Nutrition and Feed Technology	Comparison of chicken performance when fed diets containing MON 89034xNK 603 corn  Evaluation of nutritional value of diets containing Bt rice grains in broiler chickens	M/s Monsanto India Limited, New Delhi  M/s Maharashtra Hybrid Seeds Company Ltd., Mumbai
Livestock Based Farming System	Holistic approach for improving livelihood security through livestock based farming system in Barabanki and Raibareili districts of U.P.  Goat husbandry based integrated approach for livelihood security in disadvantaged districts of Bundelkhand region	NAIP, New Delhi  NAIP, New Delhi
Nutrient Gene Interaction	Enhancement of post-hatch immune-competence and growth of broiler chickens through <i>in ovo</i> approaches	DBT, Ministry of Science and Technology, New Delhi
Basic and Fundamental Research on Parthenogenesis	Development potency of parthenogenetic goat embryos <i>Sub area:</i> Identification of molecular basis of spontaneous parthenogenesis in turkey	NAIP, New Delhi
Poultry Housing and Management	Poultry rearing practices at high altitude	IVRI, Mukteswar (Uttarakhand)
Technology Transfer	Popularization poultry through radio-An effective means of mass communication	NECC, Pune AIR, Rampur
Backyard Poultry Production	Sustainable livelihood improvement through integrated freshwater aquaculture, horticulture and livestock development in Mayurbhanj, Keonjhar and Sambalpur districts of Orissa	NAIP, New Delhi

# List of Publications

## RESEARCH PAPERS

- Ahmed, S.U. and Sharma, D. (2010). Allele specific PCR for genotyping the probable SNPs in mitochondrial genome in red jungle fowl and domestic chicken. *J. Applied Anim. Res.*, 38: 49-53.
- Ahmed, S.U. and Sharma, D. (2010). Mitochondrial genome diversity among jungle fowl and domestic chicken. *Indian J. Poult. Sci.*, 45(3): 265-68.
- Alyethodi, R.R. and Kumar, S. (2010). Genetic characterization of Moti Indian native duck using microsatellite markers. *J. Applied Anim. Res.*, 38 (1): 223-27.
- Arora, G., Mishra, S.K., Nautiyal, B., Pratap, S.O., Gupta, A., Singh, D.P., Beura, C.K. and Kataria, M.C. (2010). Genetic variation in hyperpigmentation of an F2 chicken population involving Kadakanath and White Rock chickens. *Indian J. Poult. Sci.*, 45 (3): 247-53.
- Bhushan, S., Sharma, D. and Rajkhowa, C. (2010). Estimation of genetic relation of mithun (*Bos frontalis*) with other livestock species through RAPD-PAGE. *Indian J Anim Sci.* 80: 72-74.
- Biswas, A., Ranganatha, O.S. and Mohan, J. (2010). The effect of different foam concentrations on sperm motility in Japanese quail. *Vet. Med. International*. Doi: 10.4061/2010/564921.
- Churchil, R.R. and Sharma, D. (2010). Effect of initial semen quality, processing conditions and semen extenders on post processing semen qualities in chicken. *Indian Vet. J.*, 87: 1214-16.
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- Gangwar, L.S., Saran, S. and Kumar, S. (2010). Broilers' supply value chain in the national capital region Delhi: A case study of Ghazipur poultry market. *Agricultural Economics Res. Review*, 23 (Conf.): 461-68.
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- Gupta T., Kumar S., Prasad Y. and Kataria M.C. (2010). Genetic distance between divergent White Leghorn chicken lines after three generations of selection for humoral response to sheep erythrocytes. *J. Applied Anim. Res.*, 38: 265-69.
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#### **PAPERS PRESENTED IN CONFERENCES/ SYMPOSIA/SEMINARS**

##### **Seminar on “Emerging opportunities in alternative poultry farming systems” held on April 22-23, 2010 at TNVASU, Chennai**

Madhu, N.T., Gangwar, L.S. and Saran, S. Price spread, cost and margin in marketing of eggs in Mysore district of Karnataka. p. 227.

Sachdev, A.K. and Gopal, R. Quality assessment and value addition of guinea fowl meat. p. 181.

Saran, S. and Gangwar, L.S. Role of National Egg Coordination Committee in egg market co-integration in India. p. 226-27.

Shit, N., Singh, R.P., Sastry, K.V.H., Mohan, J., Pandey, N. and Moudgal, R.P. Cloacal gland size significantly alters semen production, sperm activities and fertility in different lines of Japanese quail (*Coturnix coturnix japonica*). p. 195.

##### **National Seminar on “Animal resource development and poverty alleviation” held on June 08-09, 2010 at Bhubaneswar**

Mishra, S.K., Singh, D.P., Beura, C.K., Narayan, R., Bais, R.K.S., Mishra, A. and Kataria, M.C. Efficient upgrading strategies for indigenous chickens aimed at higher productivity with wider acceptability among consumer-masses.

##### **International Conference on “Biotechnology and Nanotechnology” held on July 28-30, 2010 at Paris, France**

Goel, A., Bhanja, S.K., Mehra, M., Pandey, N., Majumdar, S., and Mandal, A.B. Effect of *in ovo* injection of carbohydrates on the differential expression of growth related genes in broiler chickens. ID. FR67000.

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Arora, G., Mishra, S.K., Nautiyal, B., Pratap, S.O., Prasad, Y., Singh, D.P. and Kataria, M.C. Evolutionary perspective of Indian native chicken breed Kadakanath: by Mitochondrial D-loop sequence analysis.

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# Participation in Workshops, Conference, symposia and Meetings

<i>Date</i>	<i>Event</i>	<i>Venue</i>	<i>Participant (s)</i>
April 22-23, 2010	National Seminar on “Emerging opportunities on alternate poultry farming systems”	TNVASU, Chennai	Dr. Deepak Sharma
June 03-04, 2010	XXVIII Scientist Meet of AICRP on Poultry Breeding for Egg and Meat	HPKVV, Palampur	Dr. R.K.S. Bais
June 08-09, 2010	National Seminar on “Animal resource development and poverty alleviation”	Bhubaneswar	Dr. S.K. Mishra
June 15-16, 2010	National Seminar on “Advances in animal cancer research in India: Diagnosis, treatment and clinical management”	IVRI, Izatnagar	Dr. V.K. Saxena
June 16, 2010	Seminar on “Importance of rural backyard poultry”	Patna	Dr. D.P. Singh
June 28, 2010	Meeting of National Fund for Basic, Strategic and Frontier Application Research in Agriculture (NFBSFARA)	KAB, New Delhi	Dr. V.K. Saxena
August 11, 2010	Technical Expert meeting convened by Animal Husbandry Department (Govt. of India) in connection with formation of guidelines for risk analysis of import of poultry products	Krishi Bhawan, New Delhi	Dr. A.S. Yadav
September 16-18, 2010	XXVII Annual Conference and National Symposium of Indian Poultry Science Association	MVC, Chennai	Dr. R.P. Singh Dr. S.K. Agarwal Dr. R.P. Moudgal Dr. A.B. Mandal Dr. S. Majumdar Dr. D.P. Singh Dr. Jag Mohan Dr. Praveen K. Tyagi Dr. V.K. Saxena Dr. J.S. Tyagi Dr. Pramod K. Tyagi Dr. Raj Narayan Dr. S.K. Mishra Dr. K.V.H. Sastry Dr. C.K. Beura Dr. A.K. Mishra

<i>Date</i>	<i>Event</i>	<i>Venue</i>	<i>Participant (s)</i>
October 22-23, 2010	National Symposium on "Conservation and modern breeding technologies for genetic improvement of Livestock and Poultry in India"	GBPUAT, Pantnagar	Dr. Deepak Sharma
November 04-05, 2010	Midterm Scientist Meet of AICRP on Poultry for Egg	Hyderabad	Dr. M.C. Kataria Dr. V.K. Saxena
November 11-13, 2010	SAPI Silver Jubilee International Conference on "Physiological capacity building in livestock under changing climate scenario"	IVRI, Izatnagar	Dr. R.P. Moudgal Dr. A.B. Mandal Dr. S. Majumdar Dr. D.P. Singh Dr. Jag Mohan Dr. V.K. Saxena Dr. J.S. Tyagi Dr. S.K. Mishra
November 18-20, 2010	Consultation meeting on "Abiotic stress management"	NIAM, Baramati	Dr. V.K. Saxena
November 18-20, 2010	XVIII Annual Conference of Agricultural Economics Research Association on "Value chains of agricultural commodities and their role in food security and poverty alleviation"	NAARM, Hyderabad	Dr. Sandeep Saran Dr. L.S. Gangwar
November 19-20, 2010	Fourth Convention of Indian Meat Science Association and National Symposium on "Strategies for sustainable meat production for nutritional security and employment generation"	IVRI, Izatnagar	Dr. A.K. Sachdev Dr. Deepak Sharma
December 14-15, 2010	DBT Task force meeting	New Delhi	Dr. V.K. Saxena
December 17-19, 2010	7th Biennial Animal Nutrition Association Conference (ANA 2010) on "Animal nutrition strategies for environment protection and poverty alleviation"	OUAT, Bhubaneswar	Dr. S.K. Sahoo
December 28, 2010	Present scenario of biodiversity in domesticated poultry species and strategies for its conservation	CARI, Izatnagar	Dr. D.P. Singh Dr. Deepak Sharma Dr. V.K. Saxena Dr. Sanjeev Kumar Dr. S.K. Mishra Dr. R.K.S. Bais Dr. Raj Narayan Dr. Simmi Tomar

<i>Date</i>	<i>Event</i>	<i>Venue</i>	<i>Participant (s)</i>
December 28, 2010	Workshop on "Small-holder poultry rearing: A sustainable livelihood opportunity for the rural poor"	New Delhi	Dr. D.P. Singh
January 20-21, 2011	National Conference on "New horizons animal breeding technologies for accelerating livestock production and health"	IVRI, Izatnagar	Dr. Deepak Sharma Dr. D.P. Singh Dr. Sanjeev Kumar Dr. V.K. Saxena Dr. M.C. Kataria Dr. R.K.S. Bais Dr. A.K. Mishra Dr. Simmi Tomar
January 28-29, 2011	National Symposium on "New paradigm in laboratory animal science in an era of advanced biomedical research"	IVRI, Izatnagar	Dr. Sanjeev Kumar
February 8-10, 2011	1st International Symposium on "Propagation of endangered species of birds"	Abu Dhabi, UAE	Dr. S.K. Mishra
February 10-11, 2011	X Agricultural Science Congress	NBFGR, Lucknow	Dr. R.P. Singh Dr. A.S. Yadav
February 21-22, 2011	DBT Task force meeting	AAU, Anand	Dr. V.K. Saxena
January 23- February 18, 2011	E-conference for International Family Poultry Development (INFPD) I. Opportunities of poultry breeding programmes for family production in developing countries: The bird for the poor, coordinated from CARI, Izatnagar		Dr. D.P. Singh
March 25-27, 2011	VII International Poultry Show and Seminar (IPSS) 2011, WPSA-Bangladesh Branch	Dhaka, Bangladesh	Dr. D.P. Singh
March 26, 2011	Meeting of International Network for Family Poultry development (INFPD) members from all over Asia-Pacific region	Dhaka, Bangladesh	Dr. D.P. Singh

# Consultancy, Patents and Commercialization of technology

- The Post Harvest Technology Division has developed the following seven technologies commercialized for processing:
  - ✚ Salted Chicken Egg
  - ✚ Quail Egg Pickle
  - ✚ Chicken Gizzrd Pickle (Mustard Oil Based)
  - ✚ Chicken Gizzrd Pickle (Vinegar Based),
  - ✚ One Minute Curried Chicken (Cooked Chicken Stock)
  - ✚ Mixed Meat Loaf
  - ✚ Cooked Chicken Roll
- The Regional Centre, CARI, Bhubneswar has applied for patent entitled "A process to enhance production of female chicks in colour broiler poultry bird through incorporation of certain additives to semen prior to artificial insemination".
- Following consultancies were provided for preparation of project reports for establishing poultry units under MoU signed between the Institute and the contracting parties.
  1. Shri Liyakat Ali, Bareilly (UP) for preparing a bankable project for production of about 15,000 broilers per year in a cycle of 500 in 30 batches in deep litter system.
  2. Shri Narendra Singh, Aonla, Bareilly (UP) for preparing a bankable project for production of about 43,500 broilers per year in a cycle of 1500 broilers every fortnight.
  3. Shri Prem Pal Singh, Budaun (UP) for preparing a bankable project for production of about 23,200 broilers per year in a cycle of 800 broilers every fortnight.
  4. Shri Munni Lal, Ramabai Nagar (UP) for preparing a bankable project for production of about 23,200 broilers per year in a cycle of 800 per batch in deep litter system.
  5. Shri Ashok Shrivastava, Shahjahanpur (UP) for preparing a bankable project for production of about 23,200 broilers per year in a cycle of 800 every fortnight in deep litter system.
  6. Shri Nawal Kishor Sinha, Gaya (Bihar) for preparing a bankable project for production of about 23,200 broilers per year in a cycle of 800 every fortnight in deep litter system.

# Workshops, Seminars and Farmers' Day Organized

- Organized short-term training on poultry production management at the Institute during April 12-17, 2010 for 31 farmers and unemployed youths from five districts of U.P.; one district each of Bihar, New Delhi and Uttarakhand.
- Organized short-term training on poultry production management at the Institute during August 16-21, 2010 for 45 farmers and unemployed youths from sixteen districts of U.P. and one district of Uttarakhand.
- Organized sponsored training on poultry production management at the Institute during August 30 to September 04, 2010. Total 91 army soldiers of Gorkha Resettlement Training Unit, C/O 56 APO participated in the programme.
- Organized sponsored short-term training on poultry production management at the Institute during October 26 to November 01, 2010 for the farmers nominated by Animal Husbandry Deptt., Government of Bihar under Rashtriya Krishi Vikas Yojna. Total 15 farmers from Bhagalpur district participated in this programme. Besides, 17 other trainees belonging to nine districts of Uttar Pradesh also participated in the training programme.
- Organized 32<sup>nd</sup> Foundation day of the Institute on November 02, 2010. On this occasion, 15 winning farmers of Farm School on AIR were awarded with the cash prizes and certificates. Besides, one poultry farmer of Devaria district (U.P.) was felicitated with a shawl and certificate.
- Organized kisan gosthi on November 02, 2010 on the occasion of Foundation Day of the Institute. During the gosthi, lectures on different aspects of poultry farming were delivered by the scientists of the Institute. Total 114 poultry farmers from different district of U.P., Bihar and Uttarakhand participated in the gosthi.
- Organized one day Seminar on "Present scenario of biodiversity in domesticated poultry species and strategies for its conservation" on December 28, 2010 at CARI, Izatnagar.
- Organized sponsored training on poultry production management at the Institute during January 10-15, 2011 for the farmers nominated by Animal Husbandry Deptt., Government of Bihar under Rashtriya Krishi Vikas Yojna. Total 15 farmers from Patna district participated in this programme.
- Organized sponsored training on poultry production management at the Institute during February 14-19, 2011 for the farmers nominated by Animal Husbandry Deptt., Government of Bihar under Rashtriya Krishi Vikas Yojna. Total 14 farmers from Kishanganj district participated in this programme besides, two selected farmers of village panchayat-Navdia Harkishan (adopted village).
- Organized sponsored training on poultry production management at the Institute during February 21-26, 2011 for 13 farmers nominated by ATMA, Madhubani, Bihar and 39 army soldiers of Gorkha Resettlement Training Unit, C/O 56 APO.
- Organized one day Workshop cum training programme on "Rural poultry and duck production for sustainable livelihood and food security" on March 10, 2011 at Regional Centre, CARI, Bhubaneswar to establish linkages between farmers, field veterinarians, technocrats and business groups w.r.t. backyard poultry and duck farming in rural Orissa.
- Organized sponsored training on poultry production management at the Institute during March 14-19, 2011. Total 15 farmers of Poornea district nominated by Animal Husbandry Deptt., Government of Bihar under Rashtriya Krishi Vikas Yojna participated in this programme.

# Distinguished Visitors

<i>Date</i>	<i>Name</i>	<i>Address</i>
April 19-20, 2010	Dr. P. Thangaraju Dr. K. Gajendran Dr. M.G. Govindaiah Dr. H.K. Pradhan Dr. A.G. Khan Dr. S.N. Maurya	Chairman, QRT and VC, TNVASU, Chennai Emeritus Scientist, TNVASU, Chennai Ex-Dean, KAVFSU, Bangalore Ex-Joint Director, IVRI, Izatnagar Retd. Professor, JNKVV, Jabalpur Retd. Professor, GBPUA&T, Pantnagar
June 04, 2010	Dr. S. Ayyappan Prof. K.M.L. Pathak Dr. Lal Krishan	Secretary, DARE and DG, ICAR, New Delhi DDG (AS), ICAR, New Delhi ADG (Health), ICAR, New Delhi
July 08, 2010	Seventy farmers of Entrepreneurship Development Programme	IVRI, Izatnagar
July 19, 2010	Dr. Arvind Kumar and 15 trainee farmers	IFFCO, Bareilly
July 23, 2010	Shri A.R. Banerjee	Retd. IAS and Ex-Chief Secretary, Govt. of Gujrat
July 30, 2010	Dr. Balbir Singh with 16 poultry farmers from Barabanki and Raebareli	Under NAIP project
August 03, 2010	Dr. Thom Wright	USDA, US Embassy, New Delhi
August 18, 2010	Dr. Mahendra A. Bale with 25 farmers	Goa state
November 02, 2010,	Dr. S.N.S. Gaur Dr. R.M. Acharya Prof. M.P. Sharma Dr. S.C. Gupta	Prof. and Head (Retd.), GBPUA&T, Pantnagar Ex-DDG (AS), ICAR, New Delhi Director, IVRI, Izatnagar ADG (AP&B), ICAR, New Delhi
January 21, 2011	Dr. Chanda Nimbkar	ICAR G.B. Member and Director, Nimbkar Agricultural Research Institute, Phaltan (M.S.)
January 29, 2011	Prof. Nadhim S. Abdulaziz Jakhsi Dr. P.K.Uppal	Cultural Councillor, Embassy of the Republic of Iraq, New Delhi Ex-Director, NRC on Equines, Hissar
January 31, 2011	Dr, Getret Asseta and team	Ethiopian Delegation through Embassy of Ethiopia, New Delhi

# Personnel

## ADMINISTRATION

### DIRECTOR

Dr. R.P. Singh (upto 18.03.2011)  
(w.e.f. 13.04.2011 till date)  
Dr. A.K. Shrivastav (Officiating)  
(w.e.f. 19.03.2011 to 12.04 2011)

### DIRECTOR PERSONAL SECTION

Dr. D. Chaudhuri, Pr. Scientist  
Shri G.K. Bisaria, PS to Director

### ADMINISTRATIVE UNIT

Shri P.K. Maurya, AO (upto 31.12.2010)  
Shri H.M. Azad, AO (w.e.f. 02.02.2011 F.N.)  
Shri Shiv K. Saxena, AAO  
Shri B.S. Bisht, AAO  
Shri K.K. Verma, Asstt.  
Smt Bimla Devi, Asstt.  
Smt Reeta Adhikari, Sr. Clerk  
Smt Prema Joshi, Sr. Clerk  
Shri Ajay Kumar, Jr. Clerk

### DRAWING AND DISBURSING UNIT

Shri Shiv K. Saxena, AAO  
Shri I.A. Khan, Asstt.  
Shri H.C. Saxena, Asstt.  
Shri C.S. Bisht, Asstt. (Cashier)  
Shri Vikas Kumar, Jr. Clerk (upto 29.04.2010)

### ACCOUNTS AND FINANCE UNIT

Shri P.K. Singh, AF&AO  
Shri Jagdish Prasad, Asstt.  
Shri G.D. Mainali, Asstt.  
Shri P.K. Sarkar, Sr. Clerk (EBABX Unit)  
Smt Rekha Rani, Sr. Clerk  
Shri Sachin Kant Sharma, Jr. Clerk  
(upto 19.02.2011)

### Technical Staff

Shri Mohd. Anis Khan, T-5 (T.O. Driver)  
Shri Sudhir Kumar, T-2 (Xerox Operator)

## DIVISION OF AVIAN GENETICS AND BREEDING

Dr. M.C. Kataria, Pr. Scientist & Head  
Dr. D.P. Singh, Pr. Scientist  
Dr. Deepak Sharma, Pr. Scientist  
Dr. V.K. Saxena, Pr. Scientist  
Dr. Sanjeev Kumar, Pr. Scientist  
Dr. S.K. Mishra, Pr. Scientist  
Dr. Raj Narayan, Sr. Scientist  
Dr. R.K.S. Bais, Sr. Scientist  
Dr. Anil K. Mishra, Sr. Scientist  
Dr. (Mrs) Simmi Tomar, Sr. Scientist  
Shri Ram Gopal, Scientist (SG)  
Dr. Mintu Nath, Scientist

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Shri Ram Manorath, T-7/8 (T.O.)  
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Shri H.K. Sagar, T-5 (T.O.)  
Shri M.N. Pandey, T-5 (T.O.)  
Shri R.K. Bharti, T-5 (T.O.)  
Shri P.D. Tiwari, T-5 (T.O.)  
Shri Arun K. Singh, T-5 (T.O.)  
Shri Womiq Raza, T-5 (T.O.)  
Shri S.K. Johari, T-5 (T.O.)  
Shri S.R. Meena, T-5 (T.O.)  
Shri Deepak S. Singh, T-5 (T.O.)  
Shri V.K. Bhasin, T-4 (Lab. Tech.)  
Shri S.R. Arya, T-4 (Lab. Tech.)  
Shri V.P. Yadav, T-3 (Lab. Tech.)  
Shri Arun Kumar, T-2 (Farm Asstt.)  
Shri Ajay Das, T-2 (Farm Asstt.)

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Dr. H.P. Shrivastava, Pr. Scientist  
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Dr. A.B. Mandal, Pr. Scientist  
Dr. Praveen Kumar Tyagi, Pr. Scientist

Dr. Pramod Kumar Tyagi, Sr. Scientist  
Dr. Chandra Deo, Sr. Scientist  
Dr. Ram Singh, Sr. Scientist

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Shri R.K. Goel, T-2 (Lab. Asstt.)

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(upto 31.08.2010)  
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Dr. A.B. Mandal, Pr. Scientist & Head  
(w.e.f. 01.11.2010)

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**COMPUTER CENTRE**

Shri Ram Gopal, Scientist (SG) & Incharge

**Technical Staff**

Dr. R.D. Sharma, T-7/8 (T.O.)

Shri Arun K. Singh, T-5 (T.O.)

Shri Womiq Raza, T-5 (T.O.)

Shri S.K. Johari, T-5 (T.O.)

**ARIS CELL**

Dr. R.D. Sharma, T-7/8 (T.O.) & Incharge

**FEED STORAGE AND PROCESSING SECTION**

Dr. Pramod K. Tyagi, Sr. Scientist & Incharge

**Technical Staff**

Shri M.C. Pathak, T-5 (T.O.)

**LIBRARY**

Shri S. Bhatnagar, T-7/8 (T.O.) & Incharge

**EXPERIMENTAL HATCHERY**

Dr. Jagbir S. Tyagi, Pr. Scientist & Incharge

**Technical Staff**

Shri K.K. Das, T-4 (Lab. Tech.)

**MARKETING CENTRE**

Dr. N.K. Pandey, Pr. Scientist & Incharge

**Administrative Staff**

Shri Om Shanker, Jr. Clerk

**ENGINEERING AND MAINTENANCE SECTION**

Dr. C.K. Beura, Sr. Scientist & Coordinator

Shri Shafiq Ahmed, T-5 (Elect.) &  
Incharge, Electric

Shri Tasneem Ahmed, T-5 (Civil) & Incharge,  
Civil

**HINDI CELL**

Shri P.N. Yadav, T-5 (T.O. Rajbhasha)  
& Incharge

**INSTRUMENTATION SECTION**

Dr. N.K. Pandey, Pr. Scientist & Incharge

**Technical Staff**

Shri Prem Chandra, T-5 (Instr.)

**CENTRAL STORE**

Shri B.S. Bisht, AAO & Incharge

**Administrative Staff**

Shri Tara Kumar, Sr. Clerk

**FARM AND ESTATE SECTION**

Shri R.K. Bharti, T-5 (T.O.) & Incharge

**Technical Staff**

Shri Arvind Kumar, T-2 (Tractor Driver)

**TRAINEES' HOSTEL CUM GUEST HOUSE**

Shri Prem Chandra, T-5 (Instr.) & Incharge

**SECURITY SECTION**

Shri. R.K. Bharti, T-5 (T.O.) & Incharge

**MEDICAL OFFICER**

Dr. Amitabh Mishra, Sr. M.O.

**REGIONAL CENTRE, BHUBANESWAR**

Dr. D. Mondal, Sr. Scientist & Incharge

Dr. S.K. Sahoo, Sr. Scientist

Dr. S.C. Giri, Sr. Scientist

**Technical Staff**

Shri A.K. Nanda, T-5 (T.O.)

Shri A.K. Jha, T-3 (Lab. Tech.)

**Administrative Staff**

Shri Sukul Hansda, Sr. Clerk

# Other Relevant Information

## INSTITUTE RESEARCH COMMITTEE MEETING

The annual Institute Research Committee (IRC) meeting of the Institute was held during May 28-29, 2010 under the chairmanship of Dr. R.P. Singh, Director, CARI, Izatnagar. Drs. V.P. Varshney, Emeritus Scientist, Division of Physiology & Climatology, IVRI, Izatnagar; D.C. Johari, Ex-Director, CARI; T.S. Johri, Ex-Director, CARI, Izatnagar; and Satish Kumar, Head, Division of Physiology and Climatology, IVRI, Izatnagar attended the meeting as expert invitees. Dr. Sandeep Saran, Head, PME and Secretary, IRC conducted the meeting which was attended by all scientists of the Institute. In the beginning, Dr. R.P. Singh, Director, CARI welcomed all the expert invitees and the scientists to the IRC meeting. Dr. Sandeep Saran presented a brief overview of the Institute research programmes/projects. During the two days meetings, the scientists presented their research, teaching and extension accomplishments. Besides, ongoing research projects, externally funded, contract research and new research projects proposals were also discussed during the meeting.

The following major expert recommendations were brought out during the plenary session.

- In most of the biotechnological research work of this Institute, results are of fundamental nature. These results should be correlated with egg/broiler meat production traits so that specialized stocks could be developed.
- Priority should be given to incorporate new good germplasm (New lines) from outside the country to reduce the inbreeding depression in the lines available at this Institute. These germplasm, in Govt. sector, are having very good pure lines of layer and broiler stocks.
- Urgent need was emphasized to set up a nucleus laboratory for production of enzyme specific to cereals, cereal by-products, oil-cakes and compounded feeds available in the country instead of depending upon the commercially available enzyme preparations. This laboratory could be used for revenue generation also.

- Research work on anti-nutritional factors should be intensified and work on feed processing technology must be initiated immediately by the Institute.
- The concentration of Zn for molecular evaluation of forced moulting procedures to develop effective alternatives in White Leghorn hens should be revalidated/checked.
- The semi-automatic poultry processing techniques with up-scaling at mechanical pilot plant level should be established at the Institute and demonstrated to the end users. It would be useful to propagate CARI ready to commercialized poultry processing and value added products to the clients.

## RESEARCH ADVISORY COMMITTEE MEETING-2010

The 4<sup>th</sup> Meeting of the Common Research Advisory Committee (RAC) of Central Avian Research Institute (CARI), Izatnagar and Project Directorate on Poultry (PDP), Hyderabad was held at PDP, Hyderabad on May 18-19, 2010 under the Chairmanship of Dr. Lalji Singh, Ex-Director, CCMB, Hyderabad. The members present were Dr. K.S. Prajapati, Professor and Head, Dept. of Pathology, AAU, Anand; Dr. A.S. Ranade, Professor and Head, Department of Poultry Science, Bombay Veterinary College, Mumbai; Dr. A. G. Khan, Ex Professor and Head, Dept. of Poultry Science, JNKVV, Jabalpur; Dr. D. Thyagarajan, Director, Centre for Animal Production Studies, TANUVAS, Chennai, Dr. R.P. Singh, Director, CARI; Dr. R.P. Sharma, Director, PDP; Dr. S.C. Gupta, Assistant Director General (AP&B), ICAR, Krishi Bhavan, New Delhi; Dr. M.V.L.N. Raju, I/c PME Cell, PDP (Member Secretary) and Dr. P.K. Shukla, Joint Commissioner (Poultry), Dept. of Animal Husbandry, Dairying and Fisheries, Govt. of India (Special Invitee). Dr. S.S. Nagra, Prof. and Head, GADVASU, Ludhiana; Mrs. Anuradha Desai, Venkateswara Farm, Pune and Shri Rajendra Pawar, CMD Baramathi Agro Ltd., Pimpali, District Pune could not attend the RAC due to unavoidable reasons. Dr. A.B. Mandal, Principal Scientist (Nodal Officer), CARI, Dr. R.P. Moudgal, Pr. Scientist and Head, P&R Div., CARI; Dr. M.C. Kataria, Pr. Scientist and Head, AGB Div., CARI; Dr. A.K. Sachdev, Pr. Scientist and

Head, PHT Div., CARI; Dr. V.K. Saxena, Pr. Scientist, CARI; Dr. D. Mondal, I/c Reg. Station (CARI), Bhubaneswar; Dr. L.S. Gangwar, Sr. Scientist, CARI; Dr. S.K. Bhanja, Sr. Scientist, CARI; Dr. R.N. Chatterjee, Pr. Scientist, PDP, Dr. M.R. Reddy, Sr. Scientist, PDP and Dr. T.K. Bhattacharya, Sr. Scientist, PDP were present. The following recommendations emerged out of the deliberations of the meeting.

1. The RAC appreciates the research conducted and recommends continuation of on-going research projects at both the institutes for the approved period.
2. As mandated, research emphasis at CARI should be on research in other avian species, while PDP should concentrate on chicken with special emphasis to rural poultry production (CARI and PDP).
3. Divergent lines may be developed for QTL studies (CARI and PDP).
4. To ameliorate heat stress impacts on poultry production, the work on heat shock proteins (HSP) and expression of other relevant genes may be intensified (CARI).
5. Molecular work on disease resistance and feed efficiency needs to be further strengthened (CARI and PDP).
6. Research on thermostable ND vaccine may be intensified (PDP).
7. Research on housing and management systems should be geared up especially for rural ecosystem (CARI).
8. Processing and packaging studies on value-added poultry egg and meat products may be intensified and shelled value added eggs may be developed (CARI).
9. Genetic, physiological and nutritional studies on native chicken and improved germplasm including Red Jungle Fowl need to be strengthened (CARI and PDP).
10. Effect of global warming/climate change on poultry may be studied along with possible mitigation measures, preferably in environmentally controlled chamber (CARI and PDP).

11. Systematic selection should be continued and standardisation of AI for other poultry species may be initiated (CARI).
12. Managerial package of practices for diversified poultry species including ducks, emu, turkey, guinea fowl, quail etc. needs to be developed. A network programme for promotion of alternate poultry species may be considered (CARI).
13. Infrastructure for development and multiplication of improved rural poultry germplasm needs to be increased for bridging the gap between demand and supply (CARI and PDP).
14. Research on molecular characterisation may be given due emphasis for protection of IPR of elite germplasm (CARI and PDP).
15. Apart from the varieties developed at the institute, comparative nutritional studies need to be taken up on chickens of standard performance potential (CARI and PDP).
16. A separate section for avian health needs to be created in order to intensify the research on emerging and re-emerging diseases (CARI and PDP).
17. For coping up with the enhanced research activities, scientific manpower specialised in poultry science discipline should be provided along with proportionate technical support at both the institutes as per ICAR norms (CARI and PDP).
18. Academic programmes in poultry science should be strengthened at national level for meeting the growing demand of poultry sector (CARI).

The RAC also recommended developing long-term strategies for basic research on the following emerging areas so as to complement the on-going applied research with due infrastructural (equipment like automatic DNA sequencer, automatic karyo type machine, high resolution microscope etc.) and HRD support.

1. Research on molecular genetics in the areas of tissue culture, functional genomics, cytogenetic analysis and mitochondrial DNA analysis, etc. (CARI and PDP).
2. Transgenesis of chicken to understand gene function and production of low-volume high-

value proteins of therapeutic importance, etc. (CARI and PDP).

3. Plasma proteomics for studying heat tolerance in chicken (CARI and PDP).
4. Nutrigenomics, antimicrobial and neuropeptides, phytobiotics, functional foods, amino acid-dense diet, value-addition of eggs etc. (CARI).
5. In silico analysis and development of multiplex PCR for viruses (CARI).
6. Gut modifiers and metagenomics of gut microflora (CARI).

### **QRT FINAL REPORT (2003-2009)**

The interactive meeting was held under the chairmanship of Hon'ble DG, ICAR for submission of the final report of the QRT (2003-2009). Dr. P. Thangaraju, VC, TANUVAS, Chennai and the Chairman, QRT of this Institute, in the presence of Dr. K.M.L. Pathak, DDG (AS), ICAR; Dr. R.P. Singh, Director, CARI; Dr. C.S. Prasad, ADG; Dr. A.K. Srivastav, PS and Member Secretary, QRT; and Dr. Sandeep Saran, PS and Head, PME, CARI, Izatnagar presented the final QRT report before Hon'ble DG, ICAR on 10.05.2010.

### **INSTITUTE MANAGEMENT COMMITTEE MEETINGS**

35<sup>th</sup> Institute Management Committee meeting was held on April 20, 2010 under the chairmanship of Dr. R.P. Singh, Director, CARI, Izatnagar consisting of Shri P.K. Maurya, Member Secretary, Dr. Deepak Sharma, Dr. Kuldeep Dhama, Dr. Sanjeev Kumar, Shri G.C. Pant and Dr. Sandeep Saran.

The Committee was satisfied with the research activities and achievements made by this Institute. Research Projects for the year 2009-10 were brought to the notice of all the members and were approved by IMC. The IMC encouraged the administration to maintain homely atmosphere, as there has been no grievance of the employees at this Institute.

36<sup>th</sup> Institute Management Committee meeting was held on February 17, 2011 under the chairmanship of Dr. R.P. Singh, Director, CARI, Izatnagar consisting of Shri H.M. Azad, Member Secretary, Dr. Sandeep Saran, Shri Prashant Kumar, Dr. A.B. Mandal, Dr. S.D. Singh and Shri P.K. Singh.

The Committee was satisfied with the research activities and achievements made by this Institute. Research Projects for the year 2010-11 were brought to the notice of all the members and were approved by IMC. The IMC encouraged the administration to maintain homely atmosphere, as there has been no grievance of the employees at this Institute.

### **PRIORITY SETTING, MONITORING AND EVALUATION**

The Priority Setting, Monitoring and Evaluation Section is responsible for reviewing and scrutinizing the research projects/proposals. The section also coordinates activities within and outside the Institute with the other external agencies. The section serves as a central hub for providing information on various research training and extension activities of the Institute to various government, semi government, public sector units and private agencies besides a coordinating link between the Institute and the Council. Following activities were carried out during the year.

- Institute Research committee (IRC) meeting was conducted under the chairmanship of Director during May 28-29, 2010.
- Compilation of Institute salient achievement and agenda for Institutional Management Committee (IMC) meetings.
- Institute research highlights were compiled and submitted to the council for DARE-ICAR Annual Report 2010-11.
- Prepared and submitted quarterly performance review (QPR), and monthly cabinet reports to the Council, regularly. Also submitted scientists' half yearly reports to the Council.
- Disposed off applications received under the RTI Act-2005 and filed quarterly, half yearly and annual information returns to the Council in respect of RTI cases.
- Replied parliamentary questions. Compiled various reports and replied letters received from the Council and industry.

### **Processed the following:**

- Information regarding projects (RPFs) required by the ARIS of ICAR HQ.
- Provided information about all the RPFs pertaining to the ongoing and completed

projects for the last five years, i.e., 2005-2010 to the Council.

- Undertook consultancy and contract research for generating revenue for Institute.
- Monitoring and coordination of research projects and maintenance of project file.
- Handled matters related to all research and scientific subjects in planning and policy making as per directives of the council.
- Information on resource generation targets and performance indicators for this Institute.
- Papers pertaining to publication of the scientists in Indian as well as foreign journals.

## **TECHNOLOGY TRANSFER**

### **Supply of Commercial Germ-Plasm**

During the period under report, total egg production in the Demonstration farm was 41,063 eggs. Besides; 16,009 eggs were received from Broiler farm during the same period. A total of 53,423 eggs were set for commercial and pure line hatching; while 1,037 eggs were given to Broiler Farm and 4,048 eggs to the Marketing centre of the Institute. Total 37,351 day-old broiler chicks were supplied to the 85 farmers, NAIP project on "Holistic approach for improving livelihood security through livestock based farming system in Barabanki and Raibareli districts of U.P." and project on "Poultry rearing practices at high altitude". Total 3,073 kg adult stock (146 growers, 208 males and 526 females) were sold to the farmers. Besides, 45 adult males and 38 adult females (live wt. 305.5 kg) were issued to Poultry Processing unit for dressed sale. A total of 4,050 kg starter; 10,500 kg grower; and 48,500 kg layer ration were received from Feed Processing unit and issued to farm for livestock.

### **Pilot Study on Poultry-Mushroom Integrated Farming System**

#### **A. Use of Poultry Litter for Mushroom Growing**

In order to explore possibility of integration between poultry and mushroom cultivation, utilization of poultry litter for oyster mushroom cultivation was tried. The supplementation of poultry litter in the growing

substrate (wheat straw) is usually not practiced for oyster mushroom cultivation while, it is a major ingredient used in compost preparation for cultivation of button mushroom. In order to use poultry litter in oyster mushroom substrate, an experiment was conducted during the period of February–April 2010. *Pleurotus florida* species of oyster mushroom was used. Poultry litter (rotten) was mixed in wheat straw in three levels viz. 15, 25 and 35% of base material (wheat straw). Thus, there were three treatments, each having 10 kg wheat straw and specified quantity of poultry litter. Aerobic fermentation method was adopted to prepare suitable substrate for oyster mushroom. Wheat straw was soaked in drum for 4 hrs. , taken out and left for an hour to leach out excess water. Poultry litter was mixed thoroughly in the moist wheat straw. The mixed ingredients were stacked in triangular shape heap maintaining height of 60-75 cm. After two days (48 hrs), stacked material was given turning and again stacked for two days. During the process, temperature of stack reached up to 45-50°C. The stack was break opened at last and allowed to cool down up to 25-30°C to make the substrate suitable for spawning. The fermented substrate was spawned @ 30g/kg (wet substrate). Each bag was filled with 3 kg spawned substrate. Thus, treatment-I (15%), II (25%) and III (35%) were replicated with 12, 11 and 12 bags of 3 kg each, respectively. All the bags were incubated in a thatched hut for spawn run maintaining room temperature 20-25°C. The spawn run took one month to complete. There was no spawn run in the treatment supplemented with 35% poultry litter, while treatments with 15 and 25% poultry litter show moderate spawn run. The treatments having 15 and 25% poultry litter were yielded on an average 370 and 443 g mushroom per bag (1 kg dry substrate) in one month duration, respectively. The fruitbodies were tough and they appeared in big bunches.

The another trial was laid down to use poultry litter in mushroom growing using *Pleurotus sajor-caju* instead of *Pleurotus florida* species during the period Sept.–Nov., 2010. The substrate was prepared in the manner described above. The substrate for control treatment was prepared using Chemical Sterilization Technique. There were total four treatments including control. The requisite temperature and humidity was maintained during the experiment. It was observed that initially, spawn run activity was noticed in all the treatments on the upper side of

the bags but after a week, spawn run activity became very slow. While control treatment showed fast spawn run activity even after a week. Two weeks later, growth of ink caps was observed in all the treatments except control, which indicates formation of ammonia in the substrate. The spawn run in control treatment took 15 days and gave good crop. It yielded on an average 488g fresh mushroom per bag (1 kg dry substrate) in 45 days cropping period.

### **B. Use of Chicken Manure for Mushroom Growing**

In order to use chicken manure for oyster mushroom growing, two experiments were conducted during the year. First experiment was conducted during the month of Oct. 2010. To conduct this experiment, chicken manure was collected from cages of layer birds, sun dried and coarse grinded. It was mixed in wheat straw in proportion of 20 & 30% of base material (wheat straw). Aerobic fermentation method was adopted to prepare suitable substrate for oyster mushroom. Each treatment was having 10 kg wheat straw and specified quantity of chicken manure. The fermented substrate was spawned @ 30 g/kg (wet substrate). Each bag was filled with 3 kg spawned substrate. *Pleurotus sajor-caju* species of oyster mushroom was used. Bags were incubated in the thatched hut for spawn run. There was no spawn run in any treatment. In order to find out cause of this, pH of the substrate was checked. In both the treatments, pH value was higher than acceptable limit.

Second trial was laid out to use chicken manure in mushroom growing using *Pleurotus florida* instead of *Pleurotus sajor-caju* species during the month of Feb. 2011. The substrate was prepared in the manner described above. The substrate for control treatment was prepared using Chemical Sterilization Technique. There are total three treatments including control. After 50 days of spawning, both the treatments having 20 and 30 % chicken manure are not showing good progress. Treatment-I (20% CM) shows spawn run activity on the upper side of the bags. While control treatment is in fruiting stage.

### **C. Use of Quail Droppings for Mushroom Growing**

In order to utilize quail droppings for oyster mushroom growing, fresh quail droppings was collected, sun dried and coarse grinded. It was mixed in wheat straw @ 20, 30 and 40% of

the base material (wheat straw). Substrate was prepared using aerobic fermentation method as described in the above experiments. There was one control treatment for comparison. In each treatment 10 kg wheat straw was used. Trial was conducted during Nov. 2010–Jan. 2011. *Pleurotus florida* species of oyster mushroom was used. The fermented substrate was spawned @ 30 g/kg (wet substrate). Each bag was filled with 3 kg spawned substrate. During the substrate fermentation process, temperature of pile in all the treatments was high (52-72°C) which indicates ideal conditions for decomposition of substrate. The spawn run in the treatment having 20% quail droppings showed moderate growth while very less in 30%. There was no spawn run in treatment containing 40% quail droppings. The level of spawn run in the treatments with 20 & 30% quail dropping was not sufficient to produce fruitbody of mushroom. The control treatment gave good crop of oyster mushroom.

### **Publication Unit**

Production of all the following Institute publications including compilation, editing, printing and distribution were undertaken during the period under report.

- CARI Annual Report (2009-10)
- The CARI News (3 issues) (Bilingual)
- Glorious Facets of CARI – Book
- Saghan Kukkut Palan - Book
- Vyavasayik Broiler Palan - Book on XI Farm School on AIR

Besides, Invitation cards of Foundation day; Certificates for trainees, special training programmes and farm school participants; Noting pads; and Plastic envelopes were also produced.

A total of 101 Adhunik Kukkut Palan (2<sup>nd</sup> ed.), 8 Adhunik Kukkut Palan (1<sup>st</sup> ed.), 70 Saghan Kukkut Palan, 27 Clinical Information System for Poultry, 4 Poultry Production, 7 Battakh Palan, 15 Layer Cage Management, 24 Management of Commercial Layers, 32 Incubation and Hatching, 36 Poultry Housing and Management, 9 Bater Palan, one set of Poultry Research Priorities to 2020, one set of Poultry Science Education and Human Resource Planning for Poultry Sector, and 512 Extension Leaflets were sold to the farmers, students and other interested persons.

Besides, 72 Adhunik Kukkut Palan (2<sup>nd</sup> ed.), one set of Poultry Research Priorities to 2020, one set of Poultry Science Education and Human Resource Planning for Poultry Sector, and 1624 Extension Leaflets were issued to the participants of special training programme and other dignitaries.

In addition to this, 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

Meetings of Institute Official Language Committee were held time to time to review the progressive use of Hindi in the Institute. Quarterly reports of progressive use of Hindi were prepared to each quarter and sent to ICAR HQ and Department of Official Language, Govt. of India. Many suggestive circulars and guidelines were issued to increase the progressive use of Official Language. All technical/scientific and administrative materials obtained from different Divisions/Sections of the Institutes were translated and typed accordingly. Hindi Saptah was organized during September 14-20, 2010 in the Institute. In which, many competitions/programmes were organized for making a favourable atmosphere to use of official language.

### Maintenance of Conference Hall/Poultry Science Museum

The section is maintaining the Conference Hall of the Institute. During the reporting period, necessary arrangements were made for various meetings and functions of the Institute viz. Students' seminars, IRC meeting, RAC meeting, QRT meeting, Hindi Saptah, Farewell functions of staff members and Invited Lectures of dignitaries etc.

Besides, a large number of important dignitaries including students, farmers and other people visited the Poultry Science Museum and appreciated the display and its maintenance. The section also made necessary arrangements for the visit of students and farmers to various farms and laboratories of the Institute.

### Other Services Rendered

The staff of this section also contributed effectively during the annual games and sports, staff welfare club and staff welfare fund scheme activities.

### Revenue Generation

Sale of Broiler day-old chicks	-	Rs. 4,79,623=00
Sale of Broiler Grower and Adult stock	-	Rs. 1,44,388=00
Sale of Experimental Birds under High Altitude Project	-	Rs. 1,34,997=00
Cost of Broiler Adult stock given to Poultry Processing unit	-	Rs. 14,443=00
Registration Fees for Short term training	-	Rs. 2,63,000=00
Sale of Publications	-	Rs. 23,368=00
Sale of Mushroom	-	Rs. 478=00
<b>Total</b>		<b>Rs. 10,60,297=00</b>

## EXPERIMENTAL HATCHERY

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 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 37,392 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 2010-11. At occasion the highest hatchability (FES) 100.00% was obtained in broiler chicken.

## ARIS CELL

The ARIS Cell has been instrumental in providing Network services, internet access, database service, training of personnel, hardware and software trouble shooting, virus alerts, Institute e-mail handling, scientific data processing, software development for Institute related activities/research projects, updating and maintenance of Institute website, loading of different types of software, pay bill processing, support to scientists and administration in terms

of data entry, word processing, computerized accounting etc., and maintenance of computers and peripherals.

## Work done during the year

- ARIS Cell has been instrumental in establishment and management of Local Area Network (LAN) connecting about 80 functional nodes for providing internet & e-mail connectivity to the all scientists, other officers and students including important offices in the Institute. Also, managed and maintained the LAN based on Fiber Optic & UTP cables on switching network throughout the year.
- To overcome various types of troubles related to switches and running faults on LAN necessary steps were taken immediately on the spot. The IP address, Gateway, DNS etc. were provided at all the nodes for proper management and functioning of the Internet and Intranet services at the institute round the clock (7x24).
- Also, Internet connectivity were provided as a standby from Broad Band (2 mbps) connectivity from BSNL, Bareilly to all the computers installed at different locations of the institute.
- Efforts have been made to manage the institute's Website bilingual (Hindi and English) and it is being updated regularly under the web site address [www.icar.org.in/cari/index.html](http://www.icar.org.in/cari/index.html) and [www.bareilly.nic.in/cari.htm](http://www.bareilly.nic.in/cari.htm).
- The computer-related facilities were provided to the scientists/officers and other staff of the institute at their working places. The efforts were made to literate the staff for the use of computer, internet and intranet.
- For the preparation of monthly cabinet reports, quarterly progress reports and half yearly reports of AGB Division, the work related to collection, compilation and computerization of the material was carried out and the reports were transmitted well in time.
- The project leaders of other projects and PG students of the institute were also cooperated in carrying out of their statistical work. Further, the software was developed

as and when required according to the need of the scientists and PG student.

- For active implementation of Personnel Management Information System Network (PERMISnet), the collection, compilation and computerization of personal information of each & everyone employee of the Institute was carried out. The change/addition/deletion in information provided by the administration was entertained every month and necessary modifications were done on the web site [www.iasri.nic.in/permisnet](http://www.iasri.nic.in/permisnet). The entire database is maintained for the use of RMPs/Administrators. In this, the Bio-data of all categories of staff is being maintained on line in the institute.
- The jobs pertaining to Bill and Cash Section of the Institute. Payrolls were processed every month after entertaining all corrections in playbills data file. Pay-slips of all the months were distributed to the employees timely.
- Preparation of posters and printing of technical information was entertained for display in different symposium/Seminars/Mela/ Kukkut Pradarshni.
- The ARIS Cell is well equipped with Pentium Computers, Laser and Dot matrix Printers, Heavy duty Scanner and different application software.
- Preparing of 5 years database of RPFs (I, II and III) related of all the projects of institute including regional centre as desired by the ICAR.

### **LIBRARY AND INFORMATION SERVICES**

During the year, 110 new publications were added to the collections. This brings the total number of books, bound volumes of scientific journals and poultry science theses etc in the library to 5516. The library subscribed 32 journals out of which 14 were reputed foreign journals, besides this a number of scientific national and international serial publications, Annual Reports and Newsletters were received on gratis. CARI Library is a member of consortium for e-resources in Agriculture (CeRA), a project under NAIP, ICAR along with other institute and SAU libraries. Under the above project institute library is getting access to about 2000 online full

text online journals. Under Document Delivery Request facility of CeRA, CARI, library received number of reprints, requested by institute Scientists from other ICAR institute/Agriculture Universities libraries, and was provided to concern Scientist. Library has also sent the reprints to other ICAR Institute/SAU libraries on request. The library provides Internet & E-Mail services, besides CD-ROM literature access through CD-ROM of Animal production database and AGRIS CD. Xerox facility of the library meeting day-to-day requirement of scientific, technical, research scholar and administrative personnel efficiently.

### **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 plasma 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 and SAUs. During the period under report, the feed unit has manufactured and supplied 13,534.25 qtls different types of poultry feed which is 1155.92 qtls (8.54%) in excess of last year's supply. Detailed break up of feed supplied to different projects is shown below:

<i>Project/Division</i>	<i>Total Quantity (Qtls)</i>
Broiler project	3,972.00
Layer project	4,341.60
Desi fowl	1,662.30
Quail farm	980.00
Guinea fowl unit	618.50
Turkey unit	641.00
AN&FT	32.05
P&R Div.	174.60
PHM	266.60
IVRI	35.65
TT Section	756.40
NAIP	44.25
Avian Medicine	4.00
SAUs	45.00
<b>Total</b>	<b>13,534.25</b>

## MARKETING CENTRE

The activities of this centre included processing and sale of eggs received from various farms of the Institute and sale of processed and packaged poultry meat received from Poultry Processing Unit of PHT Division. Detailed break-up of eggs and poultry meat sold at the centre and the net revenue generated from sale during the period April 2010 to March 2011 is given in Table 29-31.

**Table 29:** Net revenue generated from sale of eggs and poultry meat

<i>Commodity</i>	<i>Revenue (Rs.)</i>
Chicken eggs	23,64,984
Quail eggs	2,34,215
Chicken meat	12,43,010
Guinea fowl meat	18,208
Kadakanath meat	47,037
Quail meat	3,14,866
Turkey meat	35,953
<b>TOTAL</b>	<b>42,58,273</b>

## INSTRUMENTATION SECTION

As a service section of the Institute, the main activities of Instrumentation Section include repair, service and maintenance of Scientific and Laboratory equipments, refrigerators, air-conditioners and other cooling appliances etc. of the Institute during the period under report. This section dealt with repair, service and maintenance work of window and split air conditioners, refrigerators, deep freezers, water coolers, refrigerated centrifuges, UPS, CVTs, stabilizers, power supply, incubators and hatchers, micro centrifuge, icematic machine, sun flow heaters, electronic balances, water baths, hot air ovens, autoclave, geezers, juicer-mixer-grinder, scalding machine, incinerator, lift machine, fogger unit etc. In addition, this section looked after the maintenance of Egg Drying Unit of PHT Division, cooling unit of Hatchery and Layer Farm. This Section also undertook the testing and verification work of newly purchased equipments/machines and unserviceable equipments/machines of different Divisions and Sections of the Institute.

## IJSC MEETINGS

The IJSC meetings were held on May 26, 2010 and November 25, 2010. All the meetings held at Committee Room of Administrative Block. All the meetings chaired by the Director, CARI, Izatnagar.

**Table 30:** Number of chicken and quail eggs marketed

<i>Month</i>	<i>Chicken eggs</i>	<i>Quail eggs</i>
April 2010	1,29,047	96,790
May 2010	1,29,033	62,650
June 2010	1,27,211	74,350
July 2010	1,07,649	62,150
August 2010	1,15,765	54,750
September 2010	1,07,756	54,400
October 2010	94,636	39,780
November 2010	94,278	30,125
December 2010	69,972	25,525
January 2011	73,694	15,915
February 2011	75,879	13,977
March 2011	1,08,238	22,170
<b>TOTAL</b>	<b>12,33,158</b>	<b>5,52,582</b>

## GRIEVANCE CELL MEETINGS

The meetings of Grievance Cell were held on April 15, 2010; May 26, 2010; August 07, 2010; November 25, 2010; and March 28, 2011. All the meetings held at committee Room of Administrative Block. All the meetings chaired by the Director, CARI, Izatnagar.

## NATIONAL DAY CELEBRATIONS

The Independence Day and Republic Days were celebrated at the Institute on August 15, 2010 and January 26, 2011 with great zeal and enthusiasm. Dr. R.P. Singh, Director, CARI hoisted the national flag and addressed the staff. Sweets were distributed on these occasions under the aegis of Staff Welfare Club of the Institute.

## GAMES AND SPORTS COMMITTEE

The XXX Annual Games and Sports Meet were conducted by the Games and Sports Committee of the Institute on October 30, 2010.

Dr. R.P. Singh, Director, CARI inaugurated the Sports Meet. Dr. Jagbir Singh Tyagi, Chairman and Shri Prem Chandra, Secretary delivered their welcome address and vote of thanks, respectively. The men and women staff members of the Institute showed great zeal and enthusiasm through mass participation in sports events. The prizes and running shields were distributed by the Director to the winners.

### **STAFF WELFARE CLUB ACTIVITIES**

The Staff Welfare Club (SWC) of the Institute organized art competition and athletic events for the families of Institute staff on October 31, 2010. Dr. R.P. Singh, Director, CARI and his wife distributed the prizes and running trophies to the children and ladies. The Club also arranged debate, baby show, fancy dress competitions and a musical evening by the staff children on November 03, 2010. Mrs. Dr. R.P. Singh distributed the prizes to the participants. Shri Divesh C. Garg, Secretary of the Club presented vote of thanks.

On the eve of New Year's Day, the SWC organized annual get together on January 01, 2011. The Director, CARI conveyed his best wishes for a better 2011 to the staff and their families. Apart from this, the Club also managed SWC canteen to the entire satisfaction of staff members.

### **HUMAN RESOURCE DEVELOPMENT**

- Dr. K.V.H. Sastry, Senior Scientist attended Endeavour Executive Award sponsored by Deptt. of Education, Employees and Workplace Relations (DEEWR), Govt. of Australia for a period of four months from May 12, 2010 to August 19, 2010.
- Dr (Mrs) Simmi Tomar, Senior Scientist received the Trainers Training program on SAS at IVRI, Izatanagr from July 19 to August 23, 2010.
- Dr. A.S. Yadav, Senior Scientist attended Advanced International Training in the area of Biosecurity (Animal Science) on "*Salmonella* behaviour in chicken: Development of predictive model applicable to poultry processing operations" sponsored by HRD Unit of NAIP (Component-1) ICAR, KAB-II, New Delhi during September 01 to December 01, 2010 under the supervision of Dr. V.K. Juneja, Lead Scientist, Predictive Microbiology and Residue Chemistry Unit,

Eastern Regional Research Centre, USDA, Wyndmoor, PA, USA.

- Dr D.P. Singh and Dr Sanjeev Kumar, Principal Scientists received the training on "Programme on leadership for innovations in agriculture" organized by Indian Institute of Management, Lucknow from October 18-22, 2010.
- Dr. S.K. Bhanja, Senior Scientist attended three months' training under HRD programme of NAIP in the area of Nanotechnology (Animal Science) during November 01, 2010 to January 31, 2011 under the supervision of Prof. Andre Chwalibog, Head, Department of Basic Animal and Veterinary Sciences, Faculty of Life science, University of Copenhagaen, Denmark.
- Dr. J.S. Tyagi, Principal Scientist attended training on "Data analysis using SAS" during November 22-27, 2010 at Division of LES, IVRI, Izatanagar.
- Dr. D.P. Singh, Dr. Sanjeev Kumar, Dr. S.K. Mishra, Principal Scientists; and Dr. R.K.S. Bais, Dr. Chandra Deo and Dr. A.K. Mishra, Senior Scientist participated in Researcher Training III: Data Analysis using SAS during January 15-20, 2011 at LES Division, IVRI, Izatanagar.

### **STAFF PERSONALIA**

#### **POSTINGS**

- Dr. Niranjana Lal, Scientist joined CARI, Izatanagar on May 18, 2010 (F.N.) after transfer from National Research Centre on Equines, Hisar.
- Shri H.M. Azad, Administrative Officer joined CARI on February 02, 2011 (F.N.) after transfer from National Research Centre on Soybean, Indore.

#### **TRANSFERS**

- Shri P.K. Maurya, Administrative Officer relieved on December 31, 2010 (A.N.) to join his new assignment as Administrative Officer at G.B. Pant Social Science Institute, Allahabad.

## **PROMOTIONS**

### **Scientific**

- Dr. S.K. Mishra, Senior Scientist, Promoted to the post of Principal Scientist w.e.f. 05.08.2008.

### **Technical**

- Shri B. Arya, T-6 (Technical Officer) to the post of T-7/8 (Technical Officer) with effect from 01.01.2010.
- Shri Kapil Kumar Sharma, T-4 promoted to the post of T-5 (Technical Officer) w.e.f. 10.01.2007.
- Shri Kundan Kumar, T-4 promoted to the post of T-5 (Technical Officer) w.e.f. 22.05.2009.
- Shri Lalit Kumar Mishra, T-4 promoted to the post of T-5 (Technical Officer) w.e.f. 01.07.2009.
- Shri Ravi Prakash, T-4 promoted to the post of T-5 (Technical Officer) w.e.f. 01.07.2009.
- Shri P.N. Bajpai, T-4 promoted to the post of T-5 (Technical Officer) w.e.f. 07.10.2009.
- Shri H.B. Singh, T-4 promoted to the post of T-5 (Technical Officer) w.e.f. 03.02.2010.
- Shri Deepak S. Singh, T-4 promoted to the post of T-5 (Technical Officer) w.e.f. 03.02.2010.
- Shri S.R. Arya, T-3 promoted to the post of T-4 (Lab Tech.) w.e.f. 01.07.2006.
- Shri V.K. Bhasin, T-3 promoted to the post of T-4 (Lab Tech.) w.e.f. 01.07.2006.
- Shri Ram Kishan Singh, T-3 promoted to the post of T-4 (Lab Tech.) w.e.f. 01.07.2006.
- Shri K.K. Das, T-3 promoted to the post of T-4 (Lab Tech.) w.e.f. 01.01.2010.
- Shri Jaideep Arora, T-2 promoted to the post of T-3 (Lab Tech.) w.e.f. 24.10.2010.
- Shri Arvind Kumar, T-1 (Tractor Driver) to the post of T-2 (Tractor Driver) w.e.f. 04.10.2009.

### **Administrative**

- Shri B.S. Bisht Assistant promoted to the post of Assistant Administrative Officer w.e.f. 05.10.2010.

- Shri G.K. Bisaria, Personal Assistant to Director promoted to the post of Personal Secretary to Director w.e.f. 06.09.2010.
- Shri G.D. Mainali, UDC promoted to the post of Assistant w.e.f. 11.06.2010.
- Shri A.K. Saxena UDC promoted to the post of Assistant w.e.f. 05.10.2010.
- Shri C.S. Bisht, UDC promoted to the post of Assistant w.e.f. 22.01.2011.
- Smt Bimla Devi, UDC promoted to the post of Assistant w.e.f. 25.01.2011.

## **RETIREMENTS**

### **Scientific**

- Dr. H.P. Shrivastava, Principal Scientist retired on October 31, 2010.
- Dr. S.K. Agarwal, Principal Scientist retired on October 31, 2010.

### **Technical**

- Shri Harbhajan Singh, T-4 retired on August 31, 2010.
- Shri Ram Manorath, T-7/8 retired on December 31, 2010.

### **Supporting**

- Shri Desh Raj Sagar, S.S.S. retired on January 31, 2010.
- Shri Darshan Singh, S.S.S. retired on January 31, 2010.

# Empowerment of Women and the mainstreaming Gender Issues

- Technologies for processing Salted Chicken Egg, Quail Egg Pickle, Chicken Gizzard Pickle (Mustard Oil Based) and Chicken Gizzard Pickle (Vinegar Based) commercialized, do not require huge financial investment or skill. Hence, these are expected to be adopted even by the unskilled, uneducated household women to supplement their family income and main streaming of gender issues.
- Imparted training to the farm women under NAIP and DBT projects in the districts of Keonjhar, Mayurbhanga, Sambalpur and Khurda districts of Orissa.
- Training to women S.H.G. for backyard poultry and duck farming were initiated under DST project entitled "Backyard poultry and duck farming as a tool to sustainable livelihood of rural women of Khurda district of Orissa" at Regional Centre, CARI, Bhubaneswar.



## Usable and Transferable Technologies

- Low cost feed formulae for rural poultry production.
- Process of preparing Egg Cutlets, a nutritious and versatile snack food perfect for the breakfast meal, has been standardized.
- Protocol for setting up of standard curve to quality Salmonella by realtime PCR technique was standardized which can be used for Salmonella quantification from chicken egg surface.
- The farmers has been educated about the various central/state Government poultry development schemes under which they could get loan from banks to raise capital for establishing poultry uints/breeding farms /feed mills/hatchary etc.
- Backyard poultry and duck farming as a sustainable tool for landless and marginal farmers

# Approved On-Going Research Projects

<i>Sl. No.</i>	<i>Project Code No.</i>	<i>Project Title</i>	<i>Principal Investigator</i>	<i>Co-Investigator</i>
<b>PROGRAMME-1: PRODUCTIVITY INCREASE IN SELECTED AVIAN SPECIES</b>				
<b>Sub Programme - (i) Conventional and MAS for important economic traits</b>				
1.	P-1/2007/2- IAV/L10/6510 DOS: 01.09.2007 DOC: 01.09.2012	Development and improvement of specialized quail lines using alternate feather colour genes	Dr. Raj Narayan	Dr. D.P. Singh Dr. S.K. Mishra Dr. Anil Kumar
2.	P-1/2007/1-IAV/L10 / 6400 DOS: August 2007 DOC: August 2011	Differential expression studies for some important genes influencing disease resistance in guinea fowl	Dr. Deepak Sharma	--
3.	P-1/2008/1-IAV/L10-L73/ 6000 DOS: 02.07.2008 DOC: 31.07.2011	Native fowl genomics for disease resistance and molecular breeding for high yielding chickens	Dr. S.K. Mishra	Dr. D.P. Singh Dr. M.C. Kataria Dr. Deepak Sharma Dr. Raj Narayan Dr. Anil Kumar
4.	P-1/2009/1- IAV/L10/L30/6100 DOS: June 01, 2009 DOC: May 31, 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 Dr. K. Dhama
5.	P-1/2010/1- IAV/L10/6100 DOS: 01.06.2010 DOC: 31.05.2013	Expression profiling of genes related to immunity in Aseel, Kadaknath and WL chickens	Dr. Sanjeev Kumar	Dr. V.K. Saxena Dr. K.V.H. Sastry
6.	P-1/2006/1- IAV/L10/6000/ 9600/RIR DOS: 01.04.2006 DOC: 31.03.2011	Improvement of RIR for rural poultry production.	Dr. R.K.S. Bais	Dr. M.C. Kataria Dr. A.S. Yadav Dr. Anil Kumar
7.	P-1/2006/1- IAV/L10/6100/ 9610/WL (Component-AICRP-PB, Hyderabad) DOS: 01.04.2006 DOC: 31.03.2011	Improvement of poultry for egg production.	Dr. M.C. Kataria - CCPI	Dr. R.K.S. Bais Shri Ram Gopal Dr. A.S. Yadav Dr. Pramod K. Tyagi Dr. Anil Kumar Dr. Sanjeev Kumar Dr. Niranjana Lal (w.e.f. 26.11.2010)
8.	P-1/85/95/1- IAV/L10/6100/9705 (Component-AICRP-PB, Hyderabad) DOS: 1985	Development and evaluation of synthetic broiler sire line.	Dr. (Mrs) Simmi Tomar	Dr. V.K. Saxena Shri Ram Gopal Dr. S.K. Bhanja Dr. A.S. Yadav Dr. A.K. Sachdev (w.e.f. 13.09.2010)
9.	P-1/85/95/2- IAV/L10/6100/9705 (Component-AICRP-PB, Hyderabad) DOS: 1985	Development and evaluation of synthetic broiler dam line.	Dr. V.K. Saxena- CCPI	Shri Ram Gopal Dr. S.K. Bhanja Dr. (Mrs) Simmi Tomar Dr. A.K. Sachdev (w.e.f. 13.09.2010)

<b>Sub Programme - (ii) Nutrient balancing using conventional and alternate feed resources</b>				
1.	P-1/2001/1- IAV/L30/3740/ 3840/6100 DOS: 01.07.2001 DOC: 30.06.2011	Nutritional manipulation of the gastro-intestinal tract to control intestinal pathogens and their effects on the utilization of nutrients and immune response in poultry	Dr. A.K. Shrivastav	Dr. Pramod K. Tyagi Dr. B.B. Dash (PD, FMD, Mukteswar)
2.	P-1/2008/1- IAV/L30/6100 DOS: 01.06.2008 DOC: 30.06.2012	Studies on nutritional and pharmacological levels of copper for poultry	Dr. Chandra Deo	Dr. H.P. Shrivastava (upto 31.10.2010) Dr. A.B. Mandal Dr. Praveen K. Tyagi Dr. Ram Singh (upto June 2010)
3.	P-1/2008/1- IAV/L30/6200 DOS: December, 2008 DOC: November, 2013	Nutrient requirements of ducks	Dr. S.K. Sahoo	Dr. A.B. Mandal Dr. S.C. Giri Dr. D. Mondal
4.	P-1/2007/1- IAV/L30/8959 DOS: 01.06.2007 DOC: 30.06.2012	Augmenting nutrient utilization of alternate feed resources in poultry	Dr. Pramod K. Tyagi	Dr. A.K. Shrivastav Dr. A.B. Mandal Dr. Praveen K. Tyagi Dr. A.S. Yadav
5	P-1/2007/1- IAV/L30/9642-9644 DOS: 01.04.2007 DOC: 31.03.2012	Dietary manipulation of external and internal egg quality	Dr. Praveen K. Tyagi	Dr. A.K. Shrivastav Dr. H.P. Shrivastava (Till 31.10.2010) Dr. A.B. Mandal Dr. Pramod K. Tyagi Dr. Chandra Deo
6.	P-1/2009/2- IAV/L30/6000-3790 DOS: April, 2009 DOC: March, 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
7.	P-1/2010/1- IAV/L34/3745/6000 DOS: June, 2010 DOC: May 2013	Management of Mycotoxicosis in Poultry	Dr. Ram Singh	Dr. A.B. Mandal Dr. A.K. Shrivastav
<b>Sub Programme - (iii) Physiological interventions to enhance and sustain productivity under normal and stressed conditions</b>				
1.	P-1/2005/1- IAV/L50/6100/ 8967 DOS: July, 2005 DOC: June, 2011	Studies on reproductive system remodeling, stress responses and amelioration strategies during forced moulting in White Leghorn Hens.	Dr. K.V.H. Sastry	Dr. R.P.Moudgal Dr. Jag Mohan Dr. V.K. Saxena Dr. Jagbir Singh Tyagi Dr. M. Sirajudeen Dr. Sandeep Saran
2.	P-1/2008/1- IAV/L50/6100 DOS: April, 2008 DOC: March, 2012	Molecular mechanism of ova capturing and interventions to improve egg size and number during early laying phase in broilers	Dr. R.P. Moudgal	Dr. M. Sirajudeen Dr. K.V.H. Sastry Dr. Jagbir Singh Tyagi Dr. Jag Mohan

4.	P-1/2010/1- IAV/L50/6400/6100 DOS: June 2010 DOC: May 2015	Evaluation and improvement of reproductive efficiency in guinea fowl and chicken	Dr. Jag Mohan	Dr. K.V.H. Sastry Dr. R.P. Moudgal Dr. Jagbir Singh Tyagi Dr. Deepak Sharma
5.	P-1/2010/1- IAV/L50/6000/3730 DOS: July 2010 DOC: June 2015	Role of heat shock protein on the efficiency of digestive system under normal and stressed conditions in poultry	Dr. Jagbir Singh Tyagi	Dr. R.P. Moudgal Dr. Jag Mohan Dr. K.V.H. Sastry Dr. M. Sirajudeen
<b>Sub Programme - (iv) Development of health, shelter and other management packages</b>				
1.	P-1/96/1-IAV/L00/6600 DOS: 15.05.1996 DOC: May, 2011	Rearing and management practices of turkey under tropical climate	Dr. S. Majumdar	Dr. S.K. Agarwal (upto 31.10.2010) Dr. D.P. Singh Dr. R.P. Singh Dr. S.K. Bhanja
2.	P-1/2008/2- IAV/L05/6100 DOS: 03.01.2008 DOC: 02.01.2013	Poultry rearing practices at high altitude	Dr. S. Majumdar	Dr. A.B. Mandal Dr. Praveen K. Tyagi Dr. K.V.H. Sastry Dr. B.B. Dash (PD, FMD, Mukteswar) Dr. A.K. Sharma (IVRI, Mukteswar) Dr. Vikas Chandra (IVRI, Mukteswar)
3.	<i>Service Project</i>	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	--
4.	<i>Service Project CARI Regional Centre</i>	Surveillance and monitoring of duck diseases and their biosecurity measures	Dr. Dayamoy Mondal	Dr. S.K. Sahoo
<b>Sub Programme - (v) Development of poultry germplasm and package of practices for rural poultry</b>				
1.	P-1/2009/2- IAV/L10/6400 DOS: 01.06.2010 DOC: 31.05.2014	Improving guinea fowl for low input poultry production system	Dr. Deepak Sharma	--
2.	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. S.K. Mishra Dr. Raj Narayan Dr. A.K. Mishra
<b>PROGRAMME 2: PROCESSING, VALUE ADDITION, PRODUCT SAFETY AND QUALITY PARAMETERS</b>				
<b>Sub Programme - (i) Standardization of protocols of products / by-products handling and processing in unorganized sector</b>				
1.	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
2.	P-1/2009/1- IAV/L73/6000-4200 DOS: 01.10.2009 DOC: 30.09.2014	Detection of quantification of bacterial pathogens in poultry products and poultry environment	Dr. A.S. Yadav	Dr. R.P. Singh
3.	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. R.P. Singh

<b>Sub Programme – (ii) Value addition to different poultry products and by-products</b>				
1.	P-1/2007/1- IAV/Q10/9705 DOS: 01.09.2007 DOC: 31.08.2012	Development of poultry products based functional foods.	Dr. A.K. Sachdev	Shri Ram Gopal
<b>PROGRAMME 3: ASSESSMENT OF POULTRY PRODUCTION AS INFLUENCED BY MARKET DYNAMICS</b>				
<b>Sub Programme – (i) Market intelligence gathering and contingency planning</b>				
1.	P-1/2008/1- IAV/E00/9600-9705 DOS: April, 2008 DOC: April, 2011	International trade and export opportunities for Indian poultry sector	Dr. Sandeep Saran	Dr. L.S. Gangwar
2.	P-1/2010/1- IAV/E10/6000 DOS: 01.06.2010 DOC: 31.05.2013	Economic analysis of poultry production in Kumaon Hills.	Dr. L.S.Gangwar	Dr. Sandeep Saran

### NAIP RESEARCH PROJECTS

<b>Sl. No.</b>	<b>Project Code No.</b>	<b>Project Title</b>	<b>Name of CCPI/ Consortium Partner</b>
1.	Sanction order No. NAIP (SRLS-III) 3 <sup>rd</sup> Call-6/2008 dated 13.04.08 DOS: 13.04.2008 DOC: June, 2012	Holistic approach for improving livelihood security through livestock based farming system in Barabanki and Raibareili districts of U.P.	Dr. D.P. Singh
2.	Sanction order No. NAIP (SRLS-C)III-(2)7/2008 dated 07.06.2008 DOS: April, 2008 DOC: March, 2012	Goat husbandry based integrated approach for livelihood security in disadvantaged districts of Bundelkhand region.	Dr. Deepak Sharma
3.	Sanction order No.NAIP/Comp-4/C-4/ C30016/2008 dated 06.01.2009 DOS: 06.01.2009 DOC: 31.03.2012	Development potency of parthenogenetic goat embryos	Dr. S.K. Bhanja Dr. S. Majumdar
4.	Sanction order No. NAIP(SRLS-III) 3 <sup>rd</sup> Call-9/2008 dated 06.04.2009 DOS: 06.04.2009 DOC: June, 2012	Sustainable livelihood improvement through integrated fresh water aquaculture, horticulture and livestock development in Mayurbhanj, Keonjhar and Sambalpur district of Orissa	Dr. S.C. Giri

### EXTERNALLY FUNDED PROJECTS

<b>Sl. No.</b>	<b>Sanction order No.</b>	<b>Title of the project</b>	<b>Name of PI</b>	<b>Name of Co-PI</b>
1.	BT/PR9519/AAQ/01/345/2007 dated 13.06.2008 (DBT Project)DOS: 13.06.2008DOC: 12.06.2011	Enhancement of post-hatch immune-competence and growth of broiler chickens through <i>in ovo</i> approaches	Dr. S.K. Bhanja	Dr. A.B. Mandal Dr. S.K. Mishra Dr. S. Majumdar Dr. S.K. Agarwal (upto 31.10.2010)
2.	BT/PR12887/AGR/36/622/2009 dated 21.5.2010 (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
3.	F.No.9(1)/2010-HRD dated 26 <sup>th</sup> August, 2010 (Emeritus Scientist Scheme) DOS: 26.08.2010 DOC: 25.07.2012	Augmentation of production in naked neck white population using conventional breeding and nano-biotechnological approaches	Dr. B.P. Singh	-

## CONTRACT RESEARCH PROJECTS

<i>Sl. No.</i>	<i>Sanction order No.</i>	<i>Title of the project</i>	<i>Name of PI</i>	<i>Name of Co-PI</i>
1.	Contract Research Project No. CARI/AN&FT/CRP/06-07 by M/s Monsanto India Ltd., New Delhi DOS: 15.12.06 DOC: Continuing (Fresh MoU Submitted)	Comparison of chicken performance when fed diets containing MON 89034xNK 603 corn	Dr. Praveen K. Tyagi	Dr. A.K. Shrivastav Dr. A.B. Mandal Dr. Pramod K. Tyagi
2.	Contract Research Project No. CARI/AN&FT/CRP/10-11 dtd. 25th Oct. 2010 by M/s Maharashtra Hybrid Seeds Co. Ltd.(MAHYCO), Mumbai DOS: 18.11.2010 DOC: Continuing	Evaluation of nutritional value of diets containing Bt. rice grains in broiler chickens	Dr. Pramod K. Tyagi	Dr. A.K. Shrivastav Dr. A.B. Mandal Dr. Praveen K. Tyagi Dr. Chandra Deo

## INTER- INSTITUTIONAL PROJECTS

<i>Sl. No.</i>	<i>Sanction order No.</i>	<i>Title of the project</i>	<i>Name of PI</i>	<i>Name of Co-PI</i>
1.	CARI, Izatnagar -IVRI, Izatnagar -IARI, New Delhi-IIT, Roorkee Inter Institutional Collaborative Research Proj. C-2/2007/1-IAV/E00/6100-4200 DOS: 01.09.2007 DOC: 31.8.2011	Recycling of animal and farm waste and application of their value added products in sustainable crop production and animal husbandry  <i>Hazard analysis of poultry waste and Techno-economic evaluation of its alternative uses – Component-B</i>	Dr. Sandeep Saran	Dr. L.S. Gangwar