

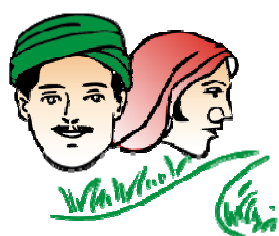


Vision 2050



Central Avian Research Institute
Izatnagar-243 122 (Bareilly), U.P.

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शरद पवार
SHARAD PAWAR



कृषि एवं खाद्य प्रसंस्करण उद्योग मंत्री
भारत सरकार
MINISTER OF AGRICULTURE &
FOOD PROCESSING INDUSTRIES
GOVERNMENT OF INDIA

MESSAGE

The scientific and technological inputs have been major drivers of growth and development in agriculture and allied sectors that have enabled us to achieve self reliant food security with a reasonable degree of resilience even in times of natural calamities, in recent years. In the present times, agricultural development is faced with several challenges relating to state of natural resources, climate change, fragmentation and diversion of agricultural land to non-agricultural uses, factor productivity, global trade and IPR regime. Some of these developments are taking place at much faster pace than ever before. In order to address these changes impacting agriculture and to remain globally competent, it is essential that our R&D institutions are able to foresee the challenges and formulate prioritised research programmes so that our agriculture is not constrained for want of technological interventions.

It is a pleasure to see that Central Avian Research Institute (CARI), Izatnagar, a constituent institution of the Indian Council of Agricultural Research (ICAR) has prepared Vision-2050 document. The document embodies a pragmatic assessment of the agricultural production and food demand scenario by the year 2050. Taking due cognizance of the rapidly evolving national and international agriculture, the institute, has drawn up its Strategic Framework, clearly identifying Goals and Approach.

I wish CARI all success in realisation of the Vision-2050.

(SHARAD PAWAR)



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सचिव एवं महानिदेशक
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SECRETARY & DIRECTOR GENERAL



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FOREWORD

The Indian Council of Agricultural Research, since inception in the year 1929, is spearheading science and technology led development in agriculture in the country. This is being accomplished through agricultural research, higher education and frontline extension undertaken by a network of research institutes, agricultural universities and Krishi Vigyan Kendras. Besides developing and disseminating new technologies, ICAR has also been developing competent human resources to address the present and future requirements of agriculture in the country. Committed and dedicated efforts of ICAR have led to appreciable enhancement in productivity and production of different crops and commodities, which has enabled the country to raise food production at a faster rate than the growth in demand. This has enabled the country to become self-sufficient in food and emerge as a net food exporter. However, agriculture is now facing several challenges that are expected to become even more diverse and stiffer. Natural resources (both physical and biological) are deteriorating and getting depleted; risks associated with climate change are rising, new forms of biotic and abiotic stress are emerging, production is becoming more energy intensive, and biosafety concerns are growing. Intellectual property rights and trade regulations impacting technology acquisition and transfer, declining preference for farm work, shrinking farm size and changes in dietary preferences are formidable challenges.

These challenges call for a paradigm shift in our research approach to harness the potential of modern science, innovations in technology generation and delivery, and enabling policy and investment support. Some of the critical areas as genomics, molecular breeding, diagnostics and vaccines, nanotechnology, secondary agriculture, farm mechanization, energy efficiency, agri-incubators and technology dissemination need to be given priority. Multi-disciplinary and multi-institutional research will be of paramount importance, given the fact that technology generation is increasingly getting knowledge and capital intensive.

It is an opportune time that the formulation of 'Vision-2050' by ICAR institutions coincides with the launch of the national 12th Five Year Plan. In this Plan period, the ICAR has proposed to take several new initiatives in research, education and frontline extension. These include creation of consortia research platforms in key areas, wherein besides the ICAR institutions, other science and development organizations would be participating; short term and focused research project through scheme of extramural grants; Agri-Innovation fund; Agri-incubation fund and Agri-tech Foresight Centres (ATFC) for research and technology generation. The innovative programme of the Council, 'Farmer FIRST' (Farmer's farm, Innovations, Resources, Science and Technology) will focus on enriching knowledge and integrating technologies in the farmer's conditions through enhanced farmer-scientist interface. The 'Student READY' (Rural Entrepreneurship and Awareness Development Yojana) and 'ARYA' (Attracting and Retaining Youth in Agriculture) are aimed to make agricultural education comprehensive for enhanced entrepreneurial skills of the agricultural graduates.

I am happy to note that the Vision-2050 document of **Central Avian Research Institute, Izatnagar** has been prepared, based on the assessment of present situation, trends in various factors and changes in operating environment around agriculture to visualize the agricultural scenario about 40 years hence and chalk out a demand-driven research agenda for science-led development of agriculture for food, nutrition, livelihood and environmental security, with a human touch.

I am sure that the '**Vision-2050**' would be valuable in guiding our efforts in agricultural R&D to provide food and nutritional security to the billion plus population of the country for all times to come.

(S. Ayyappan)

Dated the 27th June, 2013
New Delhi

Preface

Since its establishment in 1979, Central Avian Research Institute, Izatnagar has been contributing enormously towards shaping up of the Indian poultry sector (IPS) and giving the much needed technological support to the then budding poultry industry. The vibrancy of the Sector worth over Rs 400 billion, as we witness today, is the result of timely technological support to the poultry industry by this institute in terms of, not only the proven germplasm of chicken and its alternate diversified poultry species such as quail, turkey, Guinea fowl and ducks apart from improved native fowls, but also in terms of soft technologies leading to better management, higher productivity and product quality along with reduction in production cost. Many of the technologies developed and propagated by the institute have changed the whole economic gamut of agro-based products such as brans, oilcakes and other non-conventional poultry feed stuffs resulting into major cost savings. In economic terms, the institute has left a significant mark of triumph as a technology leader by translating its technologies into an estimated cumulative saving of about 14 mmt poultry feed worth Rs. 250 billion and an estimated gain of 32% in egg productivity resulting in cumulative incremental egg production worth Rs. 625 billion at current market prices since 1981. The institute is also credited with introducing quail and turkey in India. Further, the institute has also been supporting HRD and capacity building activities in tune with the growing demands of IPS for trained manpower. However, despite spectacular performance of the IPS, nutritional gaps at the grass root levels, trade liberalization under WTO, inequitably rising incomes, ever growing consumerism, depleting feed and other resources leading to escalation in production cost, impending threats of climatic shifts and its impact on poultry including resultant predictable shortages of agro based feed ingredients and quality water as also growing consciousness for quality foods amongst consumers pose newer challenges.

Vision 2050 document presents perspective planning of the institute to overcome the challenges and their mitigation strategies through suitable technology interventions for augmenting and sustaining productivity of the poultry production systems as also to focus on qualitative aspects in poultry value chain. It proposes to undertake basic, applied and strategic research and to serve as national repository in all aspects of Poultry Science to solve the existing and foreseen problems in a planned and timely manner.

I am highly thankful to Dr. S. Ayyappan, Secretary, DARE and Director General, ICAR for his valuable guidance in shaping up Institute's Vision 2050. I express my gratitude to Dr. K.M.L. Pathak, DDG (AS) and his team at the ICAR HQ for their kind support. I record my sincere appreciation and thanks to Dr. Sandeep Saran, PS and Head, Prioritization, Monitoring & Evaluation & Poultry Economics and Agribusiness Research and Dr. V.K. Saxena, PS, AG&B for their efforts in preparation of the document. Last but not the least, I acknowledge valuable inputs from all the scientists of the institute and am thankful for extending their full cooperation in preparation of this document.

June 2013



(Dr. J.M. Kataria)

Director

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Context

The remarkable growth achieved in the Indian poultry sector is due to several factors like initiation of pure line breeding within the country in both public and private sectors leading to availability of elite commercial layer and broiler germplasm; and introduction and improvement of diversified poultry species such as quail, turkey, guinea fowl, emu and duck. The parallel development of other input sub-sectors like feed mill, hatchery and farm appliances, poultry biological, feed analytical and disease diagnostic labs., modern mechanized poultry and egg processing plants, vertical and horizontal integration in poultry farming, availability of soft credit, and above all ever-increasing demand of poultry products, etc. have also contributed to the growth. In addition, Central Avian Research Institute, Izatnagar, Project Directorate on Poultry, Hyderabad and some State Agricultural or Veterinary Universities having sound Poultry Science education and research base in conjunction with the Central Poultry Development Organization have played a key role in providing highly qualified man-power, training support to poultry farmers/entrepreneurs and R&D support to the growth of poultry sector.

Having established on November 2, 1979, the Central Avian Research Institute (upgraded from the erstwhile Poultry Research Division, Indian Veterinary Research Institute, Izatnagar) has been the major driving force steering the Indian poultry sector through various phases of development during the past four decades providing much needed technological support to the poultry industry especially the rural poor. The Institute with its main campus at Izatnagar, Bareilly, Uttar Pradesh and a Regional Centre at Bhubaneswar, Odisha is the only one of its kind wholly dedicated to Poultry Science research, education and extension in the Country with the following vision, mission and the mandate.

Vision

Revolutionizing the diversified poultry production for household nutritional security, income and employment generation as a viable alternative to chicken.

Mission

Developing and popularizing appropriate poultry production and processing technologies in respect of diversified avian species for enhanced profitability.

Mandate

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

Focus

In order to realize its vision and mission, the institute accords highest priority to the needs of the farming community at the grass root level including women folk. The institute is committed to the requirements of the small poultry entrepreneurs on one hand and is also responsive to the problems and challenges faced by the commercial poultry industry on the other hand. The institute has addressed a wide range of challenges faced by the poultry industry in the years bygone, as already envisioned by the institute, some of which are outlined as follows:

Germplasm Development: Doing away with the dependence of Indian poultry sector on imported poultry stock, the institute made significant strides in developing germplasm of diversified poultry species in the country and developed, improved and released the following germplasm. These are immensely popular in the poultry farming community across the country. Their production technologies have been disseminated not only to the private sector but also to CPDOs, SAUs/SVUs, KVKs, State AH departments and NGOs etc. which in turn have been providing the germplasm to the poultry farming community in their respective command areas. Besides, the institute has also recently introduced emus.

The high performing improved indigenous fowls have very high demand in rural/tribal areas as they are highly suitable for the concept of 'production by masses' under sub-optimal input regime. The pure lines of various important breeds of diversified poultry species including chicken layers, broilers and *desi*

fowls are available with the institute, apart from the parent lines of the above-mentioned commercial seed material.

Species	Commercial Crosses/ Strains/Varieties
Quails	CARI Pearl, CARI Sweta, CARI Ujjawal, CARI Uttam
Turkeys	CARI Virat
Guinea Fowls	Chitambari, Kadambari, Swetambari
Ducks	White Pekin, Khaki Campbell, Moti, <i>Desi</i>
Dual Purpose Chicken	CARI Debendra
Improved Indigenous Fowls	CARI Nirbheek, Upcari, Hitcari, CARI Shyama
Broilers	CARIBRO Vishal, CARIBRO Dhanraja, CARIBRO Mrityunjai, CARIBRO Tropicana
Layers	CARI Priya, CARI Sonali

Poultry Biotechnology: The challenges poultry industry is facing have been addressed by advance biotechnological tools which are being used for enhancement of productivity, disease resistance, tropical adaptability, as well as genetic resource characterization and for specified goals. In these frontier areas of research, the institute has made significant advancements in the following areas.

- The layer, broiler, duck, quail, guinea fowl and turkey germplasm have been characterized using RAPD, AFLP and microsatellite markers. QTLs and candidate genes analysis for identifying molecular markers related with economic traits, disease resistance and tropical adaptability has been carried out. PCR based techniques were standardized for sex differentiation in different poultry species.
- The expression, genomic analysis and epigenetic modifications of various candidate genes involved in heat shock response have been studied in broiler strains. Various physiological and haemo-biochemical parameters were also evaluated under different stress conditions. The naked neck

broiler developed at this institute was found to have better production and heat tolerance capabilities.

- The work on gene driven technologies like transgenesis (transgenesis sperm and silencing of myostatin gene), RNA interference (RNAi), *in-vivo* embryo-culture system using single and double window approach etc. has been carried out for augmenting productivity and disease resistance. The *in-vivo* silencing of myostatin (~70%) was achieved in chicken by administering shRNA targeting myostatin cloned in lentivector with GFP at day old stage. rDNA technology for production of poultry cytokines for their use as vaccine adjuvant, immune modulator and growth promoter has been utilized.
- Nucleotide variations and SNPs among species/ strains have been analysed. Critical genes involved in forced moulting have been identified.
- Immuno-divergent lines for humoral and cell mediated immune response have been developed. Identification of an SNP associated with ND vaccine response and development of new MHC genotyping procedure and selection criteria for enhanced immunocompetence have been achieved. Analysis of TvB locus to find ALV resistant/susceptible alleles among WLH, Kadakanath and Aseel highlighted the scope of molecular breeding for ALV resistance.
- Techniques of *in-ovo* nutrient supplementation package based on gene expression analysis has been standardized to improve early chick growth and development of vital organs. Technique of *in-ovo* procedures for multiple vaccine delivery has been standardized for better post hatch immunity.
- Key factor influencing parthenogenetic development in unfertilized turkey and chicken eggs has been identified through micro array, real time PCR and chromosomal analysis.

Quality Poultry Nutrition and Feed Resources: Faced with the challenges of ever increasing feed cost, the institute has devised ways and means to ensure precise nutrient supply in tune with the requirements of different nutrients (amino acids, energy, minerals, protein, vitamins etc.) for different classes and age groups of poultry species under different rearing conditions to minimize feed cost. Several alternate feed resources have been identified, evaluated for

their feeding value and efficiently utilized in poultry rations in a bid to buffer the shortage of maize and soybean meal. Some of such feedstuffs are nutritious cereals (pearl millet, sorghum-red, brown and white, undersized wheat, finger millet and small millets, quality protein maize), cereal by-products (maize germ meal, maize gluten meal, rice polish, broken rice, deoiled rice bran, wheat bran), oilcakes (sunflower, mustard/rapeseed-exPELLER and solvent extracted, cottonseed, sesame, karanja, neem seed, safflower, castor seed), gum-industry residues (guar meal, high protein roasted guar korma), fruit processing waste (apple pomace) and animal protein supplements (slaughter house poultry by-product meal, meat-cum-bone meal, meat meal, earthworm meal) and other stuffs (dried yeast, azolla meal). The effective combinations of cereal and protein mixtures have also been established. The database of nutrient contents, digestibility/availability of amino acids and minerals and safe/effective level of inclusion of different feedstuffs has been developed. Different processing techniques like acid/alkali treatment, autoclaving, fermentation, fungal treatment, roasting, water washing and soaking (reconstitution), supplementation/addition of enzymes, prebiotics, probiotics, acidifiers, water and feed sanitizers and supplementation of critical nutrients (amino acids, minerals, energy) have been used to augment the nutritive value of feedstuffs. Low cholesterol and ω -3 fatty acid enriched eggs have been developed through dietary intervention. The efficacy of different herbs, additives and nutritional agents, and dietary manipulations has been established for climate resilience poultry production. The Institute has made significant achievements in developing technologies to deal with the anti-nutritional factors, adulterants and toxicants in various feeds compromising their quality. *MakeFeed Poultry*, the Windows^(R) based software developed to design cost-effective feed-formulae for different classes and age groups of various poultry species, has been immensely popular in the poultry industry and over 300 copies have already been sold.

Housing Systems and Package of Practices The institute has pioneered the rearing and management practices of different poultry species under diverse systems of rearing. Entire range of rearing appliances such as battery brooders, feeders, incubation trays, laying and rearing cages, waterers, etc. for different avian species have been designed and got fabricated. The institute has also designed low cost poultry houses utilizing locally available materials for semi-intensive or small scale poultry rearing. Effective floor space requirement for

cage and floor rearing of turkey and quail have been standardized. Package of practices for high altitude poultry farming has been standardized.

Stress Management and Reproduction Technology: Several technological interventions have been developed in the form of additives/supplements to mitigate various types of stress in poultry. The techniques of artificial insemination in various poultry species have been standardized. Development of semen storage techniques and semen dilutor for AI in poultry species have been important landmark achievements. Moreover, several physiological mechanisms have been evolved in a bid to accommodate suitable interventions aimed at enhancing productivity of the poultry species.

Processing, Value-Addition and Product Quality: The institute has developed a number of value-added products utilizing poultry eggs and meat. Slaughter waste has been utilized for production of pet food and poultry byproduct meat. The effective and economical techniques of preservation /shelf-life extension including suitable packaging of poultry products have also been standardized. The efficacy of natural preservatives for shelf-life extension of poultry products has been evaluated. The techniques of meat tenderization have been standardized to pave the way for effectively utilizing tough meat of culled birds. The Institute has also generated some database on product safety parameters such as occurrence of potent pesticides' residues, presence of aflatoxin and heavy metals in poultry products as well as surveillance of the microbial quality including food pathogens in poultry products.

Market Watch and IP Protection: The institute also keeps a close tab on the market trends and developments taking place in the poultry sector in India as well as globally. Institute also provides consultancy services for establishing poultry units and for raising institutional finance. The cost and returns from quails, turkeys, guinea fowls, ducks, broilers and layers under different systems of rearing are continuously updated. Economics of parent lines rearing integrating with production of commercial broilers and layers has also been worked out and updated. The institute has already initiated the process to obtain trademarks for its flagship germplasm/commercial strains/crosses. Some of the novel processes/techniques have also been granted patents in the past and are in the process of commercialization.

Technology Transfer and HRD: The institute has made significant strides in disseminating the proven technologies developed by the Institute. The species

like quail, turkey and duck have been widely disseminated across the length and breadth of the Country. Quails and turkeys have already gained substantial popularity in the Country. But for the restrictions of the Wild Life Act 1972, the Japanese quails are likely to grow exponentially in the country as a viable alternative to chicken being an elite delicacy. Similarly, the Institute has also made significant contributions towards revamping the small scale rural poultry farming in India. The native type dual purpose improved chicken varieties have been developed and propagated throughout the Country. These varieties are being further propagated by the NGOs, social organizations, CPDOs, private hatcheries, SAUs/SVUs and the State AH departments to provide equity base along with house hold nutritional security and supplementary incomes to the poorest of poor.

The availability of technical manpower for the industry is less than adequate at present. The human resource development and capacity building exercise is taken up by this Institute in the form of short term and specialized trainings on various aspects of poultry production and management. Besides, the Institute, in collaboration with the deemed university, IVRI, Izatnagar also imparts post-graduate education in various sub-disciplines of Poultry Science. Other modes of capacity building such as summer/winter schools, farmers' fair, conferences, seminars and symposia are also organized by the Institute from time to time.

CARI Vision 2050 document briefly presents the current scenario of global as well as domestic poultry sector, prospects for its further growth along with issues, concerns and perceived future threats and challenges in the next four decades for developing appropriate strategies and a road map to elucidate the role of Central Avian Research Institute in solving these issues by providing consistent technological support to the poultry sector for its sustained development and growth for ensuring nutritional security for about 1.6 billion Indian population by 2050.

Challenges before Indian Poultry Sector

At present more than half of the world's protein-energy malnutrition problem is in South Asia. FAO Global Perspective Studies Unit, 2006, has projected that food consumption levels in India from current average level of about 2,400 kilo calories per capita per day will increase to about 3,000 kilo calories per day in 2050. With ever rising incomes, the share of calories derived from cereals is declining in India, and is projected to fall below 50% by 2050. The number of undernourished people in India remained unacceptably high at 221 million (22%) in 1999-2000 which is expected to be 70 million (5%) by 2050. Poultry *per se* is expected to play the most crucial role in transforming the nutritional demography of India with ever growing share of protein based cheap human diets. Some of the specific challenges the Indian poultry sector is faced with are as follows.

Regional Imbalances in Poultry Production

Regional imbalances in poultry production are inevitable since both large commercial egg and broiler production farms are mainly confined to the Southern states, apart from Maharashtra, Punjab, Uttarakhand and Haryana in the North. More than 60% of eggs are produced in Andhra Pradesh, Haryana, Maharashtra, Punjab and Tamil Nadu states, whereas more than 60% of poultry meat is produced in Andhra Pradesh, Karnataka, Maharashtra, Punjab and West Bengal. However, poultry production, particularly broiler farming is gradually catching up in some deficit Northern, Central and Eastern regions of the Country in the recent years. The commercial layer farming is yet to make a dent in some of the most populous states like Bihar, Madhya Pradesh, Odisha, Rajasthan and Uttar Pradesh and also in hilly regions of the Country.

Underexploited Poultry Diversity

Among poultry species, chicken production has already acquired large scale commercial dimensions in India due to its better efficiency than other domesticated poultry species to convert poultry feed into nutritious egg and meat. Chicken (including *desi* fowl) accounts for about 95.21% of the total poultry population, followed by 4.25% ducks. The remaining 0.54% is comprised of other domesticated poultry species such as quail, turkey, guinea fowl and goose etc. The population of quails and turkeys is growing

exponentially in the Country owing to their ever increasing popularity, lower susceptibility to common poultry diseases and higher returns. Ducks are mostly reared in coastal states, Jammu and Kashmir and NE region of our country. Although, commercial quail farming for meat and egg production is becoming increasingly popular and this institute has emerged as the focal point for evolving high yielding quail germplasm and its spread in the country, sincere efforts in terms of financial resources, trained scientific manpower and R&D infrastructure are required to place the diversified poultry species against chicken in the market as its commercially viable alternatives. While guinea fowl farming is still in confinement in certain areas, rearing of emu and ostrich is a more recent and nascent development in the country.

Natural Resource Degradation

Over exploitation of natural resources in an unsustainable manner has proved to be the mother of all ill effects such as frequent climatic extremes, associated stresses on crops, livestock and poultry, etc., directly or indirectly leading to loss of agro productivity as well as quality. The poultry sector has, thus, not remained insulated from bearing the brunt of such exploitation. Moreover, growing human population along with the needs of livestock including poultry has further strained the feed resources of the Country.

Rising Feed Cost

India produces some 19 mmt of compounded poultry feed per year of which 10.24 mmt and 5.62 mmt is utilized to produce 3.2 mmt eggs (64 billion) and 5.62 mmt of poultry meat, respectively. Rest 3.14 mmt feed is utilized by the parent and grandparent stocks in the Country. At the present level of feed efficiency, it has been estimated that about 80 mmt poultry feed will be required to produce 9 mmt (180 billion) eggs and about 18 mmt poultry meat by 2050. Clearly, the growth in poultry has outpaced the growth in cereal production leading to severe feed shortages and consequent rise in feed cost. Cereal by-products and oilseed residues usually constitute about 50% of poultry diet. Coarse cereals such as pearl millet, grain sorghum, corn, minor millets and *ragi* etc. also form the staple diet of millions of marginal farmers and landless labourers. These coarse cereals are the most important and most widely used poultry feed ingredients all over the world. The demand for coarse cereals is continuously increasing at 4% per year due to ever increasing population and their use in livestock rations.

The yield of maize grain, the most important ingredient of poultry feed in India is just about 40% of the world's average which is attributed to limited availability of quality seeds, pesticides and fertilizers etc. The consumption of maize growing at 6% per annum has clearly outstripped production growth due to stagnant productivity and acreage at about 6.6 million ha. Thus, the consumption and production gap will keep rising due to growth of poultry sector as also due to its increasing industrial use (for production of maize starch and high fructose corn syrup etc.)

Soybean meal is yet another important poultry feed ingredient used as protein source in poultry rations. Instability in its production and indiscriminate exports has resulted in its shortage for the poultry industry leading to its high prices. The soybean production in the Country was about 12.6 mmt in 2012-13 which is likely to reach 41 mmt by 2050 at the present rate of growth in production.

Poultry feed which accounts for ~70% of the total cost of poultry production, has become one of the most serious challenges for the industry owing to growing population, alternative uses and resultant increase in demand for the poultry feed ingredients, hence their escalated prices. Therefore, improving feed conversion efficiency would be crucial to profitability apart from the feed cost itself. Over the past two decades, feed conversion rates for poultry have improved by about 40% due to improved productivity and efficient feeding strategies. However, still only 25-35% of the nutrients consumed by poultry are utilized. Hence, further understanding of digestive physiology and biochemistry can be expected to improve nutrient utilization efficiency.

Declining Share of Backyard/Small Scale Poultry

Rural poultry production constitutes important component of agricultural economy in India, small poultry holders are practically capable of contributing more significantly to alleviate malnutrition, poverty and unemployment. India requires both mass production as well as production by masses to cater both its rural and urban population. Hence, public funded R&D support is critical for spread and popularization of small scale poultry amongst farming community having less than 2.0 ha. of land holding, but owning 80% of the total poultry population of the Country.

Emerging and Re-Emerging Poultry Diseases

In the recent past, poultry sector has faced frequent onslaught of newer poultry diseases like bird flu (Avian Influenza) leading to enormous losses to the poultry

sector not only in India but globally. The total losses to the Indian poultry sector till 2009 have been estimated to the tune of over Rs. 2200 crore. In addition to this, other existing diseases viz. infectious bronchitis, infectious bursal disease, Ranikhet disease, Marek's disease and fowl pox have emerged in more virulent form. Therefore, scientific interventions are urgently needed to curb the menace of such emerging poultry diseases in the Country as well as effective control measures against already existing major poultry diseases.

Poultry Waste Disposal and Environmental Concerns

The magnitude of poultry wastes is constantly on increase due to growth of the poultry industry. The problem of waste disposal is all the more grave due to concentration of poultry in some well-defined pockets or geographical boundaries. The annual poultry waste generation has been estimated to the tune of about 22 MT at present which is likely to increase manifold in conjunction with the fast growing poultry population. There is a need to devise cost-effective ways and means for proper disposal of wastes arising from dressing plants, hatchery and poultry manure etc. to minimize environmental pollution and for putting them to alternative efficient use. Some of the alternative uses of poultry waste are production of pet foods, manure or bio-fertilizers (vermi-compost), biogas and electricity etc. Promotion of cost-effective methods of waste disposal has to be taken up to entice the commercial sector for putting the same into practice.

Climate Change and Associated Stresses

Global warming projected to increase the earth's temperature by 1.8° to 4.0°C by the end of this century, is likely to result in frequent extreme climates, floods, droughts, cyclones and recession in glaciers with threatened coastal lines. Therefore, technology driven systems need to be evolved to counter such environmental and climate associated threats. Increase in climatic extremes is likely to cause stresses to poultry birds compromising their productivity. Hence, deeper insight into the genetic and physiological underpinnings under such stressful conditions is required to develop its mitigating strategies.

Poultry Marketing Infrastructure

Marketing of poultry products is the major issue faced by the industry. In the absence of orderly marketing network, sufficient regulated markets, lack of adequate cold-chain and warehousing facilities etc., the wholesale prices of

poultry products suffer violent fluctuations and often become unremunerative, due to cyclic boom-and-bust phenomena. The poultry marketing is largely in the hands of commission agents and private traders. Procurement and distribution in remote places receive low priority. Fragmented and remote rural markets also restrict reach of commercial poultry products to the far flung rural areas. Strong marketing network covering the entire Country is needed to set the industry free from the clutches of middlemen.

World Trade and Markets

The international trade in poultry meat and egg accounts for about 12% and 2% of global output of nearly 100 mmt poultry meat and 64 mmt eggs, respectively. Brazil, USA and Netherlands are the major chicken meat exporting countries together accounting for over 72% of world's chicken exports whereas Russian Federation, Hong Kong, China, Saudi Arabia and Japan are the major chicken meat importers together accounting for about 40% world's chicken imports. Similarly, Netherlands, Spain, Germany and China are the important exporters of hen eggs together accounting for about 50% world's hen eggs exports whereas Netherlands, USA, Germany and Spain are the major egg importers with a total share of over 51% of the world's egg imports. The traditional channels of international trade in poultry have also been distorted owing to frequent outbreaks of deadly poultry diseases like bird flu etc.

Limited acceptance of processed poultry products in the domestic markets is yet another constraint restricting capacity utilization of already established processing units and further investments in this area. Only about 5-6% of table eggs produced in the Country are presently processed commercially. Wet marketing of broilers is still preferred and is widely prevalent in the Country in the absence of general awareness about food safety and quality, and statutory provisions to restrict the same. This is the primary reason for almost dismal share (about 0.7%) of the Country in the global poultry trade. The prominent poultry products being exported post- WTO are *eggs-liquid* followed by *frozen chicken meat*, *egg-dried*, *duck meat*, *hen-egg-in-shell* and *chicken canned*. India is presently exporting egg powder and frozen liquid egg to Europe, Japan and other countries on a modest scale. The product quality and safety issues are now of paramount importance in the wake of WTO not only to promote poultry exports but also to save the domestic markets from the onslaught of imported poultry products owing to open market access and trade liberalization policies.

Institutional and Capital Constraints

The available miniscule public funded institutional support is far from adequate for the mammoth Indian poultry sector worth Rs. 6000 crore. Support for Poultry Science education and R&D is meagre in the National Agricultural Research System. Similarly, there is an urgent need to establish National Poultry Development Board on the lines of National Dairy Development Board in the Country in order to develop the Indian poultry sector in a regulated and planned manner, though National Meat and Poultry Processing Board has recently been set up for addressing key issues related to development of meat and poultry processing sector.

The facilities of micro credit for poultry businesses are totally illusive which need to be extended to the poultry sector to promote poultry production by the masses.

Intellectual Property (IP) Regimes

Biodiversity is insurance to genetic progress as well for sustenance of life. The characterization, documentation and conservation of Indian poultry genetic resources is of paramount importance to safeguard Country's genetic assets due to growing implications of IP cataloguing. Poultry genetic resources of the Country require considerable efforts in the form of manpower, financial and infrastructural inputs. Expansion of IP regime and its economic implications worldwide is likely to pose newer challenges and opportunities by 2050.

Human Resource Needs

Growing Indian poultry sector also requires trained manpower not only to man the commercial establishments but also to support the required R&D in sync with ever evolving scientific needs. It has been estimated that the highly skilled technical manpower requirement of the Indian poultry sector will almost double by 2050, at the present rate of outturn and the present capacity of the Country's educational and training institutions. Besides, the sector would also witness growth in skilled and semi-skilled manpower requirement @ at least 5% per year for specific and general operations concerning poultry production and processing. Therefore, developing and sustaining the required capacity building infrastructure to meet the ever growing manpower demand of the poultry sector will be a challenge before the Country.

The changing poultry scenario in the overall frame of growing economy has posed newer challenges to the Institute not only for reorienting its research programme aimed at developing technologies which are competitive, cost-effective, eco- and farmers-friendly, commercially viable, sustainable and acceptable internationally but also to redefine its clients and to develop technologies as per their requirements in a focussed manner.

Focus

Keeping in view the above facts, following key long term objectives have been synthesized on which the Institute will direct its R&D focus in order to realize its cherished vision and mission.

- Enhancing productivity of alternate poultry species.
- Promote and propagate integrated farming of diversified poultry species with horticulture and aquaculture under zero waste regime through technological development for their sustainable and profitable production.
- Search for alternate and effective utilization of poultry feed resources in precision feeding to minimize the feed cost in the face of stiff competition between the human beings and poultry for the common feed resources.
- Developing cost-effective and efficient processing technologies for production of value-added poultry products with extended shelf-life, and utilization of poultry by-products and wastes.
- Promoting feed and product safety and development of technological interventions for their quality assurance.
- Contingency planning for facing the challenges of climate change for sustainable poultry production by evolving technologies for mitigating their adverse effects and associated stresses.
- Promote innovations and infuse capacity building for meeting the requirements of all stakeholders in the poultry value chain.
- Establishment of an information clearing mechanism for efficient dissemination of technologies and technical know-how.
- Strengthening and modernization of R&D infrastructure, improvement in the quality of human resources.
- Foster linkages and collaborations with the stakeholders in both private and public sectors as also with international agencies.

The R&D efforts of the Institute are targeted on Japanese quails, turkeys, ducks, guinea fowls, native fowls and emus.

Having drawn a sketch of Indian poultry sector appreciating various challenges thrown open in a transforming poultry economy, it is imperative to review the operating environment vis-a-vis the Indian poultry sector to access the needs of technological interventions.

Operating Environment

The world population in 2011 stood at 7 billion, which is expected to rise further to 8.30 billion by 2030 and about 9 to 9.5 billion by 2050 (UNFPA, 2011). World's total production of poultry meat during 2011 was approximately 101.6 mmt comprising of 85.6% chicken, 6.8% turkey, 4.6% duck, 2.6% goose and guinea fowl meat. The share of Asian and South American continents has been steadily rising, presently contributing over 52% of global poultry meat production. Nearly one third of worldwide high yielding stocks placement is in Asian countries such as India and China and these countries are emerging as important locations for production and trade of poultry products.

The global average per capita availability of eggs and poultry meat was about 9.1 and 12.27 kg per year during 2011-12, respectively (FAO). Global poultry meat production is expected to reach 193.3 mmt by 2050 (<http://www.fao.org/docrep/014/i2373e/i2373e03.pdf>). Global growth in egg uptake has been remarkable, from less than 20 mmt per year in the 1960s and 1970s to around 40 mmt by the 1990s, reaching about 64.7 mmt in 2012 of which over 60% is contributed by Asia alone. By 2050, the world's egg production is likely to reach about 121 mmt. Feed International has estimated that out of a total of some 870 mmt compound feed produced by commercial mills for all species in 2011, 357 mmt (41%) was utilized for feeding the poultry alone worldwide making it the largest single segment of compound feed consumption on a global basis. Therefore, the feed requirement for the animal based sector as a whole and poultry in particular is likely to increase manifold by 2050.

Needless to say that the poultry production systems are changing very fast both at national and international levels. Large middle class armed with ample purchasing power, untapped demand from rural areas, growing preference for non-vegetarian quality and safe food, high socio-religious acceptability coupled with potential to yield higher returns at low investments and gestation period offer excellent platform for growth of poultry sector.

Indian Poultry Scenario

Poultry industry contributes about Rs. 600 billion accounting for about 0.77% of the national GDP and ~10% of the livestock GDP and provides employment

to over five million people in the Country. Poultry sector is dubbed as the one having highest employability per unit of investment. The Indian poultry sector with 7.3% growth in poultry population, has witnessed one of the fastest annual growth of about 6% in eggs and 10% in meat production over the last decade amongst all animal based sectors. The high growth has placed India at 3rd position after China and USA with a production of 63 billion eggs and 5th after USA, China, Brazil and Mexico with a production of 3.2 mmt of chicken meat during 2011-12. Despite such progress, the average per capital availability is still merely 53 eggs and 2.6 kg of poultry meat against the recommended levels of 180 eggs and 11 kg meat per annum. It has been estimated that under moderate growth scenario of 6% per annum in the Country's GDP, by 2050, the demand for meat and eggs is likely to shoot up to 18 and 9 mmt, respectively.

The poultry farming in India occupies an important position due to its enormous potential to bring about rapid economic growth, particularly benefiting the weaker sections due to its low investment requirement and short gestation period. The poultry, which was considered as a backyard proposition in the early 60's has now been transformed into a strong agro-based commercial activity having tremendous employability and income generation potential.

The poultry sector in the Country during the last ten years has witnessed cyclic boom and burst phenomena due to accelerating factors such as high demand for poultry products as a result of overall economic growth and consequent rise in incomes, investments from multi-national food giants, disintegrating joint family system leaving limited scope for home cooking etc. on one hand and decelerating factors such as high feed cost due to instable supplies of agro-feed ingredients, emergence of deadly poultry diseases and resultant distortions in domestic as well as global poultry trade, limited investments in poultry infrastructure and more recent economic factors such as high inflation and ever rising cost of energy/fuel etc.

The growth in poultry sector has been highly skewed in favour of some well-defined geographical boundaries termed as 'poultry belts' whereas most of the remaining parts of the Country suffer from inadequate supplies and high prices of poultry products.

Therefore, technological support is crucial for the development and consistent growth of the poultry sector to protect and safeguard the interests of all stakeholders in the poultry value chain particularly the more vulnerable small

poultry holders throughout the Country. Indian poultry sector is expected to witness the following structural shifts in near future.

Safe/Organic Poultry Production: With rising incomes and education, preference for safe food is also on the rise especially among the urban elites. This is why the organic products are also gaining ground and popularity in the Country despite high costs of production associated with such products. Growing demand for safe food as well as the statutory requirements to meet the safe food norms is also expected to witness greater adherence to food safety protocols such as HACCP, TQM and GMP etc. warranting cost cutting and energy efficient technology interventions and development of processes compliant to such protocols.

Designer Poultry Products: Again shifting the focus from quantity to quality, the health conscious elite population of the Country now desire for poultry products rich in Omega-3 fatty acids, low in cholesterol and having low trans fats etc. With development of technologies for production of nutraceuticals and pharmaceuticals utilizing poultry egg and meat, the demand for such designer products is expected to rise further coupled with rising income, education and health consciousness.

Changing Marketing Formats: Growing urbanization in the Country along with presence of multi-nationals is forcing unorganized retailing to transform into organized formats. The urban population in India is about 31% which is likely to surpass rural population by 2050 to reach at 52%. Such structural shifts are likely to change storage, transportation, processing and packaging pattern in respect of poultry products in the Country. Therefore, appropriate technology interventions will be needed to address such issues.

Market Intelligence: The National Egg Coordination Committee (NECC) with its corporate office at Pune and several branch offices carries out the functions of market intelligence to support poultry farmers cum egg producers enrolled as its members. The NECC also promotes national advertising campaigns for enhancing egg consumption. National Meat and Poultry Processing Board has recently been set up for addressing key issues related to development of meat and poultry processing sector.

Poultry Health Management: The available infrastructure to address the health care aspects of poultry such as accredited disease diagnostic laboratories, disease monitoring and surveillance services and training facilities are far from

adequate in the Country. Moreover, the cost of prophylactics and therapeutics is also on the rise. Therefore, technology driven cost-effective and efficient disease monitoring, diagnosis and combat systems need to be devised to address the health care issues concerning poultry.

Shrinking Energy Resources: India is an energy-deficit country since its energy requirements are met through large scale imports of crude oil. Shrinking global reserves of fossil fuel and growing cost of electricity generation is further fuelling the energy cost which is expected to rise further, leading to escalation in production, transportation, processing, and storage and marketing costs. Hence, energy efficient processes including biogas production from poultry by-products are required to be developed to address the issues concerning rising energy cost.

Integrated /Contractual Production Systems: With a population of about 1.2 billion and per capita incomes now growing @ over 5% annually, India constitutes a large potential market for poultry products. The key structural changes spurring production growth in the sector is integration of poultry production activities wherein breeding, feed milling, contract growing and marketing activities are combined under single management to attain overall production and marketing efficiencies. Contractual arrangements in poultry production is relatively new phenomenon wherein the farmer is rewarded /paid for only rearing the poultry for which all physical and technical inputs (including buy back facility) are provided by the contracting party.

R&D in the Private Sector: The research efforts of private sector have been primarily focussed on pure line breeding of chicken for eggs and meat. The private companies engaged in pure line breeding of broiler chicken include Arambagh Hatcheries Limited (Ltd.) , Kolkata; Godrej Agrovet Ltd., Mumbai; Pioneer Breeding Farms, Coimbatore; Shanti Hatcheries, Coimbatore; Suguna Poultry Group, Coimbatore; Venkateshwara Hatcheries Ltd., Pune. Similarly, Bovans Breeders Private (Pvt.) Ltd., Hyderabad; Kasila Farms Pvt. Ltd., Hyderabad; Kegg Farms Pvt. Ltd., Gurgaon; Poona Pearls Breeder Pvt. Ltd., Pune; Tarkeshwara Hatcheries, Nashik; Venco Research and Breeding Farms Ltd., Pune, Ponni at Namakkal are some of major players in the field of pure line breeding for layers.

Some of the private firms are also manufacturing and supplying quality compounded feeds, vaccines and biologicals. The indigenously manufactured

incubators and hatchers have received wide acceptance both within and outside the Country. However, no serious efforts in private sector are visible in the areas of poultry housing, equipment design improvements, frontier areas of research such as biotechnology and molecular breeding, developing germplasm for small scale/family poultry production by masses especially diversified poultry, precise nutrient supply to ensure better feed utilization efficiency etc. and innovative energy efficient processing technology with a view to reduce cost of production/processing and to be globally competitive.

Untapped Rural Demand: Due to fragmentation of markets in rural areas and problems of access owing to infrastructural bottlenecks, the demand for poultry products in rural areas has remained by and large untapped as is evident from highly skewed consumption pattern of poultry products favouring urban areas. Hardly 10 eggs per capita are consumed annually in a typical Indian village. The availability of poultry eggs and meat is grossly inadequate in rural areas leading to their high prices as compared to those in urban areas.

New Opportunities

The insatiable human quest and consequent advancements in scientific knowledge has led to development of advance tools, techniques, methods and approaches capable of technological breakthroughs. The scientific advancements taking place in the other related spheres of knowledge and IT enabled accessing facilities leading to shifts in level of interactions among scientific and social domains have thrown open large vistas for research and development which enables infusion of fresh ideas to accomplish the envisioned goals of enhancing production of poultry species to meet its ever growing demand.

The Institute intends to reap the benefits of synergies of modern scientific tools and techniques, viz., bio-informatics, geographical information system, nano-science, information and communication technologies in conjunction with the conventional and core scientific techniques to enhance productivity, input use efficiency, reducing cost and post-harvest losses, minimizing risks and improving quality of poultry products as also to address and shield diverse interests of various stakeholders in the poultry supply chain. Some of the ardent aspects requiring focus in the next four decades are outlined hereunder.

Augmenting Genetic Potential of Diversified Avian Species

The Institute would reorient its pure line breeding programmes, laying renewed emphasis on alternate and promising avian species to establish them in the chicken dominated Indian poultry industry for commercial exploitation. The issues like impact of climate change, disease resistance and improvement in productivity along with feed conversion efficiency etc. would receive focussed attention harnessing the power of latest biotechnological tools. To address the future needs, research would focus on sustainable use of available genetic resources through their characterization and genetic improvement, functional genomics, epigenetics, proteomics, gene mining, molecular breeding tools like marker assisted selection and gene staking, and customized genetic engineering aimed at production of trait specific transgenics, etc.

Efficient Feeding Systems Nutritional requirements of diversified poultry species vary with climatic conditions, genetic potential and production status. The same would be regularly fine tuned for ensuring precise nutrient supply so

as to improve feed utilization efficiency and productivity aimed at reducing stress to the birds and finally the feed cost. The research output would be utilized for developing and updating nutritional standards of various poultry species in collaboration with the ICAR and Bureau of Indian Standards (BIS).

Highly diverse landscape and agro-climatic conditions in India and newer food processing techniques provide wider options for choosing alternate feedstuffs aimed at lowering the cost of production. The database preparation on nutrient contents, their digestibility/ bioavailability and effective/safe level of inclusion of such feed stuffs in poultry rations is of prime importance for practical feed formulation. Such database is also important in the face of instability in food chain due to threats of climatic extremes. Efforts would be made to improve the feed conversion rates further by ensuring efficient digestibility/ bioavailability and utilization of nutrients from diverse high fiber feed resources through application of biotechnological tools and strengthening of feed processing technology.

Efficient Health Management: Identification of pathogens and development of innovative methods to control poultry diseases by developing hyper-immune egg yolk antibodies to boost the immune system of young chicks against infectious diseases is the latest development to combat the diseases. Further, metagenomics is being used to confirm and discover microorganisms in entire microbial population. Also the bacteriophages are important because they can be used as alternatives to antibiotics and as weapons against multi-drug-resistant pathogens. 'Egging On' is novel technology to develop passive immunization strategies to control poultry diseases. DIVA (Differentiating Infected from Vaccinated Animals) vaccines are recent novel development in controlling the emerging poultry diseases. The Institute will strive to make use of the latest developments taking place in the field of animal disease management as applicable to poultry. The latest biosecurity protocols in sync with the emerging needs to save poultry from onslaught of newer and threatening diseases will be developed, tested and adopted at the Institute as a demo-model. The mandate of the Institute may be further widened in near future to include poultry health aspects in view of growing importance of the subject in the industry and limited research attention and resources allocated elsewhere in the NARS.

Waste Management: The poultry wastes from poultry farming mainly comprise of hatchery wastes, litter material, poultry droppings and slaughter house

wastes which pose a serious threat to ecology if left untreated. Cost-effective and efficient processing technologies for hatchery and slaughter waste will also open up new business opportunities for the entrepreneurs. Efforts will also be made to develop suitable self propelling and efficient integrated composite farming systems under zero waste regime.

Food Safety and Product Quality Assurance: In view of the growing health consciousness, there is an ardent need to develop convenient and affordable functional poultry products with adequate food safety and longer shelf-life not only for the domestic markets but also to tap international markets and to realize full export potential by conforming to the international food safety norms. Hence, research efforts would be directed towards microbial risk assessment as well as use of predictive microbiology approaches to produce safe poultry products. Further, surveillance/assessment of level of potent food pathogens for predicting their growth in poultry products along with simple and quick laboratory methods for detection and quantitative estimation of incriminating factors such as pesticide, heavy metals, veterinary drugs and other toxic residues in poultry feed and products would be developed apart from their amelioration techniques for safer poultry products. The production and processing technologies will be further improved and fine tuned to make them compliant to the food safety protocols such as HACCP, TQM and GMP by interweaving their critical requirements into the processes.

Efficient Management Systems for Poultry Farming: Strategies for physiological balancing and improving core organ functioning would be evolved in order to overcome the stress associated with higher productivity of poultry species as also to cope up with threats of unfavourable weather conditions. Housing systems and farm management practices would be developed to address the growing animal welfare concerns, WTO obligations and climatic extremes. Reproductive efficiency of diversified poultry species would be enhanced by evolving technologies for prolongation of reproductive phase, artificial insemination and development of semen extenders etc.

Contingency Planning for Disaster Management: The impending threats of global warming are likely to jeopardize the food chain and overall ecological balance. Therefore, technology driven systems such as integrated risk-and-disaster management production systems would be developed to mitigate the adverse affects of climatic extremes like floods, droughts, cyclones and erratic rainfall patterns etc. on poultry production. Alternative poultry feeding systems

need to be evolved to counter the environmental and climate associated eventualities. Similarly, the diseases patterns and pathogenesis of the agents causing such diseases are likely to alter warranting newer strategies to manage them.

Capacity Building and Technology Transfer

Growth of poultry sector demands matching growth in efficient and well trained human resources not only for the organizational needs of the sector but also to meet the requirements of R&D institutions for developing newer technologies. Therefore, the Institute would strive to strengthen its HRD programme by revising and developing need based course curricula. Tailor made training programmes with emphasis on hands on training would be developed. Technology delivery systems involving latest mass communication tools would be developed and strengthened by forging linkages with various public and private sector entities and international agencies. Participatory approaches would be employed for refining and re-delivery of technologies to the stake holders. For quicker dissemination of information/ feedback and providing a common platform for information sharing, a cyber based information exchange system would be developed. Such system may also be helpful in alerting the poultry sector about the impending threats and upcoming opportunities.

Institutional and Policy Support

Augmentation and modernization of infrastructure and establishment of hi-tech laboratories in the area of Avian Biotechnology, Disease Diagnostics and Forecasting, Feed/Food Microbiology, Feed and Poultry Processing and Quality Assurance on International Standard Organization norms etc. are essential to face the R&D challenges emanating from rising demands, instabilities in production-consumption systems and growing globalization etc. Furthermore, to popularize and disseminate the diversified poultry species, research centres would be established. Institutional arrangements would also be strengthened to tackle the issues concerning IPRs.

Goals and Targets

In order to resolve the challenges of poultry sector which is expected to maintain the past annual growth trends in egg and meat production at 6% and 10%, respectively, utilizing the existing resources in an efficient and planned manner and building the new state-of-the-art R&D infrastructure would be the main stay. The following strategies would be adopted to realize the cherished vision and goals of the Institute.

- Vying for increased budgetary provisions for R&D support for genetic improvement and evolving package of feeding, management and health care practices as well as enhancing productive and reproductive efficiency of diversified poultry species.
- Need-based infusion of superior genetic stocks of diversified poultry species with strict enforcement of bio-security measures as and when required to improve the efficiency of the breeding programmes for developing elite poultry stocks with higher productivity, immuno-competence/disease resistance and adaptability to diverse climates employing molecular and bio-technological approaches in conjunction with the conventional techniques.
- Promotion of rural/small scale rearing of diversified poultry species as an alternative to chicken through development of suitable germplasm by conserving, improving and utilization of native (indigenous) breeds in view of their hardy character and tropical adaptability for developing egg type, meat type or dual purpose *desi* varieties in different agro-ecological zones, particularly in hilly regions.
- Survey of unexplored alternate feed resources as an alternative or supplement to conventional poultry feed ingredients and developing precise nutrient supply regimes for diversified poultry species ensuring enhanced nutrient utilization for reducing feed cost.
- Assessment and monitoring of potent pathogens and residues of heavy metals/pesticides/veterinary drugs etc. in compounded feed/feed additives, raw and processed poultry products and development of their data-base for improving food safety and product quality.
- Developing proactive strategies for mitigation of adverse affects of epidemics/natural disasters and impending climate change by enhancing resilience of the poultry farming and its support systems.

- Evolving cost-effective and efficient technologies for the production of market-oriented, value-added, convenient poultry products akin to customers' demand including designer/organic egg/meat to boost domestic consumption of poultry products and promote exports.
- Developing national database on occurrence of bio- and phyto-contaminants to address safety concerns of poultry products and promote their exports under the WTO regime.
- Technology development for cost-effective utilization of poultry by-products arising from hatchery, poultry slaughter and poultry droppings as feed, fuel and fertilizer to address environmental concerns and reduce cost of poultry production.
- Strengthening the HRD support by introducing vocational poultry diploma courses (poultry polytechnics) for matriculates/10+2 students to meet the shortage of mid-level technicians in private sectors in addition to the training programmes for the poultry farmers and entrepreneurs.
- Forging public-private partnerships and effective dynamic linkages between R&D institutions and the stakeholders for transfer of proven technologies and for getting feedback.
- Appropriate technologies for prevention/control of emerging and re-emerging poultry diseases through effective bio-security measures and evolving effective control systems.
- Development of market intelligence mechanisms for assessment of demand and supply of poultry products and inputs (especially feed and chicks) for research priority setting, forecasting and entrepreneurial development.
- Recommending formation of a suitable institutional support mechanism in the form of Poultry Development Board for coordinating and supporting poultry sector on the lines of National Dairy Development Board.
- Inter-institutional collaboration wherever necessary to speed up the progress of R&D efforts and to reduce burden on exchequer and establishment of effective linkages among Govt., private institutions and Non-Government Organizations (NGOs).
- Capacity building through international training and faculty improvement/exchange programmes for the scientists and periodic revision of the Poultry Science course curricula.

Strategic Frame and the Long term Goals/Targets

<i>Goal</i>	<i>Approach</i>	<i>Performance Measure</i>
Improving productivity, protection and adaptability of diversified poultry species	Integration of conventional and molecular approaches for characterization and breeding	-Increase in productivity/ adaptability/ disease resistance -No. of stocks characterized/developed -Development of designer/ enriched poultry products
	Application of biotechnological tools like transgenesis, RNAi, proteomics, nanotechnology epigenetics, aptamers, <i>in-ovo</i> approaches, etc.	
	Production and utilization of recombinant proteins, e.g., cytokines and pharmaceutical/ nutraceutical, etc.	
	Sequencing/re-sequencing of genome of poultry species; comparative and functional genomic applications	
	Induction of new poultry species/breeds viz. ostrich, geese, Red jungle fowl etc. and their utilization/improvement	-No. of species/breeds introduced, improved and utilized.
Standardization of package of practices for diversified poultry production	Improving FCR and growth by identification of symbionts using metagenomic approaches and their utilization	-Improvement in FCR -No. of symbionts identified and evaluated
	Identification of newer feed resources, by-products and wastes, their evaluation and utilization through processing, improving gut-health, biotechnological tools, supplements and management of anti-nutritional factors	-Improvement in productivity, immune-responsiveness, FCR, stress response, etc. -Reduction in feed-cost
	Determination and fine-tuning of nutrient requirements of diversified poultry under different systems of rearing and climates	

	Stress management through physiological balancing and improving core organ functioning, use of phyto-hormones and neuro-endocrine tools, etc.	-Improvement in productivity, reduction in morbidity and mortality
	Surveillance, monitoring and prevention of poultry diseases by developing effective bio-security, bio-safety procedures	
	Prolongation of reproductive phase of birds through conventional and molecular techniques	Improvement in productivity
	Developing climate resilient low cost housing and feeding systems including developing poultry strains tolerant to saline water	
Designer eggs and meat production	Modulation of poultry diets	-Cholesterol reduction and targeted nutrients enrichment in eggs and meat
	Application of biotechnological tools like transgenesis and RNAi	
Developing self sustainable production systems and effective management of farm waste and by-products	Development of integrated composite production systems aimed at zero waste production regime	Enhancement of overall input use efficiency and reduction in production cost
	Processing and recycling techniques employing conventional and biotechnological methods for efficient utilization of all wastes from poultry farming	-Reduction in levels of pollutants due to poultry waste -Number of products developed
Improving food safety, value addition and quality assurance	Developing technologies for production of demand driven convenient value-added poultry products, their shelf life extension and quality assurance	-Number of products, processing techniques developed and commercialized

Development of user friendly soft tools to support poultry production.	Development and updating software for formulating cost-effective feed-recipes (<i>MakeFeed</i>), disease diagnosis including genetic selection and bioinformatics for diversified poultry species	-Number of soft tools developed and their demand by the target groups/ clienteles
Improving risk management in production and marketing of diversified poultry	Application of market intelligence approaches for risks assessment in poultry production and marketing and its mitigation strategies	-Entrepreneurial development in poultry sector
	Priority setting through ex-ante analysis and simulation techniques for optimum utilization of resources and investment opportunities	
HRD, Capacity building and technology transfer	Improvising course curricula for imparting post graduate education in Poultry Science, organizing need based training programmes, trainers' training programmes, interactive meets, conferences/ symposia, seminars, etc.	-Students' throughput. -Number of trainings organized. -Level of participation
	Dissemination of proven technologies through mass media approaches, exhibitions etc.	-Demand for technologies and revenue earned

Way Forward

Fuelled by the need based import of grand-parent stocks and proactive pure line breeding programme coupled with simultaneous development of other allied sectors, the Indian poultry industry has already been on the spiralling growth path. However, in the process of intensification in commercial poultry production, small holder rural poultry sector remained neglected. Besides, the growth in the Indian poultry sector has been chicken centred ignoring at large, the potentials available in the form of diversified poultry species. The CARI, will therefore, strive to lead a technology driven revolution in the Indian poultry sector to meet the challenges of nutritional security, improving livelihood opportunities and ensuring sustainable and consistent growth of the sector by evolving technologies for production of alternate poultry species such as quails, ducks, turkeys, guinea fowls and emus etc. apart from the improved varieties of *desi* chicken.

The Indian poultry sector characterized by its frequent upheavals due to uncertainties in feed supply and onslaught of poultry diseases, further compounded owing to several missing links in the poultry supply chain would be transformed into vibrant and globally competitive sector through innovations and technology development in the times to come. The Institute is envisioned to acquire leadership in the Country towards placing the alternate poultry species of high economic importance in to commercial realm by reaping the benefits of their innate traits in which chicken dominated industry defaults.

Sincere efforts will be made to transform the Institute into a more responsible, responsive and sensitive organization befitting to the needs of all the players of the poultry sector right from vulnerable small/marginal poultry farmers to large scale commercial integrators including the allied stake holders. The Institute will focus in the areas wherein private sector has shown reluctance. Keeping with the traditions of high standards of research and need based problem solving approach coupled with most efficient and optimal utilization of scarce resources, the Institute will play a lead role in the field of Poultry Science research and education in the National Agricultural Research System.

The Institute will remain ever vigilant to the changes taking place at the national and international levels, responding strategically in a timely manner

to protect and further the interests of all the stake holders following participatory approaches and by shaping up a tradition of scientific conscientiousness, reliability and veracity at all levels.

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