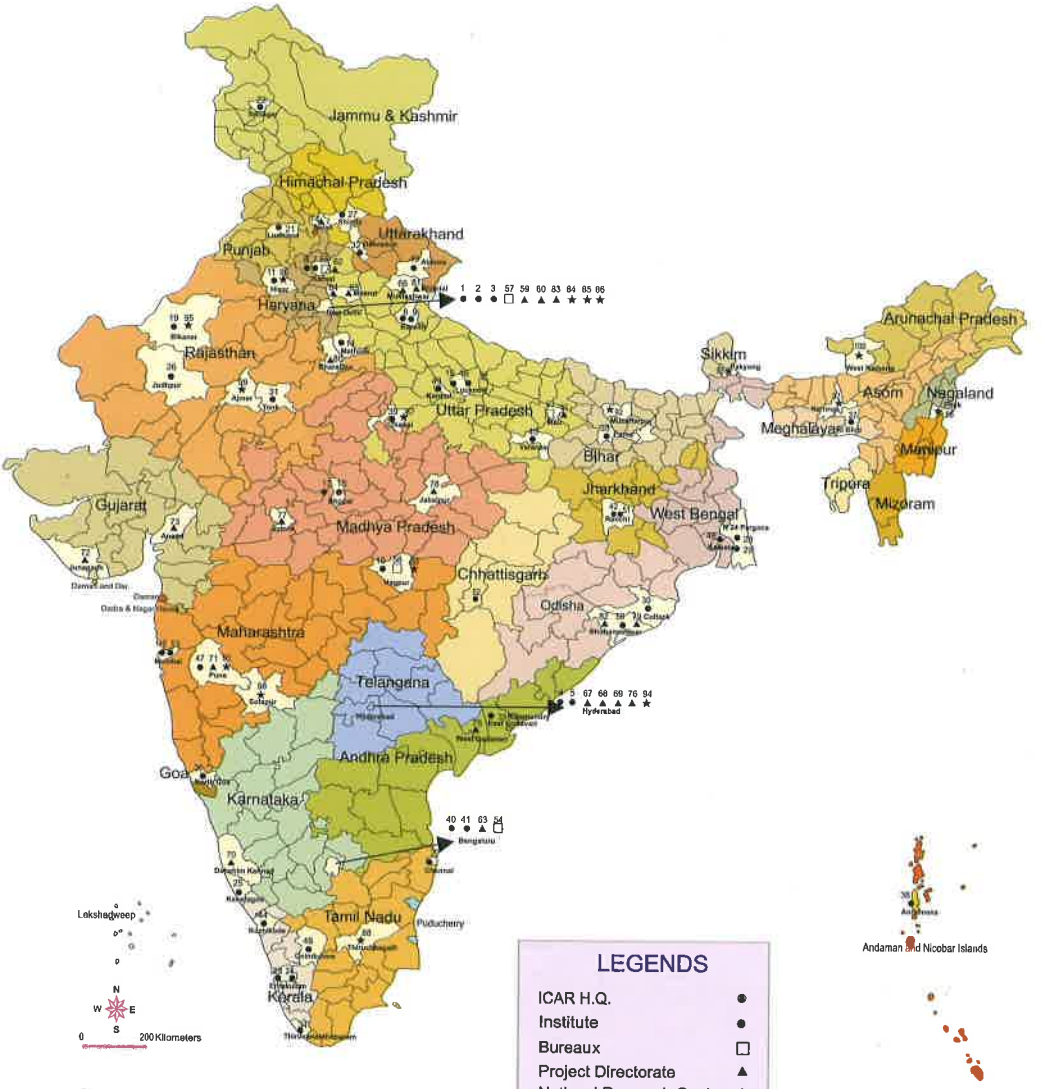
Vision 2050

Directorate of Poultry Research

Indian Council of Agricultural Research

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

Institutes, Bureaux, Directorates and National Research Centres



• 64 Research Institutes • 6 Bureaux • 15 National Research Centres • 15 Project Directorates

Vision 2050

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संदेश

भारतीय सभ्यता कृषि विकास की एक आधार रही है और आज भी हमारे देश में एक सुदृढ़ कृषि व्यवस्था मौजूद है जिसका राष्ट्रीय सकल घरेलू उत्पाद और रोजगार में प्रमुख योगदान है। ग्रामीण युवाओं का बड़े पैमाने पर, विशेष रूप से शहरी क्षेत्रों में प्रवास होने के बावजूद, देश की लगभग दो-तिहाई आबादी के लिए आजीविका के साधन के रूप में, प्रत्यक्ष या अप्रत्यक्ष, कृषि की भूमिका में कई बदलाव होने की उम्मीद नहीं की जाती है। अत: खाद्य, पोषण, पर्यावरण आजीविका सुरक्षा के लिए तथा समावेशी विकास हासिल करने के लिए कृषि क्षेत्र में स्थायी विकास बहुत जरूरी है।

पिछले 50 वर्षों के दौरान हमारे कृषि अनुसंधान द्वारा सृजित की गई प्रौद्योगिकियों से भारतीय कृषि में बदलाव आयां है। तथापि, भौतिक रूप से (मृदा, जल, जलवायु), बायोलोजिकल रूप से (जैव विविधता, हॉस्ट-परजीवि संबंध), अनुसंधान एवं शिक्षा में बदलाव के चलते तथा सूचना, ज्ञान और नीति एवं निवेश (जो कृषि उत्पादन को प्रभावित करने वाले कारक हैं) आज भी एक चुनौती बने हुए हैं। उत्पादन के परिवेश में बदलाव हमेशा ही होते आए हैं, परन्तु जिस गति से यह हो रहे हैं, वह एक चिंता का विषय है जो उपयुक्त प्रौद्योगिकी विकल्पों के आधार पर कृषि प्रणाली को और अधिक मजबूत करने की मांग करते हैं।

पिछली प्रवृत्तियों से सबक लेते हुए हम निश्चित रूप से भावी बेहतर कृषि परिदृश्य की कल्पना कर सकते हैं, जिसके लिए हमें विभिन्न तकनीकों और आकलनों के मॉडलों का उपयोग करना होगा तथा भविष्य के लिए एक ब्लूप्रिंट तैयार करना होगा। इसमें कोई संदेह नहीं है कि विज्ञान, प्रौद्योगिकी, सूचना, ज्ञान-जानकारी, सक्षम मानव संसाधन और निवेशों का बढ़ता प्रयोग भावी वृद्धि और विकास के प्रमुख निर्धारक होंगे।

इस संदर्भ में, भारतीय कृषि अनुसंधान परिषद के संस्थानों के लिए विजन-2050 की रूपरेखा तैयार की गई है। यह आशा की जाती है कि वर्तमान और उभरते परिदृश्य का बेहतर रूप से किया गया मूल्यांकन, मौजूदा नए अवसर और कृषि क्षेत्र की स्थायी वृद्धि और विकास के लिए आगामी दशकों हेतु प्रासंगिक अनुसंधान संबंधी मुद्दे तथा कार्यनीतिक फ्रेमवर्क काफी उपयोगी साबित होंगे।

(राधा मोहन सिंह)
केन्द्रीय कृषि मंत्री, भारत सरकार

Foreword

Indian Council of Agricultural Research, since inception in the year 1929, is spearheading national programmes on agricultural research, higher education and frontline extension through a network of Research Institutes, Agricultural Universities, All India Coordinated Research Projects and Krishi Vigyan Kendras to develop and demonstrate new technologies, as also to develop competent human resource for strengthening agriculture in all its dimensions, in the country. The science and technology-led development in agriculture has resulted in manifold enhancement in productivity and production of different crops and commodities to match the pace of growth in food demand.

Agricultural production environment, being a dynamic entity, has kept evolving continuously. The present phase of changes being encountered by the agricultural sector, such as reducing availability of quality water, nutrient deficiency in soils, climate change, farm energy availability, loss of biodiversity, emergence of new pest and diseases, fragmentation of farms, rural-urban migration, coupled with new IPRs and trade regulations, are some of the new challenges.

These changes impacting agriculture call for a paradigm shift in our research approach. We have to harness the potential of modern science, encourage innovations in technology generation, and provide for an enabling policy and investment support. Some of the critical areas as genomics, molecular breeding, diagnostics and vaccines, nanotechnology, secondary agriculture, farm mechanization, energy, 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. Our institutions of agricultural research and education must attain highest levels of excellence in development of technologies and competent human resource to effectively deal with the changing scenario.

Vision-2050 document of ICAR-Directorate of Poultry Research (DPR), Hyderabad has been prepared, based on a comprehensive assessment of past and present trends in factors that impact agriculture, to visualise scenario 35 years hence, towards science-led sustainable development of agriculture.

We are hopeful that in the years ahead, Vision-2050 would prove to be valuable in guiding our efforts in agricultural R&D and also for the young scientists who would shoulder the responsibility to generate farm technologies in future for food, nutrition, livelihood and environmental security of the billion plus population of the country, for all times to come.

(S. AYYAPPAN)
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Preface

ICAR-Directorate of Poultry Research (Formerly Project Directorate on Poultry) came into existence with main objective of coordinating and monitoring the All India Coordinated Research Project on Poultry Breeding of Indian Council of Agricultural Research during IV Five Year Plan. In this silver jubilee year of its existence the institute has grown beyond its initial objectives and garnered immense laurels from all corners of the country for spearheading poultry research and extension activities in both intensive and extensive system of poultry production.

In fulfilling the mandated responsibilities of developing and propagating high yielding varieties like Vanaraja, Gramapriya and Srinidhi for uplifting rural and tribal population, the Institute is marching further with field testing of newer crosses to meet the diverse requirements of low input system. For obtaining maximum genetic gain of poultry population, conventional breeding should be employed along with improved genomics and biotechnological tools. Variety development process should be accelerated according to the preferences and demand of consumers not only for enhanced productivity but also for quality improvement of poultry variety. Optimization of nutritional regimen, development of low cost feeding strategies and use of alternative feed resources are the need of hour to strengthen the management practices of poultry more economic, efficient and viable. Research on health aspect and adaptation strategies to ameliorate impact of climate change are very much essential to combat various emerging and re-emerging diseases, which has become serious threat to the poultry farming. Effective poultry waste management, nanotechnology and IP management should be given due emphasis to make poultry more environment friendly, productive and economically more profitable enterprise. This apart, efforts are also on for conservation of native breeds of chicken for future utilisation in breeding programmes. Under AICRP on Poultry Breeding, commercial layer varieties with higher egg laying capacity have been developed and focus is being given for local chicken breed conservation and their molecular characterization.

India is predicted to become world's most populous country with a population of 1.7 billion in 2050. This scenario throws two major challenges. Firstly, the chicken egg and meat production has to be

increased manifold to meet the high demand. This assumes significance in light of not being able to match at present the recommended egg and meat consumption, more so in rural parts of the country. Secondly, there will be competition between poultry industry and human population for cereals, which is the main ingredient in chicken. This requires search for other alternate sources of energy and other feed ingredients. Further nutritional approaches should be devised for high growth rate chicken. The aforementioned problems are still confounded by the reality of global warming. This event is expected to alter many geographical events leading to increase in ambient temperature and scarcity of feed resources. Thus, research focus should be on development of climate resilient varieties for intensive and extensive poultry systems. Use of biotechnological tools for producing designer eggs and meat is also needs to be addressed.

I am grateful for the guidance and support received from Dr. S. Ayyappan, Secretary, DARE and Director General, ICAR and Dr. K.M.L. Pathak, Deputy Director General (Animal Sciences) for their interest in the Institute activities and advice in the preparation of Vision 2050. I also express my gratitude to Dr. R.S. Gandhi, ADG (AP&B), Dr. Gaya Prasad, ADG (AH), Dr. B.S. Prakash, ADG (AN&P), Dr. Vineet Bhasin, Principal Scientist and other scientists of Animal Sciences Division of ICAR for their support. I convey my thanks to the Vision 2050 committee of the Institute (Dr. T.K. Bhattacharya, Chairman and other members, Dr. B. Prakash, Dr. M. Shanmugam and Dr. (Mrs.) T.R. Kannaki) who have prepared the document for the Institute in this present form. Thanks are due to all colleagues of the Institute for the cooperation and contribution in finalising this vision document.

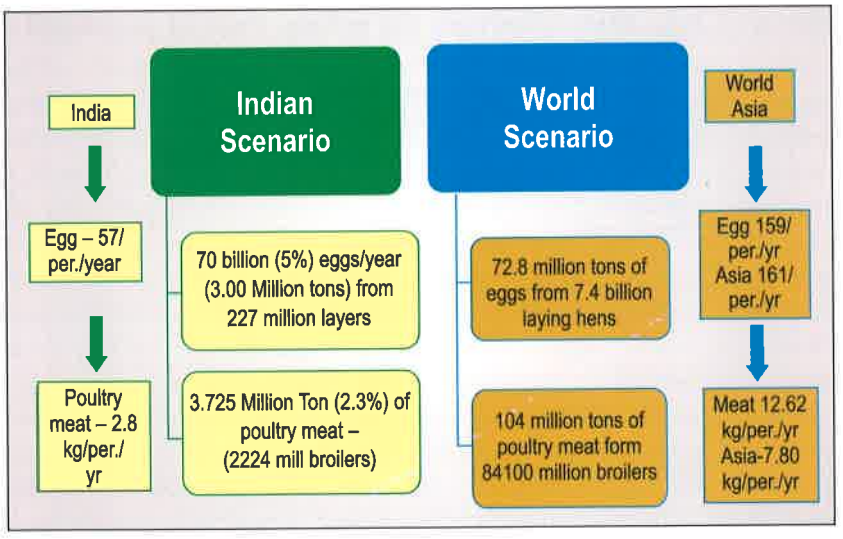
R.N. Chatterjee
Director

Contents

Context

The world poultry meat production increased from 91.9 to 103.5 million tonnes from 2009 to 2012. In poultry meat production, chicken contributes about 87.4% while other species contribute to the meat production are turkey (6.6%), duck (4.2%) and geese (2.7%) (Watt Executive Guide, 2012). Continent-wise statistics indicate that Asia produces nearly 36.5% of the world chicken meat, whereas the other major producers are North America (21.1%), South America (21.7%), Europe (16.9%) and Africa (4.0%). Among countries, USA contributes 20.3% of global chicken meat followed by China (14.3%), Brazil (12.4%), Mexico (3.2%) and India (2.3%). During 2013, worldwide hen eggs production was 65.5 million tones (1.1 trillion number eggs) from a total of 19.5 billion laying flocks of hens. China has the largest stake (37.6%) followed by USA (8.5%) and India (5.0%). India stands at 3rd position for hen egg and at 5th position for chicken meat production in the world.

The world human population exceeded 7 billion in 2012 and expected to reach 9 billion in 2050 with population growth rate of 1.1% per year (Policy paper No. 67, 2014). Consequently, to feed such a vast population in 2050, the food production would have to be increased

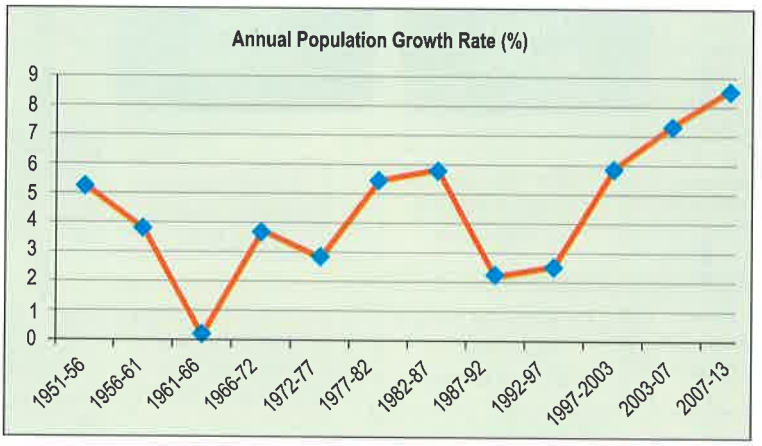


Brief Scenario of Poultry Production

by 70% over and above the present quantity of food grain production (Watt Executive Guide, 2010).

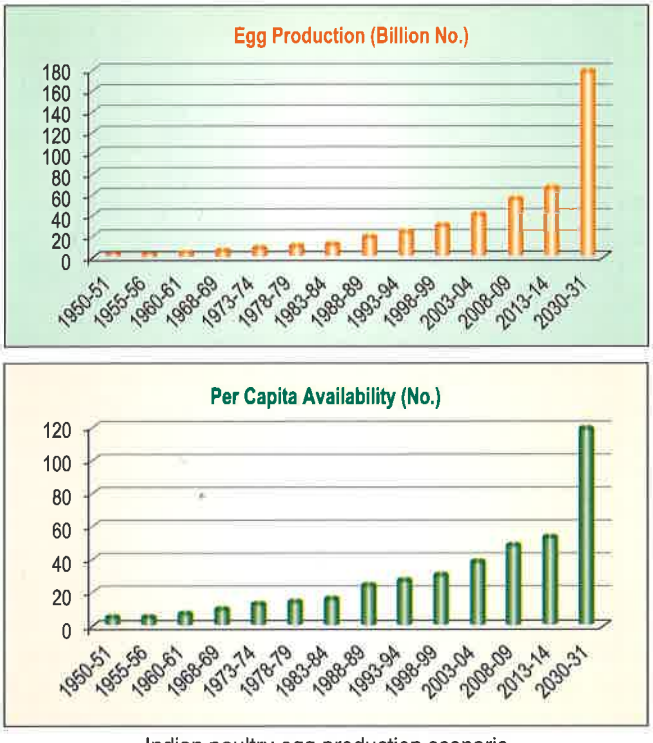
During the year 2003, world poultry meat consumption was 11.6 kg/person/year, which increased to 12.62 kg in 2009. The poultry meat consumption in 2007 was the highest in North America (49.4 kg/person/year) followed by South America (27.2 kg/person/year) and Europe (20.3 kg/person/year) and the lowest in Africa (4.5kg/person/year) and Asia (7.8 kg/person/year) (FAO, 2007). Similarly, the global average egg consumption is currently around 8.57 kg/person/year. Highest egg consumption (13.9 kg) in 2003 was reported in North Central America followed by Europe (12.7 kg) and Asia (8.7 kg). The biggest rise in egg consumption was noted in Asia (60%). Globally, there has been increasing demand for organic poultry produce and the consumers pay premium price for such eggs and meat. Therefore, it is imperative to encourage the farmers in rural areas to undertake backyard poultry, which has immense potential for producing organic poultry to meet the demand of billions of health conscious people all over the globe.

In the context of Indian poultry production, during the past four decades, poultry industry has transformed itself from the age-old backyard farming into a dynamic agri-based industry. India is currently producing 3.725 million tones of chicken meat and 70.00 billions of hen eggs/year. The poultry industry with the strength of 227 million layers and 2224 million broilers provide employment to more than 25 million people and contributes Rs.58,000 crores to the Gross National Product (ICRA, 2014). However, the percent share of population of



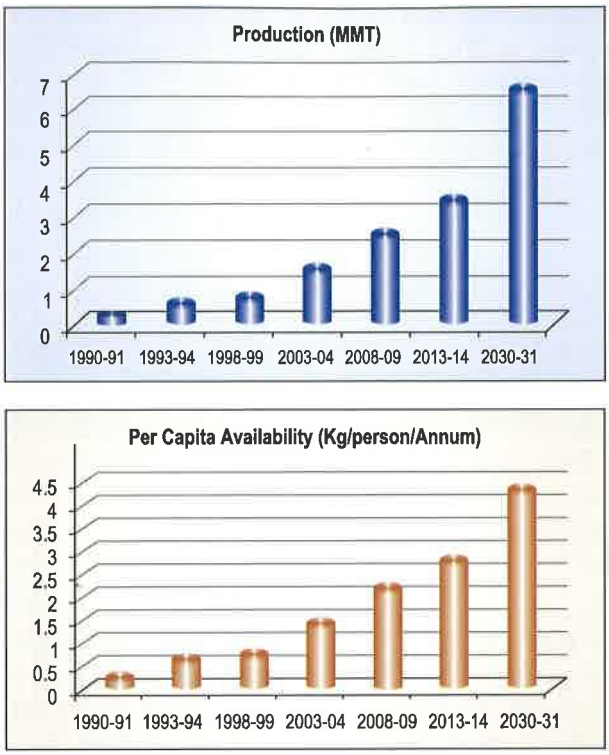
Growth pattern of annual population growth rate (%) of poultry

chicken, ducks, turkey and others in the country were 95%, 3% and 2%, respectively, in 2012 (19th Livestock Census-2012).



Indian poultry egg production scenario

The human population of India is about 1220 million in 2014 and by 2050, it would be around 1.7 billion with a growth rate of 1.6% per year (Policy paper No. 67, 2013). The present per-capita availability of eggs is 57, while chicken meat consumption is 2.8 kg (ICRA, 2014). However, the ICMR recommends the consumption of 180 eggs and 10.8 kg poultry meat per person per annum. Therefore, to bridge the gap between availability and requirement, the layer and broiler production have to be upscaled by 5 and 10 folds, respectively. However, the projected growth of industry correspondingly depends on the availability of feed ingredients to meet the nutritional requirement of poultry. The total poultry feed requirement is 28 million tonnes. More than 90% of the demand is being met through organized mills and about 10% from the unorganized sector. The estimated compound feed demand for the broiler and layer sectors in 2050 will be around 77 million tonnes. Maize, jowar and soyabean meal may fetch higher demand for human consumption and may not be available to the



Indian broiler meat production scenario

poultry feed industry in required quantity due to their increased usage in human food industry and enhanced export value. Therefore, it becomes necessary to evolve strategies for increasing the productivity of raw feed ingredients, search for newer feed resources and effectively regulate the supplies to feed industry to sustain the growth of poultry sector. Another operation that needs attention to sustain growth of poultry industry is the bio-security measures. Liberal importation of genetically improved stocks, clustering of commercial farms, import of vaccines, inadequate quarantine facilities etc., offset the balance of biosecurity and threaten the progress of poultry industry. Suitable strategies need to be drawn to achieve and sustain the projected growth of the industry. Genetic selection has played a significant role in historical improvement in the production efficiency of layers and broilers, which brought about 85 to 90% of the change that has occurred in broiler growth rate over the past 50 years. However, as growth rate, feed efficiency, and meat yield have been improved, livability, skeletal integrity, cardiovascular health and immune responsiveness have declined as correlated genetic responses.

Acceptance of processed chicken is on the rise particularly in the urban markets. With the rise in consumer awareness and requirement for hygienic and safe food, processing will have a bright future in the poultry industry in the years to come. A few plants for processing eggs have been installed using state of art machinery in some states with an average daily turnover capacity of 0.7 to 0.8 million eggs. Whole egg powder, yolk powder, egg white powder, lysozyme etc. are being produced following standard operational protocols. The raw material production for these plants needs to be managed under strict supervision and monitoring for ensuring acceptability of final product under international food safety regulations.

Commercial farms are mostly concentrated in and around the urban and peri-urban areas. Currently, native chickens in rural and tribal areas still constitute about 38% of country's chicken population. However, due to their low productivity (50-60 eggs/year), they contribute only 20.7% to the total egg production, but their eggs and meat are sold at higher price in rural areas than in urban areas (Basic Animal Husbandry statistics, 2012). Therefore, there is adequate scope for development of backyard poultry in rural and tribal areas, which can contribute substantially to raise the overall per capita availability of eggs/meat especially in rural areas. Further, Indian eggs in the International market are facing stiff competition from those of other countries who are forcing the farmer to lose 15-20% on exported poultry products for reasons of trade subsidy. Similarly, chicken meat exports are mostly confined only to the Middle East.

Poverty alleviation is one of the prime priorities of the Indian government. Among the several popular schemes in livestock sector, poultry rearing in villages has edge over other enterprises. ICAR-Directorate of Poultry Research (Formerly Project Directorate on Poultry), a constituent of ICAR was established in 1988 with a mandate to co-ordinate and monitor ICAR sponsored network programme, to undertake applied research on genetics and breeding, and conservation of improved chicken germplasm with supportive research on nutrition, disease control and management, and to lay emphasis on development of chicken varieties for meeting the needs of rural/tribal and other under privileged sections of the society.

Since the initiation of the AICRPs in early 1970s and subsequent inception of the Project Directorate on Poultry at Hyderabad in 1988, various layer varieties (ILI-80, ILM-90 and ILR-90) and broiler varieties [B-77, IBL-80, IBB-83, IBI-91 and Pratapdhan (for rural poultry)] were released under AICRP network program. The varieties such as

Vanaraja and Gramapriya have been developed at the Institute for rearing under backyard poultry farming. Further, 4 lines (PD-1, PD-2, PD-3, and PD-4) were evolved through selective breeding at the Directorate. These lines are being used for generation of germplasm for rural poultry. The crosses evolved are extensively employed for rearing under adverse climatic conditions of the country. Further, under the poultry seed project of this Institute, 11 centers are operational in the country of which 3 are in NEH region with an objective to produce around 0.75 to 1.0 lakh improved poultry seeds (fertile eggs/chicks) for distribution to the villagers for enhancing eggs and meat production in rural areas of different regions of the country.

A Gramapriya male bird

A Vanaraja male bird

A pair of Srinidhi birds

In biotechnology research, many technologies have been evolved/ perfected at the Institute. Microsatellite marker based genotyping and molecular typing of birds with single stranded conformation polymorphism (SSCP) technique (non-radioactive method) has been perfected for molecular characterization of chicken line. The genetic markers for juvenile growth, egg production and egg quality traits have been established. The whole sequence assembly of Aseel bird has been explored for the first time. The mitochondrial genomes of 6 indigenous chicken breeds have been elucidated for evolutionary studies. Functional genomics, epigenetics and gene silencing works are being continued for improving productivity in birds.

Further, nutritional research for efficient nutrient metabolism, nutrient supplementation, fortification of meat and egg, alternative feed resources, etc. are being conducted at this Institute. Maize can be completely replaced with bajra (pearl millet), tannin-free jowar (sorghum) or korra (fox tail millet) in broiler and layer diets containing required levels of nutrients with net economic benefit; quality protein maize can be used as an effective alternative for conventional maize in both broiler and layer diets with better weight gain, egg production and feed efficiency; maize can be replaced with ragi (finger millet) up to 25% in layer chicken diet without affecting the performance; soybean

meal can be replaced up to 30% with distillery dried grain from maize, up to 67% with sunflower cake or til / sesame cake and up to 100% with low glucosinalate (double zero) mustard cake without affecting the chicken performance; karanja seed cake can be used up to 3% in broiler diet and 8% in layer diet as an alternate protein source for soybean meal without affecting the bird performance. Expensive inorganic phosphorus source like dicalcium phosphate can be minimized in diet by using microbial phytase (500 FYT/kg) or cholecalciferol (vitamin D3) in both broiler and layer diets; dietary requirements of non-phytate phosphorus and calcium were standardized for broilers and layers which reduced the cost of feeding besides reducing environmental pollution from the intensive poultry operations; toxic effects of aflatoxin (300 μg/kg) were alleviated by incorporating poly unsaturated fatty acid-rich vegetable oil, activated charcoal, ascorbic acid, liver tonic, etc. in broiler diet; adverse effects of summer stress on performance, stress and immunity were minimized by supplementing the broiler diet with organic Se, Cr and Zn. The requirements of these minerals for broilers was standardized under normal and stress conditions; supplementation of microbial enzymes enhanced the nutritional value of guar meal based diet in rural chicken germplasm. Nutritional requirements of Vanaraja, Gramapriya and Krishibro during juvenile and laying phases were established, which are being used by rural poultry farmers and Government agencies rearing the parents of these chicken varieties; access to feed / nutrients within 24 h of hatch is essential for obtaining optimum performance of broilers.

For improving disease/stress resilience and minimizing disease occurrences, several technologies have been developed or perfected at this Institute. Of which, some notable technologies are PCR based assays for detection and differentiation of Marek's disease virus and Avian Leukosis virus; duplex PCR for detection of *Mycoplasma gallisepticum* and *Mycoplasma synoviae*; PCR-RFLP method for differentiation of field strains of *M. gallisepticum* from vaccine strains of *Mycoplasma gallisepticum*, characterization of Toll-like receptors etc. To disseminate these technologies and solve farmer's problems, works have been initiated under P-P-P mode in various fields of poultry science particularly health and nutrition. However, ICAR-Directorate of Poultry Research can play pivotal role in expanding poultry industry that is essential for up scaling the poultry production in India, both under intensive and extensive systems of rearing. This will bridge the gap between availability and requirement for ever increasing human population by the year 2050. ❑

Challenges

The challenges in the poultry sector are as follows:

Production and productivity to increase: India is predicted to become world's most populous country with a population of 1.7 billion in 2050. This scenario throws two major challenges; firstly, the chicken egg and meat production has to be increased manifold to meet the higher demand. This assumes significance in light of not being able to match the present recommended egg and meat consumption, more so in rural parts of the country. Secondly, there is competition between poultry industry and human population for cereals, which are the main ingredients in chicken feed. Apart from the availability of these cereals, prices of the ingredients are rising regularly. Since the feed cost constitutes about 70 per cent of the cost of chicken production, the availability and price of the feed assumes significance, which necessitates search for alternative sources of energy and other feed ingredients. Further, the feed resources available are not uniform throughout the country. Therefore, region specific feed formulation by incorporating the locally available feed ingredients is required. Under disaster management plan, feed alternatives or methods of feeding during emergencies like flood or severe drought are needed. The alternatives may be in the form of highly concentrated feed capsules/blocks containing essential nutrients for survival.

Globally, the consumer awareness about the welfare of chicken produced for human consumption has increased in recent times. This welfare awareness has led to the elimination of cage rearing of birds in some western nations. These welfare concerns need to be addressed by adopting modern housing systems that are less stressful and better for animal welfare. This will also become a necessity for exporting poultry products to overseas markets. Different housing types need to be evaluated for the maintenance or improvement of productivity, behavioral responses and stress levels. Handling of chicken for administration of vaccines and medicines causes stress to the birds. Technologies like *in ovo* administration of vaccine and nutrients need to be simplified so that stress due to handling of live birds is minimized even in poultry at smaller scale. Chickens are moulted after a laying cycle by way of feed withdrawal so that they once again come into laying cycle. But, this practice raises welfare issues. Exploring the natural moulting process in

the birds and finding an effective method to make birds for moulting will be of immense use to poultry farmers in maximizing their return on investment.

There is steady growth in poultry sector and making available sufficient quality of manpower both technical and scientific with latest knowledge will support this growth. Involvement of private sector in the functioning of public organization will augment the benefits reaped. The technologies developed have to be protected for IP and disseminated quickly and effectively. Licensing of products and services to private or cooperatives would help in faster and deeper spread.

Global warming: Global warming and climate change process is predicted to alter many geographical events like change in rainfall pattern and more frequent incidence of drought, which will impact the agricultural output and consequently the feed availability and price of the feed ingredients. Ambient temperature projections for this century indicate an increase between 3°C and 6°C. This increase will lead to heat stress in chicken causing high morbidity and mortality. The productivity of the heat stressed birds will be declined and the birds will be more prone to diseases. Under these circumstances, the feeding strategy, housing and other management practices followed presently have to be modified to overcome the adverse conditions. The selection strategy for both layer and broilers has to be reoriented to produce heat tolerant lines or varieties. Genes responsible for conferring better adaptability needs to be introgressed into the high performing low adaptive lines through traditional as well as molecular breeding tools.

Demand for specific varieties and nutrient enrich poultry product: ICAR-DPR is engaged in developing newer varieties of chicken in response to the diverse need of the farmers and consumers. In this process, different indigenous chicken germplasm are used for which more and more new breeds/strains need to be identified and characterized both at phenotypic and genomic level. The specialized crosses and location specific varieties developed for intensive and backyard farming needs to be assessed. Conservation by *in-situ* and/or *ex-situ* methods of the existing and newly developed varieties is a must to prevent loss due to epidemics like avian influenza etc. For *in-situ* conservation, the varieties may be maintained at multiple locations of the country. In case of *ex-situ* conservation, cryopreservation of germ cells or embryonic stem cells should be attempted.

The increase in disposable income with people as well as specific health requirements have led to the demand for specific nutrient enriched poultry products. Therefore, germplasm for production of designer egg

and meat has to be developed. For comparative assessment of nutritional qualities of different poultry produces, in particular egg and meat of different chicken lines has to be documented which then, can be manipulated. Intra-population enhancement of egg and/or meat quality has been done through traditional selection and genetic engineering tools. Therapeutically important proteins in poultry products can be produced through transgenic technology. Nutritional manipulation for enhancing the egg and meat quality is another approach for production of designer poultry products.

Emerging and re-emerging diseases: The chicken should be in good health for maximizing productivity and net profit. Occurrence of infectious diseases or production disorders will reduce income to the farmers. Therefore, research focusing on minimization or preventive strategies of the disease occurrence is of paramount importance. In case of viral diseases effective vaccines and vaccination schedule for emerging and re-emerging diseases are required. Use of antibiotic in treatment of diseases or as growth promoters should be minimized or eliminated. By this way, organic poultry farming, which is having a niche clientele, may be promoted. Herbal derivative application in disease prevention and management might be another answer to this problem. The occurrence of avian influenza in chicken leads to culling of huge number of birds in the affected area. This causes huge loss to the poultry farmers and a negative impact to the poultry industry. Further, there is the possibility of zoonotic occurrence of these diseases to humans. Strategies will have to be developed on the mechanism of incidence and transmission of this disease and prevention of its occurrence. By selection for higher production level in both layer and broiler, the stress on the bird's physiological mechanisms has been increased leading to many metabolic disorders like ascites, sudden death syndrome etc. These problems have to be overcome by the way of newer solutions. Application of nanotechnology in the form of nanoparticles for delivery of drugs, vaccines etc., for better utilization efficiency and activity against the diseases is a promising area of research. Even for gene therapy applications, nanoparticles can be developed for delivery of DNA/RNA molecules. Further, nanoparticles developed can be utilized for modulating different physiological mechanisms regulating growth and production. Neutraceuticals in the form of nanoparticles may be explored for better feed utilization and counteracting some production disorders.

Poultry waste management: Poultry rearing process produces waste material which have to be disposed properly without posing health problems to human and animals and creating environmental degradation.

Hatchery operations produce wastes in form of infertile eggs and dead chicks. The poultry litter, hatchery wastes, slaughter house wastes etc. can be converted to useful animal feed resources. Poultry wastes have been the breeding ground for multiplication of house flies, insects, rodents etc. Methods have to be devised to minimize or prevent growth and multiplication of flies and other pests which can be threat to both birds as well as human. The wastes can also be converted to organic manure for using it in agricultural operations. Different methods of treatment such as physical, chemical or biological methods can be efficiently applied for converting the litter and other wastes to biodegradable manure. Alternative uses of poultry litter and wastes for production of bio-gas and electricity can be explored.

Operating Environment

Poultry rearing in our country is practised by two extremes; high input commercial rearing of chicken and low input backyard or rural poultry. The commercial rearing of broilers and layers is dominated by private players employing latest technologies whereas low input system is carried out with lesser resources by rural people. The growth of commercial poultry rearing has grown immensely in the last four decades and today, it has formed an important segment of the agri-industry. But, the growth is concentrated in and around urban areas catering to the high income groups living in that area. The major population in the country sustains on low productive native chicken. With this skewed distribution and availability of poultry products, it is not surprising to observe lower level of availability and consumption than the recommended standards of 180 eggs and 10.8 kg poultry meat/person/annum. The above scenario provided scope for further strengthening of backyard poultry in rural and tribal areas. More improved germplasm with higher productivity need to be developed and supplied apart from the present rural varieties. Besides, government institutions, and private agencies must give more focused attention in propagating improved varieties for backyard conditions.

The consumer preference in the urban areas is now changing towards value added products. The awareness and acceptance of processed meat and egg is also increasing in the urban areas. This can be observed in the number of private companies offering different processed cut up parts of chicken in big commercial establishments. The processed products are of high quality meeting international standards having export potential. Presently, in the global trade in poultry, India accounts for lesser than 0.4%. Thus, there is a huge scope in expanding the export market.

The future growth of poultry industry requires adequate availability of feed ingredients at reasonable price. Due to various factors, the price of the ingredients is soaring high, leading to higher cost of production of chicken. Therefore, information on alternative and newer feed resources is sought after by the poultry producers.

For constant monitoring of some important disease causing agents, diagnostic services from standard laboratories are required by the poultry farmers. There is also demand for simple and quick disease screening tests that can be done at the farm level to take quick corrective measures.

Disease prevention in poultry is carried out by proper scheduled vaccination programme. The vaccines available are of large doses that can be utilized fully by big commercial farms only. For use in backyard or rural poultry, where lesser number of birds is reared, smaller dose and cost effective vaccines that can be stored and transferred at room temperature is preferred but still unavailable.

In the private sector, poultry research and development in our country is progressing well but it responds to the issues concerning their operations or clients or stock and the knowledge is largely confined to their business clientele. The public sector organizations like ICAR-Directorate of Poultry Research cater to the needs of general public where information and knowledge is available in public domain, which is easily accessible from anywhere in the country. However, latest ICT has to be harnessed more effectively to disseminate knowledge to the stakeholders.

New Opportunities

The science is progressing at higher pace with many breakthroughs in different fields like biotechnology, nanotechnology, genomics and phenomics to name a few, giving ample opportunities for developing and propagating new products and technologies. India as a rich biodiversity based country with availability of more than 18 indigenous chicken breeds has immense potential to exploit native gene resources to further augment productivity, adaptability and disease resistance in the commercial stocks. With the application of biotechnology and genomics, productivity may be markedly increased to meet the demand of ever increasing human population for poultry meat and eggs. High through-put genome sequencing, molecular breeding, functional genomics, gene microarray, transgenesis and gene silencing technologies may be judiciously applied to pave the way for extremely fast genetic improvement of poultry and also to maintain its sustainability under Indian animal agricultural production scenario. For production of designer eggs and meat, molecular biology and nutritional modulation has huge potential as the consumers have better preference for value added poultry products. Low cholesterol eggs and meat, enriched protein in eggs and meat, presence of high value protein in egg/meat having therapeutic importance are preferred now by health conscious people and by 2050, these products will be the most preferential ones.

Biotechnology for developing disease resistant lines against economically important diseases such as Avian Influenza, Marek's disease, Avian leukosis, Salmonellosis and Coccidiosis etc. need to be explored. Gene chip consisting of markers for high through-put screening of elite germplasm can be developed and molecular breeding techniques like gene silencing can be used to improve overall health status and resistance to number of diseases. New inroads in proteomics opens opportunities for development of simple, easy and cost-effective field level immunodiagnostics. Nanomaterials with different properties are good materials for development of diagnostics and vaccine/medicine delivery systems. In the process of development of vaccines, growth promoters and immunomodulators by rDNA and RNAi technology provide ample scope for making user friendly products. Vaccine delivery to the farmers has been a great problem in the field for constantly maintaining cold chain. Sometimes in the village, electricity is not

available or storage facility is not available. Under these circumstances, thermostable vaccine may be very much useful and maintain required prophylaxis. Due importance and consideration should be given to develop technology for preparation of thermostable vaccine.

Propagation of information to different stakeholders at right time is essential for timely action. In this regard, the information and advisories can be disseminated to large number of farmers spread across the country in real time at negligible cost by using newer ICTs like Short Messaging Services (SMS) and Multimedia Messaging Service (MMS) to name a few. This is possible since there is wide use of mobile phones among the population of the country. There is also the possibility of live interaction between researcher and stakeholder, offering videos on different package of practices and online free courses in different languages with improvement in IT infrastructure and availability of cheaper tablets or mobile phones with connectivity facility. The different information provided to farmers may include the weather information and any adverse climate forecast for a particular region, availability of feed ingredients with their market rates, availability of alternative feed resources, market rates of different poultry products etc. The same ICT tools can be used for information gathering from stakeholders about their requirements and changing preferences for incorporation in the R&D process and refining the products and technologies developed by the Institute. Occurrence of any epidemics can be controlled by quick information (clinical signs, photos/videos) passage from the farmers to the researchers at main station so that corrective measures can be suggested on real time basis.

Goals and Targets

The organized sector of poultry industry is contributing nearly 70% of the total output and the remaining 30% by the unorganized sector (http://www.indianmirror.com/indian-industries/poultry.html). The poultry industry is well dominated in southern states in the country particularly, Telangana, Andhra Pradesh and Tamil Nadu with nearly 60-70% of the total output of chicken meat (http://www.indianmirror.com/indian-industries/poultry.html). Likewise, layer industry which is also well developed in the states of Telangana, Andhra Pradesh, Tamil Nadu and Maharashtra contributing nearly 70% of the country's total egg production (http://www.vethelplineindia.co.in/uncertainties-in-indian- poultry-sector/). India's 75% of egg produce is consumed by the 25% population living in urban and semi-urban areas (http://www.indianmirror.com/indian-industries/poultry.html). In India, about 41% population is vegetarian (http://www.vegetarians.co.nz/articles/500-million-vegetarians-in-india). The per-capita availability of poultry egg and meat is 57 and 2.8 kg per annum, respectively (ICRA, 2014), while per capita requirement as recommended by ICMR are 180 eggs and 10.8 kg meat per annum. In fact, 33% of the country's total population lives in urban and peri-urban areas while rest of the population live in rural areas. In urban areas, per-capita consumption is around 100 eggs per annum, while in villages the consumption is around 20 eggs per annum. In addition, poultry activities create job opportunities for more than 25 million people in the country involved in poultry farming and allied sectors (www.saddahaq.com/business).

India has emerged as one of the self reliant countries in the developing world having technology driven industry, with capability to produce every essential input for successful poultry farming, vaccines and medicines, specific pathogen free eggs (SPF), farms and hatchery automation systems, pelleted feed, egg processing, poultry processing and nationwide network of disease diagnostic laboratories through both private and public sectors. Rural poultry production constitutes important component of agricultural economy in India. Small poultry keepers can play more significant role to alleviate malnutrition, poverty and unemployment. Indian backyard population has increased by 118% in the last 30 years from 60 to 130.74 million (19th Livestock

Census-2012). It is a fact that China's 76% of total egg comes from rural backyard production. Hence, India requires both mass production as well as production by masses.

India produces 5.0% of global egg production. The annual growth rate of egg is 6 to 7%. However, India has the lowest cost of egg production in the world with a premium of Rs. 1.53 per egg. The introduction of new poultry products and perceptible shift in eating habits of people to branded food such as chicken yummiez, cold cuts, breaded and coated snacks, marinated snacks, chicken nuggets, canned chicken curry, freeze dried chicken pulao, meat soup, powder omelette and scrambled egg mixtures, sandwich, pizza, burger and dial-a-chicken and fast food giants, Kentucky Fried Chicken (KFC), McDonald's, Wimpy, Pizza Hut are going to change the palatability preferences of the consumer. Under the WTO regime, multinationals are being involved in poultry sector to carry forward the industry at a very fast space. They are not only providing the food items but also creating millions of job opportunities. Poultry rearing is labour intensive and has a potential to create 25,000 more jobs on the consumption of one more egg per capita and similarly 25,000 additional jobs on the consumption of 100 g more chicken meat. Diet eggs or designer eggs are getting gradual preferences by the health conscious consumers in the country. They are going to boost special eggs for vitamin E substitution, omega fatty acids and antioxidant requirements. Poultry eggs and meat have got sensorial, curative, nutritive and therapeutic potential. Chicken eggs are used to synthesize high value molecules for further use in therapeutics and immunoprophylaxis. Duck embryos are used in manufacturing anti-rabies vaccine. Poultry is the only industry where modern technology co-exists with the traditional poultry keeping because poultry technology is appropriate, adaptable, accessible, available and affordable both by the rich and the poor.

Keeping these facts and findings in mind, the goals/targets are given below:

- To develop improved varieties for intensive and backyard farming to make available about 180 eggs and 11 kg meat per head per annum
- To develop varieties according to consumer preferences
- To improve nutrient utilization and optimize precision feeding for economizing feed cost
- To control/minimize the incidence of emerging and re-emerging diseases

- To efficiently utilize poultry wastes for renewable energy or other purposes to get rid of pollution
- To develop neutraceuticals, therapeutics and diagnostics

Way Forward

Presently, India ranks third for egg production and fifth for meat production in the world. In 2050, the demand of meat and egg would be extremely high on account of stiff population growth rate. The present growth rate of layer and broiler industry is about 6-7% and 8-10%, respectively. However, to keep this growth rate intact, the poultry feed ingredients are to be provided to the poultry industry at reasonable price. At this rate, the availability of egg and meat per head per annum will reach up to 110 eggs and 8.4 kg by 2050. Hence, there will be a huge gap between requirement/demand and production of egg and meat. It is established that poultry meat is superior to other edible meats as it is a white meat and most suitable for persons having/prone to cardiac ailments. To meet the demand of poultry produce, enormous improvement for the performance of poultry birds is required for which systematic, long term strategies are to be formulated and implemented thoroughly. Cutting edge technologies should be adopted to assist conventional practices followed for genetic improvement of birds. To obtain faster growth of genetic potential, newer advanced technologies are to be implemented judiciously. Keeping the demand of farmers and consumers in view, the strategies are to be prepared and to be adopted as and when required. The genetic potential, feed efficiency and utilization and health status of the birds need to be improved upon to obtain high performing birds so that farming enterprise would be lucrative and highly profitable. The Vision 2050 of ICAR-DPR will cater to all these requirements, to not only augment productive performance of the birds but also take care of several emerging issues like environmental concern, welfare issues, natural resource degradation, WTO regime and climate change impact.

The following strategies and approaches would be adopted to accomplish the mandate and goals of ICAR-Directorate of Poultry Research keeping in view important issues including natural resource degradation, climate change and associated stresses, world trade and markets, IP regime and human resource needs.

Augmentation of Genetic Potential through Conventional Breeding, Genomics and Biotechnological Tools

- Characterization of chicken germplasm with phenomics and genomics (2015-25)

- Improvement of pure lines through conventional and molecular breeding tools (2015-50)
- Conservation of native and improved germplasm (2015-50)

Development of Improved Chicken Varieties According to Consumer Preferences

- Development of location specific varieties and specialized crosses (2015-40)
- Utilization of important major genes from native germplasm (2020-30)
- Production of designer egg and meat (2015-50)
- Development of disease resistant birds through conventional and molecular breeding (2020-30)

Optimization of Nutrition and Development of Low Cost Feeding Strategies

- Standardization of nutritional requirements and identification of novel/alternate feed ingredients (2015-35)
- Improving efficiency of nutrient utilization (2015-50)
- Development of neutraceuticals (2015-35)

Development of Health Management Practices

- Monitoring of the chicken lines for pattern and causes of mortality (2015-40)
- Development of effective vaccines and diagnostics (2020-40)
- Eradication of important vertically transmitted diseases (2015-25)
- Development of biosecurity strategies (2015-50)
- Alternative to antimicrobials (2015-25)

Development of Adaptation Strategies to Ameliorate Impact of Climate Change

- Assessment of climate change impacts (2015-17)
- Development of management and nutritional strategies to ameliorate heat stress
- Shelter management (2015-40)
- Introgression of genes responsible for conferring better adaptability to the high performing low adaptive lines (2015-25)

Nanotechnology and Its Application in Production and Health

- Development of nano-particles for delivery of drugs, vaccines etc. (2020-35)
- Application for better understanding of physiological mechanisms (2020-25)

- Efficient utilization of neutraceuticals in poultry (2020-50)

Effective Poultry Waste Management

- Physico-chemical assessment of poultry litter and wastes (2015-20)
- Use of poultry waste as feed and fertilizer (2015-25)
- Use of poultry litter as fuel (2020-25)

IP Management and Commercialization of Technologies

- IP management and patenting (2015-50)
- Commercialization of technologies (2015-50)
- Research works through P-P-P mode (2015-40)
- Training and transfer of technologies (2015-40)

Linkages

The Directorate is well equipped with the state of art infrastructure facilities for conducting advanced research in the fields of Poultry Genetics and Breeding, Biotechnology, Nutrition and Health. The facilities available at this Institute were utilized by the students of Institutions like SVVU, Hyderabad; IVRI, Izatnagar for carrying out their dissertation works. The scientists of this Institute are guiding the research work of the students as Thesis Guide/Co-chairman/Members of the students' advisory committee. The faculty and students of the local Institutions utilized the library facilities. Several trainees/students from neighboring Institutions like NAARM, SVVU, PVNR Vety. University, ANGRAU, TANUVAS, MANAGE, NIRD, IICT etc. are visiting the Directorate to get exposed to the applied aspects of poultry farming, research and extension. The Institute is also working in collaboration with several organizations such as DBT, DST, IICT, PVNR Vety. University, SVVU etc. for conducting research activities/programs.

The action mode of the Institute is in network mode, having link with various SAUs, SVUs and ICAR institutions across the country. Besides two network research programs (All India Co-ordinated Research Project and Poultry Seed Project), the Directorate is actively working with various stake holders of rural and commercial poultry farming fraternity including Animal Husbandry Department of States like Chattisgarh, Orissa, Andhra Pradesh, Telangana etc. The Institute is also working under P-P-P mode involving private organizations, farms etc. to provide consultancy and technical inputs in the field of Poultry Science so that our technologies can reach the farmers for their benefit. ❑

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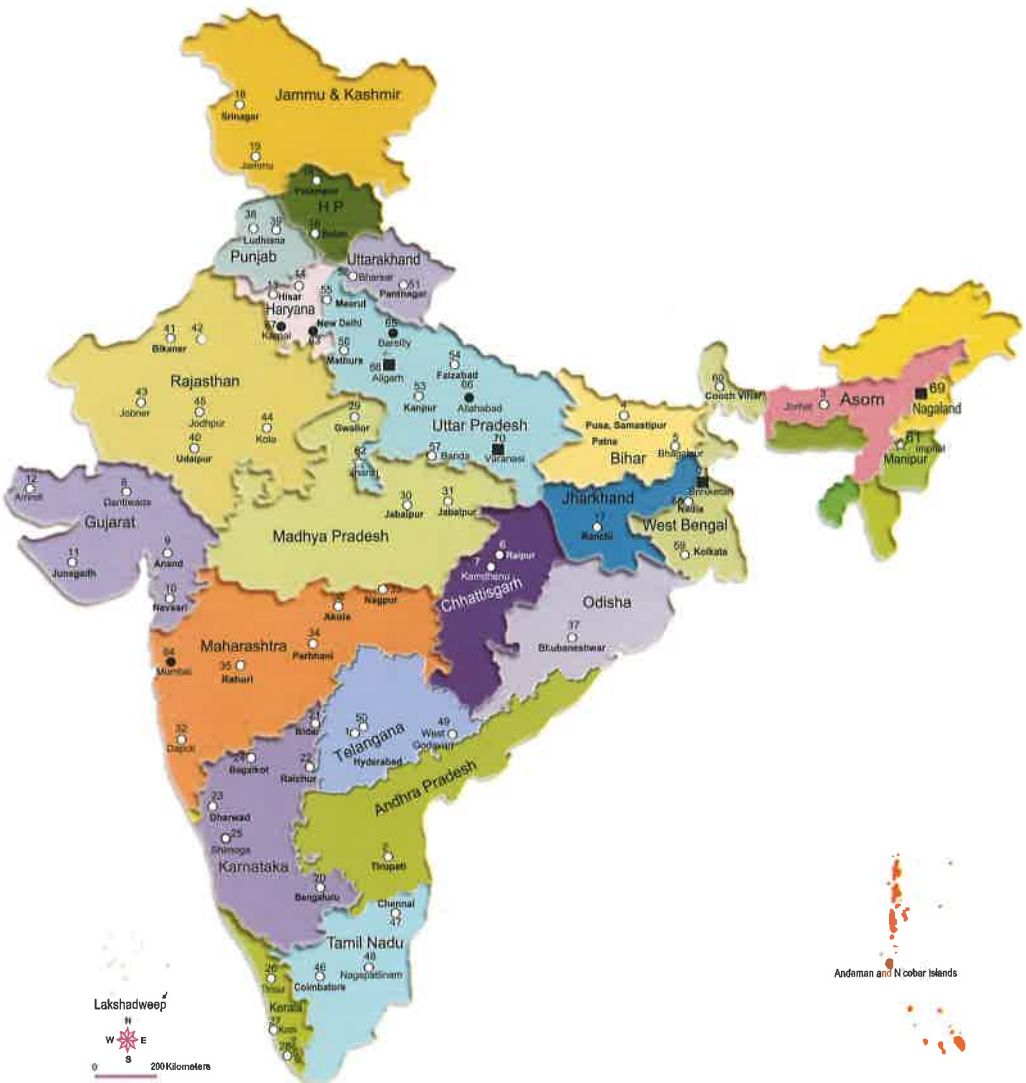

LEGENDS

- State Agricultural Universities ○
- Central Universities with Agricultural faculties ■
- Central Agricultural Universities ☆
- Deemed Universities ●


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