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Recent Developments in Poultry Production: India and International Perspectives

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Abstract

One of the fastest-growing sectors in the world agricultural economy is poultry farming. Global demand for poultry meat and eggs is consistently increasing with the drivers of population growth, urbanisation and enhanced nutrition health awareness. The world's hunger and demand for meat, milk, and egg protein have triggered innovations in breeding, feed nutrition, housing, disease management, and value-chain logistics. The poultry production industry in India, which was earlier confined to backyard birds and only to the rural areas of its developing countries, is now highly organised and technology-based. Furthermore, poultry has contributed a lot to rural livelihood and the national economy.

In the present chapter, recent advances made in poultry production in India and the world, focusing on genetic improvement, precision nutrition, disease control, automation, artificial intelligence, and eco-management, have been discussed. It examines how India has developed in the context of developments elsewhere. It also places policy and technology environments, facilitating growth and development in context. It also looks at the developments in cold-chain logistics and warehousing and product trackability that are vital for quality maintenance and post-harvest losses. Finally, this chapter identifies the future research priorities in climate adaptation, genome editing, and welfare monitoring, which will shape the next phase of growth in the poultry sector.

Keywords: *Poultry genetics, Cold-chain logistics, Automation, Genomic selection, Sustainable poultry*

1. Introduction

The poultry industry can contribute greatly towards our food and nutritional security, as the world poultry industry can give us high-quality protein cheaply. The poultry sector has recorded the highest growth rate among all livestock sub-sectors due to its short production cycle, high feed efficiency and adaptability to varying environments. According to the Food and Agriculture Organisation (FAO, 2024), world poultry meat production exceeded 140 million metric tonnes in 2023, accounting for nearly 40% of total meat output. The global protein supply needs have benefited from the availability of egg production.

The story of poultry's spontaneous success is one of technology, not just economics. The genetic progress made in poultry has produced birds that grow faster and are more resistant to disease. Automated systems now regulate temperature, humidity, and lighting. Feed optimisation plans have been introduced to reduce waste and optimise overall performance. Furthermore, the integration of data analysis, biotechnology and precision agriculture concepts has made the poultry rearing activity more predictable, efficient, and sustainable than ever.

1.1 The Indian Context

The poultry sector of India is an excellent example of how policy complementarity and innovation synergies create mass-scale change. At the beginning of the 1970s, poultry farming in India was mainly backyard and subsistence-oriented. The industry was changed by the emergence of hybrid varieties, commercial feedmills, and organised hatcheries. According to the Department of Animal Husbandry and Dairying (2024), India is currently the third largest producer of eggs and the fifth largest producer of poultry meat.

Between 2017-18 and 2023-24, egg production increased from 95.2 billion to 142.77 billion. Similarly, poultry meat production rose from 7.4 million to 10.25 million tonnes, both registering over 40% annual compound growth over six years. This increase has been supported by private sector incorporation, government-sponsored schemes and the diffusion of scientific management in small farmers.

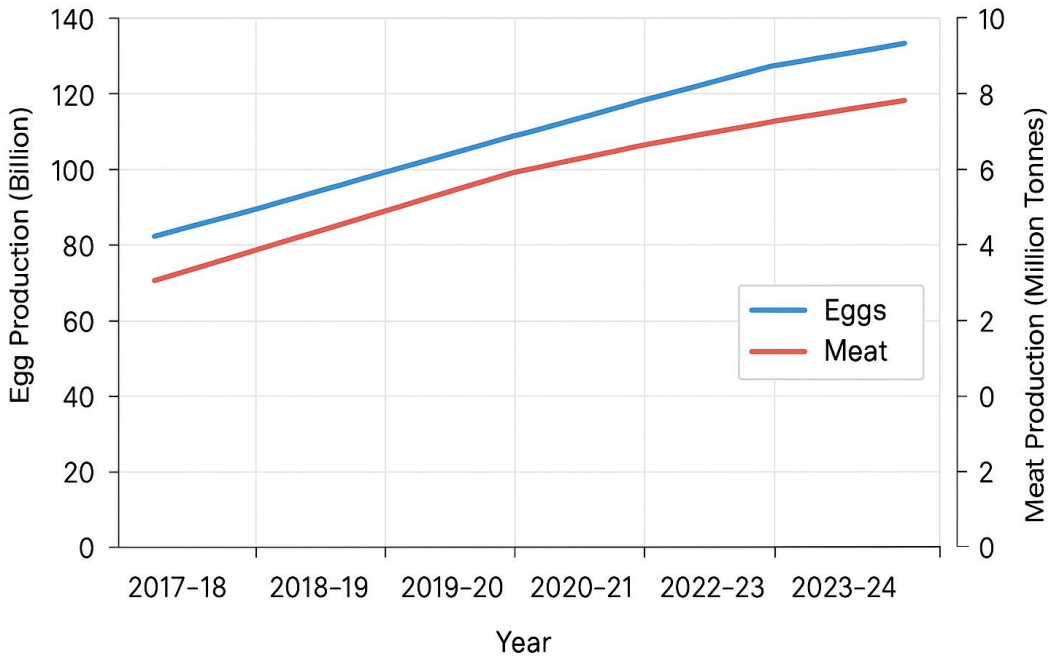

Figure 1. Year-wise Egg and Meat Production in India (Source: DAHD, 2024)

A success story in India highlights the importance of cold-chain logistics, biosecurity and value-added processing. As per DAHD (2024), the per capita availability of eggs in India increased to 103 per annum, which indicates growing consumer demand and better distribution networks. Over 1.5 % of India's Total GDP comes from Poultry farming today. Moreover, Poultry farming today provides direct or indirect employment to more than 30 million people. Thus, it has become one of the most potent rural industries of India.

1.2 Global Significance of Poultry

People all over the world consume poultry meat and eggs for animal protein sources because they are economical, have shorter production cycles and have good nutritional quality.

The Organisation for Economic Co-Operation and Development (OECD) and the Food and Agriculture Organisation (FAO) Agricultural Outlook (2024) expects that poultry will account for more than 45% of the global demand for meat by 2030. Major producers such as China, the United States, Brazil and the EU are responding to sustainability, welfare and export competitiveness imperatives.

These countries are pioneering a range of precision farming techniques, biosecure housing systems, and surveillance tools for disease prediction based on artificial intelligence. Increasingly, these are being made suitable for developing countries. India's development is along these global trends, but localised, specifically focusing on affordability and scalability.

1.3 Purpose and Scope of This Chapter

The chapter seeks to review and reflect on some of the recent developments in poultry production systems, both at the domestic and international levels. This looks at how our advancements in technology, genetics, or nutrition have increased productivity and sustainability. The study looks at how India is doing compared to other countries when it comes to infrastructure, logistics, and research-based intervention. The chapter presents a balanced picture of current poultry sector opportunities, challenges and policy priorities by drawing from scientific literature and government statistics.

2. Literature Review

The last decade has seen an all-time high in growth in research and development in most aspects of poultry production. Scientific investigation has evolved from single-discipline studies of growth and feed efficiency to holistic systems that include genomics, welfare, environment, and digitalisation. This literature review lists the key global and Indian developments reported between 2015 and 2024.

2.1 Genetic Improvement and Genomics

Genetic enhancement continues to be the foundation of productivity gain. Current studies illustrate how genomic selection enables breeders to detect and advance birds with better attributes like feed conversion ratio, growth rate, meat content, and disease resistance (Wolc, Dekkers & Fulton, 2021). Technology with single-nucleotide polymorphism (SNP) panels and whole-genome sequencing has made it possible for the targeted discovery of genetic markers that are linked to economically relevant traits.

In addition to conventional selection, multi-omics strategies combining genomics, transcriptomics, and metabolomics are now used to investigate complex traits like heat tolerance and immunity. This is especially important for tropical nations like India, where ambient temperatures can constrain productivity. Indian institutions like the ICAR Directorate of Poultry Research (Hyderabad) are working on heat-tolerant dual-purpose breeds like Vanaraja, Gramapriya, and Srinidhi, which combine adaptability and productivity.

2.2 Nutrition, Feed Innovation, and Gut Health

Poultry nutritional science has progressed from balancing macronutrients to formulating precision diets that maximise gut microbiota and immune function. Enzyme supplementation, specifically phytase and xylanase, maximises nutrient absorption while minimising waste production (Ravindran & Abdollahi, 2021). Concurrently, probiotics, prebiotics, and phytogenic feed additives are emerging as substitutes for antibiotics, responding to antimicrobial resistance issues (Rajkumar, Singh & George, 2023).

Feed ingredient innovations have also developed very quickly. Insect meals (black soldier fly larvae), algae proteins, and single-cell microbial proteins are being assessed for their sustainability and amino acid profile. Although these ingredients are already being utilised in Europe and the North American continent, Indian scientists are also looking at local alternatives that are cost-effective and acceptable locally.

In addition, AI-powered feed formulation software can now enable nutritionists to simulate feed efficiency using breed type, environmental factors, and availability of feedstocks. This application of digital technology in nutrition research represents a significant breakthrough in optimising resources and managing costs.

2.3 Disease Management and Biosecurity

The control and prevention of poultry disease have become more technologically advanced. Classical vaccination campaigns are now complemented by recombinant vector vaccines and DNA formulation that give wider and longer-lasting immunity (OIE, 2023). Expediting diagnostics like Loop-Mediated Isothermal Amplification (LAMP) and portable real-time PCR machines have brought down the time taken to identify pathogens in field settings by leaps and bounds.

In India, large networks of disease surveillance under the National Animal Disease Control Programme (NADCP) track Avian Influenza and Newcastle Disease outbreaks. Combining molecular tools with real-time information systems enables authorities to react rapidly to new threats. This combination is part of an international shift towards data-driven biosecurity, minimising economic losses as well as animal suffering.

2.4 Precision Farming and Automation

As sensors become less expensive and digital infrastructure more common, the whole concept of Precision Poultry Farming (PPF) is gaining traction. Scholars Kumar, Patel & Nair (2024) have

shown that IoT devices and machine learning models retrieve sensitive data from birds, including their activity behaviour, temperature and feed intake, and predict animal health or welfare problems before they become severe.

Small and medium-sized farms are designing low-cost versions of such systems in India. These cover mobile phone dashboard monitoring, intelligent ventilation, low-cost camera sensors, and analysis of behaviour. This localised innovation replicates technology in small farms by Zuva and narrows the digital divide in the livestock sector.

2.5 Sustainability and Environmental Concerns

Studies into sustainability in poultry farming reduce greenhouse gases, make better use of resources and ensure animal welfare. According to FAO (2024) and Gupta, Mehta & Sharma (2023), feed production and manure management are responsible for carbon footprints from the industry. Efforts made for reduction include feeding the poultry accurately to reduce nitrogen excretion, anaerobic digestion of manure to produce biogas and mixing renewable energy in the poultry house.

Today, automated computer-vision-based scoring is used to score gait, feather condition and flock uniformity to measure welfare. Compliance with the growing number of welfare standards will benefit from these objective measures, which are trade certifiable.

2.6 Indian Context in Literature

It is important to have technologies that respond to diversity among smallholders, heterogeneity of climate, and shortage of capital (Prabakaran, 2022; ICAR, 2024). Research shows how small producers are integrated into formal markets through contract farming systems and cooperative frameworks. Indian literature also points to government programs, like the Animal Husbandry Infrastructure Development Fund (AHIDF), that provide support for cold-chains and modern slaughterhouses.

In spite of these developments, there still exist gaps within feed ingredient supplies, surveillance of disease at the grassroots level, and harmonised welfare measures. Closing these gaps through multi-stakeholder coordination continues to be a main recommendation in most modern studies.

3. Global Poultry Production Overview

During the past three decades, poultry emerged as the leading type of meat globally, overtaking beef and pork in terms of volume production. Poultry growth is due to shorter production periods, a lower feed conversion ratio, and fewer constraints from cultural or religious points of view on consumption.

The production of poultry meat globally stood at more than 140 million metric tonnes in 2023, with egg production exceeding 1.5 trillion units, according to FAO (2024).

3.1 Major Producing Regions

- Top producers of these products around the world are China, the U.S.A., Brazil, the European Union and India. The world chicken industry is primarily dominated by China and the USA.
- China has taken pole position in egg production and chicken meat production worldwide. China has achieved high yields with extensive use of automation, closed-house rearing and breeding programmes.
- In the United States, hatcheries, feed mills, farms, and processing plants are owned by one corporate entity in an integrated broiler production complex to ensure quality consistency.
- With high operational efficiency, Brazil has emerged as the world's largest poultry meat exporter owing to the cost-effective feed manufacturing process used within the country and biosecurity compliance.
- The European Union is claiming the role of a global leader in ensuring humane production systems of food of animal origin.
- India is rapidly catching up with the global leaders, emerging as one of the fastest-growing producers of meat and eggs.

Table 1. Global Poultry Production Overview (2023)

Country/Region	Poultry Meat (Million Tonnes)	Egg Production (Billion Units)	Key Features
USA	21.5	110	Fully automated, vertically integrated industry
China	23.0	560	Advanced genetic improvement and automation

Brazil	15.8	110	Export-oriented, strong feed base
EU	13.0	120	Welfare-driven, sustainable production systems
India	10.2	142.8	Rapid modernisation, smallholder integration

Sources: FAO (2024); USDA (2024); DAHD (2024)

3.2 Consumption and Trade Trends

According to the OECD–FAO report 2024, per capita global poultry meat consumption rose from 12 to 18 kg between 2010 and 2023 and is projected to exceed 21 kg by 2030. The demand for eggs is also booming, as currently, the per capita consumption worldwide stands at 210 eggs a year.

Among all edible terrestrial animals, poultry meat is the most traded. Due to its price sensitivity, high demand, and shorter production cycles, poultry meat output has advanced significantly. Brazil and the United States are among the major exporters of agricultural technology goods. At the same time, new demand trends in South Asia as well as Africa are emerging as major importers. Trade is increasingly being influenced by animal welfare certification, antibiotic residue standards, and carbon footprint labelling.

4. Poultry Production in India

India's poultry business started as a rural activity and is now a global competitor. The industry is well-organised in the country and contributes significantly to farm GDPs as well as rural livelihood.

4.1 Growth Trajectory and Output

According to DAHD (2024), India produced 14.277 billion eggs and 1.025 million tonnes of poultry meat in 2023-24. The availability of eggs per person has risen to 103 eggs per year as a result of enhanced production and improved logistics. India’s poultry industry has witnessed a significant increase in growth in the past decade. The annual growth rate in egg production is between six to eight per cent. Meanwhile, the annual growth rate in meat production is between four to five per cent.

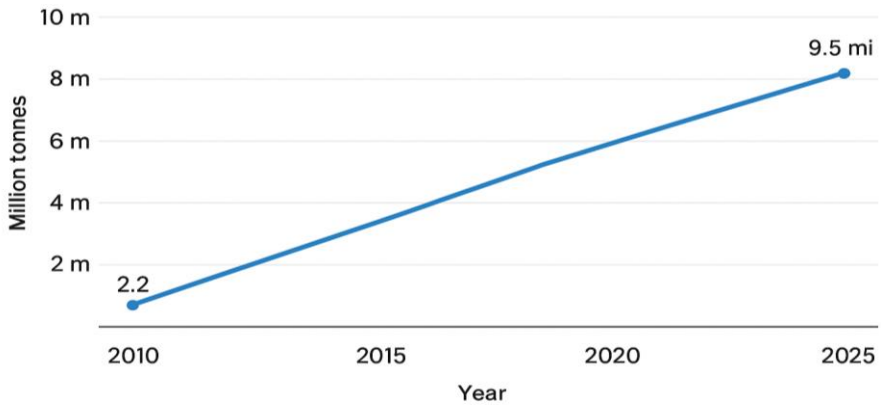

Figure 2. Growth of Poultry Meat Production in India (Source: DAHD, 2024)

Five states, West Bengal, Tamil Nadu, Andhra Pradesh, Telangana, and Karnataka, collectively produce over 60% of the national production. These states have the advantages of well-circumstanced climatic conditions, well-organised feed supply systems, and high participation by the private sector.

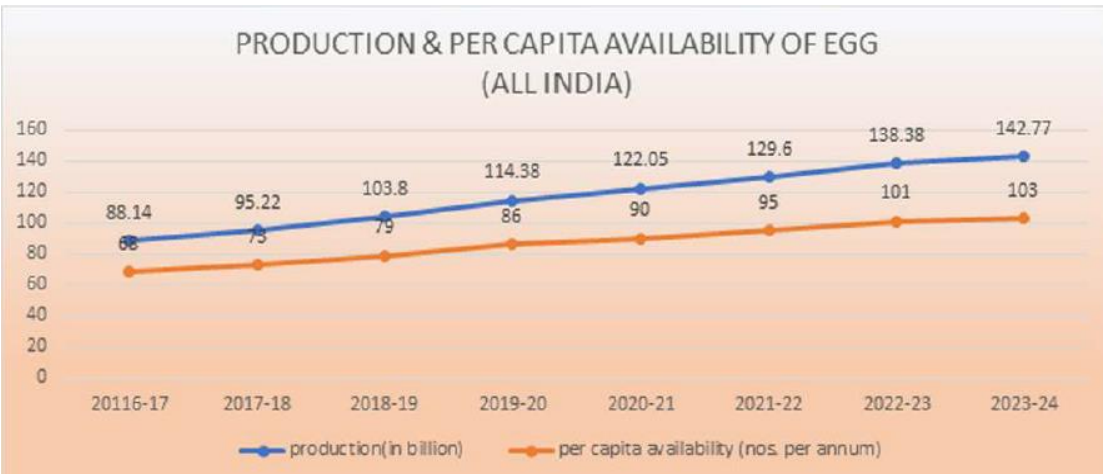

Figure 3. Production and Per-Capita Availability of Eggs in India (Source: DAHD, 2024)

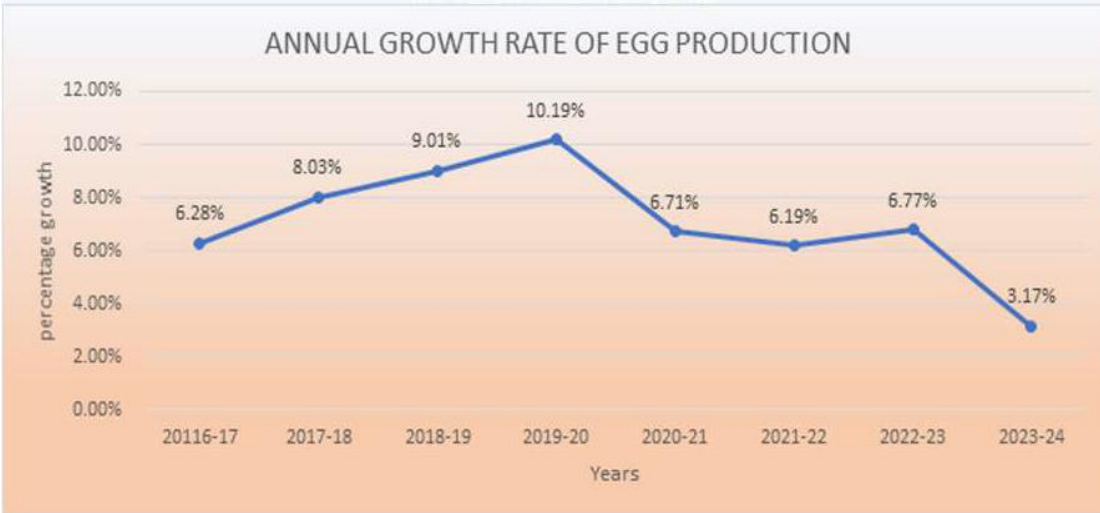

Figure 4. Annual Growth Rate of Egg Production (Source: DAHD, 2024)

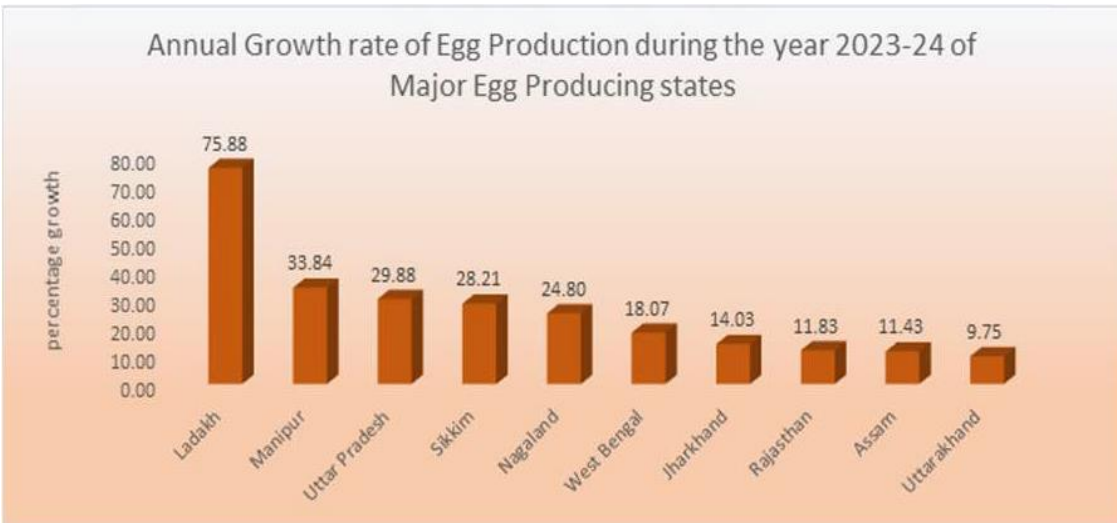

Figure 5. State-Wise Annual Growth Rate of Egg Production, 2023–24 (Source: DAHD, 2024)

The commercial poultry subsector is now the dominant force, representing about 80% of egg and 85% of meat production, whereas backyard poultry continues to generate additional income for

smallholders, especially in rural and tribal regions.

4.2 Integration and Value Chain Organisation

Integrated poultry companies like Venkateshwara Hatcheries, Suguna Foods, and Godrej Tyson are modernising this industry as they dominate all processes from breeding and feed making to processing and retailing. Integration reduces farmers' risk and stabilises their return at the same time, keeping quality consistent

Nowadays, contract farming systems are common in large poultry-producing states where integrators supply the farmers with chicks, feed, and veterinary care. The system helps improve efficiency and serves as a reliable source of income for rural families.

5. Developments in Storage, Transport, and Cold-Chain Facilities

Post-production proper handling is necessary for maintaining product quality and also for preventing loss. Weather events and gross negligence are reasons for poultry death. Further, the lack of proper cold-chain systems has remained a big problem in the Indian poultry industry for years, especially in rural areas. Still, much has been achieved in recent times under the government's efforts and investments from the private sector.

5.1 Institutional and Government Assistance.

The establishment of modern cold-storage facilities, refrigerator vans and pack houses has been supported by the funding of the Animal Husbandry Infrastructure Development Fund (AHIDF) and the Integrated Cold Chain and Value Addition Infrastructure Scheme of MoFPI. These ensure that poultry farms remain linked to urban consumer markets with controlled temperature throughout the supply chain. Key policy targets are:

- Minimising post-harvest wastage and enhancing food safety.
- Facilitating investment in processing and packaging.
- Growing export capacity through adherence to global standards.

5.2 Technical Upgrades

Technological advances in recent times have transformed poultry logistics:

- Multi-temperature reefer trucks preserve accurate temperature zones (–18°C to +4°C), enabling concurrent transport of frozen and chilled products.

- IoT-based cold-chain monitoring solutions now capture actual-time temperature, humidity, and CO_2 levels, alerting operators automatically upon deviations.
- Plastic egg tray, shock-resistant box, and conveyorised handling systems have enhanced product integrity during long-distance haul.
- Decentralised pack houses and solar-powered cold rooms have enabled storage to become possible in rural areas lacking a power supply.
- Third-party logistics providers provide "cold-chain as a service (CaaS)" facilities that enable small and medium producers to use refrigerated transport without the need to invest heavily.

These advances have saved on product spoilage, ensured freshness, and overall consumer confidence has increased.

5.3 Food Safety and Quality Assurance

State-of-the-art processing plants have blast chillers, IQF systems, and vacuum pack units that ensure bacterial contamination and shelf life extension. Electronic tracing systems following HACCP and FSSAI norms guarantee absolute traceability from the farm gate to retail.

Handler and transporter training has hygiene, temperature control, and prevention of cross-contamination as core elements, consistent with India's increasing focus on safe and export-quality poultry products.

6. Technological Advances in Poultry Production

6.1 Genetic Improvement

Today's poultry breeding schemes focus on birds growing faster, more efficiently converting feed, and more effectively resisting diseases. Genetic improvement has been hastened by genomic selection and marker-assisted breeding, which reduce generation intervals. Hybrid broilers like Cobb 500 and Ross 308 now reach feed conversion ratios (FCR) of less than 1.6, a standard for high efficiency (Wolc et al., 2021).

In India, local development programs are concentrating on tropical climate and low-input system types of breeds. The ICAR-Directorate of Poultry Research (Hyderabad) and the state agricultural universities have bred dual-purpose types that possess good egg production with moderate meat production, ideal for rural and semi-arid environments.

6.2 Precision Nutrition

Feed constitutes virtually 70% of the overall cost of production, and hence it is the key area for intervention using technology. AI-based nutrient prediction systems and near-infrared spectroscopy (NIRS) are increasingly being employed

to forecast feed ingredient content and dynamically change diets.

Additives like probiotics, prebiotics, enzymes (phytase, xylanase), and organic acids improve digestibility and decrease antibiotic reliance (Singh & Rao, 2023). Novel protein sources — insect meal, algae, and fermented by-products — are being evaluated regarding cost-effectiveness and environmental impact.

6.3 Smart Poultry Farming and Automation

Smart machines have changed how poultry is managed. Sensors in poultry houses continuously record temperature, humidity and light intensity. Mobile applications receive the readings from IoT platforms, allowing remote monitoring and control.

New technology that will require less manpower and will improve the hygiene standards has been employed for feeding, watering, collection of eggs, and removal of excreta. Machine learning can detect abnormal behaviours, including reduced feed consumption and excessive vocalisation, which are signs of stress or disease.

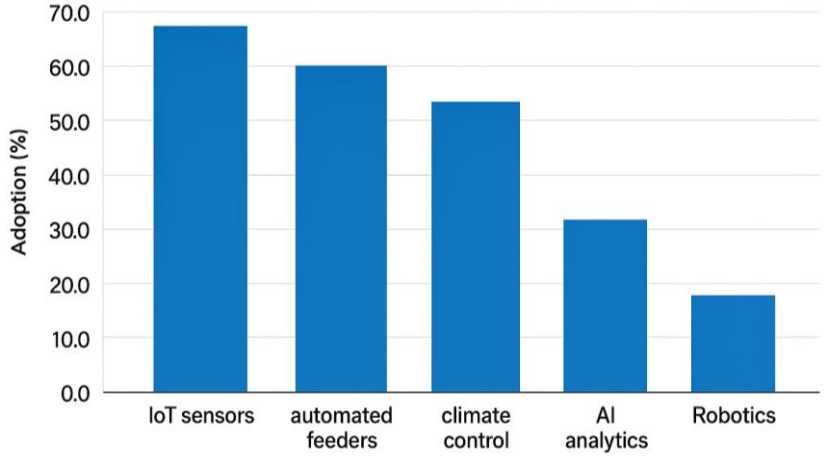

Figure 6. Key Technologies in Smart Poultry Farming (Source: ICAR, 2024)

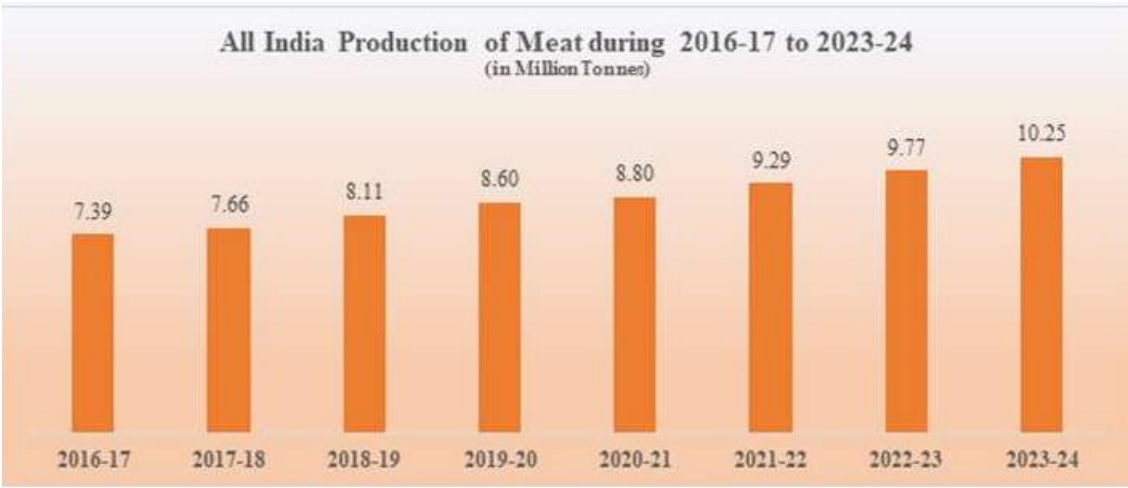

Figure 7. All-India Production of Meat, 2016–2024 (Source: DAHD, 2024)

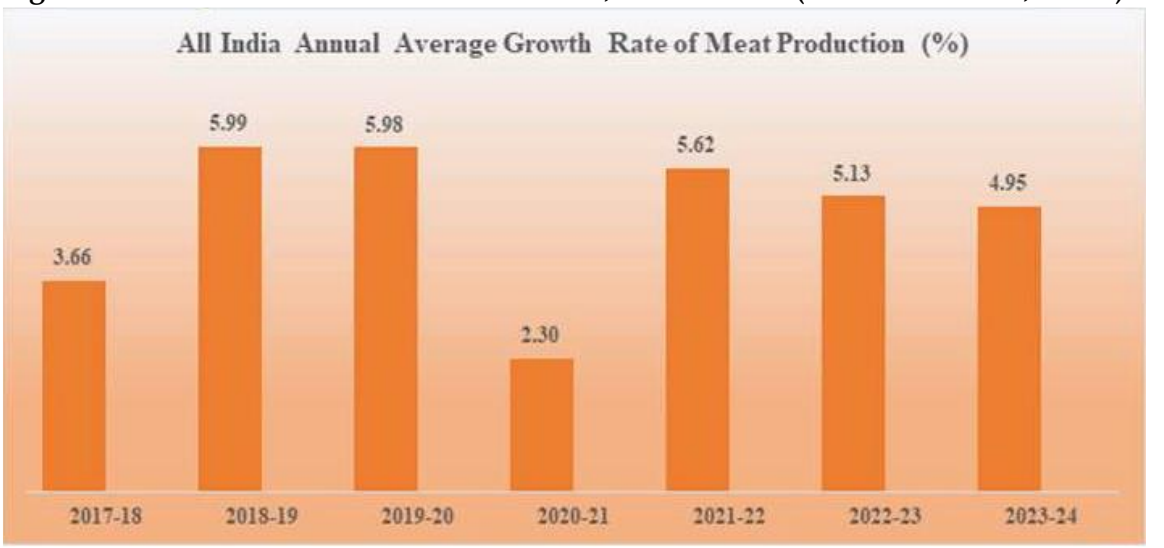

Figure 8. Annual Growth Rate of Meat Production (Source: DAHD, 2024

These technologies make work easier and help with decision-making and welfare monitoring through data. Some Indian farms have started using an AI dashboard that forecasts yields and alerts managers in real-time about environmental shifts.

6.4 Waste Management and Sustainability.

Improper management of chicken litter can cause an environmental disaster. But technology has converted it into a resource. Litter is converted into green energy and organic fertiliser through biogas plants and anaerobic digesters, among others.

Farms that put such circular waste management systems into place can cut their carbon footprint by up to 25% while also earning additional income from by-products (Gupta et al. 2023). Also, research on transforming litter into biochar shows potential for helping soil quality and locking carbon away.

7. Role of Artificial Intelligence and Data Analytics.

Big data analytics and artificial intelligence (AI) a new technologies that could help to transform today's poultry production. Technologies like these are allowing us to make decisions with data, reducing human errors and increasing productivity across the value chain.

7.1 Data-Driven Farm Management.

AI platforms treat real-time data on temperature, humidity, rate of ventilation, and light intensity. They use this data to predict feed conversion efficiency, growth rates, and susceptibility to diseases using machine learning algorithms. For instance, it was indicated by Kumar, Patel, and Nair (2024) that IoT-based monitoring combined with AI can significantly reduce mortality (up to 10%) and feed costs (6-8%) by warning against anomalies.

Computer vision technology is being increasingly harnessed to monitor the movement of birds, detect abnormal behaviour (feather pecking or lameness) and estimate flock weight. By applying predictive analytics with these technologies, intervention is enhanced along with animal welfare and overall efficiency.

7.2 Smart hatcheries and Processing Units.

Artificial intelligence is used not only in farms but also in hatcheries and processing plants. Hatcheries monitor the health of their eggs, embryos, and chicks with image recognition. Robotic arms use automated arms to sort and vaccinate. With this, there is less human handling, which results in less chance of contamination.

AI algorithms used in processing facilities control chilling time, packaging stream and quality control, which monitors for deviations in colour, weight or texture. Uniformity, waste mitigation, and improved food safety compliance through all such mechanisation and automation are vital for the export market.

7.3 Traceability and Digital Recordkeeping.

Now, cloud-based production management systems link all phases of the production chain, including breeder farms, feed mills, hatcheries, broiler units, and retail chains. Tools that maintain electronic records that allow tracing from farm to fork, a crucial standard under global trade norms.

Large poultry companies in India are using blockchain-tracked platforms to trace the production chain, from feed source to medication administration and transport conditions, at each stage. This type of transparency will boost consumer confidence and bring Indian exports up to the standards set by Codex Alimentarius and OIE.

8. Climate Adaptation and Environmental Sustainability.

The global and Indian poultry industries are increasingly focusing on sustainability and greener practices. As production capacities continue to increase, the industry must lessen the environmental burden while remaining profitable and socially accountable.

8.1 Utilisation of Energy Efficiency and Renewable

Builders are erecting new poultry sheds that optimise energy use. The poultry sheds have insulated wall systems, mechanical ventilation and LED lighting systems. In order to reduce energy costs and emissions, most farms, especially in Southern India, are installing solar-powered ventilation and light systems.

Hybrid renewable systems, which are solar plus biogas, can ensure round-the-clock operation of a temperature control facility in a region that suffers from erratic power supply. These technologies help animals remain comfortable and productive in bad weather.

8.2 Water Management And Recycling Of Waste.

Poultry farms are bringing in closed-loop water recycling systems that recycle and reuse water after it passes through filters for cleaning, cooling, ventilating, etc. Anaerobic digesters produce a gas from litter and wastewater, while the leftover slurry is used as an organic fertiliser. Environmental efficiency and cost reduction are achieved through these actions.

According to Gupta, Mehta, and Sharma (2023), greenhouse gas emissions from

poultry farms can be reduced by 20-30% by using waste-to-energy technologies. Moreover, scientists have invented a new biochar soil amendment from litter, improving nutrients and carbon storage.

8.3 Development of Breeds and Climate Resilience.

Poultry production faces major challenges due to climate change, including extreme heat, water shortages, and disease outbreaks. Indian researchers have developed various heat-resistant and dual-purpose varieties, such as Vanaraja, Krishna-J and Gramapriya, under the ICAR programme to overcome them. Under high-temperature and low-input conditions, an advantage to small farmers in tropical nations.

Also, climate-based sensors and AI can predict the heat stress levels in the house and adjust ventilation and cooling. Such systems are climate-smart poultry farming systems that build resilience.

9. Economic and Policy Perspectives.

9.1 National Policy Initiatives.

The Indian government has implemented a number of initiatives to ensure the sustainable and inclusive growth of poultry. Small poultry birds are supplied to indigenous communities under the National Livestock Mission (NLM) and Rural Backyard Poultry Development Programme. Besides, these initiatives offer assistance in securing chicks, a subsidy on feed, and a handful of technical skills.

The AHIDF and PM-FME Scheme have made it easier to process and store food using cold-storage technology. They have made these facilities more available. Entrepreneurs are expected to install hatcheries, feed mills and processing plants through credit-linked investment schemes.

Moreover, small farmers are given financial assistance from the Poultry Venture Capital Fund (PVCF) to generate employment and add value in rural India.

9.2 International Policy Trends.

Overseas, poultry production policies on antibiotic-free production, animal welfare certification, and traceable value chains. The European Union mandates welfare labelling, strict biosecurity compliance, while sustainability reporting for exports is being prioritised by the U.S. and Brazil. These worldwide changes influence Indian producers wanting to enter premium global markets.

Organisations such as FAO and ILRI, which work internationally, are facilitating the exchange of knowledge on

climate-smart practices, disease control and monitoring data.

9.3 Economic Importance and Country Progress.

The poultry industry provides direct and indirect employment to an estimated 30 million people in India's rural economy. It also provides a reliable source of income for women and tenants. Poultry production requires a small input but generates high outputs, making it a lucrative livelihood option even in backward areas.

The rise in demand for protein-rich products from consumers, organised retail and e-commerce, among others, is presenting new opportunities. Poultry prices being more stable than other meats support their role in ensuring food and nutrition security. (23 words)

10. Future Directions and Emergent Issues

10.1 Genome and Precision Breeding Development

The future of poultry genetics lies in the application of genome editing technologies like CRISPR-Cas9 to make specific changes to genes that control growth rate, feed efficiency, and disease resistance. These technologies have the potential to shorten breeding cycles and develop robust poultry lines. Ethical and regulatory systems will, however, have to be carefully considered to maintain biosafety as well as consumer acceptability.

10.2 Alternative Protein and Cultured Meat

Scientific studies of lab-grown chicken meat and plant-based poultry alternatives are unfolding globally at a fast pace due to sustainability issues. Although these technologies are yet to emerge in India, pilot projects in food technology research centres and startups are testing their viability. These alternatives can later supplement conventional poultry farming instead of substituting it, providing diversification and resilience in protein supply chains.

10.3 Digital Transformation and Automation

Within the next ten years, completely automated, AI-controlled broiler houses will be common practice for commercial producers. Robotics will replace human labour in feeding, egg collection, and cleaning, while increasing hygiene levels. Predictive analytics, blockchain traceability, and cloud-based dashboards for performance will turn poultry management into a precision-based industry.

10.4 Persistent Challenges

Even with great strides, several challenges remain:

- Volatility of feed costs is still a significant problem based on maize and soybean meal dependence.
- New diseases such as avian influenza still pose a risk to the stability of production.
- Climate extremes elevate mortality rates and diminish feed efficiency.
- Antimicrobial resistance (AMR) is becoming an increasing international public health problem.

11. Conclusion

The development of new technologies, equipment, breeding stock, and nutritious foods has transformed the management, efficiency, and sustainability of poultry farming in India and in the world. Advances in breeding, nutrition, and automation with artificial intelligence, along with supporting policy framework, have turned poultry farming into a science-based industry capable of meeting rising protein demand.

India's effort to move from backyard rearing to a more modern and integrated industry is in line with developments around the world but with locally developed solutions – heat-resistant breeds high-tech mobile advisory system, low-cost automation, and solar-powered modules for cold storage.

With the help of these innovations, productivity and inclusivity will be enhanced through millions of smallholders.

As the future unfolds, the poultry industry will increasingly depend on genomics, smart farming, and responsible management. Collaboration in research, proper infrastructure, total focus on producer policies will help in sustaining the growth and rectifying issues related to climate change, limited feed resources and compliance with welfare.

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