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RISING DEMAND FOR ANIMAL PRODUCTS AND FEED IN INDIA: PROSPECTS FOR PRODUCTION, TRADE, AND TECHNOLOGICAL ADVANCEMENT

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Abstract
India's livestock sector plays a major role in food security, rural livelihoods, agricultural diversification, and the supply of nutritious animal-source foods. Population growth, rising household incomes, urbanization, changing consumption preferences, and the expansion of food-processing industries are expected to increase demand for milk, meat, eggs, and other animal products over the coming decades. Meeting this demand will require simultaneous improvements in livestock productivity, feed availability, animal health, supply-chain efficiency, and technological innovation. Feed resources are particularly important because livestock production depends on the availability, nutritional quality, affordability, and year-round accessibility of feed and fodder. Competition for agricultural land, seasonal fodder shortages, climate variability, and fluctuations in oilseed meal and grain markets may constrain future expansion. The USDA Economic Research Service's 2025 assessment indicates that Indian demand for animal products may grow faster than supply under historical productivity trends and that additional feed imports may become necessary. This review examines the major drivers of animal-product demand, the present production outlook, feed-resource constraints, trade opportunities, and emerging technologies relevant to India's livestock economy. Potential interventions include precision feeding, improved fodder varieties, crop-residue treatment, silage production, alternative feed ingredients, genetic improvement, digital livestock management, disease surveillance, and climate-smart farming. The review argues that an integrated strategy combining productivity growth, efficient resource use, appropriate trade policies, and inclusive technology adoption is essential for a resilient livestock sector. Particular attention should be given to smallholder farmers, feed affordability, food safety, environmental sustainability, and the development of domestic feed supply chains.

Keywords: Animal products; livestock production; animal feed; feed security; India; dairy industry; poultry; meat production; agricultural trade; technological innovation; sustainability.

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1. Introduction

Animal husbandry is an important component of India's agricultural economy. It contributes to household nutrition, employment, income diversification, and the utilization of agricultural by-products. Dairy cattle, buffaloes, goats, sheep, pigs, and poultry are raised under production systems ranging from smallholder and backyard operations to specialized commercial farms. Their products supply protein, fats, minerals, vitamins, and other nutrients to consumers while supporting rural enterprises involved in feed manufacturing, veterinary services, processing, transportation, and marketing.

India occupies a prominent position in global livestock production. The Department of Animal Husbandry and Dairying identifies India as the world's largest milk producer, accounting for approximately one-quarter of global milk output.

Official statistics also demonstrate the increasing economic importance of the livestock sector[1,2].

Despite this progress, future expansion will depend on more than increasing animal numbers. Sustainable growth requires higher productivity per animal, better reproductive performance, improved disease prevention, reliable access to quality feed, and efficient conversion of feed nutrients into animal products.

The USDA Economic Research Service's report, published in March 2025, *The Growing Demand for Animal Products and Feed in India: Future Prospects for Production, Trade, and Technology Innovation*, examines long-term demand and feed-supply challenges through 2050. Its projections suggest that demand may outpace supply if productivity improvements do not exceed historical patterns. The report also highlights the potential importance of feed imports and crop technology in meeting future requirements.

This issue is important because livestock production and feed supply are closely interconnected. Increasing milk, meat, or egg production generally requires either greater feed availability, improved feed conversion, better animal productivity, or a combination of these factors. Consequently, feed security is a central determinant of the future competitiveness of India's livestock industry[3].

2. Objectives of the review

The principal objectives are:

To examine the major factors driving demand for animal products in India.

To assess production trends and future opportunities in the dairy, poultry, meat, and related sectors.

To identify constraints affecting the availability, quality, and affordability of animal feed.

To discuss the prospects for domestic production, international trade, and feed-market development.

To evaluate technological innovations that may improve livestock productivity and feed-use efficiency.

To propose policy and research priorities for sustainable, inclusive, and resilient livestock-sector growth[4].

3. Methodology

This article follows a narrative literature-review approach. It synthesizes published government statistics, official policy information, and secondary research on India's livestock, animal-feed, and agricultural markets. Particular emphasis is placed on the USDA Economic Research Service report by Beckman and colleagues (2025), official livestock statistics published by the Department of Animal Husbandry and Dairying, and literature on feed management and sustainable livestock production[5]. The review is organized thematically around demand, production, feed supply, trade, technology, and policy. It does not claim to be a systematic review or a new econometric investigation. No original farm survey, laboratory experiment, or statistical forecast has been conducted for this manuscript.To maintain clarity, historical statistics are identified by their reference year, while statements about 2030 or 2050 are treated as future scenarios rather than observed outcomes.

4. Drivers of demand for animal products in India

4.1 Population growth and changing consumption patterns

Population growth increases the number of consumers requiring food, while changes in household purchasing power influence the quantity and composition of diets. Milk and dairy products are especially important in India, while demand for eggs, poultry, fish, and other

animal products varies across regions, income groups, and cultural settings.

USDA analysis of 2022 consumption data reported approximately 81.8 kg of milk products, 8.9 kg of fish and seafood, and 4.7 kg of eggs per person. These figures illustrate the importance of dairy in the recorded consumption basket and the potential for demand diversification. They should not be interpreted as current 2026 consumption estimates[6,7].

4.2 Rising incomes and urbanization

Higher disposable incomes can increase expenditure on milk, cheese, yogurt, eggs, poultry, packaged foods, and restaurant meals. Urban consumers may also place greater value on convenience, consistent quality, product safety, refrigeration, and traceability[8].

These changes create opportunities for organized dairy processing, commercial poultry production, refrigerated distribution, animal-feed manufacturing, and modern retailing. However, the relationship between income and consumption is not uniform: dietary preferences, prices, regional food habits, and household choices remain important.

4.3 Nutrition and food security

Animal-source foods can contribute high-quality protein and important micronutrients to balanced diets. Expanding access to safe and affordable products may help improve dietary diversity, particularly where deficiencies in protein or micronutrient intake are prevalent.

Nevertheless, rising production alone does not guarantee improved nutrition. Affordability, equitable distribution, food safety, storage infrastructure, and consumer education also influence nutritional outcomes[9,10].

4.4 Expansion of food processing and organized markets

The development of dairy cooperatives, integrated poultry companies, meat-processing facilities, and digital marketing channels can improve market access and product consistency. These changes may increase demand for standardized feed, veterinary support, and predictable production schedules.

The resulting growth in commercial production can also increase demand for compound feed, feed ingredients, premixes, and specialized nutritional services[11,12].

5. Production prospects for India's livestock sector

5.1 Dairy production

Dairy is a major source of recurring income for many Indian farm households. Milk production benefits from established cooperative networks, diverse cattle and buffalo populations, and the use of crop residues and locally available feed resources[13].

According to the Department of Animal Husbandry and Dairying's *Basic Animal Husbandry Statistics 2025* brochure, milk production reached 247.87 million tonnes in 2024–25, an increase of 3.58% over 2023–24. Per-capita milk availability was reported at 485 grams per day. These are official estimates for 2024–25, not figures for 2026.

Important opportunities for future dairy development include:

Improving the balanced nutrition of lactating animals. Increasing the quality and availability of green fodder and conserved roughages. Strengthening artificial insemination, breeding, and reproductive-health services. Improving mastitis prevention, vaccination, and veterinary care. Expanding milk chilling, testing, processing, and cold-chain infrastructure. Using digital tools to monitor milk yield, feeding, health, and reproductive performance.

A major challenge is the gap between genetic potential and realized productivity. Feed shortages, heat stress, disease, poor-quality roughages, and inadequate veterinary access can limit production even where animals with high productive potential are available[14].

5.2 Poultry and egg production

Poultry production has opportunities for rapid expansion because birds have relatively short production cycles and can convert suitable balanced feed into meat and eggs efficiently. Commercial poultry is also closely linked to feed-grain markets, particularly maize and soybean meal.

Future growth will depend on the availability of cost-effective protein and energy ingredients, improved feed formulation, disease prevention, biosecurity, and reliable access to veterinary services.

Feed costs are particularly important because feed constitutes a substantial share of operating expenditure in intensive poultry production. Consequently, even modest improvements in feed conversion ratio can improve farm profitability, provided they do not compromise bird health or welfare[15,16].

5.3 Small ruminants and other livestock

Goats and sheep support meat production, household savings, and livelihoods in dryland and semi-arid regions. Their ability to utilize browse, shrubs, and some low-quality forage resources makes them important in production systems where cultivated green fodder is limited. However, their productivity can be constrained by seasonal feed shortages, parasite burdens, inadequate veterinary access, and weak market infrastructure. Community fodder banks, improved grazing management, supplementary feeding, and stronger marketing networks could improve resilience[17].

Pig production and other livestock enterprises offer opportunities in regions where consumer preferences, feed resources, and market infrastructure support their development. Production strategies must be adapted to local conditions rather than assuming that one model is appropriate for all Indian states.

5.4 Summary of production opportunities

Sector	Main growth opportunity	Major constraint	Priority intervention
Dairy	Higher milk yield and quality	Feed deficits and heat stress	Balanced rations, fodder conservation, animal health
Poultry	Meat and egg production efficiency	Feed-price volatility and disease	Precision formulation and biosecurity
Sheep and goats	Dryland meat and livelihood development	Seasonal grazing shortages	Fodder banks, pasture management, veterinary care
Pigs	Specialized regional market development	Feed costs and market limitations	Locally adapted feeding and improved health management
Feed manufacturing	Compound-feed and premix demand	Ingredient availability and quality variation	Testing, traceability, efficient processing

The table presents a qualitative assessment of opportunities and constraints, not a statistical ranking of sector performance.

6. Feed demand, availability, and resource constraints

6.1 Major feed resources

Animal feeding in India relies on a combination of cultivated fodder, natural grazing, crop residues, cereal grains, oilseed meals, and

commercial compound feed, and agro-industrial by-products[18].

The relative importance of these resources differs across species and production systems. Dairy cattle and buffaloes generally require a combination of roughages and concentrates, while intensive poultry production relies on carefully balanced energy, protein, amino acid, vitamin, and mineral sources.

Important feed resources include:

Green fodder: maize fodder, sorghum, pearl millet, be seem, Lucerne, and other locally suitable forage crops.

Dry roughages: paddy straw, wheat straw, and other crop residues.

Energy ingredients: maize, broken grains, and suitable cereal by-products.

Protein ingredients: soybean meal, groundnut cake, mustard cake, and other suitable oilseed meals.

Mineral and vitamin supplements: balanced premixes and species-appropriate supplements.

Alternative resources: selected agro-industrial by-products, processed crop residues, and other ingredients whose nutritional value and safety have been established.

Alternative ingredients should not be used indiscriminately. Their inclusion depends on nutrient composition, digestibility, anti-nutritional factors, contamination risks, palatability, and species-specific requirements.

6.2 Structural challenges in feed supply

India faces several interrelated challenges in maintaining reliable feed supply.

Competition for land: Land is needed for food crops, fodder crops, industrial crops, and other uses. Expanding feed-crop production can therefore involve trade-offs with food production and environmental priorities.

Seasonal availability: Green fodder and grazing resources may become scarce during dry seasons. Inadequate storage and conservation can lead to substantial losses of potentially usable feed[19].

Quality variability: Crop residues may contain high levels of fibre and relatively low levels of digestible energy or protein. Poor storage can further reduce quality or increase contamination risks.

Price volatility: Grain and oilseed-meal prices are affected by weather, crop yields, domestic demand, transportation costs, export policies, and international markets.

Regional imbalance: Feed resources may be abundant in one region but expensive or difficult to transport to another. This makes storage, processing, logistics, and local feed production important.

6.3 Feed security and the production–demand gap

The USDA's 2025 analysis emphasizes that India may face increasing difficulty meeting feed demand if livestock productivity continues to follow historical patterns. The authors identify the possibility of additional imports as demand grows and discuss genetically engineered crop technologies as one potential means of increasing feed supply. These findings are scenario-dependent and should not be interpreted as proof that a particular technology is the only available solution [20].

A broader strategy should also consider improved crop yields, suitable feed-crop varieties, better fodder conservation, crop-residue processing, reduction of post-harvest losses, improved feed conversion, and alternative feed ingredients. The most appropriate solution will differ by crop, region, animal species, and production system.

7. Production, feed demand, and trade: conceptual framework

Interpretation: Demand growth creates opportunities, but the realized outcome depends on whether feed resources, animal productivity, processing, and market infrastructure expand

together. Feed shortages or low productivity can increase costs and the need for imports, while improvements in efficiency can moderate these pressures.

8. Prospects for domestic production and international trade

8.1 Domestic feed production

Strengthening domestic feed supply is an important route to improving livestock-sector resilience. Possible interventions include expanding suitable fodder cultivation, raising the productivity of existing feed crops, improving the use of crop residues, and developing local feed-processing capacity.

Regional planning is essential. Areas with irrigation and suitable growing conditions may be able to support dedicated fodder production, whereas dry land areas may benefit more from drought-tolerant forage crops, pasture improvement, silage, and fodder banks.

Oilseed processing can provide protein-rich meals, while cereal processing generates by-products that may be suitable for certain livestock rations. However, the value of these resources depends on quality testing, safe handling, transport costs, and competing uses.

8.2 Feed imports and international markets

Imports can help bridge temporary or structural gaps in domestic supply. Potentially important commodities include oilseed meals and other feed ingredients, depending on prices, availability, and domestic policy.

However, greater import dependence can expose farmers and feed manufacturers to exchange-rate movements, international price fluctuations, freight costs, trade restrictions, and disruptions in global supply chains.

A resilient strategy should therefore balance domestic production, diversified sourcing, adequate storage, and predictable trade policy.

8.3 Trade in animal products

India's future trade prospects will depend on product quality, sanitary standards, traceability, processing capacity, logistics, and the competitiveness of domestic producers. Export opportunities should be assessed separately for dairy products, buffalo meat, poultry products, eggs, and other commodities because their market requirements differ.

Improving food safety, veterinary certification, residue monitoring, cold chains, and product traceability can help strengthen access to international markets[21].

At the same time, trade expansion should not undermine domestic availability or create unnecessary price volatility for producers and consumers.

8.4 Potential trade scenarios

Scenario	Domestic outcome	Trade implication
Productivity improves rapidly	More animal products produced per unit of feed	Lower pressure for feed imports than otherwise
Feed productivity grows slowly	Feed supply may lag behind requirements	Greater exposure to feed-import requirements
Global feed prices rise sharply	Production costs increase	Higher risk of domestic price pressures
Feed sources are diversified	Greater flexibility in sourcing	Reduced exposure to a single supplier or commodity
Processing and quality improve	More consistent products and better market access	Potential for stronger export competitiveness

These are analytical scenarios, not forecasts assigning probabilities or numerical import volumes.

9. Technological advancement in animal production and feed systems

Technological innovation can improve productivity, reduce waste, strengthen animal health, and increase the efficiency of feed use. The benefits depend on affordability, reliable technical support, and suitability for the production system.

9.1 Precision feeding and ration balancing

Precision feeding involves matching feed composition to animal requirements according to species, age, body weight, production stage, and physiological condition. Ration-balancing tools can help farmers identify nutrient deficits and avoid excessive supplementation.

For dairy animals, balanced rations may improve nutrient utilization and productive performance. In poultry, precise energy and amino acid formulation can help improve feed conversion and reduce unnecessary nutrient excretion.

Adoption requires accurate feed analysis, reliable ingredient information, farmer training, and regular updating of ration recommendations[22].

9.2 Fodder conservation and crop-residue processing

Silage making, hay preparation, improved storage, and the appropriate treatment of crop residues can increase the availability of feed during periods of scarcity.

Urea treatment of suitable straw, for example, can improve its feeding value when conducted using established protocols. It must be performed correctly, with treated material adequately managed before feeding. Incorrect handling can create serious animal-health risks.

Community silage units and cooperative fodder banks may help smallholder farmers access conserved feed without requiring every household to make large individual investments.

9.3 Improved feed ingredients and crop technology

Crop breeding, better agronomy, improved post-harvest management, and suitable high-yielding varieties can increase the quantity or quality of feed ingredients.

Biotechnology, including genetically engineered crops where permitted and appropriate, is one potential area for research and policy evaluation. Its adoption must be assessed in relation to Indian regulatory requirements, environmental effects, farmer access, seed availability, trade implications, and public acceptance.

Feed-security policy should not rely on a single technological pathway. Conventional breeding, improved agronomy, better storage, and efficient use of existing biomass remain important options.

9.4 Digital livestock management

Digital technologies can support farm management through mobile applications, electronic records, automated weighing, milk-yield monitoring, heat detection, and disease alerts.

Such systems can help farmers identify production problems earlier and make better decisions about breeding, feeding, and health care. Their usefulness depends on data quality, connectivity, affordability, ease of use, and access to veterinary professionals[23].

9.5 Genetic improvement and animal health

Genetic selection, artificial insemination, reproductive management, and locally adapted breeding strategies can improve production and reproductive performance. However, breeding objectives should include disease resistance, fertility, longevity, heat tolerance, and adaptation to local feed resources, not just maximum output.

Vaccination, biosecurity, early diagnosis, and disease surveillance are equally important. Higher-producing animals cannot sustain good performance when disease burdens or environmental stress remain uncontrolled.

9.6 Feed manufacturing and quality control

Modern feed manufacturing can improve mixing accuracy, particle-size control, nutrient

consistency, and traceability. Near-infrared spectroscopy and other analytical techniques may support faster feed-quality assessment where appropriately calibrated and validated.

Quality-control systems should monitor moisture, nutrient composition, contaminants, mycotoxins, and ingredient authenticity as appropriate. Better standards can protect animal health and reduce economic losses throughout the supply chain.

10. Environmental sustainability and climate resilience

Livestock-sector growth must be compatible with water availability, land conservation, animal welfare, and climate objectives. Expanding animal production without improving resource efficiency could intensify pressure on feed crops, grazing lands, and water resources.

10.1 Efficient resource utilization

Improving feed digestibility and balancing rations can help reduce the quantity of feed needed per unit of output. Appropriate manure management can return nutrients to agricultural soils, while integrated crop–livestock systems can recycle biomass and improve resource use.

Crop residues should be allocated according to their competing uses, including soil cover, organic matter, fuel, and livestock feed. Removing all residues from fields may undermine soil health in some production systems.

10.2 Climate change and heat stress

High temperatures can reduce feed intake, milk yield, fertility, and animal comfort. Heat stress is particularly relevant for high-producing animals and poultry raised under hot and humid conditions.

Adaptation measures include shade, ventilation, adequate drinking water, suitable housing, improved feeding schedules, and selection for heat tolerance. Infrastructure and management should be adapted to local climates and available resources.

10.3 Greenhouse-gas emissions and waste management

Enteric methane, manure management, feed production, and energy use contribute to the environmental footprint of livestock systems. Interventions should be evaluated for their actual effects across the production chain.

Improved feed efficiency, better manure handling, biogas production where viable, and integration of livestock with crop farming may provide environmental benefits. However, results depend on system design, local conditions, and implementation quality.

11. Major constraints and strategic responses

Constraint	Consequence	Recommended response
Insufficient quality fodder	Reduced productivity and seasonal feed shortages	Fodder cultivation, silage, hay, community feed banks
High feed costs	Lower profitability and higher product prices	Efficient formulations, diversified ingredients, better procurement
Low feed conversion efficiency	Greater feed requirements per unit of output	Precision feeding, breeding, health management
Climate and water stress	Unstable fodder production and reduced animal performance	Drought-tolerant crops, water management, heat adaptation
Poor feed quality control	Reduced performance and contamination	Testing, standards, traceability, improved

	risks	storage
Unequal access to technology	Slower adoption among smallholders	Extension, cooperatives, credit, affordable digital services
Import-price volatility	Uncertain input costs	Diversified sourcing, domestic productivity, strategic planning
Weak market infrastructure	Losses and limited market access	Cold chains, processing, transport, quality certification

The responses should be designed as complementary measures. For example, improving feed production without improving storage may fail to address seasonal shortages, while investing in high-yielding animals without ensuring adequate nutrition may not generate expected productivity gains.

12. Policy and research priorities

12.1 Strengthen feed and fodder planning

State-level feed and fodder assessments should identify seasonal deficits, locally available feed resources, transportation constraints, and the potential for fodder conservation. Planning should reflect regional differences in rainfall, irrigation, cropping patterns, livestock species, and production systems.

12.2 Increase research and extension investment

Agricultural universities, veterinary institutions, research organizations, and private enterprises should collaborate on region-specific feeding recommendations, forage improvement, feed testing, animal health, and technology evaluation.

Extension programmes should prioritize practical demonstrations, farmer training, and follow-up support rather than one-time technology distribution.

12.3 Support smallholders and producer organizations

Cooperatives and farmer-producer organizations can improve access to feed ingredients, veterinary services, credit, processing, and markets. Shared infrastructure for silage making, feed testing, milk chilling, and bulk purchasing may reduce unit costs.

Financial assistance should be linked to technical guidance, transparent procurement, and measurable improvements in farm performance.

12.4 Develop predictable feed-trade policies

Trade policy should balance consumer affordability, producer incentives, domestic crop development, and the need for reliable feed supplies. Clear regulatory standards and predictable import procedures can help reduce uncertainty for feed manufacturers and livestock producers.

Decisions concerning biotechnology and imported feed ingredients should be based on scientific assessment, applicable law, environmental considerations, and transparent evaluation of costs and benefits.

12.5 Improve data and forecasting

Regular collection of data on feed prices, feed availability, animal productivity, disease, and product demand can improve planning. Better regional statistics are particularly important because national averages can conceal major local shortages.

Scenario analysis should assess how productivity, weather, crop yields, trade policy, and consumer demand may affect the balance between feed supply and livestock production.

13. Future outlook to 2030 and 2050

India's long-term livestock prospects will depend on the relationship between demand growth and improvements in production efficiency. Rather than treating one future

outcome as certain, three broad scenarios are useful for planning.

The most promising pathway is one that improves feed efficiency and animal productivity while maintaining affordable products, environmental safeguards, and access to technology for smallholder farmers[24].

14. Research gaps and future directions

Further research is needed in several areas.

Regional feed balances: Updated state- and district-level estimates of feed demand, supply, quality, seasonality, and transport costs.

Alternative feed ingredients: Nutritional evaluation, digestibility, safety, inclusion limits, and economic feasibility of locally available by-products.

Technology adoption: Barriers affecting smallholders' use of digital tools, balanced-ration services, improved fodder varieties, and feed-conservation systems.

Productivity and environmental performance: Assessment of the combined effects of feeding, genetics, animal health, heat stress, and manure management.

Trade and price transmission: Analysis of how international commodity prices, exchange rates, and trade policies influence domestic feed costs and animal-product prices.

Long-term scenario modelling: Integrated projections of animal-product demand, feed requirements, crop yields, productivity, climate impacts, and trade through 2030 and 2050.

Equity and livelihoods: Evaluation of how production intensification and market restructuring affect smallholder income, women's work, employment, and access to affordable nutrition.

Future studies should combine official statistics, farm-level data, feed-composition analysis, economic modelling, and environmental indicators to produce more detailed and regionally relevant recommendations.

15. Conclusion

The rising demand for animal products in India creates substantial opportunities for livestock farmers, feed manufacturers, processors, researchers, and agricultural service providers. However, the sector's long-term success will depend on whether growth in production is supported by reliable feed supplies, improved productivity, effective animal-health systems, and efficient market infrastructure.

Feed availability and quality are among the most important determinants of future performance. Increasing domestic fodder production, improving the utilization of crop residues, conserving seasonal feed surpluses, diversifying feed ingredients, and strengthening feed-quality assurance can help reduce supply risks. At the same time, genetic improvement, precision feeding, digital monitoring, better veterinary services, and climate adaptation can improve output and resilience.

Trade can complement domestic production, but dependence on imported feed ingredients may expose the sector to external price and supply shocks. A balanced approach should therefore combine stronger domestic capacity with diversified sourcing and predictable trade policies.

Ultimately, India's livestock-sector strategy should move beyond increasing animal numbers towards producing more efficiently, safely, and sustainably from available resources. Coordinated action by government agencies, research institutions, private enterprises, cooperatives, and farmers will be essential to meet future demand while protecting rural livelihoods, consumer welfare, and the environment.

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