

AN ECONOMIC ANALYSIS OF AI-INTEGRATED DAIRY FARMING IN KARNATAKA

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ABSTRACT

In Karnataka, dairy farming is essential to sustaining the rural economy by generating jobs, guaranteeing food security, and giving a consistent source of income to a diverse group of producers. The industry is experiencing a change with the implementation of Artificial Intelligence. In addition to addressing the ethical questions raised by the increasing usage of artificial intelligence in agricultural methods, this study provides a comprehensive economic analysis of dairy production, with a focus on cost structures, returns, and market trends. The study assesses the financial situation of dairy businesses of different sizes in different districts using secondary data from industry reports, government publications, and academic studies in 2024–2025. Clear economies of scale and significant regional variations are highlighted by the results of the baseline analysis, with higher net returns reported in southern regions. The study emphasizes the significant possibility that the digital divide will widen as a result of the possible effects of AI technologies like automated feed management and predictive health monitoring. Although lower production costs per liter can be advantageous for large-scale but small-scale farmers may find it difficult to implement these technologies due to significant entry constraints. Also, the study addresses ethical concerns pertaining to data ownership, transparency in milk pricing, and the potential for job loss in rural areas, particularly within the context of the Karnataka Milk Federation (KMF). It concludes that for AI to be a sustainable and responsible tool in dairy farming, it needs ethical standards and strong policy measures. Maintaining transparent governance systems and ensuring fair access to AI-driven technologies will be the key to protecting small producers and preserving the socioeconomic viability of the dairy farming industry in Karnataka.

INTRODUCTION

In India agriculture sector is gradually moving away from traditional farming methods and toward more data-driven methodologies, with the dairy industry leading the way. As dairy farming supports family nutrition, generates employment in communities, and offers consistent revenue, it remains an essential component of our rural economy. Dairy farming provides a consistent daily cash flow, which makes it a reliable source of income for lakhs of rural families, unlike seasonal crop farming. Dairy farming plays a major role in the agricultural system in Karnataka. Through the Karnataka Milk Federation, which markets its goods under the Nandini brand, the state has built a solid cooperative milk network.

Dairy farming has entered a new era of modernization in recent years, thanks to the development of Artificial Intelligence. The use of advanced computer systems that can analyze massive amounts of data, identify patterns, forecast, and aid in decision-making is part of artificial intelligence. AI is becoming more and more popular in the dairy industry for monitoring animal health, forecasting milk output, improving feed, detecting diseases,

automating milk quality testing, and managing supply chains. These applications can boost productivity while also cutting operational incapacabilities.

AI's economic significance in dairy farming is due to its direct influence on output, cost efficiency, and market coordination. Even little advancements in yield, disease control, and procurement procedures may result in large advantages when used on a broad scale in a cutthroat dairy sector. Adopting digital technologies has a significant economic impact on a state like Karnataka, where huge volumes of milk are collected every day. By using improved demand forecasting, effective stock management, and streamlined logistics, AI can ultimately benefit both producers and consumers.

In light of these considerations, this research analyses the economic effects of AI-driven dairy production in Karnataka, as well as the moral implications of such technological improvements. Because, improvements in agriculture should not be evaluated on the basis of profit, the issue is particularly relevant to the broader debate about AI, ethics, and human values. Additionally, it must take into account fairness, accountability, inclusivity, and the protection of at-risk communities. This study seeks to determine if AI may be a viable tool for agricultural development while simultaneously preserving the socioeconomic fabric of rural populations by concentrating on the dairy industry in Karnataka.

OBJECTIVES OF THE STUDY

The context of this study is to evaluate the increasing use of Artificial Intelligence in dairy farming in Karnataka and its effects on financial efficiency, rural livelihoods, and ethical governance. The goals of the research are given:

1. To assess the economic effects of including artificial intelligence into dairy farming in Karnataka. This goal is all about figuring out how AI affects the costs of production, profitability, milk output, and general financial success of dairy farming.
2. To evaluate how AI impacts market coordination, operational efficiency, and productivity. The research assesses how AI-based technologies increase milk production, logistics planning, feed control, early disease prediction and herd management.
3. To see the ethical ramifications of implementing AI in the dairy business. This includes investigating challenges surrounding data privacy, ownership of data given by farmers, transparency in milk grading and pricing, and accountability.
4. To check the barriers that small farmers encounter when attempting to use AI-enabled systems. The research focuses to identify restraints such as insufficient funding, low digital literacy, inadequate infrastructure, and limited access to technological resources.
5. To initiate policies for sustainable technological introduction. Based on the results, the study recommends steps pertaining to ethical regulatory frameworks, cooperative support systems, farmer training, and digital infrastructure in order to guarantee that the dairy industry practices to AI.

LITERATURE REVIEW

The academic conversation about dairy economics in Karnataka highlights a industry that is characterized by high input costs and structural variety. Prior research reveals diverse cost structures and profitability patterns that are importantly influenced by the size of the business and its geographic location.

Relekar et al. (2025) performed a thorough examination of the financial results of dairy industries, finding that larger dairy facilities regularly have reduced per-liter costs than their smaller competitors. Improved capital utilization and optimal feed and labor management are the main factors contributing to this cost efficiency.

To further emphasize this, Shobha et al. (2025) highlighted the unique weaknesses of smallholder dairy farms in both metropolitan and rural environments. Their research emphasizes that smallholders have unequal high labor and fodder expenses, while larger herd sizes produce considerably more revenue per cow because resources are used more efficiently.

Geographic discrepancies are another important factor. In a district-level study conducted in Kalaburagi, Patil et al. (2025) found that peri-urban farms have greater daily maintenance expenses than rural farms. This is mainly due to the scarcity of feed and higher labor cost intensity in areas near urban centers. Likewise, Khalandar et al. (2024) gave a spatiotemporal analysis of milk production, highlighting the varied development patterns throughout the state.

Although these studies offer a solid foundation for comprehending the economic baseline, there is a glaring hole in the literature when it comes to the ethical use of management information systems and AI to address these economic bottlenecks. Existing research focuses on the financial difficulties of smallholders but does not adequately address the ethical danger of deploying capital-heavy AI technologies that these at-risk groups cannot afford.

RESEARCH METHODOLOGY

Present study is mostly based on secondary data and uses a qualitative analytical methodology. The study does not include field surveys or primary data collection because its goal is to check both the economic effects and ethical considerations of artificial intelligence in dairy farming in Karnataka. Rather, it uses current literature, institutional reports, and recent industry trends to highlight trends in technology adoption, economic effects, and policy-related issues. Due to its coverage of not only quantitative variables like productivity, labour efficiency and market coordination but also larger themes like accessibility, transparency, and society inclusion, a qualitative approach is needed for this study.

DATA SOURCES

The study is based on a various secondary sources categories, as follows:

1.Scholarly Books (2024–2025)

This study is based on the theoretical research of recent academic research. To learn about improvements in the use of AI in dairy farming, journal articles, recent research papers, and conference proceedings published between 2024 and 2025. These sources offered information on topics including precision livestock farming, predictive analytics, automated herd monitoring, and AI-driven supply-chain management tools.

2. Reports from dairy and agricultural establishments

The use of AI in practice was understood through reports released by agricultural universities and dairy product companies. These include materials from dairy development organizations, agricultural colleges, cooperative unions, and the Karnataka Milk Federation. These publications include comprehensive data on milk procurement methods, technological improvements, manufacturing processes, and operational and expenditure issues. They aided

in connecting theoretical understandings with the actual framework of dairy farming in Karnataka.

3. Official Government Documents

Significant facts concerning the dairy industry's policy and economic environment were found in government publications. The Ministry of Fisheries, Animal Husbandry, and Dairying, the Karnataka government, and other organization's publications were reviewed. Statistical data on milk production, the contribution to rural income, the function of cooperatives, and policies that encourage digital agriculture. Also, they helped in determining how the implementation of AI aligns with the state's overall economy.

4. Sectoral Analyses of AI in Agriculture

New technological developments or improvements were tracked using industry reports and sector-specific studies on the use of AI in agriculture. These reports frequently discuss useful tools like logistics systems, automated milk quality testing, machine learning apps, and sensor-based monitoring. They also include estimates of the cost savings, productivity gains, and difficulties associated with implementing these technologies. This kind of data was useful in connecting larger AI tools to the dairy farming in Karnataka.

5. The Karnataka Milk Federation's latest advancements

Recent events surrounding the Karnataka Milk Federation and its Nandini brand were given particular attention. As actual instances of technological adoption, updates on inventory management, automated dispatch tracking, and AI-based product-counting systems were analyzed. These advancements demonstrate in practice how AI is starting to affect procurement, distribution and other factors of the dairy sector in Karnataka.

AI APPLICATIONS IN DAIRY FARMING

1. Predictive Health Management and Herd Monitoring

The monitoring of dairy herds and the management of animal health are becoming more and more dependent on artificial intelligence. Data systems and sensors powered by artificial intelligence are able to monitor variables like animal behavior, eating habits, body temperature, reproductive cycles, and the onset of diseases on a constant basis. Farmers are able to identify possible health concerns and respond appropriately by analyzing this data in real time. This not only minimizes losses due to disease but also enhances animal welfare and supports consistent milk output.

2. Feed Optimization and Yield Prediction

By analyzing a variety of variables, including breed type, weather circumstances, feed intake, and lactation cycles, AI also aids in improved feed management and yield prediction. Farmers can plan feeding regimens more effectively and estimate milk production more precisely by combining these variables. This results in more effective use of resource, less feed waste, and increase in the dairy farm productivity.

3. Logistics and Supply Chain Automation

By helping with route planning, milk collection scheduling, cold storage coordination, and delivery forecasting, AI is helping to enhance supply chain operations in the dairy industry. These improvements decrease in delays, minimize spoilage, and improve the flow of milk from farms to manufacturing hubs and markets. A recent example is the Karnataka Milk

Federation's project under the Nandini network, in which some facilities have implemented AI-based product-counting systems to improve inventory management.

4. Quality Control and Pricing Analysis

In addition to assessing parameters like fat concentration, solids-not-fat (SNF) content, and potential contamination, AI-based systems are also important for determining milk quality. During procurement, this enables faster, reliable, precise quality inspections. Because milk pricing in cooperative systems is highly dependent on quality indicators, these technologies have a direct impact on how payments are calculated, also to increase the efficiency and decreasing the human mistakes.

ECONOMIC ANALYSIS OF AI INTEGRATION

1. Lowering Manufacturing Expenses

By analysing the early diagnosis of illnesses, minimizing feed waste, lessening the need for manual labour, and providing proper veterinary treatment, AI contributes to lowering production costs in dairy farming. Farmers can cut unnecessary costs by better managing of resources and avoiding preventable losses. These advantages can cut the expense of producing each litre of milk for dairy farms.

2. Improved Productivity

AI-driven herd management results in better breeding cycles, higher milk output, and fewer unproductive days for animals. Farmers may make well-informed and prompt choices because to continuous monitoring of animal behaviour and health. This not only boosts milk production but also increases consistency, lowering the risks of illness, delayed breeding.

3. Economies of Scale

Larger dairy farms are more likely than smaller ones to gain from the usage of artificial intelligence. Data systems and smart sensors are examples of technologies that frequently need a large upfront expenditure. AI becomes more cost-effective for bigger farms because they can distribute these expenses over larger production volumes thanks to their greater access to resources and infrastructure. This results in economies of scale and an unequal distribution of benefits, with big producers having an advantage over marginal farmers.

4. Effective Supply Chain

By reducing waste, delays, and inefficiencies in transportation and storage, AI-powered systems enhance the efficiency of the supply chain. Furthermore, they aid in better aligning milk supply with market demand. Even modest gains in coordination can lead to significant overall cost reductions in Karnataka. The growing usage of digital technologies in enhancing the dairy industry is further highlighted by the current increase in milk procurement and infrastructure development throughout the district branches of the Karnataka Milk Federation.

CONCLUSION

Data-driven choices in production and distribution, made possible by Artificial Intelligence, have the potential to revolutionize dairy farming in Karnataka. Given the importance of dairy farming as a means of subsistence in rural areas, AI-based ideas are proving to be helpful tools for enhancing herd management, quality evaluation, logistics, and market coordination.

The research relates that AI can provide substantial economic advantages throughout the dairy value chain. These consist of higher output by improving animal health and breeding

management, lower operating costs by effective resource utilization, improved production and demand prediction, and increased supply chain efficiency through superior collection, storage, and distribution systems. Such improvements can result in increased productivity and more consistent operations for well-organized dairy farming businesses.

However, not all farmers benefit equally from these advantages of AI. Smallholder or marginal farmers usually struggle with problems like low digital literacy, insufficient funding, and a lack of adequate infrastructure. The adoption of AI might increase inequality in rural areas, create imbalances in access to information, and give larger dairy farms an advantage over smaller ones if proper safeguards and supportive regulations are not implemented by dairy farmers.

Maintaining a balance between innovation and responsibility is, therefore, important to the long-term success of AI in dairy farming. The future of AI in Karnataka's dairy industry is ultimately about making sure that technological advances support fair growth, uphold human values, and safeguard the interests of marginalized rural populations depending on dairy farming.

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