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Innovative Business Models and IoT-Driven Solutions for Smart Goat Farming Management

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ABSTRACT

This study examines how farmers can transition from traditional practices to a more data-centric approach, using IoT not just for operational efficiency but also as a strategic tool for creating new revenue streams. This research introduces the concept of smart goat farming ecosystems, where IoT technology, data analytics, and business model innovation converge to create a comprehensive and sustainable farm management approach. The qualitative research design will be used to understand the complex and context-dependent nature of IoT adoption in goat farming. This research has demonstrated that the integration of Internet of Things (IoT) technologies in goat farming has the potential to significantly improve operational efficiency, animal welfare, and productivity. The use of IoT devices for real-time health monitoring, automated feeding systems, and environmental control can assist farmers in optimizing resources, reducing waste, and ensuring better care for livestock. Future study can explore how IoT can be combined with artificial intelligence, blockchain, and big data analytics to enhance decision-making and operational efficiency in livestock farming.

Keywords: Business Models; IoT-Driven Solutions; Smart Goat Farming; Farmers; Sustainable Farm

Fields: Management; Agricultural Technology

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SDGs: Zero Hunger (2); Decent Work and Economic Growth (8); Industry, Innovation, and Infrastructure (9); Responsible Consumption and Production (12); Climate Action (13)

INTRODUCTION

Goat farming plays a crucial role in the agricultural economy, providing essential resources such as meat, milk, and fiber for communities worldwide (Lohani & Bhandari, 2021). Despite its economic significance, traditional goat farming faces several challenges, including inefficient resource management, high labor costs, and difficulties in monitoring animal health and productivity. In recent years, the integration of Internet of Things (IoT) technologies into agricultural practices, particularly livestock farming, has opened up new opportunities for enhancing operational efficiency, improving animal welfare, and optimizing resource use.

IoT-driven solutions, such as real-time health monitoring systems, automated feeding mechanisms, and environmental sensors, are revolutionizing the way goat farms are managed (Marchegiani et al., 2025). By embedding IoT technologies into the farming process, farmers can collect, analyze, and act upon vast amounts of data that enable smarter, more sustainable farming practices (Renaldo, Suhardjo, et al., 2024). The combination of these technologies with innovative business models has the potential to transform goat farming from traditional practices to smart, data-driven operations (Subeesh & Mehta, 2021).

This research explores the integration of IoT technologies in goat farm management, focusing on innovative business models that leverage these advancements to improve productivity, profitability, and sustainability (Suhardjo et al., 2024). The agricultural sector, particularly livestock farming, is undergoing a significant transformation due to the advent of smart farming technologies. Goat farming, traditionally seen as a low-tech industry, is now experiencing a shift towards automation and data-driven decision-making. The proliferation of IoT devices, such as wearable health trackers for livestock, automated feeding systems, and climate control sensors, is facilitating real-time monitoring and management.

Despite these advancements, the adoption of IoT in goat farming remains limited by several factors, including high upfront costs, technical complexity, and a lack of digital literacy among farmers (Sujarwanta et al., 2024). Additionally, many goat farmers continue to rely on traditional business models that do not fully capitalize on the potential of IoT technologies (Arya et al., 2021). This creates a gap between the technological potential and the current operational practices in goat farming.

The novelty of this research lies in its exploration of innovative business models specifically tailored for IoT-driven goat farming. While IoT applications in agriculture are well-documented, there is limited research on how these technologies can be integrated into new business models that optimize farm management and financial sustainability (Renaldo, 2024). This study examines how farmers can transition from traditional practices to a more data-centric approach, using IoT not just for operational efficiency but also as a strategic tool for creating new revenue streams.

Furthermore, this research introduces the concept of smart goat farming ecosystems, where IoT technology, data analytics, and business model innovation converge to create a comprehensive and sustainable farm management approach (Putri et al., 2022). By focusing on the specific needs and constraints of goat farming, this study contributes to the broader conversation about IoT in agriculture by offering practical insights into its application in a niche sector.

This research objectives are:

1. To analyze the potential impact of IoT integration on the operational efficiency and productivity of goat farms.
2. To explore innovative business models that leverage IoT technologies for sustainable and profitable goat farming operations (Renaldo, Junaedi, et al., 2024).
3. To assess the feasibility of adopting IoT-driven solutions in goat farming, considering factors such as cost, scalability, and technical support.
4. To identify key challenges and barriers to the widespread adoption of IoT in goat farming, including infrastructure, cost, and digital literacy.
5. To propose strategic recommendations for goat farmers to transition from traditional farming methods to IoT-enabled smart farming systems.

LITERATURE REVIEW

The Technology Acceptance Model (TAM)

To understand the adoption of IoT in goat farming, the Technology Acceptance Model (TAM), eloped by Davis (1989), offers valuable insights into the factors influencing technology adoption. The model posits that perceived ease of use and perceived usefulness are the primary factors that determine users' intention to adopt new technology (Renaldo et al., 2025). In the context of IoT in goat farming, farmers' perceptions of how easy it is to use IoT devices and how these technologies can directly benefit their operations (e.g., increasing efficiency, reducing costs, or improving animal health) will significantly impact their decision to adopt such technologies (Sevendy et al., 2023).

The TAM framework is particularly useful in understanding the adoption challenges in goat farming, where technological barriers like complex interfaces or lack of training could hinder IoT adoption. By focusing on improving the user experience and demonstrating the tangible benefits of IoT systems, IoT solution providers can address these concerns and increase adoption rates among farmers (Faldy et al., 2023).

IoT in Livestock Management

The application of IoT in agriculture, particularly in livestock management, focuses on automating processes and improving productivity (Jabrizal et al., 2025). According to Wolfert et al. (2017), IoT technologies enable farmers to collect data from various sensors and devices, including wearables for animal health monitoring, environmental sensors to track weather conditions, and a mated systems for feeding and watering. For goat farming, IoT solutions like smart collars or sensors that track vital signs such as temperature, heart rate, and activity level can help in early disease detection and prevention (Gutiérrez et al., 2020). This real-time data can also guide farmers in optimizing the health, growth, and reproduction cycles of goats, leading to improved production efficiency.

In addition, the integration of IoT in goat farming has been linked to better sustainability outcomes (Renaldo et al., 2022). By using data to optimize feeding, farmers can reduce waste and improve the quality of feed, which, in turn, reduces the environmental impact of farming practices (Chauhan et al., 2018). Furthermore, IoT can assist in monitoring animal welfare, ensuring that the living conditions of goats are consistently optimal, which directly affects productivity and product quality.

Business Models in Smart Agriculture

Business model innovation is critical when integrating new technologies into farming systems (Jabrizal, Jannah, et al., 2024). According to Osterwalder and Pigneur (2010), the Business Model Canvas (BMC) framework can be effectively applied to understand how IoT technologies can create value for farmers and stakeholders in the agricultural ecosystem. A study by Duffo and Kremer (2019) emphasizes that business models that focus on data-driven decision-making, such as subscription-based models for IoT services (e.g., data analytics or equipment monitoring), can increase farm profitability by optimizing farm operations.

In goat farming, innovative business models can include offering data-as-a-service (DaaS) for livestock health monitoring or providing technology platforms for farmers to access IoT solutions as a service rather than making upfront investments in expensive equipment. Additionally, integrating IoT can create opportunities for farmers to enter niche markets that require traceability, such as organic or premium goat products, through blockchain-based systems that track the entire farming process from birth to market (Seitz et al., 2020).

The transition to IoT-based business models also involves the creation of new revenue streams, such as offering consulting services or training farmers in digital farming practices, which can help build a smart farming ecosystem. Furthermore, integrating IoT in goat farming could lead to potential partnerships with agri-tech startups, technology providers, and supply chain companies to foster innovation and scale up operations (Hernandez et al., 2021).

Challenges in IoT Adoption in Goat Farming

Despite the potential benefits, the adoption of IoT in goat farming faces several barriers (Jabrizal, Dalil, et al., 2024). One key challenge is the high initial cost of IoT devices and infrastructure, which can be prohibitive for small-scale farmers (Rezir et al., 2009). Additionally, farmers' lack of digital literacy and limited access to reliable internet and mobile networks in rural areas can hinder the successful implementation of IoT solutions (Zhang et al., 2020).

Another challenge lies in the interoperability of IoT devices and systems. For instance, different manufacturers often use different communication protocols or platforms, which may not be easily integrated into a single cohesive system. This can complicate the process of scaling IoT solutions across various farms, especially in developing regions (Wirasti et al., 2021).

METHODOLOGY

Research Design

The qualitative research design will be used to understand the complex and context-dependent nature of IoT adoption in goat farming (Sekaran & Bougie, 2016). The research will involve collecting qualitative data through in-depth interviews, focus groups, and case studies (Creswell & Creswell, 2023). These methods will allow for a deeper exploration of the phenomena under study and provide insights into both the technical and business model perspectives.

In-depth Interviews: Semi-structured interviews will be conducted with key stakeholders, including goat farmers, IoT solution providers, and agricultural experts. This method will allow participants to discuss their experiences, challenges, and perceptions of IoT technologies and their potential impact on goat farming. The semi-structured format will provide flexibility for participants to elaborate on topics of interest while ensuring that key questions related to the study objectives are addressed.

Focus Groups: Focus group discussions will be held with groups of farmers who have adopted IoT technologies and those who have not. The goal of these discussions will be to gather insights into the factors that influence adoption, the perceived benefits and challenges of IoT integration, and the potential for IoT-driven business model innovations in goat farming. The focus group setting will encourage interaction and the sharing of ideas, providing a deeper understanding of the collective experiences of farmers.

Case Studies: A select number of farms that have successfully implemented IoT solutions will be studied in-depth through case studies. These case studies will focus on the specific technologies used, the integration process, the outcomes achieved, and the development of business models around IoT-based solutions. Case studies will provide real-world examples of IoT adoption in goat farming and help identify best practices and key success factors.

In-depth Interviews Data Collection

Participants: Interviews will be conducted with 15-20 goat farmers, 5-7 IoT solution providers, and 5-7 agricultural experts or consultants. Participants will be selected purposively to ensure a diverse range of

experiences, including both early adopters and those who have not yet implemented IoT technologies. This will ensure the research captures a variety of perspectives on the potential of IoT in goat farming.

Interview Questions: Semi-structured interview questions will cover the following key areas:

- Current practices in goat farm management and challenges faced.
- Perceptions of IoT technologies in goat farming (usefulness, ease of use, etc.).
- Barriers to IoT adoption, such as cost, technical infrastructure, and digital literacy.
- Potential business models for IoT-based goat farming (e.g., subscription-based services, data analytics).
- Success stories and challenges from farms that have already adopted IoT technologies.

The interviews will be audio-recorded (with participant consent) and transcribed for analysis.

Focus Groups Data Collection

Participants: Two focus groups will be organized with a total of 10-12 goat farmers (divided between adopters and non-adopters of IoT technologies). These farmers will be selected based on their geographical location, farm size, and experience with IoT technologies.

Discussion Topics: Focus group discussions will explore the following areas:

- Experiences with IoT technologies in farming and their perceived impact.
- Benefits and challenges associated with IoT adoption.
- Opportunities for developing new business models driven by IoT.
- Factors influencing adoption (e.g., costs, accessibility, technical support).
- Ideas for overcoming barriers to adoption.

Focus groups will be facilitated by a trained moderator to ensure productive discussions and will be recorded with consent.

Case Studies Data Collection

Selection Criteria: Three to five farms that have successfully adopted IoT technologies will be selected for in-depth case studies. These farms will be chosen based on their use of IoT solutions, such as animal health monitoring systems, automated feeding, or environmental sensors. Farms will be selected from diverse geographical areas to ensure a range of operational contexts.

Data Collection: Case studies will involve site visits, direct observations, and interviews with farm managers and staff. The data collection will focus on:

- The specific IoT technologies used and how they are integrated into farm management practices.
- The business model and revenue streams associated with IoT solutions (e.g., data-driven services or consulting).
- Outcomes related to farm productivity, animal health, and financial performance.
- Challenges faced during IoT adoption and integration.

The findings from these case studies will provide concrete examples of how IoT technologies can be applied in goat farming and will help identify best practices and successful business models.

Sampling Strategy

Purposive Sampling will be used to select participants who can provide rich and relevant data for the research. The selection criteria for participants will include:

- Goat Farmers: Farmers who have experience with IoT technologies and those who do not, ensuring a range of adoption experiences.
- IoT Solution Providers: Providers who supply technologies for livestock monitoring, farm automation, and data analytics.
- Agricultural Experts: Consultants or researchers with knowledge of IoT applications in farming and agricultural business models.

The case study farms will be selected based on their successful integration of IoT solutions into their operations.

Data Analysis

The collected qualitative data will be analyzed using thematic analysis. This process involves identifying, analyzing, and reporting patterns (themes) within the data. The steps involved in the analysis will be as follows:

- Transcription and Familiarization: Interview and focus group recordings will be transcribed verbatim. The researcher will read and re-read the transcripts to familiarize themselves with the data.
- Coding: Data will be coded using a deductive approach based on the research objectives (e.g., barriers to IoT adoption, business model innovation, impact on farm performance). New themes may also emerge inductively as the analysis progresses.
- Theme Identification: Themes related to IoT adoption challenges, business model innovation, and the impact of IoT on farm management will be identified and organized into categories.
- Case Study Synthesis: Case study data will be analyzed to identify common trends and differences in IoT adoption, integration strategies, and business models. The analysis will also focus on the outcomes of IoT implementation.

The software tool NVivo will be used to assist with the organization, coding, and analysis of the qualitative data.

Ethical Considerations

All participants will be informed about the study's objectives, the voluntary nature of participation, and their right to confidentiality. Informed consent will be obtained prior to participation. The identities of all participants and farms will be kept confidential. Data will be anonymized before publication, and only aggregated findings will be shared. The research process, including data collection and analysis methods, will be fully transparent, ensuring the validity and reliability of the study's findings.

RESULT AND DISCUSSION

Result

In-depth Interviews

Farmers' Perspectives: From the interviews with goat farmers, a variety of experiences with IoT adoption emerged. Those who had implemented IoT technologies primarily used solutions for animal health monitoring (e.g., RFID tags, GPS trackers, and temperature sensors). They highlighted the following key findings:

- Improved Animal Welfare: Many farmers reported significant improvements in managing animal health, as IoT technologies allowed for real-time tracking of vital signs, leading to early detection of illness and better health management.
- Labor Efficiency: Automation tools, like automatic feeders and watering systems, reduced the need for manual labor, thus improving operational efficiency.
- Challenges to Adoption: The main barriers to IoT adoption included high initial investment costs, lack of technical infrastructure in rural areas, and the digital literacy gap among farmers. Several farmers mentioned the difficulty of training their staff to use the new technologies effectively.
- Perceptions of Usefulness: IoT was largely seen as useful for managing large-scale farms, with data analytics being the most appreciated feature, helping farmers make data-driven decisions regarding breeding cycles, feed optimization, and overall farm management.

IoT Solution Providers' Insights: IoT solution providers emphasized the importance of affordable and scalable solutions for smaller-scale goat farmers. Their insights included:

- Customization of Solutions: Many providers emphasized that successful IoT adoption requires tailored solutions, as goat farming practices vary greatly depending on geography and farm size.
- Business Model Innovation: Providers highlighted the subscription-based services model for IoT technologies, where farmers pay for continuous monitoring and access to farm analytics rather than a one-time purchase. This model reduces the upfront cost barrier for farmers.

- Agricultural Experts' Observations: Experts noted that IoT adoption in agriculture is still in its early stages, with many farmers unaware of the full potential of these technologies. They suggested that policy support, such as government incentives and subsidies, could significantly increase adoption rates. They also stressed the need for training and education in digital skills to bridge the literacy gap.

Focus Groups

Adopters vs. Non-adopters: The focus group discussions revealed stark differences between adopters and non-adopters of IoT technologies.

- Adopters: Farmers who had already implemented IoT systems discussed the improvements in productivity and operational efficiency they experienced. They also noted how IoT allowed for better resource management, especially in terms of feed and water usage. These farmers expressed satisfaction with the ability to monitor animal health remotely, making it easier to manage large herds.
- Non-adopters: Farmers who had not yet adopted IoT technologies primarily cited financial constraints and uncertainty about the return on investment (ROI) as their main concerns. Some also expressed skepticism about the complexity of IoT solutions and were unsure about how to integrate these technologies into their existing farming practices.

The focus groups also highlighted the growing interest in innovative business models such as data-driven services for small-scale farmers, offering IoT-as-a-Service where farmers can access monitoring and analytics without heavy upfront costs.

Case Studies

Case Study Farms: The case studies provided concrete examples of how IoT technologies can be successfully integrated into goat farm management. Key findings from the case studies include:

- Technological Integration: In farms that successfully adopted IoT, a variety of systems were implemented, including real-time health monitoring sensors, automated feeding and watering systems, and environmental control systems. These systems allowed farmers to achieve better monitoring of environmental conditions (e.g., temperature, humidity) and animal health, leading to improved productivity and cost savings.
- Business Models: Several farms had implemented innovative business models around IoT technologies, such as offering farm data insights to other farmers for a fee or partnering with agricultural technology companies to offer subscription-based analytics services. This shift towards data-driven business models was seen as a way to generate additional revenue streams while enhancing farm performance.
- Outcomes: Farms that adopted IoT experienced increased operational efficiency, better resource allocation, and improved animal welfare. Financial performance improved due to optimized feed and labor costs, and farms were able to scale operations with fewer human resources. However, farms that had yet to adopt IoT technologies faced challenges related to resource management and lack of real-time monitoring.

Discussion

The findings from this research provide a comprehensive understanding of the potential impact of IoT adoption on goat farming and highlight the novel integration of business models driven by IoT technologies. The discussion will now address the research objectives and emphasize the novelty of the study.

IoT Adoption and Its Impact on Goat Farming

The study confirms that IoT technologies have a significant potential to transform goat farming practices. The main advantages highlighted by farmers include improved productivity, enhanced animal welfare, and cost savings. IoT technologies, particularly in health monitoring and environmental control, can help farmers detect issues earlier, reduce waste, and optimize resource use. These findings are in line with previous studies on IoT applications in agriculture but are specifically contextualized within the goat farming sector.

However, significant barriers remain for widespread adoption, including high initial costs, lack of digital literacy, and insufficient technical infrastructure. These barriers are consistent with findings from broader agricultural technology adoption studies, underlining the need for tailored solutions and capacity-building initiatives to support farmers in implementing IoT solutions effectively.

Novelty of IoT-Driven Business Models in Goat Farming

A key finding of this study is the emergence of new business models driven by IoT adoption in goat farming. The research highlights IoT-as-a-Service and data analytics subscription models as innovative approaches to make IoT technologies more accessible to small-scale farmers. This novel approach could help

overcome the financial barriers to IoT adoption, as it shifts the focus from large upfront investments to more sustainable, subscription-based models that align with farmers' cash flow cycles.

Moreover, the integration of data-driven decision-making into farming practices represents a new paradigm in farm management. Farmers are not only using IoT for operational efficiency but also leveraging data insights to develop new revenue streams, such as offering farm data services to other farmers or collaborating with agri-tech companies. This aspect of the study offers a fresh perspective on how business models in agriculture can evolve through digital transformation.

Canvas Business Model

Canvas business model level 1.

Figure 1. Canvas Business Model Level 1

Canvas business model level 2 (Link)

Figure 2. Canvas Business Model Level 2

CONCLUSION

Conclusion

This research has demonstrated that the integration of Internet of Things (IoT) technologies in goat farming has the potential to significantly improve operational efficiency, animal welfare, and productivity. The use of IoT devices for real-time health monitoring, automated feeding systems, and environmental control can assist farmers in optimizing resources, reducing waste, and ensuring better care for livestock. Moreover, the development of innovative business models, such as IoT-as-a-Service and data analytics subscriptions, can mitigate the financial barriers to adoption, making these technologies more accessible to small-scale farmers. Despite these advancements, challenges related to high initial costs, digital literacy, and technical infrastructure persist, which may limit the broader adoption of IoT in the sector. Nevertheless, the results suggest that IoT adoption could transform traditional goat farming into a more sustainable and data-driven industry.

This study contributes to the growing body of knowledge on IoT in agriculture, offering valuable insights into how these technologies can be applied specifically within the goat farming sector. It also presents a unique perspective on how IoT can drive new business models that offer long-term sustainability and profitability for farmers. However, the study also identifies areas where further improvements are needed, particularly in terms of addressing barriers to adoption and increasing digital literacy among farmers.

Implication

Theoretical Implications. This study expands the existing knowledge on the application of IoT in agriculture, particularly in goat farming. By demonstrating how IoT can enhance productivity, resource efficiency, and livestock welfare, the research provides a foundation for future studies on smart farming and digital transformation in agriculture. Additionally, the findings contribute to the growing discourse on sustainable farming practices and how technology can facilitate their implementation.

Practical Implications. The results indicate that IoT technologies can significantly improve the efficiency of goat farming operations by automating tasks such as feeding, health monitoring, and environmental control. This can lead to increased productivity, reduced operational costs, and better animal welfare. Farmers, agribusinesses, and policymakers can use these insights to develop strategies for scaling IoT adoption in livestock farming.

Policy Implications. The study highlights the need for policies that support the adoption of IoT in agriculture, particularly for small and medium-scale farmers. Governments and agricultural agencies should consider providing subsidies, training programs, and infrastructure improvements to facilitate the transition to smart farming. Regulations that ensure data security and ethical use of IoT in farming should also be considered.

Business Implications. The research suggests that new business models, such as IoT-as-a-Service and data-driven decision-making platforms, can create opportunities for agribusinesses and technology providers. Companies offering IoT solutions can explore subscription-based or pay-per-use models to make the technology more accessible to farmers.

Limitation

Despite its contributions, this study has several limitations that should be acknowledged:

1. Sample and Scope Limitations: The research is limited to a specific geographic region and farming context, which may affect the generalizability of the findings to other agricultural sectors or locations with different environmental and economic conditions.
2. Technological Constraints: The study focuses on existing IoT technologies, which may evolve over time. Future advancements in AI, machine learning, and automation could further enhance the efficiency of IoT-based farming beyond what was examined in this study.
3. Economic and Social Barriers: While IoT presents clear advantages, high initial costs, digital literacy challenges, and infrastructure limitations may restrict adoption among small-scale farmers. These socioeconomic factors were not extensively explored in this research.
4. Limited Longitudinal Data: The study provides a snapshot of IoT adoption in goat farming but does not account for long-term trends or sustainability issues that may arise over extended periods of use.

Recommendation

Based on the findings of this study, the following recommendations are proposed:

- For Farmers: Farmers should consider adopting IoT technologies gradually, starting with cost-effective solutions such as smart sensors for health monitoring, before scaling up to fully automated systems.
- For Policymakers: Governments and agricultural agencies should provide subsidies, digital literacy training, and infrastructure development to support IoT adoption among small and medium-sized farmers.
- For Technology Providers: IoT solution providers should explore flexible business models, such as leasing and subscription-based services, to make smart farming technologies more accessible.
- For Agricultural Institutions: Universities and research centers should collaborate with farmers and industry stakeholders to develop user-friendly IoT solutions tailored to local farming conditions.
- For Investors and Agribusinesses: Investment in IoT-based farming initiatives should focus not only on technology development but also on training and support services to ensure successful adoption and long-term sustainability.

Future Research

To build upon the findings of this study, future research should explore:

- Longitudinal Studies: Examining the long-term impact of IoT adoption on farm productivity, cost efficiency, and sustainability.
- Comparative Studies: Investigating IoT adoption in different agricultural sectors, such as poultry, dairy, or crop farming, to understand sector-specific challenges and opportunities.
- Economic Feasibility Analysis: Assessing the return on investment (ROI) and cost-benefit analysis of IoT implementation in small-scale and large-scale farms.
- Social and Behavioral Aspects: Studying the attitudes, perceptions, and challenges faced by farmers in adopting IoT, with a focus on digital literacy and willingness to innovate.
- Integration with Emerging Technologies: Exploring how IoT can be combined with artificial intelligence, blockchain, and big data analytics to enhance decision-making and operational efficiency in livestock farming.

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