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Strengthening Goat Productivity and Health through Smart Technology and Digital Management Assistance

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ABSTRACT

Goat farming plays a vital role in supporting rural livelihoods and local food security; however, small-scale goat farmers often face challenges related to low productivity, limited disease detection, and weak farm management practices. This community service program aims to strengthen goat productivity and health through the integration of smart technology and digital management assistance. The program adopts a participatory, technology-assisted empowerment approach involving smallholder goat farmers and local institutions. Key interventions include the implementation of IoT-based goat weighing systems, technology-supported health monitoring, and digital farm management tools, accompanied by structured training and continuous mentoring. The program is implemented through five stages: socialization and needs assessment, capacity building, smart technology deployment, digital management assistance, and monitoring and evaluation. The results indicate improvements in the accuracy of livestock monitoring, adoption of data-driven feeding and health management practices, and enhanced farmer capacity to utilize digital tools. In addition, the program contributes to institutional strengthening through collective learning and standardized management practices. Overall, the findings demonstrate that the integration of smart technology with continuous digital management assistance provides a practical and sustainable model for community-based goat farming development and rural economic empowerment.

Keywords: Goat Farming; Smart Technology; Internet of Things (IoT); Digital Farm Management; Community Empowerment

Fields: Community Service; Rural Development; Smart Agriculture; Livestock 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)

INTRODUCTION

Goat farming plays a strategic role in supporting rural livelihoods and local food security, particularly in developing regions where small-scale livestock systems dominate agricultural activities (Jahrizal, M Dalil, et al., 2025). Goats are valued for their adaptability, relatively low production costs, and multifunctional outputs, including meat, milk, and organic fertilizer (Junaedi, Panjaitan, et al., 2025). Despite this potential, many smallholder goat farmers continue to face persistent challenges related to low productivity, limited disease detection capacity, and inefficient farm management practices (Junaedi, Renaldo, Susanti, et al., 2024).

In many rural communities, goat production is still managed using traditional methods that rely heavily on visual observation and manual record-keeping (Dalil et al., 2024). The absence of accurate and routine weight measurement systems makes it difficult for farmers to objectively monitor growth performance, optimize feeding

strategies, and determine optimal selling times (Rahman et al., 2024). Similarly, early detection of animal health problems remains limited (Arlia et al., 2025), increasing the risk of disease outbreaks, productivity losses, and livestock mortality (Jahrizal, M. Dalil, et al., 2025). These constraints are often exacerbated by low levels of digital literacy and the lack of integrated management systems that support data-driven decision-making (Suhardjo et al., 2023).

Recent advances in smart technology, including the Internet of Things (IoT) (Junaedi, Suhardjo, Andi, et al., 2024) and artificial intelligence (AI) (Renaldo & Veronica, 2024), offer new opportunities to address these challenges in small-scale livestock farming. Smart weighing systems, health monitoring tools, and digital dashboards enable real-time data collection, early disease detection, and systematic farm management. However, the successful adoption of such technologies requires not only appropriate tools but also structured assistance, training, and continuous mentoring to ensure that farmers are able to operate, interpret, and utilize digital information effectively.

In response to these challenges, this community service program aims to strengthen goat productivity and health through the implementation of smart technology combined with digital management assistance. The program focuses on introducing IoT-based goat weighing systems, technology-supported health monitoring, and digital farm management practices, accompanied by hands-on training and mentoring for farmers and local institutions. By integrating technology adoption with capacity building, this initiative seeks to improve livestock productivity, enhance animal health management, and support the sustainable development of community-based goat farming systems.

LITERATURE REVIEW

Goat Productivity and Health Management in Small-Scale Farming

Goat farming is widely recognized as a key component of smallholder livestock systems due to its resilience, low capital requirements, and contribution to household income and food security (Sarma, 2024). Studies indicate that goats play an essential role in rural economies, particularly in developing regions, by providing meat, milk, and livelihood diversification opportunities. However, productivity levels in small-scale goat farming remain relatively low, primarily due to suboptimal feeding practices, inadequate health monitoring, and weak farm management systems.

Previous research highlights that growth performance and animal health are strongly influenced by the farmer's ability to monitor body weight, detect diseases early, and maintain accurate production records. In traditional farming systems, these activities are often conducted subjectively, relying on visual assessment and experience-based judgment. Such approaches limit the accuracy of decision-making related to feeding efficiency, breeding cycles, and market timing, ultimately reducing overall farm performance (Nyoto, Sudarno, et al., 2023).

Smart Technology in Livestock Farming

The application of smart technology in livestock farming has expanded rapidly with the development of the Internet of Things (IoT), sensor-based monitoring systems, and artificial intelligence (Susanti et al., 2026). In the context of goat farming, smart weighing systems enable automated and routine measurement of animal body weight, providing objective data that supports growth monitoring and feed optimization. Similarly, sensor-based and image-based technologies have been increasingly used to support early detection of animal health issues, reducing the risk of disease spread and mortality.

Empirical studies show that IoT-based livestock monitoring systems improve data accuracy, reduce labor intensity, and enhance farmers' capacity to respond promptly to changes in animal conditions. However, the literature also emphasizes that technological effectiveness depends on system simplicity, affordability, and contextual suitability, particularly for small-scale farmers. Without appropriate adaptation, advanced technologies may remain underutilized or abandoned after initial implementation.

Digital Management Systems for Smallholder Livestock Enterprises

Digital management systems have been shown to improve farm efficiency by integrating production, health, and financial data into a single platform (Junaedi, Renaldo, Yovita, et al., 2024). Digital dashboards and mobile-based applications enable farmers to record livestock data systematically, track performance trends, and support planning and evaluation processes. In smallholder settings, digital management tools are associated with improved transparency, better resource allocation, and stronger institutional management when adopted by farmer groups or village enterprises.

Nevertheless, the literature identifies digital literacy as a critical barrier to adoption. Many smallholder farmers lack experience with digital tools, limiting their ability to interpret data and translate information into practical decisions. As a result, digital management systems require not only technical deployment but also continuous guidance and mentoring to ensure effective use and long-term sustainability.

Community-Based Technology Adoption and Capacity Building

Community service and empowerment-oriented studies emphasize that technology transfer in rural areas is most effective when combined with participatory approaches and capacity-building initiatives (Nyoto et al., 2024). Training, mentoring, and hands-on assistance are essential to bridge the gap between technology availability and practical utilization. Programs that integrate technology introduction with farmer education and institutional strengthening tend to produce more sustainable outcomes than technology-only interventions.

The literature further suggests that involving local institutions, such as farmer groups, cooperatives, or village-owned enterprises, enhances collective learning, accountability, and scalability. Digital management assistance plays a strategic role in enabling these institutions to adopt data-driven practices while maintaining local knowledge and social values.

Research Gap and Relevance to Community Service

While numerous studies have examined smart technology applications in livestock farming, most focus on large-scale or commercial operations. There remains a limited body of applied literature addressing integrated smart technology and digital management assistance specifically designed for small-scale goat farmers within community empowerment programs. Existing studies often emphasize technological performance rather than practical adoption, capacity building, and institutional integration.

Therefore, this community service initiative addresses a critical gap by combining smart technology implementation with structured digital management assistance tailored to smallholder goat farming contexts. By aligning technological innovation (Mukhsin et al., 2025) with farmer mentoring and local institutional support, the program contributes to applied knowledge and offers a replicable model for strengthening goat productivity and health in rural communities.

METHODOLOGY

Approach and Program Design

This community service program adopts a participatory and technology-assisted empowerment approach, combining smart technology implementation with continuous digital management assistance (Sekaran & Bougie, 2016). The methodology is designed to ensure that technological interventions are not only introduced but also effectively adopted and sustained by the community. The program integrates technical deployment, capacity building, mentoring, and evaluation to support small-scale goat farmers in improving productivity and animal health.

The target beneficiaries are smallholder goat farmers and local institutions involved in livestock management. Farmers are actively engaged throughout the program as participants, co-learners, and end-users of the technology, ensuring relevance and ownership of the intervention.

Stages of Implementation

The methodology is implemented through five main stages:

1. Socialization and Needs Assessment

The initial stage involves socialization activities and field assessments conducted in collaboration with local stakeholders. This stage aims to:

- Introduce the objectives, scope, and benefits of the program;
- Identify key challenges related to goat productivity, health management, and farm administration;
- Assess farmers' technological readiness and digital literacy levels.

Data are collected through observations, focused group discussions, and informal interviews with farmers and local leaders to ensure that the program is tailored to community needs.

2. Training and Capacity Building

Capacity-building activities are conducted through hands-on training sessions covering:

- Basic concepts of smart livestock management;

- Operation of IoT-based goat weighing systems;
- Introduction to technology-supported health monitoring practices;
- Fundamentals of digital farm management, including data recording and interpretation.

Training methods emphasize experiential learning, simple demonstrations, and practical exercises to accommodate varying literacy and technology familiarity among participants.

3. Smart Technology Implementation

At this stage, smart technologies are installed and tested in the field. The implementation includes:

- Deployment of IoT-based goat weighing systems for routine weight monitoring;
- Introduction of digital tools to support health observation and early disease identification;
- Integration of collected data into a digital management platform or dashboard.

Farmers are guided directly during the initial operation phase to ensure accurate data entry and system functionality.

4. Digital Management Assistance and Mentoring

Following technology deployment, continuous digital management assistance is provided through mentoring and on-site support. This stage focuses on:

- Assisting farmers in using digital data for feeding, health, and management decisions;
- Supporting regular data recording and interpretation;
- Strengthening basic managerial practices such as production tracking and simple financial recording.

Mentoring activities are conducted periodically to reinforce learning and address operational challenges encountered by farmers.

5. Monitoring, Evaluation, and Sustainability

Monitoring and evaluation are conducted to measure program effectiveness and identify areas for improvement. Key indicators include:

- Changes in goat weight gain and health condition;
- Frequency and accuracy of digital data recording;
- Farmers' ability to independently operate the technology and management system.

To ensure sustainability, selected farmers or local representatives are prepared as local facilitators who can continue mentoring activities after the program concludes. Recommendations for scaling and replication are formulated based on evaluation results.

Data Collection and Analysis

Data collected during the program include quantitative data (e.g., goat body weight, health records, usage frequency of digital tools) and qualitative data (e.g., farmer perceptions, learning outcomes, and adoption challenges). Descriptive analysis is used to evaluate improvements in productivity and management capacity, while qualitative insights support understanding of adoption dynamics and community impact.

Ethical Considerations and Community Participation

The program is implemented with respect for local values, animal welfare standards, and community norms. Participation is voluntary, and all activities are conducted transparently in collaboration with community stakeholders. Emphasis is placed on mutual learning and respect between the service team and community members (Renaldo et al., 2024).

RESULTS AND DISCUSSION

Implementation Outcomes of Smart Technology

The implementation of smart technology in goat farming resulted in significant improvements in the accuracy and consistency of livestock monitoring. The installation of an IoT-based goat weighing system enabled routine and objective measurement of animal body weight, replacing previous estimation-based practices. Farmers were able to record weight data more frequently, allowing them to monitor growth patterns and identify deviations at an early stage.

The use of technology-supported health observation tools also contributed to improved awareness of animal health conditions. Farmers reported a better ability to recognize early signs of health problems, which supported timely intervention and reduced the risk of productivity losses. These outcomes demonstrate that smart technology can function effectively in small-scale farming contexts when systems are designed to be simple and user-friendly.

Improvement in Goat Productivity and Health Management

Following the introduction of smart monitoring tools, improvements were observed in goat productivity and health management practices. Regular weight monitoring enabled farmers to adjust feeding strategies based on growth data rather than intuition alone. This data-driven approach contributed to more efficient feed utilization and more predictable growth performance.

In terms of health management, early identification of abnormal weight changes and visible health symptoms encouraged preventive action. Farmers became more proactive in managing animal health, reducing dependency on reactive treatment. These findings support existing literature indicating that data-based livestock management enhances productivity and animal welfare, even in smallholder systems.

Adoption of Digital Management Practices

The introduction of digital management assistance played a crucial role in translating technology use into practical farm management improvements. Farmers gradually adopted digital recording practices for production and basic management data. Although initial difficulties were encountered, particularly among participants with limited digital experience, continuous mentoring helped overcome these barriers.

The integration of digital records supported better organization and transparency in farm operations. Farmers were able to review historical data, compare performance across periods, and make more informed decisions. This outcome highlights the importance of combining technology deployment with sustained assistance rather than one-time training.

Community Capacity Building and Institutional Strengthening

Beyond individual farmers, the program contributed to broader community capacity building. Collective training and mentoring activities encouraged knowledge sharing among farmers and strengthened cooperation within farmer groups or local institutions. The involvement of local facilitators enhanced peer learning and increased confidence in using digital tools.

The results indicate that digital management assistance also supported institutional strengthening by promoting standardized data recording and shared responsibility (Junaedi, Hestia, et al., 2025). This aligns with community empowerment literature emphasizing that collective engagement enhances technology adoption and sustainability.

Discussion

The results demonstrate that strengthening goat productivity and health requires an integrated approach that combines smart technology with human capacity development. While technology provided objective data and monitoring capabilities, digital management assistance ensured that farmers could interpret and utilize information effectively.

These findings suggest that community service programs should prioritize usability, continuous mentoring, and institutional involvement to maximize impact. The program provides practical evidence that smart technology can be successfully adapted for small-scale goat farming when supported by participatory and capacity-building strategies. Moreover, the approach offers a replicable model for community-based livestock development that balances technological innovation with social empowerment.

CONCLUSION

Conclusion

This community service program demonstrates that the integration of smart technology and digital management assistance can effectively strengthen goat productivity and health in small-scale farming systems. The introduction of IoT-based monitoring tools improved the accuracy of growth and health observation, while continuous mentoring enabled farmers to adopt data-driven management practices. Beyond technological outcomes, the program contributed to enhanced farmer capacity, improved management awareness, and stronger collective engagement within the community. Overall, the initiative confirms that technology-assisted

empowerment, when combined with participatory support, offers a practical and sustainable approach to community-based livestock development.

Implications

The results of this program have several important implications. Practically, the findings highlight that smart livestock technologies can be successfully applied in smallholder contexts when accompanied by appropriate training and ongoing assistance. Institutionally, the program underscores the role of local organizations and farmer groups in facilitating technology adoption and sustaining digital management practices. From a development perspective, the initiative supports broader goals related to food security, rural economic resilience (Nyoto, Renaldo, et al., 2023), and digital transformation in agriculture. These implications suggest that community service programs can serve as effective bridges between technological innovation and grassroots agricultural development.

Limitations

Despite its positive outcomes, this program has several limitations. The scale of implementation was limited to a small number of farmers and livestock units, which may constrain the generalizability of the results. The duration of assistance was relatively short, limiting the ability to observe long-term productivity trends and behavioral changes. Additionally, variations in digital literacy among participants affected the pace of technology adoption, requiring differentiated mentoring approaches. These limitations should be considered when interpreting the program outcomes.

Recommendations

Based on the implementation experience, several recommendations are proposed. First, future programs should extend the duration of mentoring to reinforce digital management practices and ensure sustained adoption. Second, capacity-building activities should be tailored to different levels of digital literacy to enhance inclusivity. Third, collaboration with local institutions should be strengthened to support collective management and long-term sustainability. Finally, gradual integration of additional smart features, such as feeding optimization or market linkage tools, may further enhance program impact.

Future Community Service

Future community service initiatives should focus on scaling and replicating this integrated approach in other rural areas with similar livestock systems. Expanding the program to include broader value-chain components, such as digital marketing and cooperative-based management, could increase economic benefits for farmers. Longitudinal community service programs that combine technology deployment, institutional strengthening, and continuous learning are recommended to deepen impact and contribute to sustainable rural development. This approach has the potential to become a model for technology-driven community empowerment in the livestock sector.

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