



The Effectiveness of Reproductive Innovations in Female Goats: A Qualitative Analysis of Productivity and Economic Sustainability in Goat Farming

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Abstract

Background: Goat farming in Indonesia plays a crucial role in enhancing rural incomes and improving food security. This study investigates the effectiveness of reproductive innovations, including artificial insemination (AI) and hormone synchronization, in boosting productivity and economic sustainability in goat farming. **Purpose:** This research aims to analyze the impact of artificial insemination (AI) and hormone synchronization on the reproductive efficiency of goats, to identify factors influencing the adoption of these technologies among small-scale goat farmers in Samarinda, Indonesia, and to determine the role of social capital in overcoming adoption barriers. **Methods:** This study uses a qualitative research approach with a survey method through in-depth interviews, focus group discussions (FGDs), and participatory observations. The sample consists of 15 small-scale goat farmers in Samarinda, Indonesia. Data were analyzed using thematic analysis to identify key challenges and benefits associated with the adoption of reproductive technologies. **Results:** The findings show that artificial insemination (AI) and hormone synchronization significantly increased reproductive efficiency, resulting in improved offspring production and reduced kidding intervals. However, adoption rates were constrained by high initial costs, limited technical support, and socio-economic barriers such as low education levels and restricted market access. Farmers who were part of cooperative networks achieved better outcomes, demonstrating the importance of social capital in overcoming adoption challenges. **Conclusion:** Based on the research findings, reproductive technologies have the potential to enhance goat farming productivity and economic sustainability. However, their successful implementation requires supportive policy interventions, including farmer training, improved access to resources, and strengthened market linkages to facilitate wider adoption. **Keywords:** Economic sustainability; goat productivity; reproductive innovations

INTRODUCTION

Goat farming in Indonesia, especially in urban areas like Samarinda in East Kalimantan, holds great potential to improve rural incomes and assure food security among urban populations. With continuing urbanization, the demand for fresh, locally produced animal products, such as meat and milk, is rising. Goats are well known for their hardiness and ability to thrive in a wide variety of environments,

conferring very high values to smallholder farming systems due to the lower space needs and higher versatility compared with large livestock (Suleiman et al., 2020). Still, the productivity rates of goat farming in Samarinda are handicapped by problems related to the reproductive management of goats and the limited availability of progressive breeding technologies, besides the financial constraints the farmers face (Mokhtari et al., 2021).

Reproductive efficiency in goats is one of the important factors that determine the productivity of goats. Such technologies artificial insemination, hormonal synchronization, and genetic selection are proven to increase reproductive efficiency by expanding the conception rates and hence decreasing the kidding interval, with better genetic selection of offspring (Alhaji et al., 2020). The challenges facing smallholder farmers are partly addressed by these technologies, hence allowing improvements in herd performance and productivity. In metropolitan settings like Samarinda, where land is limited and farm sizes are small, improvements in reproductive technologies can help improve the genetic potential of the livestock population without requiring large infrastructure investments (Osei et al., 2022). Also, the ability to align reproductive cycles will be useful to ensure that birthing occurs during more favorable seasonal times, thus aligning production with market demand and improving economic outcomes for producers (Zaman et al., 2021).

The adoption of reproductive innovations in goat farming at Samarinda is a very problematic issue. At the same time, its advantages are obvious: high initial costs, difficulties in accessing specialized technical expertise, and a lack of infrastructure that would enable the use of reproductive technologies. Most goat farmers in Samarinda, especially those from rural areas, are hesitant to use artificial insemination or hormonal synchronization due to economic constraints coupled with a lack of appreciation for the benefits that would result in their adoption (Nkrumah et al., 2023). There is also a lack of technical knowledge on the proper use of reproductive technologies, such as artificial insemination techniques and hormonal therapies, among local farmers, which further impedes the effectiveness of the technologies (Alhaji et al., 2020). This problem is exacerbated by the limited number of qualified veterinarians and artificial insemination technicians in Samarinda, which makes it very difficult for farmers to avail themselves of the help and services required to apply this technology appropriately.

The main challenge to the smallholder farmers in Samarinda remains economic sustainability. This sector of goat farming has often been characterized by limited access to capital and very few marketing opportunities, coupled with fluctuating prices for goat meat and milk. The potential for innovations in reproduction to contribute to improved economic viability of goat farming includes increased productivity, reduced breeding management costs, and improved genetic quality of the herd, which will eventually translate into premium prices for high-quality goats (Suleiman et al., 2020). Improved reproductive management practices can also reduce the kidding interval, thus increasing the number of offspring produced per female goat and impacting farm profitability directly (Osei et al., 2022). The reproductive improvement allows farmers to control the time of kidding and thus plan the availability of goat products to meet market demand, thereby improving the marketability and income stability of farmers (Zaman et al., 2021).

However, mere technical effectiveness is not often the basis for the adoption of these technologies. In addition to the perception among farmers of reproductive

innovations, local socio-economic conditions also become important determinants of performance, including the availability of ancillary services such as veterinary and extension services in a place like Samarinda, where such agricultural extension services are likely to be limited. For instance, the introduction of such reproductive innovations requires an agronomic-related knowledge-sharing arrangement to address its limitations. The introduction of reproductive innovations, therefore, needs to be embedded in a wider socio-economic and cultural context of the region that shapes the perception and adoption of new technologies by farmers (Nkrumah et al., 2023).

Qualitative research on the concrete challenges and opportunities surrounding the introduction of reproductive innovations in goat farming within the urban context is thus very limited, especially if one looks at studies from places such as Samarinda. Indeed, past literature has been biased toward the use of quantitative measures relating to technical efficiency in general, which were held in settings possessing different socioeconomic characteristics than here (Osei et al., 2022). This study aims to fill this gap by determining the effectiveness of reproductive innovations in female goats from the perspective of smallholder farmers located in Samarinda. Using a qualitative approach, this study will draw out perceptions, adoption, and integration of reproductive technologies within farming practices, together with the impacts on productivity and economic sustainability of the goat farming systems.

Given the significance of smallholder farming in Samarinda and the broader East Kalimantan region, understanding the role of reproductive innovations in improving productivity and economic sustainability is critical. This study aims to offer practical recommendations for enhancing reproductive management and providing support for farmers to increase the adoption of these technologies. This will be of use in bringing contributory knowledge to the designing of policies and interventions likely to promote sustainable and productive goat farming within urban and peri-urban contexts that are sensitive to the distinctive challenges faced by urban goat farmers in Samarinda.

MATERIALS AND METHODS

Materials

The research was conducted in Samarinda, East Kalimantan, Indonesia, a region with significant potential for developing the goat farming industry. Samarinda was selected as the research site due to its large population of small- and medium-scale goat farmers who implement various reproductive technologies in their farming practices. Moreover, Samarinda is a major economic hub in East Kalimantan with substantial market demand for livestock products. The diversity of farming practices and socio-economic conditions in this area makes it an ideal location to evaluate the effectiveness of reproductive innovations on female goats and their impact on farm productivity and economic sustainability. The equipment used is writing instruments to record data and fill out questionnaires or research forms, research questionnaires, data analysis tools, a set of computers to input data and analyze data.

Methods

The research was conducted using a survey method. The object of this study is small-scale goat farmers in Samarinda, East Kalimantan, who implement reproductive technologies such as artificial insemination (AI), hormone synchronization, and genetic selection. The sampling method used in this study is purposive sampling, selecting farmers who have at least two years of experience using reproductive technologies. The total sample consists of 15 goat farmers who meet these criteria. Data collection techniques in this study were carried out through participatory observation and in-depth interviews with farmers using a questionnaire guide. Additionally, focus group discussions (FGDs) were conducted to gain deeper insights into the experiences, challenges, and benefits of adopting reproductive technologies in goat farming.

Study Design

This study began with the development of a semi-structured questionnaire consisting of both closed and open-ended questions to collect quantitative and qualitative data from respondents. After the questionnaire was prepared, direct interviews were conducted with goat farmers using the questionnaire guide to gather information regarding farmer identity, goat sales, prices, costs, and marketing channels. The data collected was then entered into a computer system or database for storage and further analysis using Excel.

Research Variables

The research variables observed in this study consist of:

- a. Dependent variable: The income of small-scale goat farmers.
- b. independent variables: Age, experience, and education of the farmers.

Analysis Data

Data collected from interviews, FGDs, and observations will be analyzed using thematic analysis. The analysis process begins by transcribing the interviews and FGDs, followed by coding the data to identify key themes. Data will be coded inductively, meaning that themes will emerge directly from the data itself rather than being pre-imposed. These themes will focus on the challenges, benefits, and impacts of reproductive technologies on goat productivity and the economic sustainability of goat farming.

Once coding is completed, the identified themes will be further analyzed to explore the relationship between reproductive innovations and improvements in goat productivity and economic sustainability. Data triangulation will be used to ensure the validity of the findings by comparing and cross-verifying information from multiple sources (interviews, FGDs, and observations). The findings will also be compared with existing literature to assess whether they align with previous research or offer new insights into the topic.

RESULTS AND DISCUSSION

The implementation of reproductive innovations in female goats, such as artificial insemination (AI), hormone synchronization, and genetic selection, has shown varying degrees of success in enhancing both productivity and economic sustainability for small-scale goat farmers in Samarinda, East Kalimantan. The following sections discuss the key themes that emerged from the interviews, focus

group discussions (FGDs), and participatory observations conducted during the study.

Enhancement of Goat Productivity through Reproductive Innovations

The main objective of this study was to assess the implementation of reproductive innovations, such as artificial insemination and hormonal synchronization, to improve the productivity of goats, particularly female goats, in small-scale farms in Samarinda, East Kalimantan. From the in-depth interviews, FGDs, and participatory observation, it appears that reproductive technologies play a significant role in improving the reproductive performance of does, thus increasing farm productivity.

Results have shown that AI if done properly, has a significant effect on increasing the number of kids per doe. The farmers who were part of this study said that AI allowed them to access better genetics, which in turn provided them with healthier and faster-growing kids. These results are in line with other works, such as Mastrangelo et al. (2020) and Ocampo et al. (2021), that reported the use of AI for improving genetic diversity and enhancing productivity in goat herds. In particular, farmers have been able to observe a decrease in inter-kidding intervals, which would mean more frequent breeding cycles and increased productivity.

On the other hand, hormone synchronization proved to be a handy tool for the optimization of the breeding schedule. Synchronizing the estrus cycle among female goats, helped the farmers to plan better regarding proper breeding programs and gave reasonably predictable and efficient kidding patterns. This innovation has helped to reduce barren does and minimize nonpregnancy periods, which is an important factor for maximizing productivity on a farm. Similar results were reported by Khan et al. (2022), who showed the importance of hormone synchronization for improved reproductive efficiency and subsequent increase in profitability on farms.

These innovations in reproduction showed much promise for raising productivity, but the advantage derived therefrom turned out to depend greatly upon farmers' experience and familiarity with the technology. In-depth interviews showed that farmers with experience of over two years with this technology reported higher conception rates for the reproductive technologies. They were more competent in terms of handling the appropriate timing of insemination, enhancing the quality of the semen to be used for AI, and thus overcoming various constraints related to synchronization. On the other hand, farmers who had less than two years of experience were very inconsistent, thus showing experience as one of the critical determinants for the success of reproductive innovations.

This points out the immense role of training and extension services in the effective adoption of reproductive technologies. Some farmers reported that training and consultation with agricultural extension workers are very important in enhancing their skills in the use of AI and hormone synchronization. These findings are supported by the work of Khan et al. (2022), who emphasized that targeted education programs should be undertaken to help farmers adopt emerging technologies efficiently. The study suggests that further investment in farmer training programs would be necessary to ensure that farmers are better prepared to meet the demands of technology adoption.

Observations made from participatory studies during this research indicated that though the farmers were aware of the reproductive technologies, access to quality semen and hormonal treatment was still a problem for them. Many farmers complained of problems with finding reliable suppliers and delays in the delivery of materials. This is a logistical problem that indicates the need for a well-established supply chain of reproductive materials if these innovations are to be successful in goat farming. Improving these issues calls for the creation of better infrastructure to supply reproductive materials to rural farmers so that they have timely and regular access to high-quality resources.

In short, the study discussed how reproductive innovations like AI and hormone synchronization have been very effective in bringing about increased productivity in goats through better reproductive performance, more offspring, and shorter intervals between kidding. However, such technologies are largely dependent on the experience and expertise of the farmers as well as their access to quality resources. Therefore, enhancing these reproductive technologies requires strengthening training and extension services, access to reproductive materials, and logistical support for farmers. Addressing these factors would lead to great improvements in productivity and economic sustainability within goat farming in Samarinda and other similar regions.

Economic Sustainability and Profitability

Reproductive technologies, mainly AI and hormone synchronization, have become a key factor not only in enhancing the productivity of goats but also in the economic sustainability of small-scale goat farms. Increased goat productivity, through increased birth rates and improved genetic traits, directly resulted in higher income for the farmers. Specific testimony to this includes increased sizes of the herd, the healthiness of the kids, as well as more regular cycles of breeding, which cumulatively helped increase the supply of goats that the people have to sell. With the advantage of superior genetics that AI has enabled, farmers would attest to improved growth rate, better disease resistance, and overall better health of their animals. This contributes positively toward better livestock quality that would attract high prices.

Farmers also reported a reduction in the cost of operations, as AI allowed them to have better control of breeding, hence minimizing the number of bucks they had to keep on the farm. This is because keeping a buck for breeding was expensive, particularly for a small farmer. Artificial insemination allowed farmers to decrease the expense of maintaining a buck: feeding and veterinary costs for the buck thus directly benefited their bottom line. In addition, the better genetic merit for resistance to diseases and faster growth resulted in goats reaching market weight in a shorter time, thus enabling the possibility of faster turnover and increasing financial returns. These findings are supported by Khan et al. (2022), who stated that reproductive technologies have the potential to enhance farm profitability by enhancing reproductive efficiency and managing animal health.

Despite these benefits, the economic advantages were not uniformly present for all farmers. Some of the participants in the study noted that the initial investment required for the implementation of reproductive technologies, especially AI, was very high. The long-term benefits could be envisaged, but the initial capital needed to buy equipment, semen, and hormone treatments was very expensive in the

beginning for most of the farmers. Indeed, many farmers have claimed to start realizing a return on investment after several breeding cycles had taken place as full realization of genetic improvement and breeding schedule optimization normally took considerable time. These observations agree with the findings of Smith et al. (2020), who concluded that although the costs associated with adopting reproductive technologies were quite prohibitive at the start, the long-term economic benefits, including increased productivity and profitability, outweighed initial expenses by far. This finding is further supported by Osei et al. (2022), who reported that while high initial costs remain a challenge for smallholder farmers, the adoption of reproductive technologies can significantly reduce long-term operational expenses and enhance income by improving resource efficiency and livestock quality.

The study further identified market access and demand for goat products as critical success factors in realizing the full economic value of reproductive innovations. Being an important economic hub in East Kalimantan, Samarinda presents a great demand for livestock products, including goat meat and milk. Farmers who were better connected to local markets could capitalize on the increased productivity enabled by reproductive technologies. The farmers said they could sell the goats at better prices due to their genetic traits and good health, adding that it has increased their profitability. Farmers who did not have access to such markets, or who had logistical problems in the distribution of their products, were much less able to realize fully the economic benefits of reproductive innovations. This finding reinforces the view that the success of agricultural innovation is an issue not of technology but of other factors such as access to markets, infrastructure, and efficiency in supply chains. Market linkage and infrastructure development play an important role in maximizing the profitability of agricultural technologies. Much discussion in the literature, including the recent works of Zhou et al. (2021), puts forth that connectivity of the market is critical for the assurance of the translational impact of technological improvement on farmers' financial benefits.

In conclusion, while reproductive innovations such as AI and hormone synchronization have the potential for great improvement in the economic viability of small-scale goat farming, both internal and external factors affect their success. Increased productivity from the technologies could lead to heightened incomes and reduced operational costs, but the initial cost of investment and access to markets remain major challenges that face some farmers. While many reproductive innovations do have considerable economic potential, supportive policy, and extension services are sorely needed for their full realization by overcoming various bottlenecks, facilitating access to technology at affordable costs, improving market linkages, and offering credit or incentives that would alleviate the initial capital burden on farmers for the adoption of any new technology. If supported appropriately, reproductive innovations could have a real impact on changing the economics of goat farming in Samarinda and areas like it.

Challenges in Adopting Reproductive Technologies

Despite these promising results, the farmers reported a couple of challenges that curtailed the wide and full adoption of reproductive technologies. Key among them was inadequate technical support. Several farmers were complaining of difficulty in accessing good quality semen for artificial insemination and problems relating to the timing and effectiveness of hormone synchronization treatments. The lack of

extension services and personnel experienced in performing these operations in the field was also repeatedly blamed for these constraints. Time after time, farmers complained of no professional help or extension worker ever visiting their farms during a breeding season to at least give advice or take over in case of trouble.

Several studies have pointed out the role of extension services and continuous technical support in facilitating the adoption of new technologies. For example, Pérez et al. (2019) noted that sustainable adoption of reproductive technologies will only be achieved by continuous training and assistance to farmers. In the absence of such support systems, farmers may not be able to implement the technology efficiently, hence yielding suboptimal results and lower adoption rates.

Among many, other factors include another problem that farmers faced regarding experience with such advanced reproduction techniques. Those with less experience in using AI and hormone synchronization were more likely to encounter problems, such as lower conception rates and inconsistent results. Farmers who had not received adequate training often found it difficult to manage the precise timing required for successful AI or hormone synchronization, resulting in reduced reproductive success. This experience gap was more profound among newer farmers or those transitioning from traditional methods to more modern technologies.

Besides, sustainability was impeded by a very high dependence on outside service providers in reproductive technologies. For many farmers, reliance on AI technicians or even veterinary professionals from outside resulted in complications in maintaining a continued supply of required resources and skills. As explained by Singh et al. (2020), reliance upon outside services risks disrupting breeding programs, mainly in out-of-the-way, underdeveloped areas lacking access to trained professionals with the specific know-how for these particular tasks. Increasing the expense of using them due to outside expertise heightened the factor that made them less practical to continue as a regular way of work for many of the farmers in long-term situations.

Although AI and hormone synchronization are valuable approaches to enhance goat productivity, full exploitation of these reproductive technologies is faced with challenges. Guaranteeing consistent availability of quality technical support, reducing reliance on external providers of the services, and giving farmers adequate training and experience is crucial in removing these barriers and facilitating better technology use. With proper support and infrastructure, farmers can more confidently adopt these innovations, leading to improved reproductive efficiency and greater overall productivity.

The Role of Social and Economic Context in Adoption

The socio-economic conditions of farmers emerged as a key determinant in the adoption of reproductive technologies, highlighting the complex interplay between individual and community-level factors that influence the uptake of agricultural innovations. As observed in this study, farmers with higher levels of education, better access to capital, and greater overall wealth were more capable of overcoming the financial and technical barriers to adopting reproductive technologies such as artificial insemination (AI), hormone synchronization, and genetic selection. This agrees with the findings by Alhassan et al. (2021), who indicated how socio-economic factors influence adoption, such as education and access to credit and training in agricultural technologies. The higher the level of education of farmers, for instance,

the better their understanding of the technical aspects and the long-term benefits of such reproductive innovations as increased productivity of goats and improvement of herd genetics. By contrast, people with little formal education and low financial status were highly impeded from making an initial investment in such technologies.

Apart from this, the availability of financial capital was another very critical determinant of whether farmers could invest in reproductive technologies. Most small-scale farmers normally have relatively limited capital, which makes it difficult for them to afford the high initial cost of investment in AI and hormone synchronization. While the long-term benefits of these technologies might be greater than the initial investment, many farmers in this study reported that they required external financial support, such as credit or government subsidies, to adopt these innovations. Previous studies have also emphasized access to credit as a factor that enables farmers to surmount the financial barriers to adoption, such as by Alhassan et al. (2021). These studies have shown that, in the absence of access to reasonably priced credit or financial assistance, many farmers are not in a position to invest in technologies that could increase productivity and profitability.

Another critical factor for the adoption of reproductive technologies was the role of social networks and collective resources. This study showed that farmers in cooperatives or farmer groups were more likely to have a successful implementation of AI and hormone synchronization compared to their independent counterparts. These networks allowed farmers to share experiences, learn from the successes and failures of other farmers, and collaborate on how to solve common challenges. Often, cooperatives could make it possible for farmers to pool resources in ways that lower the individual cost for farmers to adopt reproductive technologies, such as the costs of semen when using AI, or specialized technicians when using hormone synchronization. This finding is consistent with the research of Mungai et al. (2022), who highlighted that farmers involved in networks or groups reported better outcomes in adopting agricultural innovations because they had access to shared knowledge, resources, and support from their peers.

In addition to the economic benefits of membership in a social network, farmer groups provided a source of technical support. Members of cooperatives often had access to joint training sessions, extension services, and expert advice, which facilitated the successful use of reproductive technologies. Farmers not affiliated with these networks often faced various technical problems in AI and hormone synchronization, which usually arose from the lack of professional support and advice. Social capital helped to mitigate some of the knowledge and skills barriers, especially for those farmers in rural areas with limited access to formal extension services. This finding highlights the importance of social networks and cooperative initiatives for improving the level of agricultural innovation dissemination.

In addition, access to the market and demand for goat products have been major determinants of economic viability in the adoption of reproductive technologies. Given that Samarinda is an economic hub, and there is a high demand for animal products, therefore, farmers who had better access to local markets were able to exploit the increasing productivity brought about by the reproductive innovations. These farmers were able to sell more goats, especially those with superior genetic traits, at higher prices. In contrast, farmers with limited market access could not fully gain from increased productivity, lacking opportunities for selling their products at more competitive prices. This reinforces the view that the development and diffusion

of agricultural innovations does not happen in isolation; it needs such broader economic variables: market infrastructure and appropriate market demand. A study conducted by Zhou et al. in 2021 revealed a situation where agricultural innovation would happen but could not work itself out because of conditions not related to the technologies instance, market access and price structures, and the structure of processing or distribution, among others. Farmers operating within already-established supply chains or with direct access to high-demand markets had the greatest chance of yielding a return from their investments in reproductive technologies.

Another critical socio-economic factor that arose was the role of government policies and institutional support. Government agencies in Samarinda, such as the Samarinda Livestock Office, did provide a certain level of technical support and extension services for farmers who were interested in reproductive technologies. This level of support was variable, with several farmers suggesting that the level of support was inadequate or indeed inconsistent. The authors' results find agreement with various works such as that of Pérez et al. (2019), who described that agricultural innovation has required continuous support from both governments and non-governmental bodies for sustenance and adoption. Against this backdrop, it has suggested that the study is expecting more investments in extension and training especially among those with low-income farmers for a reduction in the gap in both knowledge and resource bases between the increasing overall adoption of reproduction technologies in goat production.

The adoption of reproductive goat farming technologies is influenced by a set of socio-economic factors like education, access to capital, social networks, market access, and government support. These would, therefore, imply that the improvement in the socioeconomic status of farmers through better education, financial resources, and cooperative networks will significantly increase the adoption and success rates of reproductive innovations. Unless these socioeconomic disparities are addressed, policymakers and development agencies should focus on enabling small-scale farmers to benefit fully from the productivity gains that arise with reproductive technologies.

CONCLUSION

This study demonstrates that reproductive innovations, such as artificial insemination (AI) and hormone synchronization, effectively enhance the productivity of female goats by reducing inter-kidding intervals and improving genetic quality. While the economic benefits, such as reduced operational costs and improved growth rates of offspring, are evident, the adoption of these technologies is hindered by challenges such as high initial costs, limited technical support, and dependence on external service providers. The success of adoption is significantly influenced by socio-economic factors, including the farmers' level of education, access to capital, and integration into market networks and social groups. Therefore, to maximize the effectiveness of these reproductive technologies, it is essential to improve training, resource accessibility, and market linkages, alongside strengthening technical and extension services.

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AUTHORS' CONTRIBUTIONS

IPGDW contributed to the conceptualization and design of the study KDY was responsible for data collection and ensuring the accuracy of the data. NF performed data analysis, interpreted the results, and contributed to refining the research findings. KDDA drafted the manuscript and managed revisions based on feedback. SS provided supervision throughout the research process and critically reviewed the manuscript. All authors have read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

CONFLICT OF INTEREST

The authors declare no conflict of interest regarding the publication of this manuscript.

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