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Analyzing Technical and Economic Performance for Developing Corn-Based Sheep Farming in Rural Indonesia

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ABSTRACT

In rural Indonesia, sheep are commonly raised using traditional methods with low technological innovation, leading to modest incomes for farmers. This study evaluates the technical and economic performance of sheep farming in the Anyer Subdistrict of Serang Regency, Banten Province. The research involved observing and interviewing 285 sheep farmers and employed Rapid Rural Appraisal (RRA) and Participatory Rural Appraisal (PRA) techniques to assess the potential agroecosystem for developing a corn-based sheep integration model. Descriptive analysis was utilized to evaluate the regional biophysical and technical performance of sheep farming, while Net Cash Benefit (NCB) and Cost-Return Analysis (CRA) were applied to determine the economic performance. Findings indicate that corn-based sheep farming has potential in the region, bolstered by the availability of corn by-products. However, the performance of sheep aged 2-3 years was found to be suboptimal, as evidenced by low average body weights (23 kg for 2-year-olds and 20.1 kg for 3-year-olds), small litter sizes (1.34 heads per litter), a high mortality rate (23.65%), and a low reproductive rate in ewes (1.55 heads/ewe/year). Despite these challenges, sheep farming proved to be profitable, with an average net benefit of IDR 2,420,400 per annum, not accounting for labor costs. The study suggests that the development of corn-based sheep farming could be supported by the introduction of feed processing technology and the use of superior sheep breeds to enhance performance and ensure business sustainability.

1. INTRODUCTION

Sheep farming, as a subsistence activity, plays a significant social and economic role in various regions. Frequently, sheep production is integrated with crop farming to increase farmers' income [1-3]. Moreover, within the community, sheep farming holds a crucial role in supporting household economies, serving as a means of savings or for emergency needs [4, 5]; it also provides a source of food [4, 6], and acts as a substitute for beef [7]. Furthermore, small ruminant production is recognized for its potential to meet the global challenge of significantly increasing food production in impoverished rural areas while remaining socioeconomically and environmentally sustainable [8].

In 2022, the sheep population in Indonesia reached 15.6 million heads, with West Java accounting for the largest share—approximately 64% of the total. Banten Province, the location of this research, contributed about 2.6%, ranking fifth nationally [9]. This figure represents a sharp decline from the 17.8 million heads recorded in 2019. The reduction in population may stem from the inability of sheep reproduction rates to match the increasing domestic and global demand. Notably, there was a 25% decrease in sheep supply from 2020 levels, partially due to the Covid-19 pandemic, which led to a market contraction of around 50%. Typically, smallholder farmers in rural areas manage sheep traditionally [10, 11], relying on local feed resources to minimize production costs, using suboptimal breeds, and operating on a small scale due to limited capital [12]. Another issue is the uncontrolled mating system; farmers often sell high-quality sheep for immediate cash flow and keep the poorer-quality ones, resulting in progressively lower performance of the flock [13]. These challenges are compounded by a lack of farmer education, leading to traditional practices that usually fall short of good operational standards [12, 14]. Such conditions lead to low production and productivity of sheep, and consequently, low income for farmers, relegating sheep farming to a secondary business. As a result, the scale of the business tends to remain relatively small [15]. Additionally, feeding challenges, particularly during the dry season, pose obstacles for farmers

wishing to scale up production.

To address the low productivity of sheep, particularly in terms of providing sustainable feed and high-quality breeds, it is necessary to implement an integrated sheep farming system with other commodities, such as corn. Additionally, Serang District, while having the highest sheep population, is also among the regencies in Banten Province that are implementing the development of hybrid corn. In 2020, the area planted with corn was 1,162 hectares, yielding a production of 6,361 tons (with a productivity rate of 5.47 t/ha). There are still ample opportunities to increase corn production in Serang Regency, either by enhancing productivity or by expanding the cultivated area, especially on dry and idle land that has not yet been fully utilized. Moreover, the demand for corn by feed mills, which reached 2 million tons per year, suggests that some of these mills (seven in total) are located in Banten Province. This provides opportunities for the development of corn-based sheep farming in the area.

Given this context, a corn-sheep integration model has significant potential for future development. Implementing technological innovations to process corn by-products into sheep feed could help overcome the challenges of meeting animal feed requirements. Therefore, the objective of this paper is to analyze the technical and economic performance of sheep farming, as well as the potential agroecosystem to develop a corn-based sheep integration model. The results of this study will be crucial for policymakers aiming to develop sustainable sheep farming in Indonesia, particularly in the research areas, which will ultimately contribute to increasing the income of farmers in rural areas.

2. LITERATURE REVIEW

Developing a multi-commodity or integrated farming system is seen as highly beneficial for the sustainability of the business. This approach serves as an alternative for conducting business efficiently on a typically constant land area. It is also capable of increasing business productivity and adding value from various mutually supporting business sectors [16]. Historically, in terms of land use and spatial development, livestock businesses have often competed with food crops and plantations that have higher economic prospects, or even with settlements and industry. The development of an integrated farming system results in several benefits, including: a) economic aspects, such as increased yield quality, reduced costs, and the ability to create product diversification; b) agronomic aspects, such as the improvement of land quality for production; c) social aspects, such as the equitable distribution of income among the main and business actors, as well as the community; and d) ecological aspects, such as the management of plant pest attacks [17].

The advancement of integrated farming also fosters farmers' self-reliance in farming practices, reduces dependency on external production inputs, and addresses issues of limited land [18]. Furthermore, Munandar et al. [19] asserted that an integrated farming system could stabilize income through various production sources from food crop-livestock integrated patterns and become an economic strategy to sustain farmers' livelihoods [20]. Additionally, the use of organic fertilizer from livestock manure can reduce or replace chemical fertilizers, thus lowering production costs. In Rio de la Plata, the integration of sheep with crops in a grazing system improves nutrient cycling, land-use efficiency, and the resilience and profitability of systems [21]. Alongside all these benefits, however, effective weed management is required [22].

Studies in the Mediterranean sheep-crop farming system found that the specialized pasture-based sheep system had the lowest intensity and efficiency and the highest sustainability compared to the partially-integrated mixed system. Meanwhile, the fully-integrated mixed system achieved a balanced position [23]. Lamb meat production in the partially integrated mixed system was 1.9 and 1.3 times more intense and efficient, respectively, than in the pasture-based sheep system, but 5.1 times less sustainable. Due to their greater capacity for utilizing local and renewable natural resources, all sheep subsystems exhibited lower intensity and higher sustainability than crops. An integrated crop-cattle-sheep farming system in the Mahbubnagar District of the Southern Telangana Zone was the most profitable, with the highest Benefit-Cost Ratio (1.82) compared to other farming systems, namely crop; crop-cattle; and crop-cattle-goat. An integrated farming system garnered higher returns than a single crop farming system alone. However, this system had the lowest adoption rate, at around 9.17%, compared to the other three systems [24]. An integrated system combining hill sheep production with native woodland creation in a Scottish mountain valley generated 20% higher revenue [25].

However, the implementation of an integrated farming system does not always succeed in increasing efficiency and farmers' incomes. It is essential to consider the performance of the business, which in this study is the technical and economic performance of sheep farming. Moreover, the adoption of this integrated farming system by farmers largely depends on the agroecosystem and socio-economic conditions in the area, which are the focus of this study. Additionally, a study indicated that during the pandemic-19, the purchase of corn by 14 feed mills in Banten Province dropped by 2.2% due to an increase in the price of corn, signaling a decrease in the supply of corn, which is mostly sourced from outside West Java [26]. This suggests an opportunity to develop corn plantations in and around West Java, particularly in Banten Province.

3. METHODOLOGY

The study was carried out in Mekarsari Village, Anyer Subdistrict, Serang Regency, Banten Province, to analyze the regional potential for the sheep farming business. Banten Province was selected as the pilot project location due to the high sheep population, which is the fifth nationwide, while Serang District has the highest sheep population in this province. Moreover, the local government has encouraged corn plant development programs that are potentially purchased by Indonesian feed mills that mostly located in Banten Province for livestock feed resources. In addition, sheep farmers in that area have utilized corn by-product as sheep feed, but they have not yet implemented complete feed innovations. Corn straw and corncob are common byproducts of corn used by farmers as feed.

The Rapid Rural Appraisal (RRA) activity [27] was used to explore opportunities for potential land resources and technical aspects and management of sheep farming as an integrated (sheep-corn) development policy step. RRA also analyzes the potential of rural areas to get a general idea of the research location. RRA for this study was conducted through

several methods which were: 1) reviewing secondary data from the Local Government report and statistics; 2) field observation; 3) interviewing keyperson involved in sheep and corn farming such as representative from Agriculture and Livestock Agencies in Serang District, farmers' group, and agricultural supporting staff in the village.

Meanwhile, the Participatory Rural Appraisal (PRA) was carried out through focus group discussion involving farmers and community in the village in regards with the problems faced by farmers in the sheep farming system, and agreement on future development through the application of technology (exploring future program agreements).

The next stage is to conduct an agro-ecosystem analysis to determine the potential carrying capacity of the region. This was also carried out through Participatory Rural Appraisal (PRA) [28] in designing future programs.

A survey to determine the performance of sheep production was conducted in the location area (inside and outside of Mekarsari village), which involved 285 sheep farmers. The production parameters regarding of the observed ewe included: a) average litter size (LS), counted by an average number of lambs born; b) sheep survival rate, counted by the number of lambs survived until weaning; and c) lambing interval of sheep (LI), which is the time interval between two consecutive births. Ewes Reproductive Rate (ERR) was also observed with the criteria of the variables LS, mortality rate, and LI, which are defined as the number of lambs born per ewe during a year and formulated as follows [29]:

$$ERR = \left(Average\ LS \times (1 - mortality\ rate)\right) / (LI) \quad (1)$$

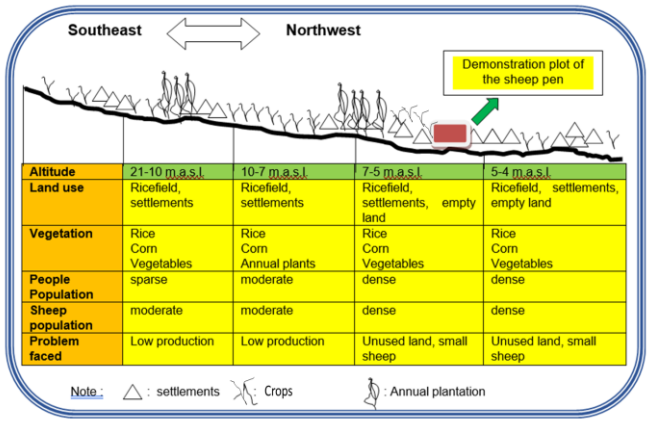
The economic analysis of the sheep business was carried out through a baseline survey of 59 farmers in Mekarsari Village. Analysis of the Net Cash benefit (NCB), which only considered cash, was implemented, as well as Cost and Return Analysis (CRA) which included family labor costs in the calculation. The allocation of labor was calculated by the length of time doing activities for feed collecting or herding sheep, which was 5 hours per the Day of Working People (DWP). The cost resulted from multiplying the wage per DWP (calculated by half the cost of wages, namely Rp. 30,000, -/DWP) considering the allocation of additional labor. However, there was no other cost such as feed cost included in the analysis considering that farmers do not purchase feed but collect it from the field and also due to mix grazing and housing management applied for sheep farming in that area. In addition, an analysis of "Business typology" is carried out to determine the contribution of each business (sheep, crops, and non-agriculture) in supporting the household income of farmers.

4. RESULTS AND DISCUSSION

4.1 Identification of regional biophysical in sheep development opportunities

The selected research location is categorized into lowland dry land area bordering the coastal area (Anyer tourism area) in Serang Regency, Banten Province. Village communities planted rice, corn, and vegetables according to village boundaries (area altitude) and raised sheep with mixed management of grazing and housing. The biophysical transect analysis of the area (Southwest vs Northwest) showed that the village area is a coastal area (Pantai Anyer) with an altitude of 4 to 21 m above sea level (m.a.s.l.), with the highest area in the Southwest location (Figure 1).

Based on land use, the research location was generally paddy fields and settlements, which were quite dense due to adjacent tourist areas. The commodities developed were generally lowland rice, corn, and vegetables, cultivated mainly by the local community. Dense residential populations tended to be distributed in the lowlands adjacent to the highway area, while in the slightly highland areas, settlements tended to be sparse. Similarly, the densest sheep population was in the lowlands, while the highlands tended to be moderate, that have the potential as a future sheep development model with modified corn-based feed. It likely becomes a good prospect in supporting the integration of sheep and food crops as feed resources. Sheep farming can be carried out in all agroecosystems, including lowland and highland areas, paddy fields, dry land, plantation land, and even forest land [30].



Altitude	21-10 m.a.s.l.	10-7 m.a.s.l.	7-5 m.a.s.l.	5-4 m.a.s.l.
Land use	Ricefield, settlements	Ricefield, settlements	Ricefield, settlements, empty land	Ricefield, settlements, empty land
Vegetation	Rice Corn Vegetables	Rice Corn Annual plants	Rice Corn Vegetables	Rice Corn Vegetables
People Population	sparse	moderate	dense	dense
Sheep population	moderate	moderate	dense	dense
Problem faced	Low production	Low production	Unused land, small sheep	Unused land, small sheep

Figure 1. Biophysical transect plot (Southwest-Northwest), Mekarsari Village, Anyer Sub District, Serang District, 2020

In crops production, particularly paddy, the main challenge faced by the farmers is low rainfall which causes farmers generally to only grow rice once a year. Only a small part (around 10 ha) of the location can be planted rice twice a year. Similarly, corn is also planted once a year. Crop yield was still low and not optimal, with rice averaging 3-4 tons per ha and corn averaging just 1.5 tons per ha, indicating that there is still room for improvement. There are around 20-hectares of vacant (unused) land in the research area that might be used for corn development.

On the other hand, the performance of sheep was found to be relatively small due to the low quality of rams, and incidences of inbreeding occurred often due to uncontrolled mating during grazing [31]. This result is in accordance with previous research findings that raising sheep in rural areas is still traditional without reasonable procedures in business management, resulting in a lower income [13]. Study [2] reported that sheep farming in suburban area of Ouagadougou, West Africa which 43% managed traditionally indicated low profitability due to feed and animal health constraints, flock and production management, and the market conditions.

Hence, the potency of the area as a model for livestock development is significant in supporting regional area-based development programs where the support for feed is available from grass and agricultural by-products, as well as pasture and grazing. In fact, there had been no effort to introduce technology until now. The potency of corn (corn straw and

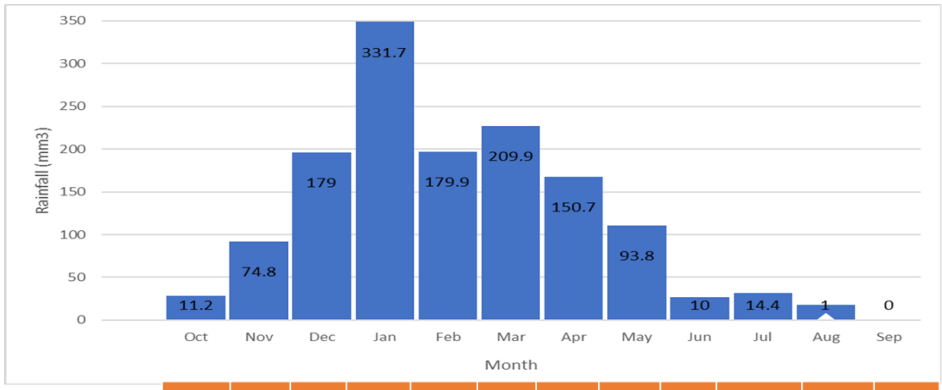
corn cob) is prospectively to be processed in the future as a source of cheap and good-quality of feed through feed processing technology in the form of complete feed (mini feed mill) supported by farmer-scale mechanization equipment (shredder).

4.2 Cropping patterns associated with carrying capacity of animal feed

Understanding of cropping patterns is necessary to perceive the availability of crop by-products production, especially the prospective availability of corn by-products as animal feed development on site. The results of cropping patterns analysis that describe agricultural business activities in the observation village showed that the cropping pattern carried out by the community was mostly paddy rice during the rainy season (in October) with a planting period of three months and land processing for about a month. This is followed by secondary crops such as corn, sweet potatoes, and horticultural plantations or vegetables (cucumber, long beans, and chilies) (Figure 2). However, there were a small number of locations where paddy rice can be planted twice a year, followed by fallow land (unplanted land). In addition, the least farmers left their land empty for livestock grazing (from February onwards) after planting paddy rice from October to January.

The potential grazing land was dominant in supporting the sustainability of the sheep business carried out by farmers in the location, supported by the potency of corn by-products as sheep feed. When rice is planted in paddy fields, some farmers feed their sheep by cut and carry, while others continue to graze their sheep on vacant land (fallows) that is still available in locations far enough away but with good quality grass.

Feeding sheep using striped maize leaves can improve average daily gain and feed efficiency [32]. A similar study reported that feeding Awassi lambs using corn stover can improve the average daily gain [33]. According to those studies, the implementation of corn by-products as sheep feed potentially increases the final product of sheep farming.



Oct	Nov	Des	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
Paddy-rice				Paddy-rice				Follow/Unused land (for livestock grazing)			
Paddy-rice				Corn and horticultural commodities (sweet potato)				Follow/Unused land (for livestock grazing)			
Paddy-rice				Corn and Vegetables commodities (Cucumber, long bean, chili)				Follow/Unused land (for livestock grazing)			
Paddy-rice				Follow/Unused land (for livestock grazing)							

Figure 2. Cropping patterns in Mekarsari Village, Anyer District, Serang Regency, Banten, 2020

4.3 Characteristics of sheep farming business

To develop sheep farming integrated with corn plantation requires understanding the characteristics of farmers who will adopt this model. Moreover, information on the scale production of sheep owned by farmers and how farmers manage their sheep is also necessary to figure out potential feed required for this sheep farming development as well as potential income generated by farmers.

4.3.1 Characteristics of sheep farmers

Initial conditions of sheep farmers which are obtained from baseline survey is presented in Table 1.

According to Table 1, the average number of family members was 4.64 people per family, which is a potential enough amount to support farmer household businesses. The age of farmers was relatively young, with an average of 46.13 years old, with a low level of education at an average of 8.70 years (equivalent to elementary school level). However, farmers had high experience raising sheep, about 13.70 years. The low level of education of farmers was also reported by some studies [5, 34, 35]; where more than 72% of farmers had education levels up to elementary school but had 1-10 years of business experience (about 54.55% farmers); and had over ten years business experience (45.45% farmers). Higher farmers' experience in sheep production was also reported [36] which was about 15 years when most farmers finished elementary school. Education and livestock business experience both significantly supported ($P<0.05$) dairy cattle business income [37]. Another study [38] discovered that the motivation of farmers of the Tani Sido Maju famers' group, Magelang, was quite high in undertaking sheep farming business, and that it was also influenced by age, formal education, and livestock experience. Other research found that education, age and experience had no effect on the income of rice farmers in Nagari Batu's lowlands [39]. Furthermore, social characteristics and conditions within the farmer, such farmer's age, education level, income level in farming, will influence the adoption of a technology such as in the decision-making process and absorption of information in the innovation

adoption process [40, 41]. The education of a person influences their perspectives, mindset, and problem-solving decisions [42].

Table 1. Characteristics of sheep farmers in Mekarsari Village, Anyer Subdistrict, 2020

Parameters	Average Value
Number of family members (person)	4.64 ± 0.78
The age of the head of the family (year)	46.13 ± 3.21
Education of the head of the family (year)	8.70 ± 1.54
Farming system experience (year)	13.70 ± 1.78

Accordingly, based on the performance characteristics of the farmers in the research area, particularly experience and family size, they have the potential to support the development of sheep livestock, which is supported by the availability of land resources and corn by-product as a source of feed ingredients. The availability of land area was the most factor influenced farmers' income in lowland area [42, 43].

4.3.2 The scale of sheep production owned by farmers

According to the results of the survey, it was found that the scale of sheep production was still low, with an average of 3.21 heads per farmer. Almost all farmers had ewes to produce lamb (breeding pattern), with an average of 1.05 head of ewes per farmer (Table 2). The scale of sheep ownership indicated the sheep business system managed by each farmer, where more sheep, particularly ewe, owned by farmers, more lambs can be produced. This will impact on farmers' income because more sheep can be sold in a certain period.

Table 2. Number of sheep owned by farmers in Mekarsari Village, Anyer Subdistrict, 2020

Physiological Status	Number of Sheep (Head)	Percentage Min - Max
Adult sheep		
Male	0.22	6.85
Female	1.05	32.71
Young sheep		
Male	0.30	9.34
Female	0.58	18.21
Lamb		
Male	0.45	14.39
Female	0.57	17.98
Total	3.21	100.00

It was noted that only a few farmers had rams because most rams were sold for regular income or during the Eid al-Adha (Islamic sacrifice day ceremony) in particular. For those who had, the average ram owned by farmers was 0.22 heads per farmer. Different study reported that only unselected males were sold or kept temporary until favourable period time [2]. Rams are typically sold as a source of income for livestock businesses, and it is expected that in the future there will be issues with the mating system (male population restriction) leading to long lambing interval and a decline in the quality of males as the good rams are sold for high prices. In this area, many farmers did not keep rams to avoid inbreeding, as rams were grazed in the same place as other sheep, making it easier for them to mating in the field. Technical recommendations are of about 35-50 ewes per ram in natural mating, depending on local conditions and sperm quality [44].

According to the survey, the highest proportion of sheep owned by farmers was the ewe reaching about 32.71%, followed by young females (18.21%) and female lambs (17.98%), which indicated that the ownership of the ewe was the principal capital for sheep production. This finding was consistent with a previous study [45] in Sukabumi, which discovered that adult ewes accounted for 42.615% of sheep owned by farmers, with young ewes accounting for 21.38%. Slightly different result revealed that the number of ewes and pre-weaned ram lambs were the highest number in the flock in two districts in Eastern Ethiopia which were counted about 29.2% and 16.5% respectively [46]. A study [47] asserted that the larger the scale of the livestock business, the greater the value of income earned by farmers. Another study revealed that the number of livestock ownership affected significantly ($P<0.05$) the income of poor farmers, as well as that crop farming had a very significant effect ($P<0.01$) on the income of sheep farmers. According to the study [48], a farmer must keep a minimum of 36.63 sheep per household, assuming sheep farming is their only source of income, to get out the poverty threshold of IDR 1,675,575 per month for households with 4.45 persons.

In order to get out poverty when families continue to work as farmhands, they must raise at least 21.37 heads of sheep. One of the efforts that can be made to increase the income of sheep farmers is to increase the business scale, particularly the ewe ownership and increase the performance of sheep through the introduction of superior breeds to form large type sheep that have high selling value. This is because the sheep farming in rural areas still had not met the production scale required, which is reflected in low income. It is also related to the limited family labor resources, thus grazing sheep on unused rice fields (fallows) became a choice. The number of sheep raised in the grazing system owned by farmers can be higher than the number of sheep kept in pens due to the limited cut and carry labor allocation [15].

4.4 The technical performance of sheep production and reproduction

In order to identify the productivity of sheep, it is required to recognize the technical performance of sheep production. This also necessary as a basic information to select and recommend types of technological innovation required for improving the sheep productivity which will impact on farmers' income.

4.4.1 Body weight performance based on age and breed

Generally, the breeds of sheep discovered in the research area were local sheep (183 heads), the Garut sheep (54 heads); and crossed Local vs Garut (14 heads) (Table 3). Majority of sheep were categorized into thin-tailed lambs. Rams were rarely found because they were usually sold to help generate the farmer's income. In terms of body weight, the study found that local sheep were lighter than crossbreed and Garut sheep. Adult local sheep that were 2-3 years old had a body weight of about 20.1 kg for females and 20.0 kg for males. Garut sheep had a larger body weight, which was around 25.0 kg for males and 28.9 kg for females. While male crossbreed sheep (local vs. Garut), at the age of 12, reached a body weight of 16.3 kg. Moreover, the body weight of local female sheep aged 4-5 years only reached 21.2 kg, while Garut sheep could reach 31.8 kg. The body weight of local sheep, which mainly were thin-tailed sheep raised by farmers in this study, was smaller than adult fat tailed sheep on the South Coast of Garut, which reached 33 kg at the age of over two years [13].

Table 3. Number of sheep owned by farmers in Mekarsari Village, Anyer Subdistrict, 2020

Breed/ Age of Sheep	Number of Male Sheep (Head)	Body Weight of Male Sheep (kg)	Number of Female Sheep (Head)	Body Weight of Female Sheep (kg)
Local Sheep				
Age				
0-3 m	18	4.6 ± 2.8	15	4.9 ± 2.6
>3-12 m	14	12.5± 4.5	50	12.7 ± 3.1
>1-1.2 y	na	na	4	16.5 ± 1.8
>1.2-2 y	na	na	32	17.9 ± 3.9
>2-3 y	1	23.0	35	20.1 ± 3.3
>3-4 y	na	na	4	20.6 ± 3.2
>4-5 y	na	na	9	21.2 ± 3.1
Total	33		150	
Local Sheep x Garut Sheep				
Age				
>3-12 m	14	16.3 ± 2.5	na	na
Total	14			
Garut Sheep				
Age				
0-3 m	3	8.0 ± 4.4	4	9.0 ± 2.8
>3-12 m	8	17.2 ± 6.6	15	19.6 ± 6.5
>1-1.2 y	na	na	1	14.0
>1.2-2 y	na	na	7	27.3 ± 7.1
>2-3 y	1	25.0	6	28.9 ± 5.8
>3-4 y	1	31.0	na	na
>4-5 y	na	na	8	31.8 ± 5.6
Total	13		41	

Note: na= data not available

A low body weight of local sheep mainly raised by farmers in the research location indicates that farmers have not selected a good quality of breed for their business plan. According to research on the behaviour of sheep farmers in rural areas, implementing good farming practices for the breed, feed, and management which was found still low, impacting low production performance [12]. Few farmers had crossed their local sheep with Garut sheep to produce higher-performance sheep. Management issues, such as grazing management system which leading to inbreeding case and decreased breed quality are also contributing to the poor performance of local sheep at the study site.

Thus, it is required to improve the quality of breed through developing superior sheep, such as superior Composite Sheep invented by Indonesian Agency for Agricultural Research and Development (IAARD), The Ministry of Agriculture. This breed is resulted from crossing local sheep with imported sheep (such as St. Croix, Barbados) that typically categorized into a large type of sheep with high body weight, adaptable to the tropical climate conditions in Indonesia, and has a high selling value compared to local sheep if supported by good quality feed. Moreover, the implementation of complete feed also can increase productivity and business efficiency, as in the rural Temanggung Regency [49]. A study [50] also suggested that a complete ratio of silage on a diet significantly ($P<0.05$) was able to increase the average daily gain. Research at the UPTD Margawati on Garut sheep reported that the weaning body weight of Garut sheep could reach 11.56 kg and 45.85 kg for Garut sheep aged eight months old [51].

4.4.2 Reproductive characteristics of local sheep

From observation of 85 ewes in the research area based on the number of parturitions, sheep raised by farmers could be lambing up to 7 times. As parity increased, the number of ewes observed decreased because many sheep were sold when they were aged and unproductive; for example, 85 ewes were in the first parturition, and only 7 ewes had the seventh parturition (Table 4).

Generally, the litter size of sheep in the research area was small, about 1.34 head per parturition, indicating that single parturition occurred in the area. Moreover, the LS was likely to increase in line with the level of parental parity, where higher LS can be reached at the fifth and sixth parturition at about 1.46 and 1.57 head, respectively, indicating that ewes were mature enough, which resulted in better reproductive power. It is similar to the results of previous study on sheep grazing in Majalengka Regency [15] on thin-tailed sheep in rural areas that there is an increase in LS with increasing parent parity. A similar study [52] reported that the LS of thin-tailed sheep in Rembang Regency was 1.35. However, higher LS, about 1.56 heads, was found in sheep with grazing systems raised in oil palm plantations in Asahan Regency (integration pattern) [53].

In terms of lamb mortality, the mortality rate remained high at around 23.65%. Furthermore, mortality decreased with increased parental parity. The lamb mortality in parity 1 was the highest percentage (about 26.72%) compared to other parities.

4.4.3 Performance of Lambing Interval (LI) on local sheep

Generally, the lambing interval of sheep in the research area was quite short, with an average of 7.98 months (Table 5). The grazing management system likely increased the appropriate time of natural mating compared to the intensive system. In this condition, the pregnancy period was five months, followed by the lactation period of only 2-3 months which was quite good. However, inbreeding cases often occur in grazing management systems that produce small-body performance sheep. Study by Binabaj et al. [54] reported that different growth traits of Iranian Baluchi sheep were affected by inbreeding considering sheep's sex and type of birth. According to observations on the period of lambing, the average lambing interval was 7.98 months, with the longest lambing interval of 8.49 moths reported at first and second lambing, fell to around seven months at sixth and seventh lambing, and increased nearly eight months at seventh to ninth lambing.

Table 4. Litter size and lamb's mortality based on the parity of the ewes in Mekarjaya Village, Anyer Subdistrict, 2020

Parameters	Parity of Ewes							
	1	2	3	4	5	6	7	Average
Number of ewes (head)	85	53	39	27	13	9	7	-
Average litter size (head)	1.36	1.27	1.38	1.29	1.46	1.57	1.25	1.34
Pre-weaned mortality (%)	26.72	24.60	20.07	20.00	5.20	18.18	20.00	23.65

Table 5. Lambing Interval (LI) and Ewes Reproductive Rate (ERR) of local sheep raised by farmers in Mekarjaya Village, Anyer Subdistrict, 2020

Parameters	Time of Lambing							
	1-2	2-3	3-4	5-6	6-7	7-8	8-9	Average
Number of ewes (head)	53	39	27	9	7	2	1	-
Lambing interval (months)	8.49	7.80	7.70	7.43	7	8	8	7.98
ERR (head/ewe/year)	-	-	-	-	-	-	-	1.55

Compared to other studies, the lambing interval obtained from this study was shorter than the fat-tailed sheep in East Lombok, which reached 8.33 months with a grazing system in the rural area [55]. It is most likely related to the type of maintenance management used, in which sheep in pastures can be mated by males in the field, but sheep quality assurance is not guaranteed. This lambing interval was also shorter than the thin-tailed sheep in Rembang (with intensive raising system) which reached 10.15 ± 1.24; and 9.17 ± 0.88 for second and third lambing, respectively [52]. However, this result was slightly longer compared to the lambing interval of thin-tailed Sumatera sheep raised in an oil-palm integration system (7.5 months) [53] due to different areas of grazing (palm oil vs paddy field).

There are several factors affected the productivity of sheep. Research in Ciburian Village, Bogor, with several ewes kept found that increasing ewes contributed to decreased productivity; good quality of forage increases the productivity or reproduction rate, as well as the availability of labor and business experience [56]. Moreover, assistance through adopting technological innovations is required to trigger production and reproduction rate in sheep production. Nurcahyo et al. [57] asserted that assistance through advising and direct demonstration (especially by implementing block mineral feed) was very effective to increase sheep production in Bantul.

In regards with the reproductivity of ewes, the estimation of ERR was still low, reaching only 1.55 head/ewe/year even though the lambing interval was relatively short (Table 5), in line with low litter size (1.34 head) and high mortality (23.65%) (Table 4). The study [52] also reported lower ERR of thin-tailed sheep in Rembang, which reached 1.24 head/ewe/year, but a higher litter size (1.82 head).

There is still a high mortality rate of sheep (pre-weaning), thus it needs a recommendation for disease control to reduce lamb mortality in the research area. Reducing lamb mortality will increase ERR at the site. The study [15] found that disease control treatment research through routine medication was able to reduce cases of death from disease in sheep, thus having an impact on increasing business income in Majalengka.

In addition, the use of composite sheep breeds shows better ewe reproductive rate compared to local sheep. Superior sheep (composite sheep) invented by IAARD had a higher ewe reproductive rate in rural areas reaching 2.28 heads. The same condition was for St Croix sheep (SC) with a reproductive ewe rate of 2.28 heads, followed by the Sumatera Composite sheep (1.68 heads). The Barbados Cross sheep and Garut Composite sheep had a lower ERR compared to this study, which was 1.53 head and 0.98 heads, respectively, due to high lamb mortality affected by feed factor [58]. The high mortality of lamb for Sumatera Composite and Garut Composite sheep was due to a shortage of milk and feed. However, after a series of multi-location testing, the body weight performance of those composite sheep outperformed the existing local sheep, indicating that it can be developed in specific locations to improve local sheep performance raised by farmers in Pandeglang District [59].

Therefore, in this case, developing a superior composite breed of sheep is required to improve local sheep in rural areas due to the higher body weight performance of those breeds compared to local sheep, by structuring the good breeding management system with the use of a superior breed.

4.5 The economic performance of sheep production

The analysis of the economic performance of farmers in the sheep farming business is required to explain the feasibility of sheep farming and how this production contributed to the households' economics.

4.5.1 Analysis of sheep farmer's income

According to the research, sheep practices conducted by farmers were still profitable, with a net cash benefit of about IDR 2,420,400 per year (excluding family labor costs). When the calculation considers family labor costs, the sheep business lost up to IDR 566,400 per year (Table 6).

Table 6. Analysis of sheep practices by sheep farmers in Mekarjaya Village, Anyer Subdistrict, 2020

Parameters	Total (IDR/Year)
Revenue	
Selling sheep (*)	2,854,000
Selling manure (**)	0
Total revenue	2,854,000
Cost	
Pen depreciation (***)	421,200
Equipment depreciation (***)	12,400
Labor (****)	2,847,000
Total cost	3,280,600
Net Cash Benefit (NCB)	2,420,400
Cost and Return Analysis (CRA)	(-566,400)

Note: (*): Revenue from selling sheep in a year (IDR)
(**): Selling manure has not been done yet
(***): Pen/equipment depreciation is counted by the value of those pen/equipment until they cannot be used
(****): allocation family hour/day converted into the year, counted by day of working people (DWP)

Sheep farmers in the research area did not use hired labor in their sheep farming operations. This low selling value may be due to farmers' low production scale and low sheep performance. A similar case also occurred for Kisar sheep practiced by farmers in West Maluku District, where a small production of 1-10 heads/farmers obtained a low income, reaching IDR 202,169 per farmer/year [60]. However, the net revenue of the Batur Sheep business integrated with horticulture by-product as major feed in Banjarnegara was reported to be higher, reaching IDR 3,419,877 per farmer/year even with average ownership of 6.6 heads [10]. It has higher selling value because Batur sheep had greater body performance and are considered as a pleasure/collection sheep rather than meat-producing sheep.

Moreover, business efficiency can be maximized by utilizing local feed (vegetable by-products) abundant in that area. Other research showed a higher average income obtained by farmers (IDR 2,979,456) per farmer per year with an average sale of 6 sheep, with an R/C ratio of 2.83 for thin-tailed sheep in Cirebon. The income received was significantly influenced by the selling price of sheep, the number of sheep sold, and the low cost of feed [34]. The establishment of horizontal and vertical arrangements in the sheep business helps to increase farmers' bargaining and negotiating power with traders, which may result in lower input prices and higher lamb sales prices [44].

4.5.2 Analysis of farming business typology by sheep farmers

A typology analysis of the livestock business was carried out to determine the contribution of the sheep farming business to total household income, which is related to the scale of the business. According to the farming typology analysis, sheep production only contributed 5.39% of the total farmer's income (IDR. 44,917,923 per farmer per year), while income from agricultural farming contributed about 15.46% of total income. The highest source of income was still focused on off-farm activities, which counted for about (79.15%) as shown in Table 7. It might be because the research location is close to tourist destinations, so many farmers work in trading or other businesses outside agriculture. A lower contribution from sheep production since the business scale is small and only treat as side business and the profits are small and even lose money if the family labor is counted, as well as low productivity due to low quality of breed. It needs improvement in the future by increasing production scale, efficiency, and productivity, as well as developing superior sheep with a higher selling value compared to current activities.

Table 7. The income of households from sheep, agricultural and non-agricultural production in the research area, 2020

Source of Income	Total Income (IDR/Year)		% of Total Income
Sheep business income	2,420,400		5.39
Agricultural income	6,948,237		15.45
Non-agricultural income	35,540,268		79.15
Farm workers		707,857	-
Traders		25,911,429	-
Other workers		8,930,000	-
Total	44,917,923		100.00

The business scale factor greatly determines the proportion of livestock business income farmers occupies in rural areas. Some studies revealed that with a large scale of production, the contribution of sheep business to farmers' income in Sukabumi District was even greater, about 37.76% with a scale of 11.14 heads. Furthermore, Kuswaryan et al. [48] also reported that the sheep farming business could alleviate poverty for farm workers in rural areas by increasing sheep ownership up to 21.37 heads per farmer. The research results [15] also reported that assistance in controlling helminthic parasitic diseases in Majalengka increased the scale of production and the proportion of sheep sales and decreased mortality. Hence, it increased the income of sheep farming with the grazing system as the main business. A simple change in sheep husbandry and management could make it more efficient to generate income and alleviate poverty [8].

The concept of a model for the development of sheep livestock at the site is also inseparable from institutional development, as declared in the establishment of Sheep Village in Pandeglang by involving community leaders as technological assistants. With assistance, introduction to the development technology of "Composite Sheep" will have a high selling value due to the performance of the large type of sheep, which is supported by disease control in suppressing livestock mortality, as well as a marketing system and group development (farmer corporations) that need cooperation with the Indonesian Sheep and Goat Breeders Association (HPDKI) to meet export targets in the long term (export based on body weight requirements).

4.6 Policy recommendations for corn-based superior sheep development

According to the results of the ex-ante analysis with several considerations, several policies (follow-up plan) for sheep farming business development can be recommended as follows:

1. Maize/corn plantation is the prospective commodity cultivated by the community with certain market from feed mills mostly developed in that area. This generates considerable corn by-products (such as corn straw and corn cob) which are potentially as a source of feed for sheep farming. The corn-sheep integration system should be developed to increase farmers' income through by-product processing technology equipped by feed processing machinery in farmers 'scale (small feed industry). According to several studies, using corn byproducts as sheep feed may increase the final product of sheep farming, hence increasing farmers' income.
2. In terms of the small production scale and low body weight performance of the existing local sheep practices due to lack of program management and poor mating systems as well as the low availability of superior breeds, it is recommended to develop superior "Composite Sheep" to improve existing local sheep performances with directed breeding management that result in a high selling value. Composite sheep are the result of crossing local sheep with imported sheep, resulting in sheep with a large type (high body weight) that can adapt to Indonesia's tropical climate. These sheep are recommended for development strategies so that the genetic potential of sheep in rural areas has a high body weight (large type) and a high selling value when compared to local sheep, supported up by good feed.
3. The unprofitable economic performance of household from sheep business, due to low production scale (average three heads/farmer) and small type sheep raised resulted in low body weight and selling price. It is required improvements through crossing existing local sheep with superior male composite sheep to obtain greater body weight performance, supported by disease control to suppress pre-weaned mortality rate.
4. The development model policy in research site through the corn-sheep integrated system is an appropriate alternative recommendation for optimizing local resource-based feed, equipped with feed processing machinery, supported by superior breed, as well as strengthening farmers' institutions (corporation). It is expected that the integrated model will be able to increase household income and sustain it in the long term (Figure 3).

5. The program should involve local community leaders in the location to develop an area-based and sustainable program. It refers to the success of the establishment of the "Sheep Village" in Pandeglang District through the involvement of local leaders in farmers' assistance and enhance the role of the HPDKI (as a sustainable marketing partner).

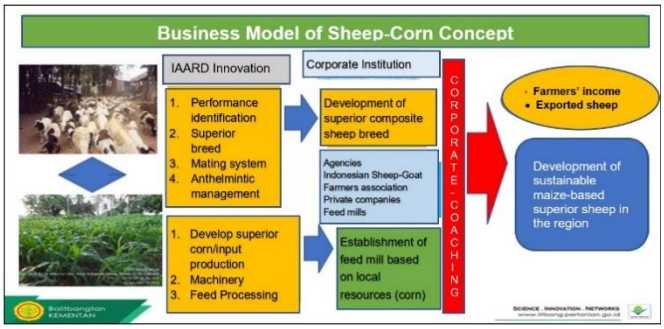


Figure 3. Policy recommendation of sheep development in the rural area

5. CONCLUSIONS

Preliminary research of corn-based sheep integration farming system shown that the corn commodity developed in the research area has potential as feed resources for sheep. Based on the assessment, in terms of human resources, the respondents were categorized as productive person with low education level but high experience on sheep farming activity, and enough number of family labor. These conditions, particularly experience and family size, have the potential to support the development of the sheep business, which is supported by the availability of land resources and corn by-products as a source of feed ingredients. In terms of technical aspects of sheep production, there is still room for improvement, especially in suppressing pre-weaned mortality rate and increasing production and productivity of sheep through improving quality of sheep breed and feed, controlled breeding management and health management. Furthermore, increasing production and economic efficiencies are required to sustain sheep business in this area by expanding the production scale, lowering production costs through maximization usage of local feed resources, and strengthening bargaining position to increase product price. Developing superior sheep breeds such as "Composite sheep" integrated with corn is recommended to improve business performance, followed by assisting farmers with feed processing technology (corn-based complete feed) to ensure sustainable feed. This composite sheep with typically a large type of sheep will encourage increased production and they have a higher selling value which will increase farmers' income in an integrated manner. In addition, to ensure long-term farming sustainability and social welfare, corn-based sheep development based on local and renewable natural resources and supported by excellent management techniques is required.

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