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Research Article
Analysis of the Production and Development of Etawah-grade (*Peranakan etawah*, PE) Dairy Goats on Post-sand-mining Land in Sumedang Regency, West Java

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Abstract

Background and Objective: Problems arising from sand mining include very low soil fertility, erosion and a lack of water resources. Reclamation to improve this mined land can initially involve recontouring, regrading, resloping and revegetation. Reclamation success, especially revegetation with plants suitable for forage, can be followed by integration with livestock. The aim of this study was to identify and analyze the production capacity and potential of dairy goat farms developed on post-sand-mining land in Sumedang Regency, West Java. **Materials and Methods:** Surveys and group discussions were performed to obtain information about farming practices and management. Secondary data were derived from the literature, reports and relevant institutions and in-depth discussions with experts were carried out as part of a detailed analysis of existing production systems. An Analytical Hierarchy Process (AHP) analysis and external (EFAS) and internal (IFAS) factor analysis strategies were used to determine the dominant factors influencing PE dairy goat production and to formulate appropriate strategies for sustainable production in post-sand-mining areas. **Results:** The results indicated a high percentage (75%) of productive females with low mating ratios 1:3-1:5. From an economic point of view, the Revenue-to-Cost (R/C) ratio was 1.57. An internal-external matrix analysis showed that growth and stability strategies should be implemented and a space matrix analysis indicated that a diversification strategy should be applied. **Conclusion:** Finally, an integrated approach, through improving the capacity of farmer's groups and support from local government will help to improve sustainable PE dairy goat production and provide benefits to small farmers on post-sand-mining land.

Key words: Post-sand-mining land, reclamation, dairy goats, production performance, integrated farming system, SWOT analysis

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Mined land has different characteristics depending on the type of mining and mining method. Problems arising following sand mining are very low soil fertility, erosion and a lack of water resources[1,2]. The process to improve so-called post-mining land is known as reclamation. Reclamation of post-mining land starts with recontouring, regrading, resloping and revegetation[3]. Successful revegetation, particularly with plants suitable for forage can be followed by the integration of farm animals, including dairy goats[4]. The plants grown for animal feed, which are at the same time intended to improve these critical areas of land, include leguminous plants such as *Gliricidia sepium*, Lamtoro/Leucaena (*Leucaena leucocephala*), Calliandra (*Calliandra haematocephala* Hassk.), jackfruit (*Artocarpus heterophyllus*) and Suren (*Toona sureni* Merr.). Active tree planting in post-sand-mining land can help to speed up the reclamation process of the area and minimize environmental damage[3,4].

Dairy goats have become an important part of some people livelihoods in Sumedang Regency[5]. This district is very rich in high-quality quarried sand; however, a lack of controlled post-sand-mining land management has resulted in a continual increase in critical land area in Sumedang[5]. The primary sector, comprising agriculture in a broad sense and working in sand mines, contributes to farmers' incomes. The development of the agricultural sector within this region is different from that in other regions that still have fairly extensive agricultural land[6]. The existing rules, such as the Regional Spatial Plan of Sumedang Regency limits farming areas; for example, livestock farming is not allowed in a residential area/settlement[7]. The livestock sub-sector does not get special attention by the government; however, the interest of farmers in raising animals on former mining land remains high; this is evidenced by the increasing number of farmers in Sumedang[5]. The integration of dairy goats with the post-sand-mine reclamation program is expected to be a solution with dual benefits. This study was conducted to analyze the production capacity and potential of dairy goat farms developed on post-sand-mining land in Sumedang Regency.

MATERIALS AND METHODS

Study area: This research was carried out on the slope of Mount Tampomas in 2 sub-districts in Sumedang Regency, West Java, Indonesia. The altitude of this region is approximately 700 masl, with a moderate climate and mild weather.

Data collection: This field study was conducted over a period of 3 month in 2011 to improve understanding of dairy goat farming practices. Data on farm conditions, characteristics of the farmers, livestock numbers, types and sources of feed, the production and reproductive traits of animals and milk production were collected. Goat farmers were purposefully chosen based on the ownership of more than 4 goats per farmer from those who were willing to participate in this study. Secondary data were obtained from a literature review, reports and previous researches. In-depth discussions with the initiator of farmer groups and owners of dairy goat farms were conducted to develop a good understanding and perform an analysis of existing goat farming systems.

Parameter measured: Production data, such as milk production, number of goats sold per year, animal disease rates, mortality, increases in goat ownership and reproduction data, such as age at first estrus, first mating and first kidding, as well as gestation length, lactation period, kidding interval, birth weight and litter size, were obtained from record books. Parameters for internal and external analyses, such as the Strengths, Weaknesses, Opportunities and Threats (SWOT) involved, were used to study the feasibility of dairy goat farming.

Profits were estimated based on the calculated production costs and the difference between total revenue and costs of production within their best levels of efficiency. This study used Revenue-to-Cost (R/C) ratios to analyze the feasibility of dairy goat farming on post-sand-mining land[8]:

$$\frac{R}{C}\ \text{ratio} = \frac{\sum_{t=1}^{n} \frac{Rt}{(1+i)} t}{\sum_{t=1}^{n} \frac{Ct}{(1+i)}}$$

where, Rt is yearly revenue, Ct is yearly cost, n is number of years, I is bank interest rate and t is year 1,2,3,.., n.

Data analysis: Data were descriptively analyzed and are presented as mean values in the tables. The Farming System Research (FSR) approach was applied in this study. An Analytical Hierarchy Process (AHP) combined with SWOT (ASWOT) was used to analyze and formulate strategies for developing programs. According to Leskinen *et al.*[9] and Rahmawati and Daroni[10], an SWOT approach is important in determining appropriate development strategies. The combined factors of SWOT are commonly used in strategic planning processes based on SWOT and the use of this quantitative technique allows for the determination of ideal

strategies, including assessing the efficiency of each proposed strategy[11]. In addition, a multicriteria approach using pairwise comparisons to make decisions was used[12]. This applies to the use of a growth strategy, stability strategy or retrenchment strategy, depending on which quadrant of the matrix the SWOT (strengths, weaknesses, opportunities and threats) are located in.

RESULTS AND DISCUSSION

Characteristics of Production and Reproduction: Based on the number of existing livestock and farmers, the average goat ownership of the farmer group in the Cimalaka sub-district was 40 head/farmer, consisting of 23 adult goats, 5 younger goats and 12 kids. A new group in the Paseh sub-district had as many as 14 goats/farmer, consisting of 6 adult goats, 4 young goats and 4 kids. The reproductive performance data in Table 1 are informative as they show proper estrus cycles and mating periods occurring at the appropriate age, which is in line with the findings of Atabany[13], who stated that the estrus cycle of *Peranakan Etawah* (PE) goats was 2.79 days, whereas that of Saanen goats was 21.73 days.

The data in Table 1 show that the average age of first estrus varied between sub-districts due to feed- and management-related factors. According to Mulyono[14], puberty (first estrus) in doe and sheep occurs at ages of 6-12 months. Sexual maturity in goats is achieved at ages of 4-6 months[15]. However, male PE goats do not become effectively reproducing bucks until they reach ages between 10-18 months, when the desire to mate is stronger and sex cells are fully developed. A delay in reproduction is also observed in female goats. Sutama and Budiarsana[16] stated that this delayed age of first mating is necessary as it allows the animal to achieve a sufficient condition and weight to maintain a pregnancy and adequate production performance, as well as have successful subsequent pregnancies.

The goat mating system used in both sub-districts still involved natural breeding and the results showed that the sex ratio in the goat herds was between 1:3 and 1:5, indicating that the mating system was inefficient. According to Atabany[13], the ratio between adult males (bucks) and adult females (does, including lactating does, does in the dry period, first-time pregnant does and ready-to-mate virgin does) on a PE goat farm was 1:14, whereas on a Saanen goat farm, the ratio was 1:3. According to Blakely and Bade[17] and Devendra and Burn[18], a healthy male could mate with between 25 and 30 productive females. A mating system that exceeded the capacity of males would lead to mating failures and a decrease in the pregnancy rate. Ginting[19] suggested that feeding management involving high quality, nutritious feed, especially regarding proteins and calories, increases feed intake and consequently improves the reproductive capacity of ewes during pregnancy and the lactation period.

The system used for raising goats in the studied farms was simple: goats were housed and feed was supplied through a cut-and-carry system, which involved cutting grass/leaves, collecting them and bringing them into the goat house; 76.47% of farmers used family labor and the remaining 23.53% used paid labor. Feed such as green grass/leaves (82%) were obtained from a common pasture approximately 5 km from the house and the rest came from their own gardens. Due to feed constraints, the feeding frequency was only 2-3 times daily, which was in line with the goats needs. Only a few farmers fed animals at the frequency of 4 times a day. Fuah *et al.*[4] revealed that feeding goats was mostly done in the morning and late afternoon and for pregnant goats and lactating goats, fermented tofu and rice bran were added as concentrates to enrich their feed. This practice aimed to increase milk production. The results of the economic analysis indicated that farmer revenues from selling goats and goat milk (Rp 7,154,620 million year^{-1} = USD $535.61) was profitable on an ownership scale of more than 20 goats, which was approximately 43 goats/farmer; below 20 goats, when feed and labor costs were calculated, this system was not profitable[20]. The benefits gained from agricultural businesses were in the form of fruits and vegetables to meet family needs.

The results in Table 2 show that based on the analysis of internal and external factors faced by farmers[21], there is the potential for dairy goat farming in Sumedang and that some strategic considerations exist. The weights obtained from the AHP analysis of the respective internal and external factors relate to the basic steps in the analysis of the planning stages that could be implemented. The high demand for goat's milk, a profitable and stable price of milk and the application of

Table 1: Reproductive characteristics of Etawah-Grade (PE) dairy goats raised on post-sand-mining land in Sumedang Regency of West Java

Parameters measured	Cimalaka	Paseh
	(Average = SE)	
The age of goats at first estrus (m[1])	10.06±1.65	12.89±3.86
The age of goats at first mating (m)	10.56±1.55	13.26±3.93
The age of goats at first kidding (m)	15.44±1.50	19.47±0.61
Gestational period (m)	5.13±0.34	5.53±0.51
Kidding interval (m)	7.75±0.58	7.17±1.11
Litter size/kidding (head)	2.13±0.50	1.75±0.62
Birth weight (kg)	3.25±000	-[2]
Weaning age (m)	3.50±0.73	4.85±1.68
Sex ratio	1:3	1:5
Kid mortality (%)	17.53±0.00	77.78±0.00
Ewe mortality (%)	3.87±0.00	5.62±0.00

[1]Months, [2]Unmeasured

Table 2: Factors of strengths, weaknesses, opportunities and threats

Internal Factor	External Factor
Strengths	**Opportunities**
• Adequate human resources	• High consumer demand for dairy products and goat meat
• Formation of institutional farmer groups	• The prices of goat milk, which were stable and likely to increase
• Extensive land to accommodate livestock-plant integration	• Implementation of the FSR approach with applied technologies to improve the efficiency and productivity of the business
• Integrated efforts to replant the land with greenery to provide animal feed	
• Strong willingness and commitment of farmers to develop goat farming	
Weaknesses	**Threats**
• Limited capital	• Conversion of post-sand-mining land into productive land
• Lack of support for the relevant agencies	• Difficulties in involving the human resources in the neighborhood
• Farmers' lack of knowledge about production systems, technology and management	• The available land is poor in nutrients (post-sand-mining land)

Table 3: Results of the *Internal Strategic Factors Analysis Summary* (IFAS) matrix

Internal factor	Weight	Rating	Score
Strengths			
Adequate human resources	0.134	2	0.268
Formation of institutional farmer groups	0.134	3	0.402
Extensive land to accommodate livestock-plant integration	0.134	2	0.268
Integrated effort to replant the land with greenery to meet feed needs	0.107	3	0.321
Farmer's strong willingness and commitment to develop farming	0.170	3	0.509
Weaknesses			
Limited capital	0.107	3	0.321
Lack of support for the relevant agencies	0.063	2	0.125
Farmer's lack of knowledge about production technology and output management	0.152	3	0.455
Total	1.000		2.670

[1]Weight between 0 and 1: 0 indicates unimportant factors and 1 indicates very important factors, [2]Rating: scale from 1 to 4: 1 indicates a major weakness, 2 indicates a minor weakness, 3 indicates a minor strength and 4 indicates a major strength

integrated technology were positive driving aspects for the development of livestock-based businesses in the region. The Human Resource (HR) manager's inputs needed for the production process consisted of the members of farmer's groups who already had skills in the management of dairy goat farming. The main element that is needed to preserve a clean environment is the management of waste from dairy goat farms. This requires technology for waste utilization as a source of organic fertilizer, with an integration pattern for its use in the growth of dragon fruit and greenery.

Analysis of internal strategy factors: The results presented in Table 3 are from the internal strategic factors analysis summary (IFAS), which gives weights (importance) based on the value of information, ratings and degree of influence. Accumulated scores of internal and external factors show the feasibility of dairy goat farming in Sumedang; based on IFAS matrix values, a value of 2.670 was obtained, which came from the strength factor score of 1.768 and a weakness factor score of 0.902. In the weight column, the weight of each factor is based on the results of analyzing questionnaires using the AHP method. According to Rangkuti[22] and Ikhsan and Aid[23], the weight determined for each factor was multiplied by 0.5 so that the total weight of the strength and weakness factors had a score of 1.000. In the rating column, it can be seen that most of the strength factors had a rating of 3 (somewhat strong), except for extensive land area to accommodate livestock-plant integration, which had rating of 2 (rather weak). For weaknesses factors, only one received a rating of 2 (rather weak), representing the lack of support from related agencies, while other factors had stronger ratings of 3.

External strategic factor analysis: The results of the EFAS are shown in Table 4, which reveal the weights (importance) and ratings of each opportunity and threat factor for dairy goat production in Sumedang. In the EFAS matrix (Table 4), the total score from the multiplication of the weight and rating of all the strength and weakness factors was 2.900. This value was derived from the opportunity factor score of 1.700 and the threat factor score of 1.200. The weight column shows the known weight of each factor from the analysis of questionnaires using the AHP method and multiplied by 0.5 so that the total weight of the opportunity and threat factors had a value of 1.000[20]. The rating column shows that most of the opportunity and threat factors have a rating of 3 (somewhat strong), except for land conversion of post-sand-mining into productive land, which has a rating of 2 (rather weak).

Analysis of internal-external factor matrix: Based on the data derived from the IFAS and EFAS matrices, the total score for internal factors was 2.670 and the total score for external factors was 2.900. This indicates that the development of dairy goat farming in Sumedang is categorized as average. If the

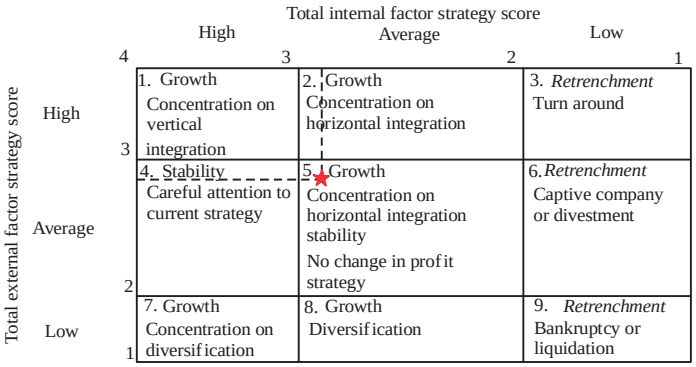

Fig. 1: Internal-external analysis matrix

Table 4: Results of the External Strategic Factors Analysis Summary (EFAS) matrix

External factor	Weight	Rating	Score
Opportunities			
High consumer demand for dairy products and goat meat	0.183	3	0.550
The prices of goat milk, which were stable and likely to increase	0.200	3	0.600
Implementation of the FSR approach with applied technologies to improve the efficiency and productivity of the business	0.183	3	0.550
Threats			
Conversion of post-sand-mining land into productive land	0.100	2	0.200
Difficulties in involving the human resources in the neighborhood	0.167	3	0.500
The available land is poor in nutrients (post-sand- mining land)	0.167	3	0.500
Total	1.000		2.900

[1]Weight between 0 and 1: 0 indicated unimportant factors and 1 indicates very important factors, [2]Rating: scale from 1 to 4: 1 indicates a major threat, 2 indicates a minor threat, 3 indicates a minor opportunity, or 4 indicates a major opportunity

scores for the internal and external factors are mapped on an internal-external factor matrix, then the development of dairy goat farms in Sumedang occupies cell 5 as shown in Fig. 1. This means that the business strategies of dairy goats in Sumedang that should be implemented are growth and stability strategies. According to Rangkuti[22], a growth strategy is designed to achieve good growth in production, assets and the rate of profit gains. This could be done by increasing quantity, improving quality and providing access to a wider market. A qualitative method was used to identify internal and external factors that affected the development of goat farming in post-sand-mining land[24].

Based on a growth strategy, dairy goat farming in Sumedang could still be feasibly developed. Increased livestock production, followed by improving the quality of products, was a requirement that had to be met. In addition, a growth strategy was implemented by concentrating on horizontal integration by increasing the types of products and services provided. According to Fuah *et al.*[4], the concept of achieving integrated livestock agriculture by optimizing the utilization of local feeds, such as silage-sorghum, became an alternative for increasing the value of critical sandy farms to develop sustainable production. This stability strategy was implemented without changing the direction of the existing applied strategy. Abdurrahim *et al.*[25] stated that the appropriate strategy for the development of goat farms in the area was to improve market penetration and product development.

Analysis of space matrix: The difference in scores between the strengths and weaknesses in the IFAS matrix and the difference in scores between opportunities and threats in the EFAS matrix represent the x and y coordinates, respectively, in the quadrants of the matrix space. Thus, the quadrant position of dairy goat farming indicates a variety of internal and external factors that had been previously analyzed.

Based on the IFAS and EFAS analyses, the difference in scores between strengths and weaknesses in the IFAS matrix was 0.866 and the difference in scores between opportunities and threats in the EFAS matrix was 0.500. The combination of these values places the result in quadrant II, as shown in Fig. 2. According to Marimin[26], business strategies can be grouped into 4 quadrants, namely, Quadrants I, II, III and IV. In quadrant I, the right strategy is an aggressive strategy; in quadrant II, a diversification strategy; in quadrant III, a turn-around strategy and in quadrant IV, a defensive strategy is the right strategy.

Based on Fig. 2, the position of dairy goat farming is in quadrant II. According to Saru in Prayudha[25], this position shows that the region faces a variety of threats but still has

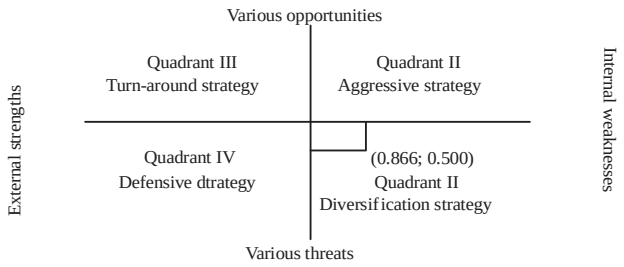

Fig. 2: Results presented in the analysis matrix space

Internal Factors / External Factors	STRENGTHS (S)	WEAKNESSES (W)
	1. Adequate human resources 2. Formation of farmer group institutions 3. Extensive land available to accommodate livestock-plant integration 4. Integrated effort to replant the land with greenery for animal feed 5. Strong willingness and commitment of farmers to develop goat farming	1. Limited capital 2. Lack of support for the relevant agencies 3. Farmers' lack of knowledge about production systems, technology and management
OPPORTUNITIES (O) 1. High demand for dairy products and goat meat 2. The prices of goat milk were stable and likely to increase 3. Implementation of an integrated FSR approach with applied technology to improve the ef?ciency and productivity of the business	1. Optimizing individual farmer's skills 2. Applied processing technology to increase productivity and the quality of products 3. Optimizing land utilization to improve the ef?ciency and productivity of businesses based on integrated farming	1. Improving production and processing technology 2. Improving farmer skills through integrated collaboration 3. Financial support from the government and related institutions
THREATS (T) 1. Land conversion of post-sand- mining land into productive land 2. Difficulties in involving human resources in the neighborhood 3. The available land is poor in nutrients (post-sand-mining land)	1. Providing guidance and its application and applying product processing technology 2. Funding support to increase the scale of goat enterprises 3. Space utilization for goat farming based on biophysical availability	1. Formulation of policies for utilization of the critical land 2. Financial support from the government and related institutions

Fig. 3: Results of the SWOT analysis

strengths and that the strategy to apply is to use strengths to take advantage of long-term opportunities by implementing a diversification strategy. Thus, the result of the space analysis confirms the external-internal matrix analysis results. The third and final stage of the strategy formulation[20] was the decision-making stage. This stage could be performed using a SWOT analysis matrix. Various results of the first and second stages can be considered and input to formulate the SWOT analysis in this decision-making stage.

Decision-making stage using a SWOT analysis: According to Abdurrahim *et al.*[25], the decision-making stage is performed after the internal-external matrix and space matrix analyses show the position of a farming system. In this study, the dairy goat business was in cell 5 of the internal-external matrix and the space matrix analysis placed it in quadrant II. Thus, the primary strategy to use, based on the SWOT matrix, is a Strengths-Threats (ST) strategy, implemented by using all the strengths to eliminate the threats to dairy goat farming in Sumedang.

Various strength and threat factors were studied and analyzed so that a strategy could be formulated for the business plans of dairy goat farming in Sumedang. The formation of farmer groups, the strong farmer spirit and the high demand for goat milk were good reasons to adopt a growth strategy. From the threat side, the issues of land conversion into a toll road and the factors relating to the conversion of post-sand-mining land should be minimized. In this regard, there should be an effort to mobilize resources related to the strengths of the organization to lessen the threats from outside and turn these threats into opportunities.

Based on the SWOT matrix, several strategies could be formulated by considering the internal factors (strengths and weaknesses) and external factors (opportunities and threats) together as shown in Fig. 3.

Guidance from the relevant authorities on the use of product processing technologies was indispensable for

breeders to improve product diversification. The formation of farmers' groups was expected to strengthen existing farmer's groups and increase the bargaining power of farmers by improving the quality of livestock products. Based on the biophysical and spatial potentials[26] and the comparative and competitive advantages, changes in the pattern of existing space in the region[27] could be proposed to accommodate the agricultural and livestock sectors with an integrated system. Optimizing the growth and production of agricultural commodities requires land with specific qualities, characteristics and management[28,29].

CONCLUSION

Integrated dairy goat farming practices on post-sand-mining land have provided various advantages, including tangible benefits to small farmers. Improving breeding management will improve reproduction, along with the provision of sufficient feed nutrients during pregnancy and lactation. A SWOT analysis provided a growth strategy based on improving the quality of goats and their products, including better marketing systems by strengthening the institutional capacity of farmers' groups. Improving land utilization using applied technology for growing Indigofera species and sorghum could improve the efficiency and productivity of the land.

SIGNIFICANT STATEMENTS

This study illustrates the success of reclaiming post-sand-mining land with forage fodder. This success was followed by use of the land by local farmers for dairy goat farming. Internal-external matrix and space matrix analyses presented strategies to improve goat farming performance and helped guide the decision-making process. This study will help researchers to uncover critically important areas in the development of Etawah-grade (*Peranakan Etawah*) dairy goats in post-sand-mining areas that have yet to be explored. Thus, a new concept for the integration of dairy goats with post-sand-mine reclamation programs is expected to provide a solution with dual benefits.

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