







# Sustainable Wool Production and Management System in Small Enterprise

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**Abstract.** Sheep are mainly raised to produce meat in Indonesia. Wool from local sheep have not been utilized and become a waste when the farmers shear the wool for sanitation purposes. On the other hand, Indonesia has sheep breed that potential as wool producer. Wonosobo Sheep, crossing of local breed and Texel, produce more wool compare to other local breeds. Studies on wool production and management in small enterprise are limited. This study aimed to analyze the internal and external environments of a small enterprise in wool production, through the identification and analysis of the strengths, weaknesses, opportunities and threats. The method of this study was descriptive with field observation in a small enterprise in Wonosobo, Central Java. The SWOT analysis was performed to analyzed certain factors for the development of a wool processing business. Data related to wool production and management were collected in the location. Questions were asked regarding wool collecting, processing and production. The result showed that the wool production and management were able to utilize the wasted wool from sheep farmers. The enterprise also managed to produce, promote, and sell the final product of wool, such as handicraft and fashion. However, the enterprise has not been able to determine the purchase price of wool suitable for farmers and the price of the products. This study suggests an improvement in wool supply and advancement in wool processing.

**Keywords:** Sheep · Wool · Sustainable

## 1 Introduction

The warm and humid climate of Indonesia is not the suitable environment to raise sheep as wool producers. However, several imported sheep breeds such as Merino, Texel and Suffolk during 1930's or even during 1980's showed good adaptation to the local environments. Those sheep were imported to improve the local sheep productivity and distributed to the small holder farmers at Wonosobo and Banjarnegara high land, and still exist until now.

The crossing between Texel sheep to the local produce offspring and has been received Ministry of Agriculture decree as local breed (No. 2915/Kpts/Ot.140/6/2011). On the hand, batur sheep of Banjarnegara also received Ministry of Agriculture decree as local sheep No. 2916/Kpts/OT.140/6/2011. Beside their main purposes as meat production, by product as wool has been utilized for handicraft. However, their wider utilization has not been done yet, and lots of the wool are found scattered in the field.

Breed and sex significantly ( $P < 0.05$ ) influenced the wool staple length, with average of Batur x Batur, Texel x Batur, Suffolk x Batur and Garut x Batur sheep was 6.6 cm; 8.7 cm; 12.0 cm dan 9.0 cm, respectively [1]. Previously, the study reported the utilization wool of Batur and Garut sheep for industrial purposes and showed that wool physical characteristic had no significant difference on their tenacity, resilient, and flammability, respectively [2]. The combination of board-Batur wool and board-Garut wool had better performance compared to board and nylon, which means there is an opportunity and challenge to utilize the wool as raw material for industrial purposes.

Sustainable wool production can be reached through regular wool shearing. Previous research reported that breed of sheep significantly influences wool production, wool quality and staple length [3]. Pakistani breed of Balochi, Bibrik, Harani and Rakshani produce wool of 2.0–2.5 kg; 1.9–2.0 kg; 1.8–2.0 kg and 1.3–1.5 kg/animal/shearing, respectively. The wool quality of Balochi, Bibrik, Harani and Rakshani was 30–32  $\mu$ ; 35–37  $\mu$ ; 37–38  $\mu$  and 38–41  $\mu$ , respectively [3]. More over the staple length of the breeds was 5.98 cm; 5.72 cm; 4.53 cm and 3.69 cm, respectively [3].

Small enterprise has the opportunity to utilize wool processing at the Wonosobo-Banjarnegara highlands. Early wool processing includes of sheep shearing, washing, drying, sorting and spinning the wool open an opportunity for farmers to take part of the system. This study aimed to analyze the internal and external environments of a small enterprise in wool production, through the identification and analysis of the strengths, weaknesses, opportunities and threats. This study is important as information to identify factors that impact a small enterprise and to provide useful information during the strategic planning process in wool production.

## 2 Materials and Methods

### 2.1 Study Area

The study was carried out in Wonosobo Regency in April 2021. The observed small enterprise was CV Ramindo Berkah Persada Sejahtera, an integrated sheep farm producing wool and compost. Wonosobo Regency is the center of Wonosobo Sheep population and a suitable microclimate conditions for crossbreed sheep. The month with the highest relative humidity is February (90.44%), while the month with the lowest relative humidity is September (83.56%). Highest number of rainy days also occurs in January (28.57 days), while the month with the lowest number of rainy days is August (11.40 days). In this location, Wonosobo Sheep have been farmed, maintained and raised by smallholder farmers for generations (Fig. 1).



**Fig. 1.** The location of Wonosobo Regency, Central Java Province.

## 2.2 Research Methods

Primary data was collected through a participatory approach, which included direct field observation and interviews with respondents who were chosen purposively. Respondents included Wonosobo sheep farmers, wool craftsmen, and related service officers. The target information obtained was related to the wool production and processing system, as well as the strategy and development plan. The collected data were then compiled and descriptively analyzed. Detail of collected data were number of sheep ownership, feed sources, manure management, purposes of sheep farming and wool processing.

SWOT analysis is used to identify internal factors (strengths and weaknesses), as well as external factors (opportunities and threats) which important for the development of a wool processing business [4]. The internal factor is investigated to discover which characteristics of strength can be utilized and which variables of weakness must be addressed. While the external factor is being analyzed to identify the primary opportunities and threats [4]. These factors are developed from the findings of surveys and discussions with wool craftsmen, sheep farmers, and staffs from Livestock Services.

## 3 Results and Discussion

### 3.1 Overview of Wonosobo Regency

Wonosobo Regency is a regency in the Central Java Province with a total area of 984.68 km<sup>2</sup> which divided into 15 subdistricts, namely Wadaslintang, Kepil, Sapuran, Kalibawang, Kaliwiro, Leksono, Sukoharjo, Solomerto, Kalikajar, Kertek, Wonosobo, Watumalang, Kejar, Garung, and Mojitengah. Wadaslintang (12,9%), Kaliwiro (10,2%), and Kepil (9,5%) are the subdistricts with the most land area accounted

12,9%; 10,2% and 9,5% of Wonosobo area, respectively. Geographically, Wonosobo Regency has the following boundaries: north: Kendal Regency and Batang Regency; east: Temanggung Regency and Magelang Regency; south: Kebumen Regency and Purworejo Regency; west: Banjarnegara Regency and Kebumen Regency.

In 2019, the total population was 790,491 people with annual population growth rate about 0.40%. Average population density account 803 people per km<sup>2</sup>, with the most populated subdistrict, namely Wonosobo subdistrict (2,793 people per km<sup>2</sup>). The sex ratio is 102.75%, with men outnumbering women (50.68% vs 49.32%). In 2019, the total workforce was 426,331 people, with 37.9% working in agriculture, forestry, hunting, and fisheries.

However, the agriculture industry continues to develop at a slower rate than other sectors such as transportation and communications, trade, hotels and restaurants, and construction. This is due to the fact that numerous challenges of farmers and agriculture in general exist in Wonosobo Regency, such as the problem of agricultural land, capital problems, market problems, technological problems, and policy concerns [4]. The findings of previous study stated that the major subsectors of agriculture in Wonosobo Regency include food crops, forestry, and animal husbandry [5].

Based on the Location Quotient (LQ) value, the major agricultural subsector in each subdistrict of Wonosobo Regency is the food crop subsector (in Sapuran, Kaliwiro, Sukoharjo, Selomerto, and Mojotengah); livestock subsector (in Kertek and Wonosobo); and forestry subsector Sapuran, Kalibawang, and Kaliwiro subdistricts) [4]. Rice, corn, cassava, peanuts, and horticulture are the leading commodities for food crops. Sheep are one of the most important livestock commodities [4].

### 3.2 General Description of Sheep Farming

This study observed three farmer groups in Wonosobo District. The farmer groups were chosen based on representation of location and sheep population size. Details on each farmer groups are shown in Table 1. In general, sheep were kept intensively at communal barn and fed vegetables by products such as carrot, cabbage and also natural grass available surrounding the location. Forages was offered twice daily, in the morning and again during afternoon.

The observed farmers in this study kept Wonosobo Sheep or known as Dombos sheep, where most of the farmers were traditional and follow their father's footsteps. Based on farmer's information, Wonosobo Sheep were originated from Texel sheep that has been adapted during the distribution and have been crossbred with local sheep (fat tailed sheep and thin tailed sheep). Dombos are distinguished by their wool fur, which covers almost all part of the body except the face, lower belly, and legs. An adult male Dombos sheep may weigh up to 100 kg–200 kg, while female Dombos may weigh up to 82 kg [6, 8]. Thus, Dombos sheep can be raised for meat and fur (wool) production based on their potential.

The average ownership of the Wonosobo Sheep was 5–10 sheep per farmer. Previous study showed study the average ownership was 8.7 sheep per farmer [1]. It shows that this situation reflected how farmers put sheep as important belongings. The other farmer's activities beside sheep keeping were horticulture farmers and general trading.

**Table 1.** Characteristics of sheep management system in observed farmers group.

| Farmer group   | Location                                 | Member (farmers) | Sheep population (head) |
|----------------|------------------------------------------|------------------|-------------------------|
| Rimba Berkarya | Surengede Village, Kejar Subdistrict     | 20               | 100                     |
| Murih Rahayu   | Butuh Village, Kalijajar Subdistrict     | 28               | 300                     |
| Purwojiwo      | Purwojiwo Village, Kalikajar Subdistrict | 12               | 80                      |

**Table 2.** Characteristics of feed sources and manure utilization in observed farmer groups.

| Farmer groups  | Feed sources (%)                                           | Manure utilization | Purpose of sheep farming |
|----------------|------------------------------------------------------------|--------------------|--------------------------|
| Rimba Berkarya | Cut and carry forages (70%), Horticulture by-product (30%) | Organic fertilizer | Breeding and fattening   |
| Murih Rahayu   | Cut and carry forages (50%), Horticulture by-product (50%) | No utilization     | Fattening                |
| Purwojiwo      | Cut and carry forages (80%) Horticulture by-product (20%)  | No utilization     | Fattening                |

The observed farmers of Wonosobo sheep did not consider the exact amount and quality of feed given to the sheep. They did not take into account the physiological status and body weight of the sheep in feeding. However, the farmers treated the pregnant and lactating ewes differently in feeding quantity. Previous study showed the farmer did not differentiate the nutrient requirement of sheep before mating, pregnant and lactating ewes [10]. The feed provided was grass and agricultural by-product especially horticulture by-product, without any supplementation. Feed quality, quantity and sustainability influence general sheep performance include of the coat cover quality. Characteristics of feed sources and manure utilization in observed farmers group are shown in Table 2.

Some farmers have planted superior grass in their fields. The supply of feedstuffs is generally abundant, and it is accessible all year. Farmers seek for grass in fields/fields or on the border of the forest/idle land, as well as the by-product of the veggies, farmers simply collect it from the land that is being harvested for free. Fresh forage feed is given without any prior processing. In addition to food crop by-product, Wonosobo sheep also can be fed by ramie plant by-product [8]. The research on the use of ramie leaves for fattening was carried out in Butuh Village, Kalikajar District, Wonosobo Regency in 2018. The use of ramie leaves as a feed for fattening Wonosobo sheep can receive up to 30% in fresh form. Some farmers are familiar with feed processing, but they are not put into practice due to a lack of labor.

### 3.3 Wool Production and Processing

Wool is now a worldwide industry, with Australia, Argentina, the United States, and New Zealand acting as key suppliers of raw wool. While the United States consumes the most wool fabric, Australia is the leading supplier. Australian wool accounts for around one-fourth of global output. What was once a tiny home-based craft has now developed into a large enterprise. Global production is now projected to be 5.5 billion pounds per year. Despite the fact that cotton is the most common plant used for fabrics and the most common fiber in general, wool remains the most common source of animal fiber.

Wool produced by Wonosobo sheep is of great quality, with a high density and more spiral curls in the fleece. However, the utilize of fleece of Wonosobo sheep has not been done optimally. The farmers shear the fleece approximately at 3 months or 4 months interval, and there is no exact frequencies either for ewes or even rams. However, the use of Wonosobo fleece has not been done optimally. Farmers aren't used to collecting fleece to clean and sell. Sheared sheep's fleece is typically discarded as garbage. Farmers do this due to the lack of knowledge about the benefits of sheep fleece and a shortage of time to clean the fleece from dirt, wool wax, salts from suint (sweat), and non-wool protein material. Cleaning fleece before collecting is critical so that the fleece does not stink after it has been stored for a length of time before being sold to collectors. Fat residues that stick to the fleece might cause the fur to smell quickly.

This condition prevents the development of the wool processing business in Wonosobo Regency. CV Ramindo Berkah Persada Sejahtera (Ramindo), one of the Wonosobo companies that pioneered the use of wool in handicrafts. Ramindo is an integrated sheep farm producing wool and compost. They practice integrated sheep farming with ramie plants (*Boehmeria nivea* L. Gaud), where the ramie stems are utilized for craft materials (rope) and as a mixture in wool crafts, and the leaves are used as feed for fattening sheep. Woolen handicrafts are in high demand among customers and companies that use wool as an industrial raw material. Wool can be blended with any number of natural or synthetic fibers, and various finishes and treatments can also be applied. The availability of fleece is the most significant impediment to the development of the wool industry.

This study observed the wool production and processing in Ramindo. Generally, shearing, cleaning and scouring, grading and sorting, carding, spinning, weaving, and finishing are the major steps in the wool processing process from sheep to fabric. However, as shown in Table 3, Ramindo processes fleece sheep till carding and spinning steps to produce wool yarn. The tools of wool processing were mainly traditional and made from wood as shown in Fig. 2.

### 3.4 Internal and External Factors Analysis

Several internal and external factors gathered by interviews with stakeholders and farmers can be used to identify strengths and opportunities, as well as weaknesses and threats, in order to establish a strategy and plan for the wool industry in Wonosobo Regency. SWOT analysis was employed in this study, as it has been in many others. As seen on Table 4, there are five (5) strengths that can be identified to develop the wool industry in Wonosobo Regency: (i) the availability of Wonosobo sheep, which are adaptable and

**Table 3.** The production and processing of wool in CV Ramindo Berkah Persada Sejahtera.

| Phase                 | Descriptions                                                                                                                                                                                                                                                        | Methods                                                     |
|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| Collecting            | The basic material for wool comes from sheared fleece Wonosobo Sheep obtained around Wonosobo Regency                                                                                                                                                               | On farm shearing                                            |
| Buying                | The purchase price fleece as wool raw material is IDR 10,000 per kg at the farmer level.                                                                                                                                                                            | On farm buying                                              |
| Cleaning and scouring | Washing and cleaning to remove dirt and grease. Materials that can be used as wool are 40% of the raw material for sheep's hair obtained from farmers. Dirt, wool wax, salts from suint (sweat), non-wool protein material, skin pieces were removed in this phase. | Washing wool in a detergent solution and rinsing the fibres |
| Finishing             | Carding and spinning                                                                                                                                                                                                                                                | Wire-covered rollers separate the fibres                    |



**Fig. 2.** The carding process using traditional wooden tools (left) and final carded wool ready for spinning (right) in CV Ramindo Berkah Persada Sejahtera

produce more fleece as wool raw material than local sheep; (ii) an abundant feed source, particularly from horticultural by-products; and (iii) the availability of wool processing business, i.e. Ramindo; (iv) farmers' experiences in rearing sheep; and (v) assistance from the central and local governments for the development of Wonosobo sheep as a domestic genetic resource. Wonosobo Regency has Dombos sheep, which are a cross-bred Texel sheep with local sheep (fat tailed sheep and thin tailed sheep) that have been adapted during distribution and have high tolerance with Wonosobo environment.

**Table 4.** Identification of internal and external factors in wool industry development in Wonosobo Regency

| Internal Factors                                                                                                                                                                |                                                                                                                                         |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| Strengths                                                                                                                                                                       | Weaknesses                                                                                                                              |
| <ul style="list-style-type: none"> <li>• The availability of Wonosobo sheep, a multipurpose sheep, that are adaptable and produce more fleece compare to local sheep</li> </ul> | <ul style="list-style-type: none"> <li>• Low scale of sheep rearing</li> </ul>                                                          |
| <ul style="list-style-type: none"> <li>• Abundant horticultural by-products as feed source</li> </ul>                                                                           | <ul style="list-style-type: none"> <li>• Limited time and labor of farmers</li> </ul>                                                   |
| <ul style="list-style-type: none"> <li>• The availability of wool processing business</li> </ul>                                                                                | <ul style="list-style-type: none"> <li>• Farmers' lack of knowledge and capabilities in sheep management and wool processing</li> </ul> |
| <ul style="list-style-type: none"> <li>• Farmers' experiences in sheep farming</li> </ul>                                                                                       | <ul style="list-style-type: none"> <li>• The younger generation's interest in sheep rearing has decreased.</li> </ul>                   |
| <ul style="list-style-type: none"> <li>• Central and local governments support</li> </ul>                                                                                       |                                                                                                                                         |
| External Factors                                                                                                                                                                |                                                                                                                                         |
| Opportunities                                                                                                                                                                   | Threats                                                                                                                                 |
| <ul style="list-style-type: none"> <li>• The demand of wool is high</li> </ul>                                                                                                  | <ul style="list-style-type: none"> <li>• Declined sheep population</li> </ul>                                                           |
| <ul style="list-style-type: none"> <li>• Wool price is high</li> </ul>                                                                                                          | <ul style="list-style-type: none"> <li>• Sheep sales to other regions/countries are not controlled.</li> </ul>                          |
| <ul style="list-style-type: none"> <li>• Available wool processing technology</li> </ul>                                                                                        | <ul style="list-style-type: none"> <li>• Low quality of Wonosobo sheep due to crossbred with other local sheep</li> </ul>               |

Aside from meat, Wonosobo sheep have the capacity to produce wool, which can be seen on practically every part of the body except the face, lower belly, and legs, which are covered with fur. The abundant supply of horticultural by-products such as carrot leaves, cabbage, etc. can be utilized as a potential source of sheep feed. Horticultural by-products that is still being discarded can be used or preserved for a long period by drying (hay) or fermenting. The presence of a wool processing enterprise may act as a trigger for the further growth of Wonosobo sheep and the wool industry. Farmers' experience in sheep rearing is another significant strength that might help the growing wool processing sector thrive. The involvement of both national and local governments, particularly in terms of provision technical support, capital/credit policy, and development of the wool market, may be critical to the success of the expanding wool processing business.

Meanwhile, there are four (4) weaknesses in the internal factor of wool industry development in Wonosobo Regency: (i) low scale of sheep rearing, around 7–10 head per farmer; (ii) farmers' limited time and labor availability to shear and process sheep fleece frequently; (iii) farmers' lack of knowledge and capabilities in sheep management and wool processing; and (iv) decreased interest of young generations in rearing sheep. Farmers' low sheep ownership will have an impact on the amount of fur generated to sustain the Wonosobo wool business. Increasing the number of sheep held by farmers is one of the most important measures that must be undertaken.



Due to lack time and labor availability, the farmers only shear the fleece approximately at 3 months or 4 months or even 6 months interval, and there is no exact frequencies either for ewes or even rams. This condition will affect the wool production, both quantity and quality. Frequent shear is needed to produce more wool with high quality. Lambing and shearing are two major husbandry practices in a sheep farm that a producer may change the timing of to improve productivity. The time of the shearing event influences wool quality and production, such as staple strength, length, and fleece weights. The bulk of sheep farmers in Wonosobo Regency are elderly, and few young people are interested in the business. This weakness is can be a threat to the sheep industry's long-term sustainability as a source of raw materials for the wool industry.

The indicators of opportunities and threats give insight into the external variables affecting the wool industry. The enormous demand for wool, combined with its high price, are the primary potential for developing the wool industry in order to improve farmer welfare. Wool has a significant economic value and can provide an alternative source of income for sheep farmers, wool crafters, and other parties involved in the wool business. Other opportunities for the development of the wool industry include the availability of science and technology in wool processing, as well as machinery. Today's issue in Wonosobo Regency sheep farming is the reduction in sheep population as a consequence of uncontrolled sheep trade to outside Wonosobo and even abroad (Malaysia), as well as the decline in quality as a result of unregulated crossbreeding with local sheep. This disorder has the potential to affect the quantity and quality of sheep fleece used as a raw material in the wool industry.

### **3.5 Strategy and Development Plan**

Based on the current condition in small wool processing enterprise, this study observed that wool processing of Wonosobo Sheep have the opportunity become one of the business activities besides sheep fattening or even breeding to produce feeder lambs. Therefore, if wool shearing can be conducted at frequent basis, this will eventually alter the farming activities such as selecting individuals with better wool production, improving feeding practices to ensure enough wool production as well as building farmer institution to facilitate wool processing activities.

In further stages, farmers will decide the beginning of wool shearing based on sex (ram or ewe), age of wool shearing (> 1 year old), shearing frequencies (yearling, twice or three times a year). Merino sheep in Australia have three wool qualities such as medium, fine and superfine, where the superfine wool can be further process for apparels). The average wool sheared of Harnai sheep in Pakistan from adult male was highest (1.90 kg), followed by adult female (1.80 kg) and male young stock (1.60 kg); while the lowest (1.55 kg) was sheared from female young stock.

## **4 Conclusions**

The result showed that the wool production and management were able to utilize the wasted wool from sheep farmers. The enterprise also managed to produce, promote, and sell the final product of wool, such as handicraft and fashion. However, the enterprise has

not been able to determine the purchase price of wool suitable for farmers and the price of the products. This study suggests an improvement in wool supply and advancement in wool processing.

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