Coat cover characteristics of sheep in North Sumatera, Indonesia

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Abstract. The study was conducted to investigate the coat cover characteristics of sheep kept by farmers in several districts in North Sumatera, as a sign of adaptability to the local environment. A total of 190 sheep (local and introduced) of both sexes and different age (10–14) were used for the study from 5 districts of Deli Serdang, Labuhan Batu Utara, Asahan, Serdang Berdagai and Batubara in North Sumatera. The data were analysed using general linear model with the independent variables was location of the study, farmers involve in the study, breed of sheep, sex, age and the dependent variables were body weight and coat quality. The study showed that the average coat color of the sheep in the study was mostly white (95.7%). Most of the sheep have solid coat cover (61.1%) and small percentage with patches (30%) and spotted (8.9%). The average body weight of the sheep was 23.2 kg with significant effect (P<0.05) of districts, farmers, sex, age and wool density. The average of product between coat cover and coat density was 14.1 with significant effect (P<0.05) of districts, farmers and age of sheep. Therefore it can be concluded that sheep in this study mostly has white coat color, with area cover approximately of 4.2 and coarse quality of wool with average score of 3.1.

1. Introduction

Sheep production centers in North Sumatra province are located in several districts such as Batubara, Deli Serdang, Serdang Berdagai, Asahan and Labuhan Batu Utara. The sheep population in North Sumatra province in 2018 was estimated around 696,838 head, the fourth largest livestock population after pigs (1,229,741 head), broilers (982,963 head) and goats (873,025 head). The sheep population as reported by BPS North Sumatera [1] in the last five years was 595,517; 610,103; 611,427; 671,013 and 689,643 head for 2013–2017, respectively, with an average increase ranging from 1–3% per year. The figure can actually be further increased given the availability of abundant natural forages found in common grazing land, forage varieties under the auspices of plantation crops, introduction of several forages varieties adapted to local environment, the availability of agricultural by product as well as by products of industrial process. Looking at the area of land in North Sumatra province as well as its land use, it is estimated that the sheep population can be optimized to more than 1 million head. There are 13 cattle fattening and breeding and fattening companies with a total of 660 people, but there is lack of information...
about sheep and goat farming business as reported by Bangun [2]. It can be the case that the information has not been recorded as a company, but the breeding and fattening activities of goats and sheep have been widely carried out by the community. Previously, the Minister of Agriculture launched and exported sheep to Malaysia in 2018, and the demand from the neighbour country is estimated around 60,000 head/year. This is a precious opportunity for North Sumatera farmers becoming an export province of small ruminants. Therefore the production site has to be improved continuously in order to adequately meet the demand.

There are genetic variety of sheep coat cover ranging from wool to hair type coverings. Mahmoud et al (2017) and Anjoula and Mc Ewan (2018) underlined that it is very important that sheep are able to be productive according to the local environment wool-covered sheep are more suitable in four seasons areas or at the high latitude [3,4]. Heritability for wool quality and coat cover was estimated to be moderate until high. On the other hand, hair cover is more suitable for sheep raised in the humid and tropics areas. In the humid and tropics of Indonesia, sheep are kept mostly as producer of meat, hyde as well as organic fertilizers, whereas in the four season countries, wool sheep is also one of the challenge for their production. In the high latitude area such as Banjarneagara and Wonosobo districts in Central Java province, batur and wonosobo sheep are well known for their wool covering. However, wool utilization in that area is very limited, and be used mostly for handicraft. Hair type sheep have a different type of skin follicle compared to wool type sheep, and this will also determine the type and quality of wool produced. There has not been much research on sheep body covering types in Indonesia, given the very limited utilization of the wool.

The purpose of this study is to investigate the effect of sheep coat cover characteristics on sheep production in five districts in North Sumatra Province.

2. Methods

2.1. Location
The study was conducted in December 2019 – February 2020, in districts of Deli Serdang, Serdang Berdagai, Asahan, Labuhan Batu Utara and Batubara of North Sumatera Province, using sheep belong to the farmers.

2.2. Materials
The study used 190 sheep of different ages, consisted of local Sumatran sheep and could also the progenies of hair sheep from St Croix and Barbados Blackbelly ancestor, as seen from their appearance. The management practices by farmers include of (1) extensive management practices, where sheep were grazed during day time (13:00 – 18:00 pm) and (2) intensive management practices, where sheep were housed most of the time and feed was provided by cut and carry system. Some farmers provided feed supplement from agriculture by products available surrounding the barns (i.e., by products of herbs, fermented sagoo by products etc).

2.3. Methods
The parameters observed can be found in table 1.
Table 1. Parameters used for the study.

| Parameter | Score | Assessment criteria |
|-----------|-------|---------------------|
| Age of sheep\(^1\) (month) | | Dentition was conducted by observing the erupted of permanent teeth, and classified as follow |
| 1 | 0 – 6 | |
| 2 | > 6 – 12 | |
| 3 | >12 – 18 | |
| 4 | >18 – 24 | |
| 5 | > 24 – 30 | |
| 6 | > 30 | |
| Coat color score\(^1\) | | The score is done by observing the color and type of patches of the animal |
| 1 | | 1. The dominant coat cover: white, black, brown |
| 2 | | 2. The type of patches: large patch, small patch, spotted |
| 3 | | 3. The dominant color of patches: white, black, brown |
| Coat area score\(^1\) | | The score is done by observing the area of coat surrounding the animal |
| 0 | Totally covered with heavy wool including lower leg and face | |
| 1 | Hair only | |
| 2 | Moderate to heavy wool along tops of back, shoulders and rump | |
| 3 | Moderate to heavy wool along tops of back, over shoulders and half way down side and rump | |
| 4 | Moderate to heavy wool over the body except not on belly, down legs on head | |
| 5 | Moderate to heavy wool over body, including belly except wool may or may not be on top of head, on lower leg or on fore and rear flanks | |
| Coat density score\(^1\) | | Short slick hair (like kacang goat), no wool, hair usually <3 cm |
| 1 | Short hair with a small amount (10–25%) of short or long kemp mixed in, length of mix about 2–4 cm | |
| 2 | Moderately long, moderately dense hair, kemp mix, about 3–5 cm long, wool usually 20–40% of mix | |
| 3 | Long, dense wool with various amounts and length of kemp and hair mixed in about 4–6 cm long, wool usually >50% of mix | |
| 4 | Very long, very dense wool (annual unclipped growth >6 cm long), may have kemp and hair mixed in, often in heavy matted, greasy locks | |

Source: 1) Bell et al [5]; 2) Modified from Sheep Production Handbook [15].

2.4. Data Analysis:
Data were analyzed using general linear model of SAS.10 (2002) statistical package, with the following model and assumption.

Model 1:
\[
Y_{ijklmnopqrs} = \mu + A_i + B_j + C_k + D_l + E_m + F_n + G_o + H_p + I_q + J_r + \epsilon_{ijklmnopqrs}
\]  
(1)

Where:
| \(Y_{ijklmnopqrs}\) | the observation of body weight from \(i^{th}\) location, \(j^{th}\) farmers, \(k^{th}\) sheep breed, \(l^{th}\) sex, \(m^{th}\) age, \(n^{th}\) dominant coat color, \(o^{th}\) type of patch, \(p^{th}\) color of patch, \(q^{th}\) coat cover and \(r^{th}\) density of wool |
| \(\mu\) | general mean |
| \(A_i\) | the effect of \(i^{th}\) location, where \(i = 1,2,3,4,5\) |
| \(B_j\) | the effect of \(j^{th}\) farmers, where \(j = 1,2,3,4,5,6,7\) |
| \(C_k\) | the effect of \(k^{th}\) breed, where \(k = 1,2,3,4\) |
| \(D_l\) | the effect of \(l^{th}\) sex, where \(l = 1,2\) |
Em: the effect of mth age, where m = 1, 2, 3, 4, 5, 6
F_n: the effect of nth dominant coat color, where n = 1, 2, 3
G_o: the effect of oth type of patches, where o = 1, 2, 3
H_p: the effect of pth color of patches, where p = 1, 2, 3
I_q: the effect of qth coat cover area, where q = 1, 3, 5, 7, 9
J_r: the effect of rth density of wool, where r = 1, 3, 5, 7, 9
E_{ijklmnopqrs}: standard error from effects of location, farmers, sheep breed, sex, age, dominant coat color, type of patch, color of patch, coat cover, density of wool

Model 2:

\[ Y_{ijklmn} = \mu + A_i + B_j + C_k + D_l + E_m + \epsilon_{ijklmn} \]  

\( Y_{ijklmn} \): the observation of product (coat cover x coat density)
\( \mu \): general mean
\( A_i \): the effect of ith location, where i = 1, 2, 3, 4, 5
\( B_j \): the effect of jth farmers, where j = 1, 2, 3, 4, 5, 6, 7
\( C_k \): the effect of kth breed, where k = 1, 2, 3, 4
\( D_l \): the effect of lth sex, where l = 1, 2
\( E_m \): the effect of mth age, where m = 1, 2, 3, 4, 5, 6
\( \epsilon_{ijklmn} \): standard error from effects of location, farmers, sheep breed, sex and age

Chi square analysis was conducted to investigate the influence of location, breed of sheep, age and sex of sheep to the occurrence of dominant coat color, the type of patches and the color of the patches with 95% degree of confidence.

3. Result and discussion

3.1. Flock management of the research site
Sheep population were found more in Deli Serdang, Batubara and North Labuhan Batu districts, while goat populations were more commonly found in Serdang Berdagai and Asahan districts. The sheep involved in this study were grazed at three districts, indicating the high opportunity for sheep development in North Sumatera provinces. Besides the intensive management practices by the farmers, grazing sheep under oil palm or rubber plantation were mostly practiced. The estimated estate crops area in the region were found in table 2.

| District        | Palmoil (ha) | Rubber (ha) | Total  | Population (head) |
|-----------------|--------------|-------------|--------|--------------------|
| Deli Serdang    | 14,561.00    | 6,320.00    | 20,881 | 33,852             |
| Serdang Berdagai| 12,661.00    | 12,032.00   | 24,693 | 158,649            |
| Asahan          | 72,416.00    | 7,263.00    | 79,679 | 74,741             |
| Labuhan Batu Utara | 68,238.00 | 22,942.00   | 91,190 | 49,628             |
| Batubara        | 8,843.00     | 524.00      | 9,377  | 65,744             |

Source: North Sumatera Estate Crop Services [6].

The grazing management practiced by the farmers, varies among the study sites, some of which were carried out around 13:00–18:00 p.m. and usually were shepherd by student after school hours. In areas where
intensive management were practiced, sheep were kept in the barn most of the time and feeds were offered twice daily, in the morning and afternoon. The sheep observed in Deli Serdang, Labuhan Batu Utara and Batubara districts were kept extensively while the sheep in Serdang Berdagai and Asahan districts were intensively reared. Farmers did not offer more feeds after sheep return to the barn, means they relied only from grazing at the plantation sites. Refering to the area of oil palm plantations and rubber plantations in the five districts, there is an opportunity to accommodate small ruminant (sheep and goats) either by intensive or extensive management system.

3.2. Coat characteristics of the sheep.
White coat cover (range 86.1–100%) was the majority of dominant coat color of sheep from five sites and only small percentage of sheep with black and brown dominant color, 2.5% and 8.5%, respectively. This evidence means that farmers preferred sheep with white color or an expression of adaptability of the sheep in low land areas of North Sumatera. This result was in contrast to the report by Komariah et al (2015) who conducted study for local sheep in West Java. Garut sheep has 45.5%, 26.4 and 18.2 % white, black and brown, respectively, whereas fat tailes sheep and thin tailed sheep were 100% white [7].

| Table 3. Coat color characteristics of sheep at five districts in North Sumatera. |
|-----------------------------------------------|
| **District** | **Batubara (n=51)** | **Labuhan Batu Utara (n=39)** | **Asahan (n=30)** | **Serdang Berdagai (n=55)** | **Deli Serdang (n=20)** | **Average** |
| Dominant coat color (%) : | | | | | | |
| Black | 1.9 | 2.6 | NA | NA | NA | 2.8 |
| White | 86.3 | 92.3 | 100 | 100 | 100 | 95.7 |
| Brown | 11.8 | 5.13 | NA | NA | NA | 8.5 |
| Type of patch (%) : | | | | | | |
| Large patch | 20.0 | 33.3 | 16.6 | 18.0 | 5.0 | 8.9 |
| Small patch | 18.0 | 12.8 | 6.7 | NA | 5.0 | 8.5 |
| Spotted | 24.0 | 5.1 | 10.0 | 2.0 | NA | 8.22 |
| No patch | 38.0 | 48.7 | 66.7 | 80.0 | 90.0 | 64.7 |
| Patch color (%) : | | | | | | |
| Black | 11.7 | 12.8 | 13.3 | 8.0 | NA | 9.2 |
| White | 9.8 | 2.6 | NA | NA | NA | 2.5 |
| Brown | 41.2 | 33.3 | 6.7 | 8.0 | 10.0 | 19.8 |
| Solid | 37.3 | 48.7 | 80.0 | 42.0 | 90.0 | 59.6 |

Note: NA= not available.

This difference can be due to the fact that some sheep farmers in West Java are also farmers of fighting sheep, where the color pattern is one of the preferred characters and will determine the price of the sheep. Therefore, the sheep farmers will look for color combination to make crosses with rams who are known to have a certain color pattern. Mahmoud et al (2017) stated that there are different locus in determining the color of several breeds of sheep in Saudi Arabia, such as MC1R gene located at chromosomes 14 which stimulate the production of melanin [3]. Melanin is a substance produced by melanocytes that gives skin, hair and eyes of different color. Not only that, the coat color in farm animals bears significant biological and economic impacts which can be a critical point for breed recognition. Dark colored coat cover can also be a growth restriction for sheep raised in lowland areas. Koseniuk et al (2018) expressed that coat color of animals is an extremely important trait that affects their behaviour and is decisive for survival in the natural
environment [8]. Especially for sheep that are kept extensive, where grazing was occurred during day until afternoon as the light intensity is very high. If sheep are not well adapted, then the frequency of respiration rate, heart rate and rectal temperature will be affected which ultimately affects feed consumption. Referring from the history of the distribution of sheep in the province, it is known as local Sumatran sheep which have a brown coat color with a slight black or white pattern. Some previous notes mentioned that the Sumatran sheep could be from e India which was brought by traders during 19th century. However, from this study, possibly the local sumatran sheep are not available anymore and been replaced by sheep which mostly of white coat cover, as the result of this study that 95.7% of sheep has white coat color.

Table 4. Coat cover characteristics of sheep at five districts in North Sumatera.

| District          | Number of sheep (head) | Average coat cover score | Average coat density score | Products 1) |
|-------------------|------------------------|--------------------------|----------------------------|-------------|
| Batubara          | 51                     | 4.4                      | 3.5                        | 15.8        |
| Labuhan Batu Utara| 39                     | 4.0                      | 3.1                        | 12.6        |
| Asahan            | 30                     | 4.6                      | 3.8                        | 17.7        |
| Serdang Bedagai   | 50                     | 4.1                      | 3.2                        | 12.9        |
| Deli Serdang      | 20                     | 3.5                      | 3.3                        | 12.0        |

Note: 1)the multiplication between individual coat cover score and coat density score.

The chi-square analysis of dominant coat color, showed that there was no significant effect of location, breeder, family, sex and age of sheep. Meanwhile, the chi square analysis for type of patches showed a significant contribution (P<0.05) from the district, farmers involve in the study and breed of sheep. It can be explained that the farmers preference will determine on certain breed of sheep being kept, which in turn influence the coat color pattern of the sheep. Form this analysis, it can be concluded that farmers choose and raised the sheep due their production or farmers do not have any option on choosing the type of sheep they raised. On the other hand, the chi-square analysis for the patches color, showed a significant (P <0.05) influence of the location, farmers involvement and breed of sheep. Likewise, the chi square analysis which was carried out on wool density, showed a significant influence (P<0.05) of the location, farmer, breed, sex and age of sheep. The heritability of wool production and quality of wool is known to have high value, therefore if there is wool of low quality, the quality of the wool will be inherited to the offspring. The heritability estimates for wool traits were considered to be medium and high heritable, such as face cover (0.56), skin folds (0.40), greece fleece weight (0.35), clean fleece weight (0.25), staple length (0.55), fibre diameter (0.4), variability of diameter (0.9) and yield (0.40) [9]. With humid and hot environmental conditions such as in Indonesia, a body covering that is suitable for sheep must be in the form of hair type. In this analysis, the product between the area of wool and the thickness of wool is an expression of the genes that regulate the area of body cover and the quality of wool. If the sheep have a thick body covering and are present all over the body, then the highest score is 81. Meanwhile, in this observation, the score was obtained in the range of 11.2–21.0, indicated that the coat cover area and the thickness of wool are only in low criteria.

3.3. The live weight performance

The average sheep body weight in this study was 22.3 kg with significant contribution (P<0.05) from location of the study, farmers participation in the study, sheep gender, age of sheep, as well as the type of sheep patch. Previous study by Fadare (2015) reported that coat cover has strong influence on the reproduction performance, where black color sheep has shorter lambing interval (7.61 months) compared to brown (7.99 months) and white (8.23 months) sheep [10].
Table 5. Least square means of body weight according to the sources of variation.

| Source of variance       | Body weight (kg) | Product (coat cover x coat density) |
|--------------------------|------------------|------------------------------------|
| Districts                |                  |                                    |
| 1. Asahan                | 22.9<sup>a</sup> (n=30) | 17.6<sup>a</sup>                   |
| 2. Batubara              | 18.7<sup>d</sup> (n=51) | 14.7<sup>a</sup>                   |
| 3. Serdang Berdagai     | 27.9<sup>a</sup> (n=50) | 12.9<sup>b</sup>                   |
| 4. Labuhan Batu Utara   | 20.8<sup>d</sup> (n=39) | 12.9<sup>b</sup>                   |
| 5. Deli Serdang         | 24.8<sup>x</sup> (n=20) | 12.0<sup>b</sup>                   |
| Farmers                  |                  |                                    |
| 1. Farmer-1              | 22.9<sup>b</sup> (n=30) | 17.7<sup>a</sup>                   |
| 2. Farmer-2              | 15.4<sup>b</sup> (n=21) | 11.2<sup>b</sup>                   |
| 3. Farmer-3              | 21.1<sup>c</sup> (n=30) | 17.0<sup>a</sup>                   |
| 4. Farmer-4              | 27.9<sup>a</sup> (n=50) | 12.9<sup>b</sup>                   |
| 5. Farmer-5              | 22.8<sup>c</sup> (n=18) | 12.0<sup>b</sup>                   |
| 6. Farmer-6              | 19.1<sup>d</sup> (n=21) | 13.8<sup>b</sup>                   |
| 7. Farmer-7              | 24.8<sup>b</sup> (n=20) | 12.0<sup>b</sup>                   |
| Sex                      |                  |                                    |
| 1. Male                  | 23.7<sup>a</sup> (n=138) | 18.2<sup>b</sup>                   |
| 2. Female                | 20.8<sup>d</sup> (n=52) | 13.2<sup>b</sup>                   |
| Age (month)              |                  |                                    |
| 1. 0–6                   | 8.8<sup>a</sup> (n=52) | 12.5<sup>b</sup>                   |
| 2. > 6–12                | 18.5<sup>b</sup> (n=37) | 18.5<sup>a</sup>                   |
| 3. >12–18                | 29.4<sup>b</sup> (n=38) | 15.1<sup>b</sup>                   |
| 4. >18–24                | 29.9<sup>c</sup> (n=43) | 12.0<sup>b</sup>                   |
| 5. > 24–30               | 36.3<sup>b</sup> (n=13) | 12.7<sup>b</sup>                   |
| 6. > 30                  | 46.5<sup>a</sup> (n=7) | 11.6<sup>b</sup>                   |
| Breed                    |                  |                                    |
| 1. Local                 | 19.7<sup>a</sup> (n=80) | 15.9<sup>a</sup>                   |
| 2. Garut                 | 16.2<sup>a</sup> (n=2)  | 12.0<sup>a</sup>                   |
| 3. Barbados              | 25.8<sup>a</sup> (n=1)  | 21.0<sup>a</sup>                   |
| 4. St Croix              | 25.4<sup>a</sup> (n=107) | 12.6<sup>a</sup>                   |
| Dominant coat cover      |                  |                                    |
| 1. White                 | 26.2 (n=180)      |                                    |
| 2. Black                 | 23.2<sup>a</sup> (n=2)  | 12.0<sup>a</sup>                   |
| 3. Brown                 | 15.5<sup>a</sup> (n=3)  | 12.0<sup>a</sup>                   |
| Type of patch            |                  |                                    |
| 1. Large patch           | 19.7<sup>b</sup> (n=38) | 12.0<sup>b</sup>                   |
| 2. Small patch           | 15.3<sup>a</sup> (n=19) | 12.0<sup>b</sup>                   |
| 3. Spotted               | 25.8<sup>a</sup> (n=17) | 12.0<sup>b</sup>                   |
| Color of patch           |                  |                                    |
| 1. White                 | 18.3<sup>a</sup> (n=8)  | 12.0<sup>a</sup>                   |
| 2. Black                 | 18.2<sup>a</sup> (n=19) | 12.0<sup>a</sup>                   |
| 3. Brown                 | 21.2<sup>a</sup> (n=42) | 12.0<sup>a</sup>                   |
| 4. Solid                 | 24.5<sup>a</sup> (n=121) | 12.0<sup>a</sup>                   |

Numbers followed by the different letter in the same category mean significantly different (P<0.05).

Michael et al (2016) underlined their findings on coat color of indigenous sheep at three different district of East Gojam Zone in Ethiopia [11]. The sheep coat color pattern (mostly of solid one color) and coat color type (mostly was white, red and combination of red with white) were significant (P<0.05) among the districts observed. However, the study did not show any relationship between coat color and production traits. In line with this, Gratten et al (2008) reported the correlation between coat color with the frame size of soya sheep.
in Scotland, where the darker sheep has bigger body size compared to the lighter color sheep [12]. In our study, such correlation was not found, where dominant coat cover and the color of the patch did not give any effect to the body weight. However, from our study, the type of patch contribute significantly (P<0.05) to the body weight, where the spotted sheep had higher body weight (25.8 kg), compared to large patch sheep (19.7) or even the small patch sheep (15.3 kg). Birteeb and Donkor (2016) reported a study conducted to investigate the correlation among coat color of Dallonke sheep in Ghana [13]. The highest percentage of coat color was a combination of brown and white (33.1%) then followed by black and white (29%) and white sheep (20.2%). The color variation in our study was of slightly different compared to the color variation from this study, however, this reflects a huge variation of coat color among sheep in the world. Anjola and McEwan (2018) reported a single locus of black coat which is dominant relative to the allele for lilac in jacob sheep in mediteranian area. The most important traits of the ajcob sheep is the appearance and color pattern of the coat, with the fleece being favourable for wool production and the hide being used for sheepskin rugs [4].

Safarai et al (2005) reported that the correlations between wool quality traits and lamb performance were non-significant (P>0.05) [14]. The genetic and phenotypic correlations between body weight at differnt ages and the wool traits (such as greasy and clean fleece weight and fibre diameter), were generally positive and moderate in magnitude. In contrast the relationship between live weight and coefficient of variation of fibre diameter and yield were generally negative and small. Correlations between staple length and strength with live weight were generally positive and weak, however the genetic correlation between adult weight and staple strength was low (0.11). Another study by Matebesi-Ranthimo et al (2018) reported that genetic correlations of sheep color with litter size, the number of lambs weaned and total weaning weight of lamb were significantly negative [15]. Significant genetic correlations of ewe reproduction traits over three lambing opportunities were found between number of lambs born and (0.23±0.11) and between total weight weaned and face cover score (-0.33±0.16). The study showed how valuable was the coat color for sheep industry. Malau-Aduli et al (2019) reported that the correlations between wool quality traits and lamb performance were non-significant for sheep received diet containing canola or flaxseed oil supplementation [16]. This study means that the absorbed nutrients in supplemented lambs produced good growth performance without any detrimental impact on wool quality. Sheep operators prefer to fee their animal with nutrient that will partition into the synthesis of muscle and wool without compromising either traits.

4. Conclusion
The study concluded that 95.7% of sheep observed from the five districts mostly are white coat color, with the average total product of coat cover and coat density was 14.1. Sheep in the study was consider as small size, with coat cover of a mixture between hair and kemp. The coverage of the coat was only along tops of back, shoulders and rump and a little bit under.

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