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INTERNATIONAL JOURNAL OF Veterinary Science and Research OPEN ACCESS JOURNAL

ISSN: 2640-7604 DOI: https://dx.doi.org/10.17352/ijvsr

Research Article

# Sheep Production System and Farmers' Breeding Practices in North Shewa and South Wollo Zones of Amhara Region, Central Ethiopia

**Teklewold Belayhun, Aweke Engdawork* and Amine Mustefa**

Ethiopian Biodiversity Institute, P.O. Box 30726, Addis Ababa, Ethiopia

**Received:** 19 September, 2025
**Accepted:** 29 September, 2025
**Published:** 30 September, 2025

***Corresponding author:** Aweke Engdawork, Ethiopian Biodiversity Institute (EBI), P.O. Box: 30726, Addis Ababa, Ethiopia, E-mail: engdaworkaweke@gmail.com

**Keywords:** Culling criteria; North Shewa; Production system; Ram selection; Sheep; South wollo



## Abstract

The study was conducted in the north Shewa and south Wollo zones of the Amhara region to identify farmers' sheep production systems and breeding practices. The study included 80 farmers in total. A chi-square test was implemented for qualitative data, considering the district as the main factor. Quantitative data were also analyzed using a general linear model (GLM), considering the district as the main factor. Both qualitative and quantitative data are analyzed using SPSS version 22. The main separation was implemented using Duncan's post-hoc multiple comparison method at a 5% error term. For the ranked data, indices were calculated using: index = [3 for rank 1 + 2 for rank 2 + 1 for rank 3] given for particular variables, divided by [3 for rank 1 + 2 for rank 2 + 1 for rank 3] using Microsoft Excel 2016. Income (0.4) and meat sources (0.24) are the main aims of sheep production in all districts. The overall ram selection criteria are shape, growth, color, and size, with respective orders of 0.34, 0.27, 0.23, and 0.14. Communal grazing, stall feeding, and private grazing are methods of sheep feeding. Moreover, supplementary feeding during the dearth period is practiced. Most farmers use rams without selection, mainly from their flock, neighbors' rams, and rams from grazing areas along the study areas, and in this case, inbreeding. Therefore, sound alternative breeding and continuous awareness creation are needed to reverse the problem.

## Introduction

Ethiopia has a huge and diverse sheep population, and this genetic diversity is a prerequisite for the present and future livelihoods of the large rural poor farmers [1]. Indigenous sheep in Ethiopia have a multipurpose role for smallholder farmers as sources of income: meat, skin, manure, coarse wool, or long, hairy fleece. They are also a means of risk avoidance during crop failure. In general, small ruminant species provide tangible and intangible benefits to farmers who keep them and the Ethiopian economy as a whole [2]. Ethiopia's major sheep production systems include the traditional management system (the pastoral, agro-pastoral, and mixed-crop livestock systems) and the government ranches, which are characterized by different production goals, priorities, management practices, and constraints [3]. Sheep are reared in extensive systems with minimal inputs; they are kept virtually as scavengers, particularly in mixed-crop livestock systems. It has been reported that sheep are produced in two main systems: sheep barley systems in sub-alpine areas and pastoral systems in arid lowlands. The majority of people in the highlands keep small flocks and practice mixed-crop livestock agriculture, whereas those in the sub-moisture, cold, very high-altitude areas and in arid lowlands keep large flocks in pastoral production systems [4].

Identifying breeding traits and designing a breeding program are less applicable in traditional production systems. However, farmers select their breeding ram and ewe even if their selection criteria differ based on the agroecologies, flock size, housing type, and culture of the communities [5]. Knowing indigenous animal breeding practices, techniques, and production systems is very important to develop sustainable genetic improvement schemes in a small-holder situation. Lack of such knowledge leads to unrealistic breeding goals for genetic improvement [6]. Moreover, in the past, in our country, different improvement activities, including crossing, nucleus-based breeding, and recently community-based breeding, were



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conducted. However, the effectiveness of the programs, mainly crossing and nucleus-based breeding, failed due to a lack of proper identification of the production system and breeding practices. Therefore, the study aimed to identify the production system and breeding practices of farmers to produce sheep in the study areas and adjacent areas.

## Materials and methods

### Study areas selection

The study was conducted in North Shewa (Menz Mama and Merehabete) and South Wollo (Wereillu) zones as presented in Figure 1. The areas selected are based on production potential from preliminary information. The study sites were selected with respective district experts by considering road accessibility, potential, and representativeness.

### Site selection and Methods of data collection

The data were collected using the FAO farm animal production system, phenotypic characterization guidelines, and questionnaire formats translated into the local language (Amharic) [7]. The farmer who gives an ample amount of information was selected purposefully based on their experience with sheep production in accordance with village-level animal science experts. The farmers give information based on the prepared questionnaires by raising each question line by line. A total of 80 farmers were included in the study (33, 24, 23) for the Menz Mama, Merehabete, and Wereillu districts, respectively.

### Data management and analysis

Both qualitative and quantitative data were entered, cleaned, and analyzed using SPSS version 22. All qualitative data were subjected to a Chi-square test, with district serving as the main effect. A general linear model (GLM) was implemented for quantitative data, and also analyzed districts as the main effect. A significance test was implemented at 5% level of error for both types of data. Post hoc test mean separation was conducted using Duncan multiple ranges for quantitative farming data. Indices were calculated using: index = [3 for rank 1 + 2 for rank 2 + 1 for rank 3] given for particular variables, divided by [3 for rank 1 + 2 for rank 2 + 1 for rank 3] using Microsoft Excel 2016.

## Results and discussion

### Socioeconomic characteristics of respondents

General information on the sex, age, and level of education of the respondents is presented in Table 1. The majority of the respondents (97.5%) were male and varied at $P<0.05$. Variation may be due to social, cultural, and economic factors, but this gives rise to gender inequality and needs to be corrected through continuous awareness creation [8]. Ownership of livestock was influenced by the respondents' age ($P<0.05$), and 30.4% of respondents were in the age group of 41–50. This may provide an opportunity for livestock intensification in general and sheep in particular, since this age group is prime working age and can easily adopt new technology. This helps boost sheep production by designing an appropriate breeding program with

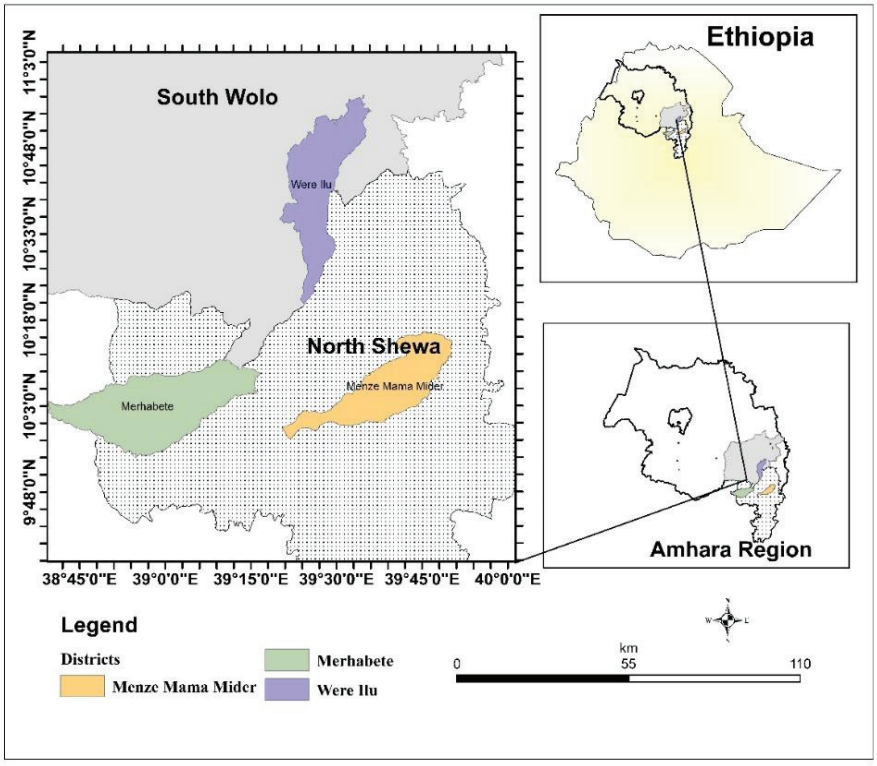


**Figure 1:** Map of the study areas.



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effective health and feeding practices [9]. Generally, knowing household socioeconomic information is vital to the nature and effectiveness of any research or development activity for intervention and policy design, technology adoption, extensions, policy analysis, evaluation, training, and other purposes [10].

## Income source of farmers

The income source of farmers and the order of income in the study areas are presented in Table 2. Accordingly, crop production is the main income source (0.56), while livestock production covers the next rank of income source (0.39). Because the study was conducted in the highlands, mixed production is a common form of production. Therefore, livestock production in general and sheep production in particular should be undertaken with this scenario in mind. The form of production is similar to the findings [11,12]. In the study areas, sheep production is the main income source (0.42), following cattle production. Sheep are the main income source for fulfilling household expenses (fertilizer buying, educating their children, and food consumption). While cattle (0.36) are mainly used for plowing their land for crop production [13].

## Livestock composition and herd/flock size

The number of livestock per species is presented in Table 3. Based on this, sheep flock size and donkey herd size have variations (P<0.05) among the study areas. Lower sheep flock size observed in Merehabete, while other districts have no variation among them. The lower observation may be related to the agro-ecology of Merehabete (the area has more gorges and is humid), which is more suitable for goat production than sheep production. The average flock size of the sheep population in Merehabete is in line with the sheep population in southern Ethiopia [14,15]. The average flock size of the sheep population in the study areas is lower than the average sheep population in Afar and Menz [16]. The finding indicates that the population size of Menz indicates a decreasing trend. This may relate to the shrinking of communal grazing land into area enclosures or crop production. The lowered (P<0.05) herd size of donkeys was also observed in the Merehabete district, while others have similar herd sizes. The average herd size of donkeys in the Merehabete district is lower than the reported donkey population in mixed-crop livestock production areas (small-scale livestock production in the highlands) [17]. The average herd size of cattle and chickens has no variation (P<0.05) among districts. The herd size of cattle and the flock size of chickens are in line with the report of CSA in the mixed production system [18].

**Table 1:** Sex, age, and education level of respondents' frequency (%).

| Sex | Districts | | | | $X^2$(P.value) |
|---|---|---|---|---|---|
| | Menz Mama | Merehabete | Wereillu | overall | |
| Male | 32(40.5) | 22(27.8) | 23(29.1) | 77(97.5) | 4.7(0.095) |
| Female | 0(0) | 2(2.5) | 0(0) | 2(2.5) | |
| **Age** | | | | | |
| <18 years | 0(0) | 3(3.8) | 0(0) | 3(3.8) | 27.26(0.007) |
| 18-30 | 2(2.5) | 4(5.1) | 1(1.3) | 7(8.9) | |
| 31-40 | 9(11.4) | 1(1.3) | 10(12.7) | 20(25.3) | |
| 41-50 | 14(17.7) | 4(5.1) | 6(7.6) | 24(30.4) | |
| 51-60 | 5(6.3) | 8(10.1) | 4(5.1) | 17(21.5) | |
| 61-70 | 2(2.5) | 4(5.1) | 1(1.3) | 7(8.9) | |
| >70 | 0(0) | 0(0) | 1(1.3) | 1(1.3) | |
| **Level of education** | | | | | |
| Illiterates | 4(5.1) | 6(7.7) | 6(7.7) | 16(20.5) | 3.48(0.90) |
| 1-6 educated | 17(21.8) | 12(15.4) | 13(16.7) | 42(53.8) | |
| 7-8 educated | 6(7.7) | 3(3.8) | 3(3.8) | 12(15.4) | |
| 9-10 educated | 3(3.8) | 2(2.6) | 1(1.3) | 6(7.7) | |
| Diploma/TVET | 1(1.3) | 1(1.3) | 0(0) | 2(2.6) | |

**Table 2:** Income source of farmers and rank of livestock utilization (index).

| Income source | Districts | | | |
|---|---|---|---|---|
| | Menz Mama | Merehabete | Wereillu | Overall |
| Crop | 0.54 | 0.55 | 0.57 | 0.56 |
| Livestock | 0.46 | 0.36 | 0.38 | 0.39 |
| Salary | 0.00 | 0.05 | 0.04 | 0.02 |
| Trade | 0.00 | 0.04 | 0.01 | 0.03 |
| **Rank of livestock use** | | | | |
| Cattle | 0.33 | 0.36 | 0.40 | 0.36 |
| Sheep | 0.45 | 0.36 | 0.43 | 0.42 |
| Chicken | 0.11 | 0.14 | 0.07 | 0.10 |
| Donkey | 0.08 | 0.09 | 0.10 | 0.10 |
| Goat | 0.02 | 0.01 | 0.00 | 0.01 |
| Honeybee | 0.02 | 0.04 | 0.00 | 0.01 |

**Table 3:** The number of livestock per species in the study areas.

| Livestock species | Districts (mean +S.E) | | | |
|---|---|---|---|---|
| | Menz Mama | Merehabete | Wereillu | Overall |
| Cattle | 3.63±0.30[a] | 3.62±0.39[a] | 4.09±0.38[a] | 3.76±0.20 |
| Sheep | 12.10±1.03[a] | 7.52±0.83[b] | 11.22±1.33[a] | 10.47±0.66 |
| Goat | 3.83±2.50[a] | 4.50±2.50[a] | 1.63±0.52[a] | 2.81±0.62 |
| Chicken | 4.73±0.50[a] | 5.16±0.88[a] | 4.26±0.51[a] | 4.72±0.36 |
| Donkey | 1.52±0.14[a] | 1.06±0.06[b] | 1.74±0.21[a] | 1.48±0.10 |
| Horse | 1.20±0.20[a] | 1.00±00[a] | 1.67±0.21[a] | 1.42±0.15 |
| Mule | 1 | 1 | 1 | 1 |

## Flock structure of sheep

The flock structure of the sheep population by age group and sex is presented in Table 4. The flock structure of sheep shows variation (P<0.05) among study areas. Based on this, a sheep population of less than 3 months of male sheep in Wereillu has a better population size. Moreover, sheep populations between the ages of 3 and 6 months show less numbering in the Menz Mama district. Furthermore, female sheep under the age of 3 months also show variation, and in the Wereillu district, a better population size is observed. Generally, a better population size is observed for females, and the finding is in line with the north-west Amhara region [19]. The flock structure can show the replacements, breeding ewe and ram, and sex ratio of sheep to sustain production. The sex ratio of sheep in the study areas is 1 ram to 4 ewes, which shows a better sex ratio for conducting breed improvement. Generally, the sex ratio is better than that of the Begait sheep breed of Ethiopia [20].

## Objective of sheep production

The objective of sheep production is presented in Table 5. Accordingly, income sources are the main aim of sheep



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Table 4: Flock structures of sheep population in the study area.

| Flock structure of sheep | Districts (mean +S.E) | | | |
|---|---|---|---|---|
| | Menz Mama | Merehabete | Wereillu | Overall |
| **Male** | | | | |
| Less than 3 months | 1.88±0.42[b] | 2.50±1.21[b] | 6.25±.86[a] | 3.54±0.51 |
| 3-6 months | 2.11±0.22[b] | 3.50±0.33[a] | 4.00±0.45[a] | 3.21±0.27 |
| Above 6 months | 1.53±0.28[a] | 2.00±0.82[a] | 3.25±0.58[a] | 2.26±0.35 |
| **Female** | | | | |
| Less than 3 months | 2.00±0.27[b] | 1.00±0.79[b] | 5.75±0.56[a] | 2.92±0.33 |
| 3-6 months | 2.00±0.31[cb] | 3.00±0.91[ba] | 4.75±0.64[a] | 3.25±0.38 |
| Above 6 months | 6.24±1.02[ba] | 3.50±2.80[c] | 13.50±2.10[a] | 7.58±1.26 |

Table 5: Objective of sheep production in the study areas(index).

| Objective of sheep production | Districts | | | |
|---|---|---|---|---|
| | Menz Mama | Merehabete | Wereillu | Overall |
| Breeding | 0.20 | 0.15 | 0.32 | 0.22 |
| Ceremony | 0.07 | 0.15 | 0.08 | 0.10 |
| Fertilizer | 0.01 | 0.08 | 0.01 | 0.03 |
| Hair | 0.03 | 0.00 | 0.01 | 0.02 |
| Income | 0.43 | 0.38 | 0.36 | 0.40 |
| Meat | 0.27 | 0.23 | 0.22 | 0.24 |
| Skin | 0.00 | 0.01 | 0.00 | 0.00 |

production in all districts. Next, the meat source and breeding are the overall objectives of sheep production. Separately, in Wereillu, some variation shows in the order of production aim (source income, breeding, and meat source), while in other districts, income source, meat source, and breeding are the aims of production in the respective order. The overall order of sheep production is in line with mixed livestock production [21]. The finding is similar to the sheep production objective of Ethiopia [22]. Moreover, the finding aligns with the aim of sheep production in western and south-western Ethiopia [23]. Income sources include the sale of sheep products, the purchase of different commodities like fertilizer, educating children, and other household consumptions, while the source of meat includes the direct consumption of sheep as a source of food [13]. Therefore, when designing breeding programs, considering the aim of production traits is important.

## Feeding and watering practices of farmers

The feeding and watering system of the farmer is presented in Table 6. The feeding practices vary based on season, and in the winter ("Bega") season, communal (free) grazing is common (53.7%). While in summer («Kiremt»), season-free grazing, stall feeding, and private area grazing cover 66.3% of respondent responses. Farmers also practice supplementary feeding during the wrath season, mainly in the winter season, and the feed items include hay, local beverage byproducts, crop residue, and tree branches. The finding is similar to the husbandry practices of sheep in the Hulet Eju Enesie district [24]. Moreover, the result is in line with sheep and goat production and marketing systems in Ethiopia [11]. Generally, rivers and streams are the sources of water, but in Menz Mama and Merehabete districts, streams are the main sources of water, and the finding is similar to the sheep production system in eastern Ethiopia [25]. While the Wereillu River is the main water source for their sheep in particular and livestock in general, the result is in line with the Wolayita Zone of Southern Ethiopia [26]. The watering point is less than one kilometer, as 77.2 percent of the respondents confirmed. This is an opportunity to intensify the sheep production system in the study areas because water is one challenge for livestock production in tropical countries [27], and the findings are unlike sheep production in pastoral and agropastoral areas of Ethiopia and the tropics [25,28].

## Ram selection criteria of farmers

The RAM selection criteria are presented in Table 7. Accordingly, the RAM selection criteria have some variation among the study areas. For example, coat color (0.33) and shape (0.33) are the main ram selection criteria in Menz Mama Midir districts, while growth (0.35) and shape (0.33) are selection criteria for Merehabete farmers. Moreover, shape, growth, and size are the selection criteria for ram in Wereillu district in the respective order of 0.38, 0.28, and 0.27. The overall selection criteria are shape, growth, color, and size, with respective orders of 0.34, 0.27, 0.23, and 0.14. Generally, the selection criteria include six traits, and most of them are positive traits. Therefore, designing an appropriate breeding program for each district may be tedious and complex. Based on this, shape, growth, color, and size can be used as breeding ram selection criteria during breeding program design, and the selection of ram is in line with the western Amhara region [1]. The finding is also similar to farmer ram selection criteria in northern and central Ethiopia [29,30].

Table 6: Method of feeding (winter and summer seasons) and watering for sheep.

| Winter season feeding | Districts frequency (%) | | | | |
|---|---|---|---|---|---|
| | Menz Mama | Merehabete | Wereillu | Overall | $X^2$(P.value) |
| Communal grazing | 14(41.9) | 18(69.3) | 11(47.8) | 43(53.7) | 5.6(0.23) |
| Communal grazing, stall feeding, private grazing | 18(56.3) | 7(28) | 12(52.2) | 37(46.3) | |
| **Summer season** | | | | | |
| Communal grazing | 12(35.7) | 14(53.3) | 1(4.3) | 27(33.8) | 14.67(0.005) |
| Communal grazing, stall feeding, private grazing | 20(62.5) | 11(44) | 22(95.7) | 53(66.3) | |
| **Source of water** | | | | | |
| River | 7(22.6) | 4(16.7) | 23(100) | 34(43.6) | 47.93(0.001) |
| Stream | 24(77.4) | 20(83.3) | 0(0) | 44(56.4) | |
| **Distance of water source** | | | | | |
| Less than one kilometer | 20(62.5) | 20(83.3) | 21(91.3) | 61(77.2) | 7.04(0.03) |
| Between 1 and 5 kilometers | 12(37.5) | 4(16.7) | 2(8.7) | 18(22.8) | |

Table 7: Ram selection criteria of farmers in the study areas(index).

| Ram selection criteria | Districts | | | |
|---|---|---|---|---|
| | Menz Mama | Merehabete | Wereillu | Overall |
| Age | 0 | 0 | 0.01 | 0.01 |
| Color | 0.33 | 0.27 | 0.06 | 0.23 |
| Docility | 0.05 | 0.01 | 0.01 | 0.02 |
| Growth | 0.2 | 0.35 | 0.28 | 0.27 |
| Shape | 0.33 | 0.33 | 0.38 | 0.34 |
| Size | 0.09 | 0.04 | 0.27 | 0.14 |



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## Castration Age and Shearing of Wool in Sheep

The age of castration and shearing of wool practiced in the study areas is presented in Table 8. The majority of the castration age of sheep is above 12 months, as 70.5% of respondents confirmed. Castration should take place at the youngest age possible since the stress of castration can adversely affect growth in older animals. Lambs can be castrated as soon as the testicles descend into the scrotum (this can be from a few days of age to three weeks), and no sedation or painkillers are necessary if castration is done at this age. Castration becomes more difficult and painful with age, and the chances of complications increase. Further, castration is accomplished more easily, and the wound heals more quickly in very young animals. Castration should ideally be done at less than 3 weeks of age. But under Ethiopian conditions, this is not usually the case, and many farmers prefer to castrate male sheep at a later age; in most cases, after sexual maturity is attained (yearling to 2 years old). The reason given for this is that early castration can cause stunted growth, resulting in a lack of desired muscling and conformation, leading to a low market price. In Ethiopia, there is a niche market for animals that are fattened to a very high weight and condition [31]. The castration of the testicle is done using the local material stone («Alelo»), which is painful and needs to be intensified to avoid such pain. The purpose of castration is to fatten sheep to get a better price at the market, to improve meat quality, and to improve the docility of rams [32].

In Menz, Mama, and Wereillu districts, the shearing of wool is common. The shearing of wool is used to make local cloth called "Bernos" and «Zitet.» This indicates that sheep in study areas are used for such purposes in addition to meat production. Therefore, when designing an appropriate breeding program, including such a trait as a breeding goal is crucial. The woolly characteristics of sheep are peculiar only to this area of Ethiopia [32,33]. Thus, the breed needs intensified improvement and conservation programs in more of the so far implemented programs.

## Sheep culling criteria of farmers

The culling criteria for sheep are presented in Table 9. Based on this, dispersed culling criteria were observed both for female and male sheep, which makes the culling criteria index small. Health is the first culling criterion for Menz Mama (0.22) and Wereillu (0.34) districts of male sheep, while reproduction is the main culling criterion for Merehabete sheep (0.31). Sheep, which show health problems, are mainly problematic to replace and are unable to sustain themselves. Sheep that get such problems are culled for household meat consumption or sold to local markets for meat retailers. Generally, the culling criteria of male sheep in Menz Mama and Wereillu are in line with Southern Ethiopia farmer culling criteria [34]. The culling criteria of Merehabete district male sheep culling are in line with the East Gojjam zone low-land sheep culling criteria [24].

Furthermore, reproduction, growth, and health are the culling criteria for female sheep in Menz Mama (0.31), Merehabete (0.37), and Wereillu (0.39) districts, respectively.

**Table 8:** Age of ram castration and shearing wool of sheep in the study areas.

| Age of castration | Districts | | | | $X^2$(P.value) |
|---|---|---|---|---|---|
| | Menz Mama | Merehabete | Wereillu | Overall | |
| 3-6 months | 13(40.6) | 2(8.7) | 0(0) | 15(19.2) | 34.56(0.001) |
| 6-12month | 0(0) | 0(0) | 8(34.8) | 8(10.3) | |
| >12month | 19(59.4) | 21(91.3) | 15(65.2) | 55(70.5) | |
| Do you shear wool | | | | | |
| yes | 30(93.8) | 0(0) | 22(100) | 42(66.7) | 69.56(0.002) |
| no | 2(6.3) | 24(100) | 0(0) | 26(33.3) | |

**Table 9:** Sheep culling criteria in the study areas(index).

| Reason for male sheep Culling criteria | Districts | | | |
|---|---|---|---|---|
| | Menz Mama | Merehabete | Wereillu | Overall |
| Age | 0.07 | 0.05 | 0.09 | 0.07 |
| Color | 0.17 | 0.25 | 0.04 | 0.16 |
| Docility | 0.04 | 0.03 | 0.00 | 0.03 |
| Growth | 0.12 | 0.10 | 0.14 | 0.12 |
| Health | 0.22 | 0.12 | 0.34 | 0.23 |
| Reproduction | 0.13 | 0.31 | 0.13 | 0.15 |
| Shape | 0.16 | 0.11 | 0.05 | 0.13 |
| Size | 0.10 | 0.03 | 0.21 | 0.11 |
| **Reason for the Female sheep culling criteria** | | | | |
| Age | 0.14 | 0.07 | 0.16 | 0.13 |
| Color | 0.05 | 0.25 | 0 | 0.08 |
| Docility | 0.06 | 0.01 | 0 | 0.03 |
| Growth | 0.06 | 0.37 | 0.12 | 0.15 |
| Health | 0.17 | 0.11 | 0.39 | 0.23 |
| Reproduction | 0.31 | 0.1 | 0.23 | 0.23 |
| Shape | 0.14 | 0.08 | 0.01 | 0.09 |
| Size | 0.07 | 0.01 | 0.09 | 0.06 |

Reproduction problems include difficulty giving birth, the inability to raise their kids, single-kidnapping, and ewes that show such problems will be culled from the flock. Moreover, growth traits include poor physical condition, a poor body size increment in accordance with the age of the animal, and traits that are also culled from the flock. Generally, the culling criteria for female sheep are similar to those of Kashmir farmers in India [35]. The finding has some similarities with the southern Ethiopian farmer culling criteria [36].

## Some (re)production performance of sheep

Some of the reproductive traits of sheep are presented in Table 10. Based on this, male sheep's puberty age varies among districts, and Merehabete sheep have a lower puberty age. Female sheep also have variation among districts, with Menz Mama having a long puberty age. Furthermore, the lambing interval of the ewe is variable, and in Merehabete districts, the ewe has a short lambing interval. Puberty is a gradual process during which animal reproductive competence is attained with respect to physiology, morphology, and behavior. The onset of puberty in sheep differs between sexes due to early sexual differentiation in the control of steroid feedback systems and, thus, GnRH secretion [37]. Genetic as well as environmental factors, and the interaction between these, clearly affect sexual development. Of the environmental factors, the plane of nutrition during rearing and the time of birth appear to be of the greatest importance [36]. Thus, the variation in puberty age



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of sheep among study districts may be due to environmental, genetic, and interaction reasons [20]. The lambing interval is the number of days between two consecutive periods. The lambing interval of sheep in Menz Mama and Wereillu is similar to the sheep populations of Adilo and Gumz, while Merehabete has a similar lambing interval to Afar, Arsi-Bale, Horro, and Washera breeds [38].

### Source of breeding ram

The source of breeding ram is presented in Table 11. Based on this, the majority of farmers use rams without selection, mainly from their own flock, neighbors' rams, and rams from grazing areas. Breeding ram selection is crucial for breed improvement, but in this area, farmers are not aware of selection. However, it is often said that the ram is half of the flock. This statement is largely true because the ram can sire many lambs, while the ewe can produce only two or three lambs during the year. To make the most rapid progress in a flock improvement. The ram is, of course, important in determining the quality and development of his progeny. But he also determines, to a greater extent, the value of the next generation by producing the future ewes of the flock. This is the way the ram exerts its greatest influence on the flock [35]. The source of breeding ram is in line with mixed crop-livestock and a pastoral system area of Ethiopia [16]. Moreover, the finding is in line with Southern Ethiopia's farming practices [34]. Farmers practice uncontrolled mating (using bucks that are obtained from the grating area without selection, neighboring bucks without selection, and their bucks). These can result in inbreeding or non-selective breeding. To overcome such a problem, continuous awareness creation and designing alternative breeding programs are needed to reverse the problem [39].

## Conclusions

Income production and meat consumption for households are the main objectives of sheep production in the study areas. Therefore, targeting this objective needs to maximize the profit and livelihood of farmers in the study areas. Communal grazing, stall feeding, and private grazing are methods of sheep feeding during the summer and winter seasons. Moreover, supplementary feeding during the dearth period is practiced mainly for hay, crop residue, which is stored during the amble period, trees (branch, seed, leaf), food and beverage byproducts, and salt (as a source of minerals). Rivers and streams are the main sources of water and are accessible within less than one kilometer, which is a good opportunity for conducting and improving activities. Shape, growth, coat color, size, docility, and age are the main ram selection criteria. Therefore, considering these traits when designing a breeding program is crucial to success. Moreover, during the breeding program design, additional breeding objective identification needs to be implemented to cross-check and to be stronger overall. The source of breeding ram is from grazing areas without selection, mainly from the own flock, neighbors' ram, and ram from grazing areas, and in this case, poor genetic selection. Therefore, sound alternative breeding and continuous awareness creation are needed to reverse the problem.

**Table 10:** Reproduction time of sheep (months) in the study areas.

| Re/production traits | Districts (mean ±S.D) | | | |
|---|---|---|---|---|
| | Menz Mama | Merehabete | Wereillu | Overall |
| Male puberty age | 9.84±3.74$^{a}$ | 7.63±2.02$^{b}$ | 10.24±2.43$^{a}$ | 9.25±3.11 |
| Female puberty age | 11.45±3.67$^{a}$ | 8.08±2.55$^{b}$ | 8.14±2.18$^{b}$ | 9.47±3.37 |
| Lambing age | 13.68±3.59$^{a}$ | 9.54±3.38$^{b}$ | 12.86±2.27$^{a}$ | 12.14±3.65 |
| lambing interval | 7.55±2.62$^{b}$ | 9.83±4.63$^{a}$ | 6.05±0.59$^{b}$ | 7.86±3.41 |
| Male marketing age | 7.55±3.97$^{a}$ | 6.71±1.23$^{a}$ | 6.57±2.80$^{a}$ | 7.01±3.01 |
| Female marketing age | 7.71±3.70$^{a}$ | 7.00±1.93$^{ab}$ | 5.95±2.20$^{b}$ | 7.00±2.90 |

**Table 11:** Source of breeding ram in the study areas.

| Source of breeding ram | Districts F (%) | | | |
|---|---|---|---|---|
| | Menz Mama | Merehabete | Wereillu | Overall |
| Selected ram (own, neighbors, from grazing area) | 9(28.1) | 1(4) | 4(17.4) | 14(17.6) |
| Without selection (own, neighbors, from the grazing area) | 23(71.9) | 24(96) | 19(82.6) | 66(82.5) |

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### Author contribution

A.M. & A.E.: Conceptualization and Design, Methodology, Investigation, Data curation, Writing-review and editing. T.B.: Data curation, Formal analysis, Writing-original draft.

### Funding

This study was financially supported by the Ethiopian Biodiversity Institute for data collection. Acknowledgment

Our special thanks go to the farmers who gave ample information during the research. Our thanks also go to the Ethiopian Biodiversity Institute (EBI) for logistical and financial support, the Zonal, Districts, and Village experts for their facilitation, and Tadesse Hunduma for mapping the study area.

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**Citation:** Belayhun T, Engdawork A, Mustefa A. Sheep Production System and Farmers' Breeding Practices in North Shewa and South Wollo Zones of Amhara Region, Central Ethiopia. Int J Vet Sci Res. 2025;11(3):019-026. Available from: https://dx.doi.org/10.17352/ijvsr.000154

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