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Original Research

Reproduction Performance, Constraints and Opportunities of Indigenous Sheep in West Shewa Zone, Oromia Regional State, Ethiopia

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Abstract

In order to build a sustainable sheep breeding plan, the current study was carried out in the West Shoa Zone's Tokke Kutaye, Ambo, and Dandi districts. It looked at the reproductive performance, limitations, and potential of the local indigenous sheep. The districts were purposefully selected based on their potential for indigenous sheep production. A semi-structured questionnaire was employed to capture all relevant information. About 270 households (90 from each district) were involved in the household survey. Statistical Packages for Social Sciences (SPSS, 2013) software was used to analyse the data. Sheep flock sizes per household were 10.2±.34, 11.98±.57, and 11.13±.43 in Tokke Kutaye, Ambo, and Dandi districts, respectively. The average age at puberty of rams was about 6.9±0.15, 6.2±0.10, and 6.3±0.10 in Tokke Kutaye, Ambo, and Dandi, whereas the age at puberty of ewes was 7.9±0.17, 7.1±0.09, and 7.1±0.08 months in Tokke Kutaye, Ambo, and Dandi districts, respectively. Average age at first lambing, lambing interval, litter size, and reproductive life span of ewes in study areas were 14.0±0.13 months, 7.1±0.08 months, 1.4±0.05 lambs/lambing, and 8.4±0.10 years, respectively. The sheep production in the study area was mostly constrained by the prevalence of disease, feed shortages, droughts, a lack of improved genotypes, and a land shortage. Therefore, those constraints have a great influence on the reproductive performance of indigenous sheep in the study area.

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INTRODUCTION

Small ruminants have great potential to contribute more to the livelihood of low-income farmers in low-input and low-output systems (Kosgey and Okeyo, 2007; Tesfaye, 2008). They have great importance in many developing countries due to the requirement of small investments, shorter production cycles, faster growth rates, and greater environmental adaptability as compared to large ruminants (Markos et al., 2006). Small ruminants also serve as a major means of livelihood for poor livestock keepers for food security (Abdel-

Aziz, 2010). The small ruminant industry in Ethiopia contributes substantially to the livelihood of the rural poor and the country at large but is faced with various challenges. At the national level, sheep and goats account for about 90% of meat and 92% of skin and hide export trade value (Sisay, 2010). Despite their importance, small ruminants' production is constrained by several factors, such as poor productivity of the genotypes and an improper institutional setting, environment, and infrastructure (Markos et al., 2006). Productivity per animal and flock-off take are low. For example, estimates of the average annual offtake rate from sheep and goat flocks for the years 2008–2010 ranged between 30% and 38% (Legesse & Fadiga, 2014). High kid/lamb mortality, low growth rates, poor nutritional status resulting in infertility, long kidding/lambing intervals, and disease prevalence were reported as some of the major bottlenecks for lower productivity. Furthermore, controlled breeding is rare, and there is limited culling of poorly performing ewes and breeding males. For instance, Gemeda (2010) reported that the proportion of older ewes that are generally past their most productive stage was higher in the Afar, Bonga, Horro, and Menz sheep flocks than the more productive middle-aged ewes. According to the author, particularly in Afar flocks, about 4% of the ewes were aged animals with one or more pairs of erupted permanent incisors, mainly due to the absence of proper culling.

The population of sheep in Ethiopia is estimated to be 31.30 million, out of which about 71.82% are females and about 28.18% are males. From the total sheep population of the country, about 99.81% are indigenous breeds (CSA, 2018). Sheep have multipurpose functions and contribute to the livelihood of a large number of small and marginal farmers (Beneberu & Jabarin, 2006; Thiruvenkadan et al., 2009). They serve as a source of income, meat, skin, manure, coarse wool, or long, hairy fleece, a means of risk avoidance during crop failure, and their role in different cultural functions during festivals is well documented (Kosgey et al., 2008).

Different studies have indicated that small ruminant production in Ethiopia needs to be addressed systematically by describing the genetic resource bases, production, and marketing systems (Tesfaye et al., 2010; 2011; Zewdu et al., 2012). In the central highlands of Ethiopia, particularly in the Western Shewa zone of Oromia, there is a paucity of scientific information on small ruminants' production systems and the production and reproduction performances of available sheep breeds (Yadeta et al., 2017). According to the authors, the west Shewa zone of the Oromia region has huge potential for small ruminant production. Therefore, the current study was conducted to characterise the reproduction performances, constraints, and opportunities of sheep production in selected districts of the West Shewa Zone.

MATERIALS AND METHODS

Description of the Study Area

The study was conducted in three districts of the West Shewa zone of the Oromia region of Ethiopia. A map of the study districts is indicated in Figure 1. The districts were Tokke Kutaye, Ambo, and Dandi. West Shewa Zone is one of the 18 zones in Oromia

Regional State. The altitude of the zone ranges from 1166 to 3238 metres above sea level (m.a.s.l.). The topography of the west Shewa zone, which is mainly levelled fields, makes it a conducive place for agriculture. The West Shewa zone has mainly midland and highland topography, which gives the area a characteristic climate that is conducive to sheep production. According to the Agricultural and Rural Bureau of West Shewa Zone (AARDB, 2016), the mean annual rainfall that this zone receives is about 900 mm (range 800 to 1000 mm), and its annual temperature ranges from 15 to 29 °C, with an average annual temperature of 22°C. The mixed crop-livestock production system is the main source of livelihood for the community in the zone. The livestock sub-sector plays an important role in the livelihood of rural people in terms of providing alternative income sources, as a strategy for building resilience to stress, and also in contributing to their food security. The total livestock populations of the zone are estimated at 3,764,183 head of cattle, 1,138,236 head of sheep, 818,792 head of goat, 282,633 head of horse, 275,738 head of donkey, 42,188 head of mule, and 1,634,423 head of chicken (AARDB, 2016).

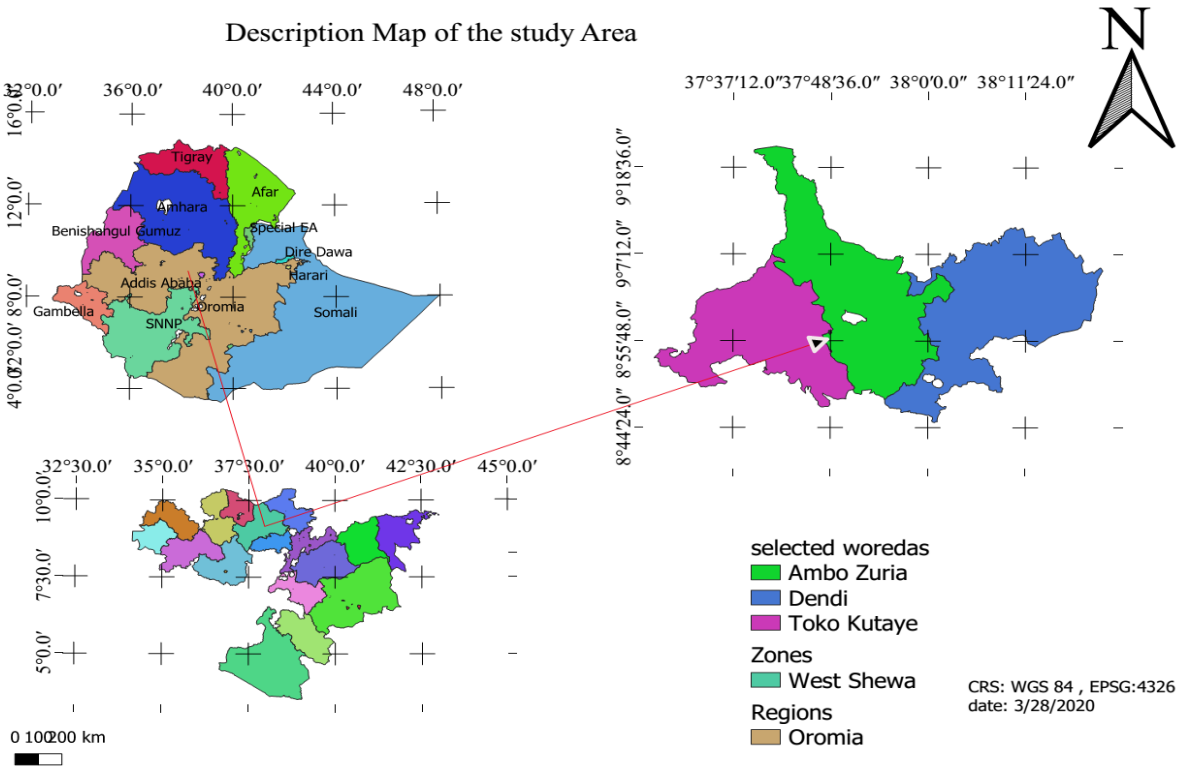

Figure 1 *Map of the study area*

Sampling and Data Collection Procedure

Sampling procedure

The study districts (Tokke Kutaye, Ambo, and Dandi) were purposefully selected based on their potential for indigenous sheep production. Furthermore, targeted peasant associations (PAs) were purposefully selected from the three districts based on sheep populations. A rapid reconnaissance survey

was conducted in each district before the commencement of the main survey to determine the distribution and concentration of indigenous sheep and establish a sampling framework. Discussions were also held with the respective zonal and district livestock experts and development agents about the distribution and concentration of indigenous sheep. A total of nine PAs (three PAs from each district) were purposefully selected considering the density of sheep. A total of 270 households (30 households from each PA) who have indigenous sheep and are experienced in producing sheep were randomly selected for interviews among the selected PAs. The total household sample size was determined by Cochran (1963).

Data collection method

A semi-structured questionnaire, focus group discussions, and secondary data sources were carried out to capture the necessary information during the current study.

Questionnaire administration

The questionnaire was prepared, pre-tested, translated into the local language (Afan Oromo), and re-framed in such a way that interviewing households would respond without difficulty or bias. Development agents (DAs) and supervisors from the respective districts were recruited as enumerators and trained to administer the questionnaire survey. The questionnaire survey was administered under the close supervision of the researchers.

Information on the flock size and structure, reproduction, and production performances, including age at first mating (service), age at first lamping, litter size, lambing interval, and growth performances of sheep, were assessed using a designed questionnaire. Similarly, information on the breeding management of sheep, including mating type, mating system, source of ram, sheep breeding season, and estrus detection methods of the sheep producers, as well as the main uses and special attributes of the sheep breed, was collected.

Focus group discussion

Focused group discussions were held in all districts, and they were composed of elderly farmers, youngsters, women sheep owners, village leaders, and socially respected individuals who are known to have better knowledge of the present and past social and economic status of the area. The members of a focus group ranged from 5 to 10 individuals. Discussions were focused on the history of the breed, the utility pattern of the breed, the current status and major constraints of the breed, special distinguished features of the breed, the production system, indigenous knowledge on the management of breeding, and their perceptions about their indigenous breed and other neighbouring indigenous sheep breeds.

Data Management and Analysis

Data collected from each district was coded, entered into the computer, and analysed using the Statistical Package for Social Sciences (SPSS, 2013) as deemed necessary. A chi-square for frequencies and qualitative data or an F-test for a quantitative survey was employed to test the independence of categories or assess their statistical significance.

The index was calculated to provide an overall ranking for qualitative data such as the purpose of keeping sheep, selection criteria for females and males, and so on, according to the

following formula: Index = Σ of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] given for particular qualitative variables divided by Σ of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all qualitative variables considered (Kosegy, 2004).

RESULTS AND DISCUSSION

Sheep flock size and structure

The average sheep flock per household and flock structure in the study districts are presented in Table 1. Flock owners determined the composition of the flock on the basis of economic and management considerations. The proportion of the different classes of sheep reflects the management decisions of the producers, which in turn are determined by their production objectives (Gizaw et al., 2010). The current study shows that there was a significant difference (P<0.01) in the overall flock size, castrates, and number of lambs across the districts. Significantly, a higher number of sheep flocks and castrates are found in Ambo district as compared to the other two districts. No significant difference (p> 0.05) was found between Tokke Kutaye and Dandi districts with regard to sheep flock size and number of castrates. There was also a significant difference in the number of lambs among the districts. Tokke Kutaye was significantly lower (p< 0.001) in both districts with regard to the number of lambs. There was no significant difference (p > 0.05) among districts in the number of breeding ewes and breeding rams (Table 1). The average breeding ewes flock size in the study area was 5.9±0.17, 6.5±0.29, and 5.9±0.20 from Tokke Kutaye, Ambo, and Dandi districts, respectively. The higher proportion of females in the flock in the present findings is consistent with the sheep flock structure reported for Menz sheep, where breeding ewes (49.2%) were dominant (Tesfaye et al., 2010).

Table 1

Sheep holding per household and flock structure in study area

	Districts				
Class of sheep	Toke kutaye	Ambo	Dandi	Test	
	Mean+SE	Mean+SE	Mean+SE	F_value	p_value
Sheep	10.2±.34[a]	11.9 ± .57[b]	11.1±0.43[a]	3.69	0.03
Castrates	2.1±0.25[a]	3.4±0.26[b]	1.9±0.19[a]	11.14	.001
Breeding ewes	5.9±0.17	6.5±0.29	5.9±0.20	2.35	.098
Breeding rams	1.8±0.12	2.1±0.17	1.9±0.17	1.05	.353
Lambs	2.8±0.17[a]	3.8±0.21[b]	3.8±0.15[b]	9.89	.001

NB: Means with different superscripts within same row are statistically different. SE = standard error

Reproductive Performance of Sheep

The reproductive performance of sheep in the study areas is presented in Table 2. Reproductive performance, such as sexual maturity, for both male (ram) and female (ewe) in Tokke Kutaye was significantly (P<0.01) higher than the sampled sheep of

Ambo and Dandi districts. The average age at first mating of males was 6.9±0.15, 6.2±0.10, and 6.3±0.10 in Tokke Kutaye and Ambo Dandi, respectively. The corresponding average age at first puberty for females (ewe) was 7.9±0.17, 7.1±0.09, and 7.1±0.08 in Tokke Kutaye, Ambo, and Dandi districts. The results were in close agreement with Zewdu (2008). The author reported an age at first service of 7.5±2.14 and 9.3±2.20 months for males and females of the Bonga sheep breed, respectively, and 7.1±3.00 and 7.8±2.40 months for males and females of the Horro sheep breed, respectively. Longer age at sexual maturity (puberty) of about 11.1±1.60, 10.9±1.70, and 9.5±1.40 months for males and 11.1±2.70, 10.8±1.90, and 9.5±1.40 months for females in Tocha, Mareka, and Konta districts, respectively, by Amelmal (2011) According to the author, total life-time production (life-time lamb crop) can be increased by encouraging first lambing at an early age.

Age at first lambing is influenced by breed, husbandry, and management practices. The mean ages at first lambing of ewes reported in the current study were 14.5±0.15 in Tokke Kutaye, 14.5±0.13 in Ambo, and 14.2±0.12 in Dandi district. The current results were comparable with the 14.3±0.08 months reported for sheep types found in Ada Barga and Ejere (Yadeta et al., 2017). Nevertheless, it was shorter than the 16.1±0.14 and 15.6±0.14 months reported by Fsahatsion (2013) for sheep types in Meket and Gidan districts and longer than the 12.4±0.28 months reported by Tarekegn et al. (2020) for sheep types in Gamogofa zone. This variation might be due to management practises, feed availability, and sheep breed.

The lambing interval across the three districts showed significant ($P<0.01$) differences. Average lambing intervals reported for sheep in the study areas were 7.4±0.10, 6.9±0.07, and 7.0±0.07 months for Tokke Kutaye, Ambo, and Dandi districts, respectively (Table 2). The results were closely comparable with the 7.8 month reported by Zewdu (2008) for the Horro sheep breed and the 8.5 month reported by Tesfaye (2008) for the Menz sheep breed. However, it was shorter than the 11.6±3.80, 10.3±4.00, and 11.0±3.80 months reported by Amelmal (2011) for indigenous sheep types found in Tocha, Mareka, and Konta districts, respectively, and the 9.1±0.11 and 8.7±0.16 months reported by Tarekegn et al. (2020) for sheep types found in Meket and Gidan districts, respectively.

In the present study, the average litter sizes reported was 1.5±0.06, 1.3±0.05, and 1.3±0.05 in Tokke Kutaye, Ambo, and Dandi districts, respectively. The maximum litter size reported was from Tokke Kutaye, and the least was from Ambo district. The average litre size reported was higher than the 1.10 reported by Hussein (2018) in the North Wollo zone.

The average reproductive life span of ewes was significantly different ($P<0.05$) among districts. Average reproductive life spans of breeding ewes of 7.9±0.13, 8.4±0.09, and 8.7±0.08 years were reported in Tokke Kutaye, Ambo, and Dandi districts, respectively. According to respondents, the average reproductive life span of ewes was slightly higher in Ambo compared to the other

two districts. Relatively, the average reproductive life span reported in this study was shorter than the 9.2±1.70, 9.8±1.51, and 9.3±1.62 years reported by Amelmal (2011) for breeding ewes found in Tocha, Mareka, and Konta districts, respectively. However, the average life span obtained in the current study is comparable with the 7.9±3.10 and 7.4±2.7 years reported for Horro and Bonga ewes, respectively (Zewdu, 2008).

Table 2

Reproductive performance of sheep in study area

Criteria	Districts				
	Toke Kutaye Mean ±SE	Ambo Mean ±SE	Dandi Mean ±SE	Test F-Value	P-Value
AFPm(month)	6.9±0.15[a]	6.2±0.10[b]	6.3±0.09[b]	9.58	.000
AFPf(month)	7.9±0.17[a]	7.1±0.09[b]	7.1±0.08[b]	18.93	.000
AFL(month)	14.5±0.15	14.5±0.13	14.2±0.11	1.42	.244
LI (month)	7.4±0.10	6.9±0.07	7.0±0.07	7.65	.001
LS (number)	1.5±0.06[a]	1.3±0.05[b]	1.3±0.05[b]	3.33	.037
PLS(years)	7.9±0.13	8.4±0.09	8.7±0.08	12.26	.000

AFPf =Age at puberty male, AFPf= Age at puberty female, AFL= Age at first lambing, LI= Lambing interval, LS= Litter size and PLS= Reproductive life span, SE=Standard Error. Different superscript within row shows significant different among districts and similar superscript shows no significant different for row within particular parameter

Constraints and Opportunities of Sheep Production

Constraints of sheep production

Identifying constraints on sheep production is a base for solving problems and improving sheep genetic resources and productivity (Abera et al., 2014). Major constraints on sheep production in the study areas are presented in Table 3. The main constraints reported in the study area were disease prevalence, seasonal feed shortages, a lack of improved genotype (mainly caused by the absence of structured genetic improvement interventions), and a shortage of land. There was variation in index intensity and ranking constraints among the studied districts (Table 3). Disease was the major constraint, followed by feed shortages in Tokke Kutaye and Ambo districts, with index values of 0.33 and 0.31 and 0.29 and 0.26, respectively. Similarly, Bamlaku (2012) reported that disease prevalence and seasonal feed shortages were the two major sheep production constraints in Goncha Siso Enesie district. The author also reported a lack of improved genotypes as a constraint on sheep production. However, feed shortage was ranked as the first constraint to sheep production with an index value of 0.30 in Dandi district, followed by disease prevalence with an index value of 0.29. Haile et al. (2015) also reported that feed shortage and disease were considered major problems for sheep production in both Basona Werena and Angolelatera areas of the North Shewa zone, with varying intensity.

Table 3

Constraints of sheep production study areas

	Districts											
	Tokke Kutaye				Ambo				Dandi			
	Rank				Rank				Rank			
	1	2	3	index	1	2	3	index	1	2	3	index
Feed shortage	32	30	8	0.31	38	8	9	0.26	36	17	20	0.30
Disease	32	32	18	0.33	24	30	24	0.29	30	31	2	0.29
Drought	6	14	8	0.10	4	6	6	0.06	4	2	4	0.04
Lack of genotype	14	8	40	0.18	16	28	20	0.23	6	18	36	0.17
Land shortage	4	6	14	0.07	8	18	33	0.17	14	22	28	0.21

Index = Σ of [3×ranked 1st + 2×ranked 2nd + 1× ranked 3rd] given for particular valued constraint divided by Σ of [3×ranked 1st + 2×ranked 2nd + 1× ranked 3rd] summed for all valued constraints

Opportunities of sheep production

Opportunities for sheep production in study areas are presented in Table 4. Mixed crop-livestock production is the major farming system in all districts. This type of farming system was the main opportunity for livestock production because animal feed was generated from crops they produced, especially in the dry season. Crop residue and crop aftermath were used as the most important feed resources for sheep (and other livestock) in the study areas during the dry season. The market was reported as a second opportunity in the study areas, with index values of 0.24, 0.25, and 0.27 in Tokke Kutaye, Ambo, and Dandi districts, respectively. Guder regional livestock markets, Ambo, and Dandi local livestock markets have great roles for sheep marketing.

Table 4

Opportunities of sheep production in study

	Districts											
	Tokke Kutaye				Ambo				Dandi			
	Rank				Rank				Rank			
	1	2	3	Index	1	2	3	index	1	2	3	index
farming system	53	15	4	0.40	60	6	7	0.37	58	10	3	0.37
Labor	8	14	44	0.20	3	29	39	0.20	5	20	43	0.18
Feed availability	10	20	20	0.16	6	25	26	0.18	6	28	26	0.20
Market	23	3	42	0.24	20	28	18	0.25	21	31	18	0.27

Index = Σ of [3×ranked 1st + 2×ranked 2nd + 1× ranked 3rd] given for particular valued opportunity divided by Σ of [3×ranked 1st + 2×ranked 2nd + 1× ranked 3rd] summed for all valued opportunities

CONCLUSIONS

The reproduction performance, constraints, and opportunities of the indigenous sheep population found in Tokke Kutaye, Ambo, and Dandi districts were investigated. Questionnaire surveys and focus group discussions were employed to capture the required information. A total of 270 households visited for the interview. The average sheep flock size obtained in the present study was 10.2±.34 in Tokke Kutaye, 11.9±0.57 in Ambo, and 11.1±0.43 in Dandi district. Among the classes of sheep, the largest proportion was females in the flocks surveyed.

Average age at puberty for rams was about 6.9±0.15, 6.2±0.10, and 6.3±0.10 in Tokke Kutaye, Ambo, and Dandi (7.24±1.06 months), whereas age at puberty for females was 7.9±0.17, 7.1±0.09, and 7.1±0.08 months in Tokke Kutaye, Ambo, and Dandi districts, respectively. Average age at first lambing, lambing interval, litter size, and reproductive life span of ewes in study areas were 14.0±0.13 months, 7.1±0.08 months, 1.4±0.05 lambs/lambing, and 8.4±0.10 years, respectively.

Disease prevalence, feed shortages, and a lack of improved genotypes were the three most important constraints on sheep production in districts. The prevalence of disease was the major constraint, followed by a feed shortage in Tokke Kutaye and Ambo districts, with index values of 0.33 and 0.31 and 0.29 and 0.26, respectively. However, in Dandi district, feed shortages and disease prevalence were major constraints reported. A mixed-crop livestock production system has created a main opportunity for sheep producers due to the ability to generate animal feed from the crops they have produced. Proximity to the market was the second most important opportunity for buying and selling sheep.

Recommendations

- In the study areas, sheep covered the key farming activities to maintain the activity of smallholder farmers. Thus, due attention to sheep production could be considered in the future.
- Conservation and efficient utilisation of crop residues (e.g., improving intake and the nutritional value of crop residues)
- Comparatively larger flock sizes and good market access in the three districts appear to be good opportunities for sheep fattening. Thus, awareness-creation training on sheep fattening technologies for producers and development workers is required.
- Genetic improvement strategies such as community-based breeding programmes shall be considered along with awareness-creation training on breeding rams' management to avoid or minimise inbreeding.

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