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BREEDING STRATEGIES OF SIMIEN SHEEP IN SIMIEN MOUNTAIN REGION OF ETHIOPIA

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ABSTRACT: This study was conducted to characterize the existing sheep breeding strategies as an essential step in designing a breeding program for linking sheep production in the Simien mountain region of Ethiopia. Interview with sheep keepers, direct ranking method of traits, and field observations were carried out in selected districts of Simien mountain region. Sheep kept mainly as a source of income, saving and meat with an index value of 0.27, 0.21, and 0.20 in the Beyeda district whereas the corresponding value for Janamora was 0.26, 0.22, and 0.19, respectively. Mean sheep flock sizes were 14.9 and 16.2 in Beyeda and Janamora districts of Ethiopia. Natural and uncontrolled breeding was common in the Simien mountain region of Ethiopia. Coat color, body conformation, and fast growth rate were important traits in selecting breeding rams in both study districts. Coat color and appearance were selection criteria for breeding ewes in both study districts. It is observed that Simien sheep is highly valued for its tasty meat and produce under low input conditions. However, the survival of Simien sheep is endangered due to uncontrolled breeding, intervention failures in livelihood, and market-oriented agricultural systems. In conclusion, the main breeding objective for sheep production have been defined as increasing meat production and marketed animals and this is driven by market demands. Compared with other local sheep types, Simien was rated highly by both producers and consumers in their tasty meat. These characteristics make the Simien sheep economically more important. Yet Simien sheep need to be conserved as they could serve as a source of safe and tasty products for consumption.

Keywords: Breeding practice, Livestock population, Mountain region, Sheep flocks, Simien sheep.

INTRODUCTION

Amhara region is believed to have the largest livestock population in Ethiopia with 11 million of sheep population (CSA, 2020). It is about 73 to 75% of the sheep population is located in the highland areas of the country. Sheep are economically important for the national economy and the farm household. It accounts for about 15 to 17% of national GDP and 35 to 49% of agricultural GDP (CSA, 2018). Sheep contribute about 37 to 87% of household incomes, providing food and non-food products. Though Ethiopia is known for its huge sheep population, livestock production systems are generally subsistence-oriented and productivity is very low (Belachew and Jemberu, 2003).

The present productivity of sheep has frequently been reported to be low when compared to other countries in the world or Africa (ILRI, 2011; Yohannes et al., 2018). Getahun et al. (2014) also revealed that the productivity of indigenous sheep in terms of meat has been limited by poor genetic potential. In Ethiopia, there are about 14 traditional sheep breeds (Solomon, 2008), among which Simien sheep is highly valued for its delectable meat and adaptation to the harsh and low-input production environment (Surafel et al., 2012). Sheep products in the form of meat have great importance and provide different nutrient that contributes to the improvement of the nutritional status of the rural poor in the region (Habtamu, 2015; Birara, 2016).

These subsistence sheep farming are also key sources of income and employment. Hence, the current drive for rapid livestock development through linking sheep production with tourism requires research to design and implement suitable breeding strategies so as to improve productivity and conserve indigenous breeds. Among the various factors, the absence of planned genetic improvement programs for local breeds is one of the causes for losing their competitive advantage, especially where production systems or external conditions are subject to change (Hiemstra et al., 2007). Therefore, improvement and conservation of Simien sheep genetic resources could be imperative as it has been contributing to sheep genetic diversity in Ethiopia (Hailu et al., 2020; Desalegn et al., 2022). There is a need to design and implement appropriate breeding strategies to improve the productivity of Simien sheep to utilize and increase its contribution to its keepers and thereby enhance its conservation by the community. However, the lack of detailed information about the existing breed management, traditional breeding practice, and identification of important traits, are perceived to be the most important hindrance for genetic improvement and the development of conservation programs. Lack of such information is a serious constraint to effective prioritization and planning of breed conservation measures including sustainable breeding strategies (Solomon et al., 2013).

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Thus, characterization of breeding practices and identification of breeding objective traits would help to ensure sustainable use and development of sheep genetic resources. Hence, the aim of this study was to characterize the existing sheep breeding practices and identify traits in relation to the breeding objectives of the community for designing a sustainable selective breeding program to improve productivity and conservation of Simien sheep breed.

MATERIALS AND METHODS

Study area description

The study was carried out in Janamora and Beyeda districts of the Simien Gondar Zone of the Amhara region. Both districts are found in the Simien mountain and Ras Dejen mountain, the highest point in Ethiopia. The Simien mountain found between 13° 11'N latitude and 38° 04'E longitude. The areas have an altitude range of 2000-3900 m.a.s.l and the mean annual temperature and rainfall of 12.4°C and 974 mm (Surafel et al., 2012). The production system of both districts is characterized as small-scale barley-dominated mixed crop-livestock system. Sheep production is a common practice. The map of the study areas is presented in Figure 1.

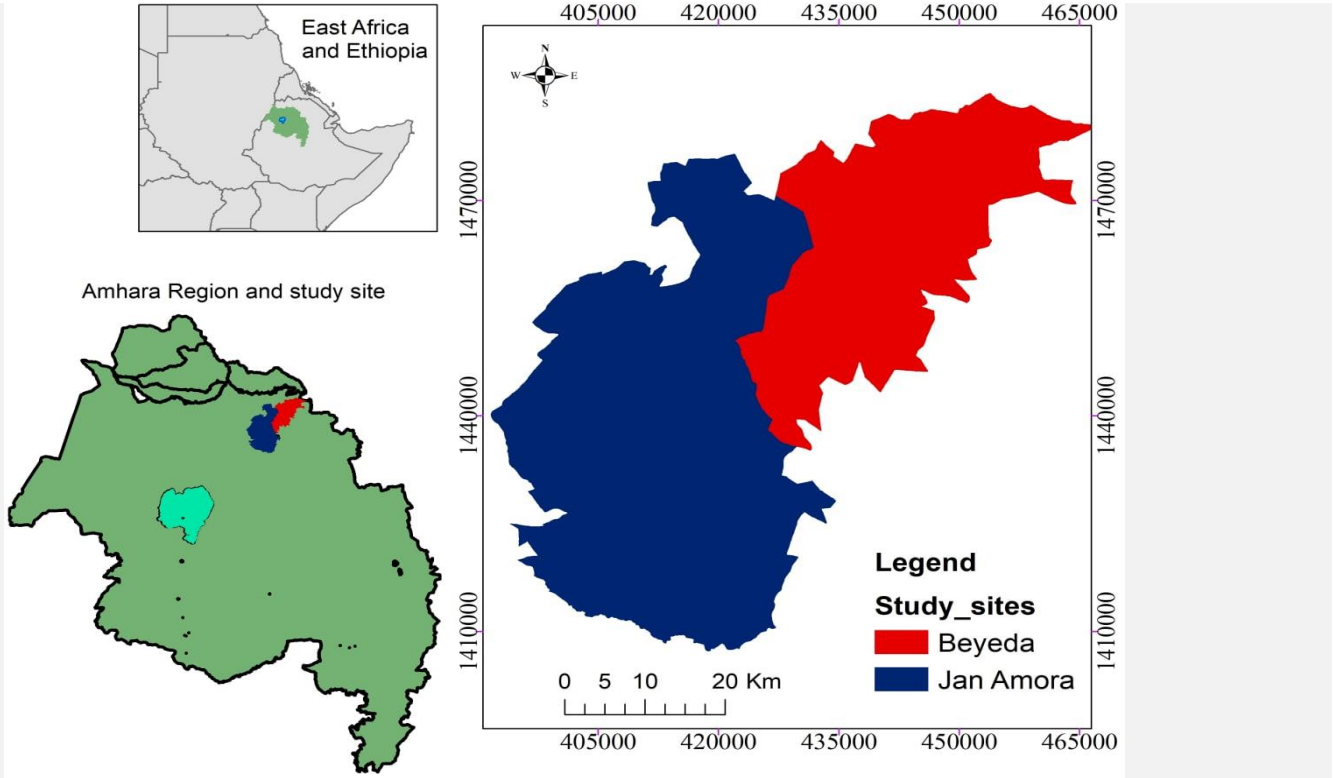

Figure 1 - Map of the study areas

Study approach

Participatory rural appraisals were conducted on characterizing indigenous breeding practices and trait preferences. This was done in rural kebeles by individual interviews, focused group discussions (FGDs) and direct flock ranking. Field surveys were carried out in three randomly selected rural kebeles. For field survey a total 184 of sheep owners were randomly selected (92 sheep owners from each district). The participant sheep owners were selected based on their indigenous knowledge. A purposive sampling was undertaken to target sheep owners in the study areas who were believed to possess more indigenous knowledge and experiences about Simien sheep. Among the recommended rural participatory approach, direct ranking experiment adopted from (Solomon et al., 2010; Yohannes et al., 2017) was used to identify trait preferences and selection criteria of sheep owners. Traits of rams and ewes were identified through an in-depth interview and discussion with sheep owners to rank the traits in order of importance. Focus group discussions were held with development agents, key informants and elders. These discussions were used to obtain information about farmers' reasons for keeping Simien sheep, breeding practice and trait preferences.

Data analysis

The statistical software SPSS Ver. 20.0 (2012) was used to analyze the data from field survey and participatory identification of trait preferences. Farmer's preference rankings were summarized into index as weighted averages. The index was computed using the following formula as suggested by Kosgey et al. (2008). Index = Sum of (3 X number of household ranked first + 2 X number of household ranked second + 1 X number of household ranked third) given for an individual reason, criteria or preference divided by the sum of (3 X number of household ranked first + 2 X number of household ranked second + 1 X number of household ranked third for overall reasons, criteria or preferences.

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RESULTS AND DISCUSSION

Sheep production objectives

Finding out the purpose keeping for sheep of the farmer gives an indication of their breeding objectives (Solomon et al., 2013). The reasons for keeping sheep are rational and related to the farmers' needs in the long or short term. Table 1 presents the sheep production objectives of farmers in the Simien mountain region. The result shows that sheep play multi-functional roles in both study districts with similar production objectives whereby their income, saving and meat consumption function ranked as paramount importance. While functions like skin and wealth were received lower ranking, respectively. The multipurpose functions of sheep in low-input traditional systems were reported in Ethiopia (Tesfaye et al., 2010; Desalegn, 2019) and elsewhere in Africa (Wurzinger et al., 2011; Zonabend et al., 2015). This implies that multiple functional roles are particularly important in low and medium-input-out sheep production systems in developing countries. Thus, a successful breeding program could be mainly achieved through including the cultural, social, and environmental benefits in the breeding objectives for sheep under smallholder production systems in the tropics. Therefore, considering the different socio-cultural perspectives of the sheep owners is important in the adoption of any breeding program.

Flock characteristics

The study of flock characteristics helps in the design of breeding programs. As indicated in Table 2, the flock size of sheep was higher in Janamora than Beyeda district. The mean flock size in the present study was comparable to reports of Solomon et al. (2007), Yohannes et al. (2017) and Desalegn (2019) for Gumuz and Simien sheep. In Beyeda, 51.3%, 24%, 17.3 %, and 3.7% of the flock are ewes, young, lamb, and rams, respectively. Similar trends are observed In Janamora (42.1%, 32.9%, 20.2 % and 3.54%). The larger proportion of breeding ewe obtained was comparable with previous results reported 46.80% for Menz sheep and 49.2% for Afar sheep (Tesfaye et al., 2010), and 38.9% for central Tigray sheep (Hagos et al., 2015). The proportion of higher breeding ewe in both districts would imply the production of a larger number of lambs (selection candidates) which in turn might increase the intensity of selection and thus ensure the effectiveness of selective breeding. The low proportion of breeding rams in both study districts indicated the tradition of marketing young ram lambs because of the greater dependence on sheep production.

Table 1 - Ranking of the sheep production objectives by smallholder farmers

Study districts / Production objectives	Beyeda (N=92)				Janamora (N=92)			
	R1	R2	R3	Index	R1	R2	R3	Index
Income	29	23	16	0.27	28	22	17	0.26
Meat	17	20	18	0.20	17	19	17	0.19
Saving	21	20	15	0.21	22	20	14	0.22
Manure	11	12	22	0.14	10	11	21	0.13
Skin	5	9	5	0.07	5	8	6	0.06
Wealth	10	9	17	0.12	9	11	16	0.11

Index = [(3 × number of households ranking as first + 2 × number of households ranking as second + 1 × number of households ranking as third) for each objective]/ [(3 × number of households ranking as first + 2 × number of households ranking as second + 1 ×number of households ranking as third) for all purposes of keeping sheep].

Table 2 - Flock size and structure of Simien sheep

Mean flock size and size of each age class as a proportion of the total flock								
Class of animal	Beyeda(N=92)				Janamora(N=92)			
	N	Mean± SD	Range	%	N	Mean± SD	Range	%
Lamb < sex month	241	2.54±1.95	0-10	17.3	266	2.85±1.59	0-8	17.82
Ram 6-12 month	97	1.04±0.83	0-3	6.98	190	2.09±1.47	0-7	12.74
Ewe 6-12 month	239	2.57±1.57	0-10	17.2	301	3.29±1.67	0-7	20.18
Breeding ewe > 1yr	713	7.67±5.17	0-24	51.3	629	6.80±4.42	0-20	42.1
Breeding ram>1yr	51	0.56±0.93	0-5	3.7	24	0.26±0.49	0-2	3.54
Castrated	49	0.53±0.74	0-5	3.54	83	0.91±0.77	0-3	5.56
Total	1390	14.91±4.8	1-50	100.0	1493	16.2±7.24	2-50	100.0

N = Number of households; % = percentage of each age class; SD = standard deviation.

Breeding managements

The flock herding practices of farmers reflect their breeding management and have serious implications for the design of controlled breeding activities. As indicated in Table 3, all sheep type of more than one household was herded together as a flock, as reported by 76% of sheep owners. As a result, there is a possibility of mixing. A similar finding is

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also reported by Tesfaye et al. (2010) and Girma et al. (2013) in the central highlands of Ethiopia. This flock mixing practice would be a good opportunity for implementing the community-based breeding program and it facilitates ram exchange which is one of the major components of the community-based breeding program.The migration of children and youth to zonal and regional cities for house servants and daily laborers has also forced them to keep sheep with other livestock. Yohannes et al. (2017), Desalegn et al. (2019) and Kiflay et al. (2019) also confirmed that sheep were herded together with other livestock species in northwestern Ethiopia.

As presented in Table 4, pure breeding of Simien sheep was practiced in the Simien mountain region. This implies the importance of pure breeding strategies for the conservation and improvement of Simien sheep. 91.4% for the Beyeda farmers and 84.6% of Janamora farmers confirmed that ram use and breeding are generally natural and uncontrolled in the Simien mountain region. Solomon et al. (2011), Surafel et al. (2012), Hayelom (2013), Yohannes et al. (2017) and Desalegn et al. (2019) reported that uncontrolled mating occurred predominantly in most traditional production systems. The primary reason for uncontrolled mating was the use of communal grazing areas, which is followed by a lack of awareness and sailing of male lambs at an early age. This may be contributed to the inbreeding, early breeding of females, and decrease genetic diversity resulting in low conception rate, low birth weight, low survival rates, and the gene pool narrows. This has to be taken into consideration when implementing a breeding program for Simien sheep.

Very few numbers of sheep owners practiced controlled breeding in which a group of ewes is left with one or more rams to mate due to strong extension services to ensure that rams are used efficiently to maximize the benefit (Zewdu et al., 2012). The reason for controlled mating was primarily to get the best animals for market. Previous studies also indicated that controlled mating is crucial for the successful implementation of genetic improvement and conservation programs (Solomon et al., 2010; Yohannes et al., 2018). This study also confirmed that few proportions of rams are used for breeding purposes. When rams were not available in their flocks, owners got the service from neighbors. These results are in line with the report of Zewdu et al. (2012), Tesfaye et al. (2016), Yohannes et al. (2017) and Kiflay et al. (2019) elsewhere in Ethiopia.

Table 3 - Herd management of Simien sheep

Herding practices \ Respondents (%)	Beyeda		Janamora	
	N	%	N	%
Sheep together with cattle	24	26.9	23	23.1
Sheep together with goat	13	10.8	12	16.5
Sheep together with equine	10	9.7	11	14.3
All herded together	40	45.2	39	40.7
Sheep herded separately	6	7.5	6	5.5
Household sheep herding system				
Sheep of a household run as a flock	23	24.7	22	24.2
Sheep of more than one household run like a flock	70	75.3	69	75.8

N =number of observations, % = percentage of proportions

Table 4 - Breeding management of Simien sheep

Breeding type practices \ Proportion (%)		Beyeda		Janamora	
		N	%	N	%
Breeding type	Pure breeding	93	100	91	100
	Crossbreeding	-	-	-	-
Mating system	Uncontrolled	83	91.4	80	84.6
	Controlled	10	8.6	11	15.4
Source of ram	Born	66	78.5	65	63.7
	Purchase	27	21.5	26	36.3

N =number of observations, % = percentage of proportions

Selection criteria for breeding ram and ewes

Within their herds, the majority of responders chose potential breeding rams and ewes. Selection practices, including selection criteria used in the Simien mountain region, but the selection of rams was more frequent than for ewes as it has been recorded previously in other districts of SNRS (Fekerte, 2008). In Beyeda, males are selected at 6-7 months, while in Janamora they are 5-6 months. This figure is comparable to the report of Tesfaye et al. (2010) but longer than Zewdu et al. (2012) who reported 4.39 ± 2.24 months for Horro rams.

Based on the reasons for keeping sheep, the breeding goals of farmers can be defined. The main breeding goal of farmers in the Simien mountain region for Simien sheep is to improve their market value through increased meat production. Selection criteria for selecting breeding rams are presented in Table 5. Among the selection criteria

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considered, coat color was an important selection criterion. Its index varied with districts and red, white, or mixed colors were more preferred in the study areas. It is ranked first by sheep owners in Beyeda and Janamora with an index value of 0.28 and 0.32, respectively. In Beyeda physical appearance and growth rate were ranked second and third with an index of 0.23 and, 0.10 respectively. Similarly, appearance and, growth rate, were ranked the second and, third selection criteria in Janamora with an index value of 0.21 and 0.09, respectively. This might be due to the association of good physical appearance of the ram with high carcass output and fetch premium price. Across districts, physically observable traits such as coat color, appearance, and horn should be considered alongside production traits in decision making to define breeding objectives of sheep owners in the sheep barley-dominated production system and to emphasize in selecting breeding rams, as their index values differed among districts.

Selection criteria for selecting breeding ewes are presented in Table 6. However, their index value differed among districts; appearance and coat color were two of the most important breeding ewe selection criteria in both study districts. In Beyeda, sheep owners have given attention primarily to appearance (index=0.21) while coat color and appearance were ranked as the first and second selection criteria for breeding ewes in Janamora district. Similar selection criteria were reported by Tesfaye et al. (2010) and Helene et al. (2013) in the Menz district and eastern Ethiopia respectively. Twining ability was ranked as the third selection criteria for ewes in Beyeda and Janamora with an index of 0.14 and 0.13, respectively.

Table 5 - Breeding objective traits for the Simien breeding ram

Breeding objective traits	Rank indexes of breeding objective traits								
	Beyeda				Janamora				Overall
	R1	R2	R3	Index	R1	R2	R3	Index	Index
Coat color	24	32	21	0.28	23	32	21	0.32	0.3
Appearance	25	11	22	0.23	25	10	21	0.21	0.22
Breeding efficiency	2	7	3	0.04	3	6	3	0.04	0.04
Paternal history	5	13	2	0.08	5	13	2	0.07	0.08
Maternal history	5	8	3	0.06	5	7	3	0.05	0.05
Libido	0	0	6	0.01	0	0	6	0.01	0.01
Growth rate	10	8	10	0.10	9	8	9	0.09	0.1
Meat yield	0	0	5	0.008	0	0	5	0.09	0.05
Temperament	0	0	2	0.003	0	0	2	0.004	0.003
Adaptability	7	6	1	0.06	7	7	1	0.07	0.06
Tolerance	4	0	6	0.03	4	0	7	0.03	0.03
Walkability	3	0	4	0.02	2	0	4	0.01	0.01
Horn	8	8	8	0.09	8	7	7	0.08	0.08

R =Rank, Index = [(3 × number of households ranking as first + 2 × number of households ranking as second + 1 × number of households ranking as third) for each selection criteria]/[(3 × number of households ranking as first + 2 × number of households ranking as second + 1 × number of households ranking as third) for all selection criteria for all traits].

Table 6 - Breeding objective traits for the Simien breeding ewe

Breeding objective traits	Rank indexes of breeding objective traits								
	Beyeda				Janamora				Overall
	R1	R2	R3	Index	R1	R2	R3	Index	Index
Coat color	21	20	18	0.21	21	19	17	0.23	0.22
Appearance	21	22	21	0.23	20	21	19	0.22	0.23
Lamb survival	12	12	7	0.12	12	12	8	0.12	0.12
Paternal history	3	1	2	0.02	3	2	2	0.03	0.025
Maternal history	4	1	0	0.03	4	1	0	0.02	0.025
Age at first sexual maturity	3	2	2	0.02	3	2	3	0.03	0.025
Lambing interval	3	7	6	0.05	3	6	6	0.05	0.05
Litter size\twinning	13	13	11	0.14	12	13	11	0.13	0.13
Meat yield	0	0	0	0	0	0	0	0	0
Temperament	0	0	3	0.05	0	0	3	0.05	0.05
Mothering ability	13	11	11	0.13	13	11	10	0.13	0.13
Walkability	0	0	0	0	0	0	0	0	0
Adaptability	0	5	5	0.08	0	0	5	0.09	0.09
Tolerance	0	7	7	0.01	0	4	7	0.03	0.19

R =Rank, Index = [(3 × number of households ranking as first + 2 × number of households ranking as second + 1 × number of households ranking as third) for each selection criteria]/[(3 × number of households ranking as first + 2 × number of households ranking as second + 1 × number of households ranking as third) for all selection criteria for all traits].

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CONCLUSION

Sheep production is an important component of the farming activity in the Simien mountain region through providing organic sheep meat to the local communities. The main breeding objective for sheep production have been defined as increasing meat production and marketed animals and this is driven by market demands. Compared with other local sheep types, Simien was rated highly by both producers and consumers in their tasty meat. These characteristics make the Simien sheep economically more important. Participatory identification of breeding objective traits indicated observable traits were preferred for selecting breeding animals. This implies that designing sheep improvement strategies in the area should primarily target meat production traits. The current information from breeding practices and participatory identification of breeding objective traits provided baseline information to design effective and sustainable genetic improvement and conservation programs for the Simien sheep breed. Conservation of Simien sheep genetic resources could be imperative as these have been contributing most to the sheep genetic diversity in Ethiopia.

DECLARATIONS

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Authors' contribution

All of the authors contribute to idea conception, data collection and analysis, and the write-up of the manuscript.

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Conflict of interests

The authors have not declared any conflict of interest.

REFERENCES

Belachew H and Jemberu E (2003).Challenges and opportunities of livestock trade in Ethiopia. Challenges and opportunities of livestock marketing in Ethiopia. Proceedings of 10th annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia, August 22–24, 2002. ESAP, Addis Ababa, Ethiopia. pp. 1–14. DOI: https://doi.org/10.1.1.468.8506&rep=rep1&type=pdf

Birara E and Zemen A (2016). Assessment of the Role of Livestock in Ethiopia : A Review. American-Eurasian Journal of Scientific Research, 11(5):405–410. DOI: https://doi.org/10.5829/idosi.aejsr.2016.11.5.22464

Central Statistics Agency of Ethiopia (CSA) (2018). Agricultural Sample Survey 2017/18 [2010 E.C.]. Volume II report on livestock and livestock characteristics (Private peasant holdings). Central Statistics Agency (CSA): Addis Ababa, Ethiopia. https://www.statsethiopia.gov.et/agriculture/livestock-and-livestock-characteristicsprivate-peasant-holdings-2017-2018-2012-e-c/

Central Statistical Agency of Ethiopia (CSA) (2020).Agricultural Sample Survey 2019/20 [2012 E.C.]. Volume II report on livestock and livestock characteristics (private peasant holdings). Central Statistical Agency (CSA): Addis Ababa, Ethiopia. https://www.statsethiopia.gov.et/agriculture/livestock-and-livestock-characteristicsprivate-peasant-holdings-2020-2021-2013-e-c/

Desalegn A (2022). Alternative Village Based-Breeding Schemes for Simien and Gumuz Sheep Breeds in Northwestern Ethiopia. Iranian Journal of Applied Animal Science, 12(2):287-294. https://journals.iau.ir/article_691727_ed32fc31504f9baff53f33948efedb29.pdf

Fekerte F (2008). On-farm Characterization of Blackhead Somali Sheep Breed and Its Production System in Shinile and Erer Districts of Shinile Zone. MSc Thesis, Haramaya University, Haramaya, Ethiopia. PP. 1-134. https://cgspace.cgiar.org/handle/10568/68875

Gebregziabhear E, Urge M, Animut G and Ketema M (2019). Characterization of Sheep Production Practices in Mixed Crop-livestock and Agro-pastoral Systems of Central and Eastern Ethiopia. East African Journal of Veterinary and Animal Sciences, 3(1): 27-38. https://haramayajournals.org/index.php/EAJVAS/article/download/914/450/

Getahun L, Aynalem H, Duncan AJ, Tadelle D, Solomon G and Rischkowsky B (2014). Sheep and Goat Value Chains in Ethiopia: A Synthesis of Opportunities and Constraints. ICARDA/ILRI Project Report, International Center for Agricultural Research in the Dry Areas/International Livestock Research Institute, Nairobi, Kenya. https://www.ilri.org/publications/sheep-and-goat-value-chains-ethiopia-synthesis-opportunities-and-constraints

Girma D, Mieso G, Feyisa H and Misgana D (2013). Assessment of farmers' management practices and factors affecting goats' production system in Adami Tulu Jido kombolcha district of East Shawa Zone, Ethiopia. Agriculture and Biology Journal of North America, 4(5): 520-526. DOI: https://doi.org/10.5251/abjna.2013.4.5.520.526

Habtamu L (2015). The contribution of livestock in meeting food production and nutrition in Ethiopia. Journal of Food Science and Quality Management, 2(3): 020-043. http://www.springjournals.net/full-articles/springjournals.netgifstarticleshabtamu.pdf?view=inline

Hagos B, Alemayehu K and Mekuriaw Z (2015). Traditional Management Practices, Breeding Objectives and Trait Preference for Indigenous Sheep in Northern Ethiopia. International Journal of Livestock Production Research, 9(6): 151-159. DOI: https://doi.org/10.5897/IJLP2017.0425

Hailu A, Mustefa A, Asegede T, Assefa A, Sinkie S and Tsewene S (2020). Phenotypic characterization of sheep populations in Tahtay Maichew district, Northern Ethiopia. Genetic Resources, 1(2):12–22. DOI: https://doi.org/10.46265/genresj.SHBD3744

Hayelom M (2013). Management practice and constraints of sheep production in southern, south eastern and eastern zones of Tigray, northern Ethiopia. World Journal of Animal Science Research, 1(1): 1-17. http://www.wjasr.com/WJASR_Vol.%201,%20No.%201,%20December%202013/MANAGEMENT%20PRACTICE.pdf

Helen N, Yoseph M, Kefelegn K, Solomon A and Sanjoy KP (2013). Production objectives, breeding practices, and selection criteria of indigenous sheep in eastern Ethiopia. Livestock Research for Rural Development, 25 (9). https://www.lrrd.cipav.org.co/lrrd25/9/nigu25157.htm

Hiemstra SJ, Drucker AG, Tvedt MW, Louwaars N, Oldenbroek JK, Awgichew K, Abegaz KS, Bhat PN and Da Mariante S A (2007). Options for strengthening the policy and regulatory framework for the exchange, use and conservation of animal genetic resources. Animal Genetic Resources Information, 41:65–74. https://www.fao.org/3/a1250e/annexes/Thematic%20Studies/Exchange_use_and_conservation.pdf

International Livestock Research Institutes (ILRI) (2011). Livestock policy analysis: ILRI Training Manual 2, ILRI, Nairobi, Kenya. http://dlc.dlib.indiana.edu/dlc/bitstream/10535/34/1/Livestock_policy_analysis.pdf

Kiflay W, Mengistu U and Solomon A (2019). Sheep Production Systems and Breeding Practices for Selected Zones of Tigray, Northern Ethiopia. Open Journal of Animal Sciences, 9: 135-140. DOI: https://doi.org/10.4236/ojas.2019.91012

Kosgey IS, Rowlands GJ, van Arendonk JAM and Baker RL (2008). Small ruminant production in smallholder and pastoral/extensive farming systems in Kenya. Small Ruminant Research, 7:11–24. DOI: https://doi.org/10.1016/j.smallrumres.2008.02.005

Solomon A, Girma A and Kassahun A (2008). Sheep and Goat Production Systems in Ethiopia. In: Alemu Yami and R.C. Merkel (Eds.), Ethiopia sheep and goat productivity improvement program (ESGPIP), Branna Printing Interprise. Addis Ababa, Ethiopia, pp: 27-32. https://agris.fao.org/agris-search/search.do?recordID=ET2008000090

Solomon A, Hegde BP and Taye M (2011). Growth and Physical Body Characteristics of Gumuz Sheep under Traditional Management Systems in Amhara Regional State, Ethiopia. Livestock Research for Rural Development, 23: 117. http://www.lrrd.org/lrrd23/5/abeg23117.htm

Solomon G (2008). Sheep resources of Ethiopia: Genetic diversity and breeding strategy. PhD thesis, Wageningen University, Netherlands. 2008. https://edepot.wur.nl/122006

Solomon G, Azage T, Berhanu G and Dirk H (2010). Sheep and goat production and marketing systems in Ethiopia: Characteristics and strategies for improvement Jido kombolcha district of east Shoa zone, Ethiopia. Working Paper No. 23. https://cgspace.cgiar.org/bitstream/handle/10568/2238/IPMS_Working_Paper_23.pdf

Solomon G, Tesfaye G, Zewdu E, Tadele M, Gemeda D, Markos T, Rischkowsky B, Mwai O, Tadelle D, Wurzinger M, Solkner J and Aynalem H (2013). Characterization of indigenous breeding strategies of the sheep farming communities of Ethiopia. A basis for designing community-based breeding programs. International Center for Agricultural Research in the Dry Areas (ICARDA). 40 pp. DOI: http://doi.org/10.22004/ag.econ.253826

Surafel M, Zeleke M, Solomon G and Mengiste T (2012). Community-based characterization of Simien sheep based on growth characteristics and farmers' breeding objectives in Simien Mountain region, Ethiopia. Research Journal of Animal Sciences, 6(3):47–55. DOI: http://doi.org/10.3923/rjnasci.2012.47.55

Tesfaye G, Ayinalem H, Markos T, Sharma AK, Sölkner J and Wurzinger M (2010). Herd Management and Breeding Practices of Sheep Owners in a Mixed Crop-Livestock and a Pastoral System of Ethiopia. African Journal of Agricultural Research, 5: 685-691. DOI: http://doi.org/10.5897/AJAR10.392

Tesfaye G, Ayinalem H, Wurzinger M, Rischkowsky B, Solomon G, Abebe A and Sölkner J (2016). Review of sheep crossbreeding based on the exotic sire and among indigenous breeds in the tropics: An Ethiopian perspective. African Journal of Agricultural Research, 11(11):901-911. DOI: http://doi.org/10.5897/AJAR2013.10626

Wurzinger M, Sölkner J and Iniguez L (2011). Important aspects and limitations in considering community-based breeding programs for low-input smallholder livestock systems. Small Ruminant Research, 98:170–175. DOI: https://doi.org/10.1016/j.smallrumres.2011.03.035

Yohannes D, Mengistu U, Tadesse Y and Solomon G (2017). Sheep Production and Breeding Systems in North Western Lowlands of Amhara Region, Ethiopia: Implication for Conservation and Improvement of Gumz Sheep Breed. Open Journal of Animal Sciences, 7(2): 179-197. DOI: https://doi.org/10.4236/ojas.2017.72015

Yohannes D, Urge M, Tadesse Y and Gizaw S (2018). Conservation-based breeding program design for genetic improvement in Gumz sheep in the western lowlands of Ethiopia. Agriculture & food security, 7(1): 34. DOI: https://doi.org/10.1186/s40066-018-0173-5

Zewdu E, Markos T, Sharma AK, Solkner J and Wurzinger M (2012). Sheep Production Systems and Breeding Practices of Smallholders in Western and South-Western Ethiopia: Implications for Designing Community-Based Breeding Strategies. Livestock Research for Rural Development, 24: Article #117. http://www.lrrd.org/lrrd24/7/edea24117.htm

Zonabend KE, Mirkena T, Strandberg E, Audho J, Ojango J, Malmfors B, Okeyo AM and Philipsson J (2016). Participatory definition of breeding objectives for sheep breeds under pastoral systems—the case of Red Maasai and Dorper sheep in Kenya. Tropical Animal Health and Production, 48(1): 9-20. DOI: http://doi.org/10.1007/s11250-015-0911-7

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