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Goat breeding practice and production constraints in Boset and Minjar Shenkora districts of Ethiopia

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Abstract

The study was conducted on a total of 144 randomly selected households of goat keepers from Boset district of Oromia region and Minjar Shenkora district of Amhara region. A semi-structured questionnaire was used to collect both qualitative data, and the data were organized and analyzed by using SPSS, version 23. The main purposes of keeping goats in the study area were mainly for cash income and meat production with an index of 0.37 and 0.23 in Boset and 0.44 and 0.23 in Minjar Shenkora district respectively. The fast growth rate, body size, and coat color of the animal were ranked as major selection criteria for breeding buck across the study area. Body condition score was considered as the first reason to cull breeding male (0.35) and female (0.31) in Boset district. Whereas, poor fertility and growth stand first as culling criteria for breeding females and males in Minjar Shenkora with an index of 0.37 and 0.32 respectively. Predator (with an index of 0.32) and shortage of grazing lands with an index of 0.28) were the major constraints of goat production in Boset and Minjar Shenkora districts. Therefore, any conservation and improvement program strategy that is intended to be implemented in the study area should consider the practical variation of the existed system, and the interest of the farmer.

Keywords: Production challenge; Purpose of keeping; Selection criteria

Introduction

Ethiopia is known for the diversity and wealth of indigenous domestic animals. Some of the factors that are considered to contribute to the diversification of livestock resources include the geographical location and presence of contrasting agro-ecologies, the richness of the agricultural ecosystem created by various cultures, nationalities, and their interaction (EBI, 2016). Both species and breed level diversity has many known benefits in terms of addressing the current and future climate change, growing demand for agricultural technology, and the success of Sustainable Development Goals.

In Ethiopia, the number of indigenous breeds of cattle, sheep, goats, camel, donkey, horse, and chickens identified so far are 28, 9, 8, 7, 6, 8, and 7, respectively. The country's total goat population reaches 32.74 million heads of which 99.77% are indigenous (CSA, 2018). Despite the large size, wide distribution, and diversified functions, the goat diversity of Ethiopia is currently diminished (losing its original content) due to various anthropogenic and natural causes (EBI, 2016).

The productivity of indigenous goats in the country is relatively low (Gatew et al., 2015) and goats mainly kept for multiple roles like income generation, meat, milk, manure, and skin production and this can vary across various locations and cultures (Engdawork, 2019a; Wendimu et.al, 2018). The

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relatively low productivity of indigenous goats in the country may be associated with various factors like the existed production system which is extensive and traditional, poor understanding of the management system, and lack of appropriate breed and breeding strategies. Goats generally traveled long-distance journey to search for feed and water. Drought, loss of grazing land, disease, and parasites are the known constraints of goat production in the country (EBI, 2016).

Efforts to improve indigenous goat productivity have been made, mainly by using exotic genotypes. However, little success has been recorded (Workneh et al., 2003), because of poor adaptation of exotic genotype to the low input production system, poor infrastructure, and capacity to adopt the technologies. On the other hand, having huge variation among and within breeds, better adaptation and disease tolerance, good reproduction ability in harsh environmental conditions, and poor quality fibrous feeds observed in indigenous breeds (Khargharia et al., 2015) justifies the importance of genetic improvement of indigenous breeds. Therefore, having in-depth knowledge about the breed, the existed production constraints, and the purpose of keeping goat is important to conserve, improve and sustainably utilize the resource. As genetic resources and production systems are not static, routine inventories and on-going monitoring is important. Moreover, investigate the breeding practice of indigenous goats under Ethiopian conditions is not exhausted (Dereje, 2015) and updating the previous results is vital. Therefore, the objective of the current study is to provide baseline information about the breeding practice and the existed production constraint of Boset and Minjar Shenkora indigenous goats for appropriate intervention, conservation, improvement, and sustainable utilization of the resource.

Materials and Methods

Study Areas

The study was conducted in two adjacently jointed and purposively selected districts namely; in Boset district of Oromia National Regional State and Minjar Shenkora district of Amhara National Regional State as shown in the study maps (Fig 1). The studied goat population was part of Central Highland goats; however proximity of towns and road accessibility in the studied districts expected to result high offtake rate and probably altered purposes of keeping goats, production challenges and selection criteria of the keeper in the area.

Boset is located at about 100 km East of Addis Ababa, in the East Shewa Zone of Oromia National Regional State at 8°24′–8°51′ north latitude and 39°16′–39°50′ east longitude with an altitude of 1500 m.a.s.l. Its total land coverage is 124,160 hectares. The administrative town of Boset district is Welenchiti. The annual rainfall and temperature of the district range from 400 to 800mm and 13.60 to 27.70C, respectively. The district falls within two major agro-climatic zones, Weinadega (midlands) and Kola (low lands).

Minjar Shenkora is located at about 135 km south East of Addis Ababa, in the North Shewa Zone of Amhara Regional State at 90º 6' and 90º 5' north latitudes and 39º 46' and 39º 26' east longitude with an altitude of 1900 m.a.s.l. It has a total area of about 229,463 hectares. The administrative town of Minjar-Shenkora district is Arerti. The annual rainfall and temperature of the district range from 162.8 to 1028mm and 7.3 to 27.7^{0}C, respectively. The district falls within three major agro-climatic zones, Dega (high lands), Weinadega (midlands), and Kola (low lands).

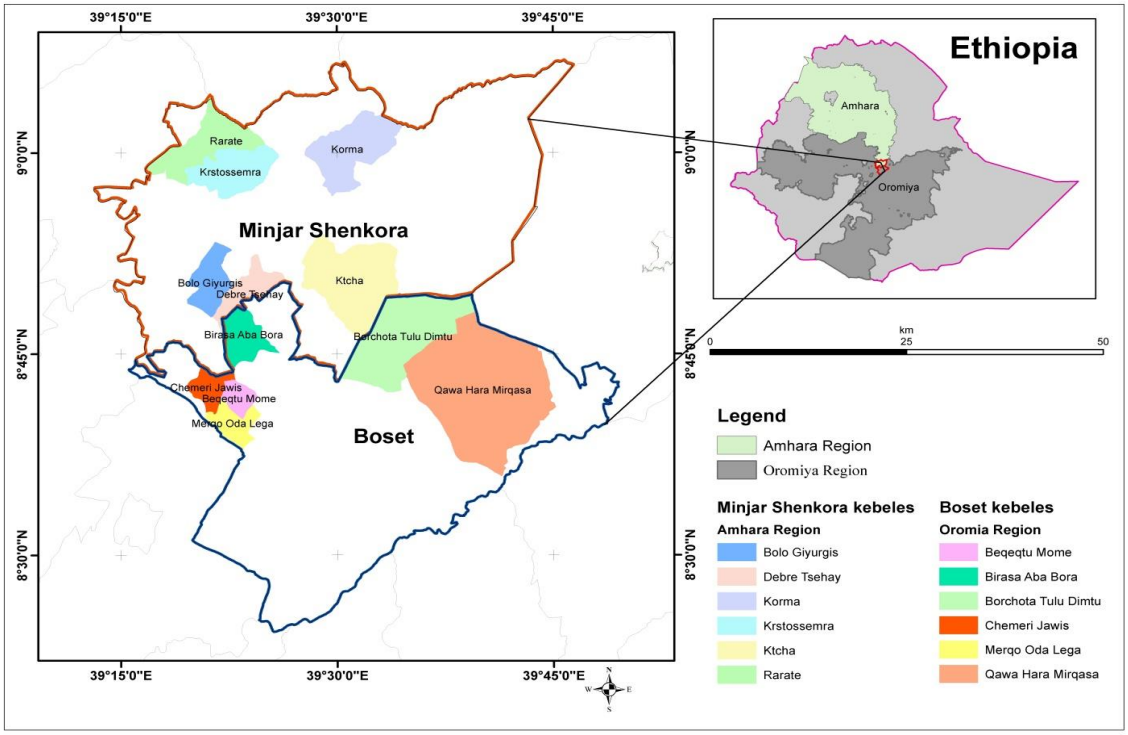

Figure 1. Map of the Study Area

Method of data collection

A multi-stage purposive sampling technique was employed for the selection of Zones, districts, and respective kebeles. Goat production potential, population size, and road accessibility were considered to trace the sampling site. Agricultural development agents were involved in the selection process. A total of 144 randomly selected households from 12 kebeles comprising 72 in each district were interviewed using a semi-structured questionnaire. The questionnaire includes household demography, purposes of keeping goats, goat production constraints, selection and culling criteria of breeding animals.

Statistical Analyses Techniques

Statistical Package for Social Sciences (SPSS) version 23 was used to analyze the survey data. Chi-square test was employed to test the association between districts and different variables like browsing practice, purposes of keeping goat, goat production constraints, selection and culling criteria. Indices were calculated to provide ranking of the reasons for keeping goats, major constraints of goat production, selection and culling criteria of breeding animals as employed by Getachew et al. (2020) as follows:

$$I_j = \sum_{i=1}^{3} r_i \, x_{ij} / \left(\sum_{j=1}^{n} \sum_{i=1}^{3} r_i \, x_{ij} \right)$$

Where, $x_{ij} =$ number of respondents giving rank i (i= 1, 2 and 3) to variable category j (j = 1- n, n = number of category in the given variables, such as category in reason of keeping goat and production constraints. r_i = Is the weight corresponding to the rank in which weight of 3, 2, and 1 assigned for the rank 1, 2 and 3, respectively.

Results and Discussion

General House-Hold Information Of Sampled Respondents

The majority of the households (88.2%) interviewed were males (Table 1). This may be because most of the females in the houses were busy doing household works. This may be also ascribed to the social hierarchy in the tropics where the female members of the family are not encouraged to divulge family information to strangers (Dejene, 2014). The finding is comparable with the report of Wendimu et al. (2018) and Debela et al. 2020), and also with Alubele (2015) for Abergelle and Central highland goat breeds. However, it's better to have equal participation of both genders, to get a clear picture of the goat husbandry practices prevailing in the study area.

The result related to the age group of the respondents indicates that 29.2 and 27.1% of the respondents' age group were from 41-50 and 51-60 respectively. This indicates that most of the respondents are well experienced in goat husbandry practices. However, the results relating to the educational status of the respondents indicate most of them were illiterate (40.6%), the findings are in close accordance with the report of Tesfaye (2015) for goats found in Yabelo Ethiopia. High levels of illiteracy demand better and appropriate goat husbandry extension services which can be easily followed by the respondents. Moreover, a higher level of illiteracy among the respondents is a challenge for modern livestock husbandry practices (Kosgey et al. 2006). Such respondents usually have difficulties in maintaining proper animal data recording and in calculating the dosages of veterinary drugs. Thus, the respondents need to be assessed with husbandry practices that are simple and easily understandable by the less educated (Tsigabu, 2015).

Table1. General Character of the sampled Household's in the study districts

Household character	Descriptors	Boset		Minjar Shenkora		Overall		$X^2(P)$
		N	%	N	%	N	%	
Sex of the respondent	Male	58	80.6	69	95.8	127	88.2	8.145
	Female	14	19.4	3	4.2	17	11.8	(0.01
	Husband	58	80.6	62	86.1	120	83.3	7)
Position of the respondent	Spouse of head	14	19.4	4	5.6	18	12.5	11.2
	Relative	-	-	4	5.6	4	2.8	(0.00
	Son	-	-	2	2.8	2	1.4	4)
Age of the respondent	<30	11	15.3	6	8.3	17	11.8	26.51
	31-40	17	23.6	12	16.7	29	20.1	(0.00)
	41-50	30	41.7	12	16.7	42	29.2	
	51-60	11	15.3	28	38.9	39	27.1	
	61-70	2	2.8	14	19.4	16	11.1	
	>71	1	1.4	-	-	1	0.7	
Education level of the respondent	Illiterate	36	50.7	22	30.6	58	40.6	
	Primary school (1-6)	22	31.0	14	19.4	36	25.2	22.67
								(0.00)
	Junior secondary school (7-8)	2	2.8	1	1.4	3	2.1	
	High school (9-10)	1	1.4	2	2.8	3	2.1	
	Diploma/TVET and above	1	1.4	1	1.4	2	1.4	
	adult education	8	11.3	14	19.4	22	15.4	
	basic education	1	1.4	18	25.0	19	13.3	

N = number of respondents

Goat Browsing Practices

The finding presented in Table 2 indicates that there was no association between goat browsing practice and location ($P < 0.05$). A combination of both private and communal browsing was commonly practiced (46.1%). This is important to design a community-based conservation and breeding program in the area, as the program needs the use of resources in common and cooperation among various communities for its success and sustainability (Mueller et al., 2015).

Table 2. Percentage of browsing practice in each district

browsing practice	Boset		Minjar Shenkora		Overall		$X^2(P)$
	N	%	N	%	N	%	
Communal	25	47.2	22	35.5	47	40.9	1.63
Private	6	11.3	9	14.5	15	13.0	(0.444)
Both	22	41.5	31	50.0	53	46.1	

N= number of respondents

Purposes of Keeping Goats in The Study Area

There was a significant association between purposes of keeping goats and studied districts ($P < 0.05$); higher values were observed for cash income and meat production in both districts (Table 3). The finding indicates that keeping goat for cash generation and meat production for consumption purposes are more important reasons in the area. The proximity of town and road accessibility in the area may facilitate goat marketing activities through easy mobilization in times of compelling and urgent financial needs. However, appropriate measurements should be taken to account for the flock structure stability. Oluwatayo (2012) reported that small ruminants are easily sold when compared to the bovines and can be sold off easily to the neighbors and traders alike. Opposing to the same, it's hard to find purchasers for bovines among the neighbors hence, small ruminants are preferred to meet the immediate cash needs of the farmers and landless alike in the developing countries (Kosgey, 2006). Small ruminants are easier to rear and the use of chevon is quite popular in the lowlands of the country as the meat is relatively leaner when compared to mutton (Madruga *et al*., 2008 and Endeshaw, 2007). Moreover, the meat from small ruminants is popular in areas where there are no refrigeration facilities as the whole carcass can be consumed by the family members in a day (Oluwatayo, 2012). The finding is also reported in related studies (Abraham et al., 2017; Wendimu et al., 2018; Debela *et al.*, 2020). Keeping goat for the purpose of milk production indicated in Boset district could be from the intention of the farmer to have fast grower animals. Since kids from high milk yielder doe can grow very fast and reach for sale or home consumption at early.

Table 3. Reason for goat keeping in the two districts

Purposes	Ranking Index (Rank)		
	Boset	Minjar Shenkora	$X^2(P)$
Meat	0.23 (2)	0.23 (2)	254.07 (0.000)
Milk	0.12 (4)	0.0 (8)	
Breeding	0.19 (3)	0.07 (5)	
Manure	0.06 (5)	0.10 (4)	
Blood	0.01 (7)	0.11 (3)	
Skin	0.00 (8)	0.02 (7)	
Cash income	0.37 (1)	0.44 (1)	
Cultural value	0.02 (6)	0.03 (6)	

Goat Production Constraints In The Study Area

There was a significant association between goat production challenges and the studied districts ($P < 0.05$). Higher values were observed for predators with index values of 0.32 in Boset and 0.21 in Minjar Shenkora district. Labor shortage and drought with a respective index of 0.19 and 0.18 were the major

goat production constraints in Boset district. Whereas, shortage of grazing land and disease with their index of 0.28 and 0.26 stands as a prominent constraint in Minjar Shenkora district (Table 4). The finding from both districts indicates that predator was considered as the most important constraint. Therefore the respondents need to ensure that the young, nursing, and the pregnant animals (who are the most vulnerable of all the classes) be herded separately and if possible be provided with forage and water at the homestead. The predators can also cause enormous damage to the flock if they are not provided with proper housing (Alubel, 2015). Therefore, it is imperative that the flocks are appropriately housed at the night and that the houses are robust and properly ventilated. The result of the study is in line with the report of Engdawork (2019b) and Damitie (2015); predators were the second most cause of goat death in Ebnat and Gonji Kolela district. Lack of labor was also considered as one of the important constraints in Boset district which can be lack of employment opportunities and also the migration of young people to the proximate cities. Shortages of grazing land for goat production indicated in Minjar Shenkora district may be ascribed with the created computation with that of crop production, as the majority of the land is devoted for this purpose. Shortage of feed leads to late maturity of the goat which in turn leads to poor body weight and low immunity (Nibret and Basaznew, 2012). This is evident for incidences of diseases and reported as a main constraint in the area. Thus, following appropriate animal management activities and vaccination for those vaccine-preventable diseases may overcome the challenge. To maintain the benefits from goats, appropriate measures regarding animal feed improvement, access, and conservation should be taken. These findings are in line with the report of Belete (2013) on the goat population of Mada wolabow, Sawana, and Rayu district.

Table 4. Major challenges of goat production in the study area

Constraints	Ranking Index (Rank)		
	Boset	Minjar Shenkora	$X^2(P)$
Disease	0.13 (4)	0.26 (2)	158.54
Predator	0.32 (1)	0.21 (3)	(0.00)
Drought	0.18 (3)	0.11 (4)	
Water shortage	0.01 (8)	0.03 (7)	
Labor shortage for herding	0.19 (2)	0.06 (5)	
Not give birth frequently	0.04 (7)	0.00 (9)	
Shortage of grazing land	0.05 (6)	0.28 (1)	
Lack of improved breed	0.01 (8)	0.04 (6)	
Lack of vaccination	0.07(5)	0.01(8)	

Culling criteria of Breeding Goat

There was an association between the culling criteria of goat and district ($P < 0.05$). Poor goat health, body condition score, and slow growth rate were the most important reason to cull breeding goat across the study area, while infertility was the most important reason to cull breeding female in Minjar Shenkora district (Table 5). It is obvious that animals with poor profile (poor body condition, health, and growth) does not fetch higher price at market and does not sound good for breeding as well. As a result, farmers are not interested to use these animals for breeding purposes. Therefore, selections against these traits have to be encouraged to improve, conserve and sustainably utilize the resource in the area. The finding is in line with Belete (2013) on the goat population of Bale Zone.

Table 5. Culling criteria of breeding male and female as perceived by the respondent

Culling characters	Ranking Index (Rank)					
	Male			Female		
	Boset	Minjar Shenkora	$X^2(P)$	Boset	Minjar Shenkora	X^2(P)
Poor body condition	0.35 (1)	0.13 (3)	115.65	0.31 (1)	0.07 (4)	139.1
Poor conformation and shape	0.04 (6)	0.12 (4)	(0.000)	0.04 (5)	0.04 (6)	(0.000)
Black color	0.09 (4)	0.06 (6)		0.02 (7)	0.02 (7)	
Temperament	0.03 (8)	0.03 (8)		0.04 (5)	0.02 (7)	
Poor health	0.23 (2)	0.21 (2)		0.28 (2)	0.12 (3)	
Poor growth	0.04 (6)	0.32 (1)		0.01 (8)	0.31 (2)	
Old age	0.15 (3)	0.04 (7)		0.15 (3)	0.05 (5)	
Poor fertility	0.07 (5)	0.09 (5)		0.15 (3)	0.37 (1)	

Selection Criteria Of Breeding Goat

In the study area, goat-breeding practice is uncontrolled and all flocks of the household are herded together throughout all time. There was an association between selection criteria of breeding male and the districts ($P < 0.05$). The higher value was observed for fast growth rate, size, and animal coat color (mainly light coat color) Table 6. This indicates that these criteria are more important to decide the parents of future generations in the area. Physically the bucks have to have a long body, strong legs, and also a strong and thick neck. Bucks with a fast growth rate can reach marketable age early, which would be helpful for the keeper in terms of getting immediate cash needs. Moreover, fast-growth also indicates that the doe of the kid had higher milk yield which ensured the trait it displayed (Ilatsia et al., 2011). Selection criteria related to large body size, and good conformation and shape could be again arising from their determinant role for the market price. Farmer mainly preferred to have fast grower and large body-sized goats. Goats with long legs are preferred to browse easily from large trees and to travel long distances journey. The study further indicates that coat color is also considered as an important criterion for selecting breeding buck. The most preferred coat colors in the area were white, brown-white, red and brown-red coat colors. While bucks are easy to be seen in the deep forest and can easily be traced out by the herders, besides white-colored animals thrive well in the lowlands due to the adaptability (Porto-Neto et al., 2014). The finding is in line with the report of Abraham et al. (2017) and Debela et al. (2020) for northwestern lowland goats. Therefore, considering these traits could be worthy for conservation and improvement works which might be designed in the area. In the study area, all-female goats were considered as breeding goats except for animals with poor health, growth, and fertility, which are mainly subjected to cull. This may be important to maintain the size of the flock at large.

Table 6. Selection criteria of breeding buck in the two districts

Selection criteria	Ranking Index (Rank)		
	Boset	Minjar Shenkora	X^2(P)
Size	0.24 (2)	0.16 (3)	64.11
Conformation and shape	0.16 (4)	0.24 (2)	(0.000)
Color (light coat color)	0.20 (3)	0.16 (3)	
Fast growth	0.26 (1)	0.27 (1)	
Temperament	0.09 (5)	0.09 (5)	
Other (attractiveness)	0.056)	0.08 (6)	

Conclusion

In the study area goat contributes higher monetary value for the grassroots community, thus, due attention regarding production improvement, health management and conservation activities should be taken. Predator which was mentioned, as the major goat production constraint in Boset district should be studied in-depth and causative agents need to be identified and appropriate precautionary measures should be set in place. Shortage of browsing land was a critical problem in Minjar

Shenkora district. Therefore, designing feed improvement and conservation strategies, and using tethered grazing systems may lighten the existed problem. The use of communal browsing land and the interest of farmer to the most economically important traits are golden opportunities to set any improvement and conservation work in the area.

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Conflict of interest

No conflict of interest

Author's Contributions

Tesfalem involved in data collection, entry, statistical analysis and paper write-up; **Abebe** , participated in data collection and entry, **Abraham** and **Fasil** designed the whole study and involved in data collection, **Tesfaye** contributed to statistical analysis and paper write- up at a various level, **Manaye and Seble** contributed to data collection and entry, Solomon participated in data collection,

Ethics

The authors declare that there is no ethical issue that may arise after the publication of this manuscript.

Reference

Abraham H. Gizaw S. Urge M 2017. Begait Goat Production Systems and Breeding Practices in Western Tigray, North Ethiopia. *Open Journal of Animal Sciences*, 07(02): 198–212. https://doi.org/10.4236/ojas.2017.72016

Alubele A 2015. On-Farm Phenotypic Characterization and Performance Evaluation of Abergelle and Central Highland Goat Breeds as an Input for Designing Community-Based Breeding Program. MSc Thesis in partial fulfillment of the requirements for the degree of Master of Science, Haramaya University, Ethiopia.

Belete A 2013. On-Farm Phenotypic Characterization of Indigenous Goats Type and Their Production System In Bale Zone of Oromia Region, Ethiopia. MSc Thesis in partial fulfillment of the requirements for the degree of Master of Science, Haramaya University, Ethiopia.

Central Statistical Agency 2018. Agricultural Sample Survey. Report on Livestock and Livestock Characteristics (Private Peasant Holdings), Federal Democratic Republic of Ethiopia, II(Statistical Bulletin 587), 104p.

Damitie K. Alemash M. Kefyalew A Shigdaf M. Sileshi A 2015. Indigenous goat production systems in selected districts of western Amhara, Ethiopia. Journal of Harmonized Research, 3(4):182–192. www.johronline.com

Debela T. Urge M. Getnet A. Zeleke M 2020. Husbandry, Productivity and Producers Trait Preference of Goats in North-Western Lowlands of Ethiopia. Open Journal of Animal Sciences, 10(02): 313–35. DOI: 10.4236/ojas.2020.102019

Dejene TG 2014. Assessment of dairy cattle husbandry and breeding management practices of lowland and mid- highland agro-ecologies of Boranaa zone. Journal of Animal and Veterinary Sciences, 2(3): 62–69. DOI: 10.11648/j.avs.20140203.12

Dereje B. 2015. On-farm phenotypic characterization of indigenous cattle and their production systems in Bako Tibe and Gobu Sayo districts of Oromia region, Ethiopia. MSc Thesis in partial fulfillment of the requirements for the degree of Master of Science, Haramaya University, Ethiopia.

Endeshaw A 2007. Assessment on Production System and Marketing of Goats at Dale district (Sidama Zone). MSc Thesis in partial fulfillment of the requirements for the degree of Master of Science,

Haramaya University, Ethiopia.

Engdawork A 2019a. Lungworms of Sheep and Cattle Slaughtered at Abattoir (Study of Debre Birhan Municipal Abattoir and Private Hotels in Central Ethiopia). International Journal of Agriculture and Agribusiness, 2 (2): 104-114. DOI: 10.13140/RG.2.2.23130.29123

Engdawork A 2019b. Types of Animal Diseases and Their Potential Threats to Sustainability of Animal Biodiversity. Journal of Animal and Veterinary Advances, 18(7): 227 - 238. DOI: 10.36478/javaa.2019.227.238

Ethiopian Biodiversity Institute, 2016. Farm Animal Diversity of Ethiopia: Breeds and Ecotypes Catalogue. Addis Ababa, Ethiopia.

Gatew H. Hassen H. Kebede K. Haile A. Nonato R. Lôbo B. Yetayew A. Rischkowsky B 2015. Characterization of Indigenous Goat Populations in Selected Areas of Ethiopia. International Center for Agricultural Research in the Dry Areas (ICARDA), (10): 287–298. DOI https://hdl.handle.net/20.500.11766/5931

Getachew T. Haile A. Tessema T. Dea D. Edea Z. Rischkowsky B 2020. Participatory identification of breeding objective traits and selection criteria for indigenous goat of the pastoral communities in Ethiopia. Tropical Animal Health Production, 52(4):2145-2155. DIO: 10.1007/s11250-020-02243-4

Ilatsia ED. Kahi AK. Migose W. B. Muhuyi S A 2011. Traits and their relationship to milk production and fertility Sahiwal cattle in Semi-Arid Kenya : Genetic aspects of growth and survival traits and their relationship to milk production and fertility. Tropical Animal Health and Production, (43): 1575–1582. DOI 10.1007/s11250-011-9845-x

Khargharia G. Kadirvel G. Kumar S. Doley PKS. Bharti Mukut Das 2015. Principal Component Analysis of Morphometrical Traits of Assam Hill Goat in Eastern Himalayan India. The Journal of Animal & Plant Sciences, 25(5):1251-1258. https://www.researchgate.net/publication/284886966

Kosgey I. Baker R. Udo H. Van Arendonk JAM 2006. Successes and failures of small ruminant breeding programs in the tropics: a review. Small Ruminant Research (61) 13-28. DOI:10.1016/j.smallrumres.2005.01.003

Madruga MS. Torres TS. Carvalho FF. Queiroga RC. Narain N. Garruti D 2008. The meat quality of Moxotó and Canindé goats is affected by two levels of feeding. Meat Science, (80): 1019-1023. https://doi.org/10.1016/j.meatsci.2008.04.020

Mueller JP. Rischkowsky B. Haile A. Philipsson J. Mwai O. Besbes B. Valle Zárate A. Tibbo M. Tadele T. Duguma G. Sölkner J. Wurzinger M 2015. Community-based livestock breeding programs: Essentials and examples. Journal of Animal Breeding and Genetics, (132) 155–168. DOI:10.1111/jbg.12136

Nibret M. Basaznew B 2012. Assessment of Major Animal Production and Health Problems of Livestock Development in Lay-Armacheho District Northwestern Ethiopia. American-Eurasian Journal of Scientific Research, 7(3): 136- 141. DOI: 10.5829/idosi.aejsr.2012.7.3.65131

Ntume B. Nalule AS. Baluka Sylvia A 2015. The role of social capital in technology adoption and livestock development. Livestock Research for Rural Development 27 (9): 181. https://www.researchgate.net/publication/281451474

Oluwatayo IBTB. Oluwatayo 2012. Small Ruminants as a Source of Financial Security: A Case Study of Women in Rural Southwest Nigeria. Institute for Money, Technology and Financial Inclusion (IMTFI), Working Paper, Ibadan. pp: 21.

Porto-Neto LR. Reverter A. Prayaga KC. Chan EKF. Johnston DJ. Hawken RJ. Fordyce G. Garcia JF. Sonstegard TS. Bolormaa S. Goddard ME. Burrow HM. Henshall JM. Lehnert SA. Barendse W 2014. The genetic architecture of climatic adaptation of tropical cattle. PLoS ONE, 9(11).DOI:10.1371/journal.pone.0113284

Tesfaye AR. Tamir B 2015. Assessment of Goat Production and Marketing Practices, Constraints and Opportunities in Yabello District of Borana Zone, Southern Ethiopia. (4): 141–149. www.ijird.com

Wendimu B. Oumer S. Habtamu A 2018. Characterization of the Indigenous Goat Production System in Asossa Zone, Benishangul Gumuz Region, Ethiopia. African Journal of Food, Agriculture, Nutrition and Development, 18(3): 13558–71. DOI:10.18697/ajfand.83.17260

Workneh W. Rischkowsky B. King JM. Bruns E 2003. Crossbreds did not generate more net benefits than indigenous goats in Ethiopian smallholdings. Agricultural Systems, 76(3):1137-1156. www.elsevier.com/locate/agsy