Indigenous sheep resources of Ethiopia: types, production systems and farmers preferences

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Summary

Ethiopia has a diverse sheep population, numbering 23.6 million, in parallel with its diverse ecology, production systems and communities. A comprehensive phenotypic and genetic characterization of Ethiopian sheep populations was initiated in 2005 to provide a nationwide framework for the management of sheep genetic resources. In this paper, we describe the indigenous sheep types in terms of physical characteristics, eco-regional distribution and community affinity. We also present relationships of sheep types with agricultural production systems, and farmers'/pastoralists' assessment of their sheep types. Fourteen traditionally recognized sheep types were identified and physically described.

The sheep types could be categorized into four groups (sub-alpine short-fat-tailed, highland long-fat-tailed, lowland fat-rumped and lowland thin-tailed) based on their ecological distribution, tail types (fat-tail versus thin-tail), tail form/shape, and fiber type. There is high morphological and ecological diversity among the major sheep groups as well as among the sheep types. There is also a strong relationship between sheep types, ethnic groups and production systems. Assessment of the genetic distinctiveness of the traditional sheep types is important for developing rational conservation-based improvement programs. Molecular genetic assessment of the population structure is a follow up activity.

Résumé

L'Ethiopie possède différentes populations ovines, 23,6 millions, selon les différentes écologies, systèmes de production et communautés. En 2005 a été mis en place un programme de caractérisation phénotipique et génétique des populations ovines en Ethiopie dans le but de créer un cadre national pour la gestion des ressources génétiques ovines. Dans cet article nous décrivons les types d'ovins indigènes du point de vue des caractéristiques physiques, de distribution eco-régionale, et affinités entre communautés. Nous présentons également les relations des types d'ovins avec les systèmes de production agricole et une enquête menée parmi les éleveurs/pastoralistes. Nous avons identifié 14 types traditionnels d'ovins qui sont décrits du point de vue physique.

Les différents types se divisent en 4 groupes: sous-alpine à queue grasse courte; haute montagne à longue queue grasse; plaine gras postérieur; et plaine queue fine, et selon leur distribution écologique, types de queues (queue grasse versus queue fine), forme de la queue, et type de fibre. Il existe une grande diversité morphologique et écologique entre la plupart des groupes principaux ovins ainsi qu'entre les types d'ovins même. Il existe aussi une forte relation entre les types d'ovins, les groupes ethniques et les systèmes de production. L'évaluation des différences génétiques des types d'ovins traditionnels est importante pour le développement des programmes de conservation basés sur l'amélioration. L'évaluation génétique moléculaire de la structure de la population sera l'activité de suivi.

Resumen

Etiopía posee diversas poblaciones de ovinos, 23,6 millones, que varían según la ecología, los sistemas de producción y las comunidades. En el 2005 se inició un programa de caracterización fenotípica y genética des las poblaciones ovinas en Etiopía con el fin de crear un marco nacional para

la gestión de los recursos genéticos ovinos. En este artículo se describen los tipo de razas indígenas desde el punto de vista de las características físicas, de la distribución eco-regional, y de las afinidades entre comunidades. Presentamos también las relaciones de los tipos de ovinos con los sistemas de producción agrícola y una encuesta realizada entre los ganaderos y pastores.

Se han identificado 14 tipos tradicionales de ovinos que se describen desde el punto de vista físico. Los diferentes tipos se dividen en 4 grupos: sub-alpinos con cola gorda corta; alta montaña con cola gorda larga; llanura con cuarto posterior graso; y llanura con cola delgada, y según su distribución ecológica, tipos de cola (cola grasa versus cola delgada), forma de la cola y tipos de fibra. Existe una gran diversidad morfológica y ecológica entre la mayor parte de los grupos principales de ovinos así como entre los tipos de ovinos mismos. También hay une relación importante entre los tipos de ovinos, los grupos étnicos y los sistemas de producción. La evaluación de las diferencias genéticas de los tipos de ovinos tradicionales es importante para el desarrollo de los programas de conservación basados en la mejora. La evaluación genética molecular de la estructura de la población será una de las actividades de seguimiento..

Key words: *Ethiopia, Sheep resources, Characterization, Physical characteristics.*

Introduction

Ethiopia has a diverse indigenous sheep population, numbering 23.6 million head (CSA, 2006), in parallel with its diverse ecology, production systems and ethnic communities. At the national level, sheep and goats account for about 90% of live animals/meat (FAO, 2004) and 92% of skin and hide (FAO, 1994) export trade value. At the farm level, sheep contribute as much as 22-63% to the net cash income derived from livestock production in the crop-livestock production system (Gryseels, 1988; Zelalem and Fletcher, 1993). In the lowlands sheep, with other livestock, are a mainstay of pastoral livelihoods.

Characterization of sheep resources is a prerequisite for their rational utilization. In developing regions, there exist types of farm animal species which owe their distinct identity to a combination of traditional 'breeding objectives' and geographical and/or cultural separation by communities which own them (Rege 2002). African (Epstein, 1971) and Ethiopian sheep (MOA, 1975) have been traditionally classified based on tail type and fiber type because of the evolutionary significance of these characters. Galal (1983) and Sisay (2002) described the physical characteristics and eco-regional distribution of some of the sheep types in Ethiopia. However, earlier classifications and descriptions were incomplete at a national level. A comprehensive nationwide phenotypic and genetic characterization of Ethiopian sheep was therefore initiated in 2005. In this paper, we describe and synthesize the indigenous sheep types in terms of physical characteristics, eco-regional distribution and ethnic affinity. We also present relationships of sheep types with agricultural production systems, and farmers'/pastoralists' assessment of their sheep types.

Materials and Methods

An Ethiopian sheep breed survey was conducted in 2005. Fourteen traditionally recognized, phenotypically distinct, and/or geographically/ecologically isolated populations were surveyed. Depending on the trait, 18 to 40 full-mouth adult ewes from each population were sampled. The FAO (1986) qualitative and quantitative sheep breed descriptor list was used to characterize the populations phenotypically. Qualitative variables observed included coat color, fiber type, face profile, ear form, presence of horn, tail type and tail shape. Quantitative characters measured were body weight, withers height, body length, heart girth, substernal height, ear length, tail length, tail width and hair length. Information regarding flock size and composition was collected through a questionnaire. Data on ewe litter size was collected using farmer recall method. Farmers were asked to recall the reproductive history of each full-mouth breeding female. Using the Rapid Rural Appraisal technique, informal group and key informant discussions with farmers and livestock experts were conducted to gather information on breed distribution, farmers' assessments of their sheep types and farming practices. In addition, we made extensive field observations, reviews of grey and published literature and personal communications. Population estimates of sheep types were extracted, based on their geographic distribution, from regional and zonal sheep population estimates (CSA, 2005).

Results and Discussion

Sheep types

The fourteen sheep types were categorized into four groups (sub-alpine short-fat-tailed, highland long-fat-tailed, lowland fat-rumped, lowland thin-tailed) based on their ecological distribution, geographic proximity, tail types and tail form/shape (short vs long). Earlier studies used tail type (MOA, 1975) and eco-regional distribution (Sisay, 2002) to describe some of the sheep types. Inclusion of tail form/shape in the current study enabled identification of two groups of fat-tailed sheep which differ in other important characteristics.

Sub-alpine short-fat-tailed

Sub-alpine short-fat-tailed sheep inhabit a contiguous central-northern highland area (2 000 - 3 600 m) between 9.11 and 14.59° N and 36.31 and 39.81° E (Figure 1). The group includes seven sheep types (Figures 4 and 5) which are characterized by their short fat tail well above the hocks (Table 1). They are also characterized by small size (Table 2), coarse wool and low ewe reproduction. Litter size ranges from 1.0±0.01 in Menz (Figure 4) to 1.09±0.05 in Farta. The short-fat-tailed Washera sheep are an exception. It is short-haired, large-sized and prolific (litter size = 1.8). Hair coat is found in several East African fat-tailed sheep that have interbred with hairy thin-tailed sheep (Epstein, 1971).

Highland long-fat-tailed

The group is distributed over the southern and south-western mid-highlands (1 500 to 2 500 m) between 10.40 – 5.85° N and 34.50 – 40.29° E (Figure 1). The tail is fat and long reaching the hocks, broad at the base and upper third with a

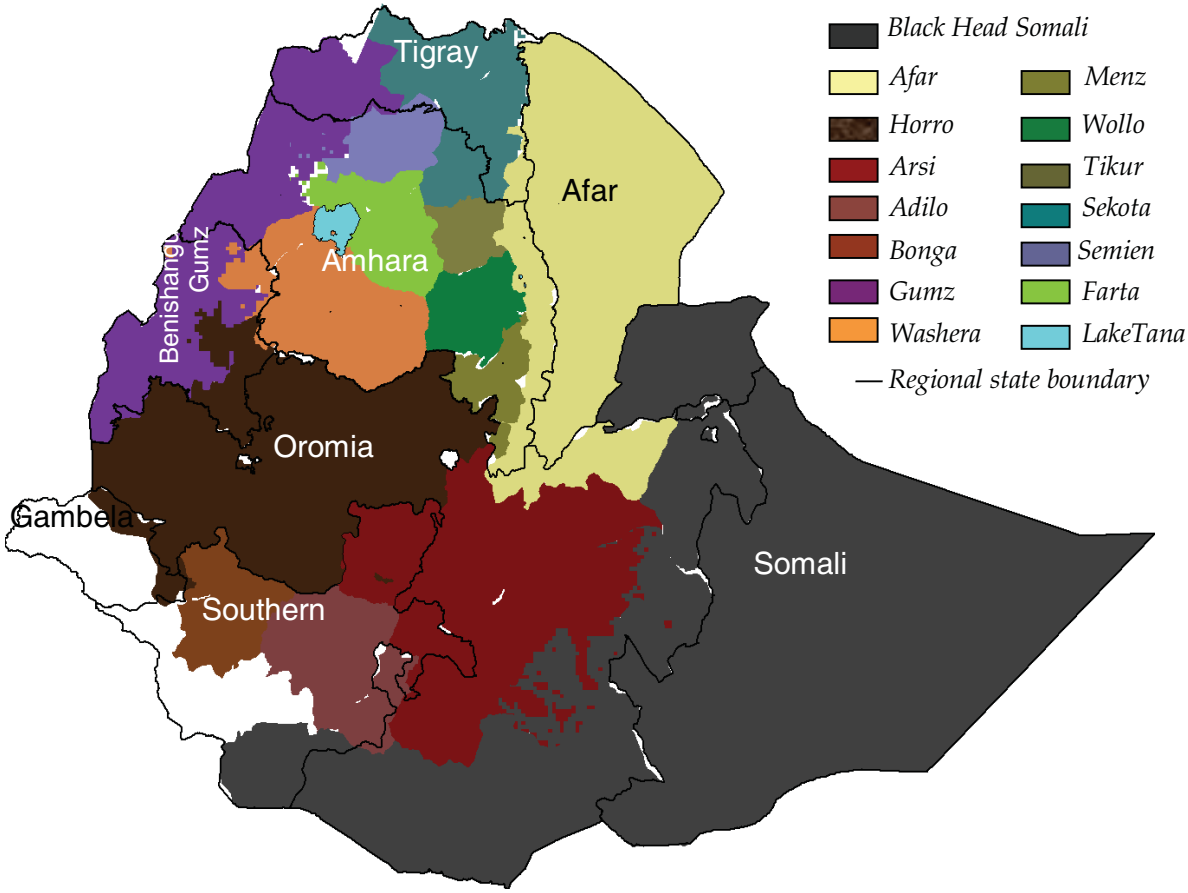

Figure 1. Geographic distribution of sheep types

Table 1. Sheep types and their ecology, geographic distribution, distinguishing physical features and population sizes.

Sheep types	Other names	Ecology	Geographic distribution	Important physical features[1]	Population (000)
Sub-alpine short-fat-tailed group					
Menz	Legegora, Shoa, Abyssinian, Ethiopian highland sheep	Sub-moist/dry, sub-alpine highlands (2 500 and 3 200 m);	North Shoa zone of Amhara State	Short fat tail turned-up at end; small body size; short-legged; long fleece with coarse wool; commonly black with white patches, white, brown, white with brown patches; straight-faced; horned males; short semi-pendulous ears with 12% rudimentary ears in the population. Kept by Amhara community	971.4
Sekota	Tigray highland, Abergelle	Cool, dry/sub-moist highlands (2 000 m); semi-arid river valley	Wag Himra zone of Amhara State and Tigray State	Short fat tail turned-up at end and fused with main part; medium-sized; Predominantly brown or white coat, few blacks with brown belly; white animals have finer hair or wooly udder-coat; semi-pendulous or rudimentary ears in Wag Himra and Tigray, predominantly rudimentary in Tekeze valley. Reared by Agew, Tigray and Amhara communities	732.3
Semien		Alpine mountains (3 000-4 000 m) including Semien Wildlife park;	North Gondar zone of Amhara State (Debark, Dabat, Janamora, Wegera)	Short fat tail; well developed wooly undercoat; plain brown, plain white, brown/white with white/brown patches, plain black and black with brown belly; unique long laterally spiral horn in males and short horns in most females; largest of the highland wooled sheep. Reared by Amhara community	347.6
Tikur		Sub-alpine highlands (3 000 m)	North Wollo zone of Amhara State	Short fat tail; wooly undercoat; Predominantly black (60%) coat; small body size; majority short semipendulous ears, 24% rudimentary ears. Reared by Amhara communities	525.3
Wollo		Cood highland (2 000-3 200 m)	South Wollo zone of Amhara State	Short-fat-tail with short twisted/coiled end, occasionally turned up at end; Small size; well developed wooly undercoat; Predominantly black, white or brown, either plain or with patches of white, black or brown; long hair with wooly undercoat; horned males. Reared by Amhara communities	1 395.9
Farta		Sub-moist highland (2 000-2 500 m)	South Gondar zone; Gondar zuria, Belesa, Dembia districts	Short fat tail; medium size; wooly under coat; Commonly white (37.5%), brown (27.5%) and black with brown belly (15%), white/brown with brown/white patches; males are horned. Reared by Amhara communities	555.6
Washera	Agew, dangilla	Wet, warmer mid-highlands (1 600-2000 m)	West and East Gojam and Agew Awi zones of Amhara state; Dangur, Madura and Alefa Takusa districts	Short fat tail; large body size; short-haired; predominantly brown; both males and females are polled; reared by Amhara and Agew communities	1 227.7

[1]*Coat colors are in order of frequency in the population.*

(... continued)

Sheep types	Other names	Ecology	Geographic distribution	Important physical features[1]	Population (000)
Highland long-fat-tailed group					
Adilo		Wet, warmer mid-highland (1 800-2 000 m)	North Omo, Derashie, Gedio and Amaro zones of Southern state; some northern Borena districts (1 300 – 2 400 m)	Long fat tail; Large size; short-haired; males are short-horned and 18.4% of ewes are horned; predominantly brown (943%), brown with white patches (32%), black (16%), black (19%) and black with brown patch (9%). Reared by southern nationalities	407.7
Arsi-Bale		Mainly wet, cool and warmer highlands (2 000-3 300); sub-moist lowlands	Arsi, Bale, E. Shoa, W. Harerghie zones, some districts in Borena zones of Oromia; Hadya, Gurage, Kembata & Sidama zones	Long fat tail with twisted end in some animals; medium size; hairy fiber, especially in adult ewes, males have minor wool growth in some parts of body; Males and most females (52%) are horned; Large size; coat colors are brown (35.1%), brown with white patches (24.3%), black, white, and combinations of above colors. Reared by Oromo communities	6345.1
Horro		Cool, wet highlands (2 991 m) to humid mid-highlands (1 600 m).	East Welega, West Welega, Illubabor, Jimma and West Shoa zones of Oromia, and some bordering Gambella and Benishangul districts	Long fat tail extending below hock, either straight (51.4%) or coiled/twisted (48.6%) at the tapering end; prominent fat tail in males; Large, leggy and prolific; dominant colors are brown and fawn, belly is lighter especially in adult ewes, less frequent are black, white, brown with white patches; both sexes are polled. Reared by Oromo, Benishangul and Gambella communities	3409.3
Bonga	Gesha, Menit	Humid mid-highland zone (1 200 – 2 500)	Keffa, Sheka and Bench zones of Southern State	Long fat tail with straight tapering end (98.4%); hair sheep; Large size; predominantly plain brown (57.9%) or with black (.9%) or white (5.3%) shade, plain white (10.5%) or with brown patches (10.5%), and black (2.6%); both sexes are polled. Reared by Keffa, Sheka and Bench communities	517.5

[1]*Coat colors are in order of frequency in the population.*

(... continued)

Sheep types	Other names	Ecology	Geographic distribution	Important physical features[1]	Population (000)
Lowland fat-rumped group					
Afar	Adal, Danakil	Mainly arid lowland(<1 000 m); mid-highland (1 200–1 900 m)	Afar state; boardering Tigray, Amhara; E. & W. Harerghe and E. Shoa of Oromia	Wide fat tail, in some large fat tail reaching below the hock; hair fiber; medium size; characteristically uniform creamy white/ beige coat; rudimentary ear; polled; dewlap. Reared by Afar, Amhara, tigray communities	681.9
BHS	Wanke, Ogaden, Berbera black head	Mainly arid lowlands (215-900 m); highlands (up to 2 000 m)	Somali state; lowlands of Bale, Borena and south Omo zones; part of east Harerghe	Short fat rump with a stumpy appendage; uniform white body and black head and neck; polled; convex face, especially in males; short, outward forward drooping ear; well developed dewlap. Reared by Somal, Oromo, Konso and South Omo communities	906.2
Lowland thin-tailed group					
Gumz		Moist lowlands (< 1 000 m)	Benishangul-Gumz state; lowlands of North Gondar	Long thin tail; some what dwarf; convex face profile; long pendulous ear; commonly plain brown or with patch (39.4%), white with brown or black patch (21%), black (15.8%), white, black with white patch, brown with black patch; polled. Reared by Gumz and Amhara communities	50.9

[1]*Coat colors are in order of frequency in the population.*

Table 2. Body weight (kg) and linear body measurements (cm) of full-mouth adult ewes (± Standard Deviation).

Sheep type	No.	Body weight	Withers height	Body length	Heart girth	Substernal height	Ear length	Tail length	Tail width	Hair length
Adilo	36	28.1±.5	65.5±.4	62.1±.5	71.8±6	35.8±.5	11.7±.5	28.1±1	6.7±.3	4.4±.2
ArsiBale	34	28.6±.6	64.1±.6	62.3±.8	73.3±.6	35.3±.4	11.0±.1	28.4±.6	6.2±.3	4.2±.1
Bonga	38	34.2±.8	66.7±.6	69.4±.5	73.5±.7	36.4±.4	9.8±.2	25.9±.9	8.1±.3	2.9±.1
Farta	39	28.3±.7	67.9±.5	65.7±.7	72.0±.7	37.3±.4	9.9±.3	22.9±.8	9.6±.2	7.5±.3
Gumz	38	31.0±.8	62.9±.7	65.8±.7	72.1±.7	32.9±.5	11.2±.2	31.6±.5	7.2±.2	3.6±.3
Horro	37	35.4±.8	70.0±.6	71.6±.6	76.9±.8	38.1±.4	10.8±.2	35.6±.6	9.9±.3	2.6±.1
Menz	40	20.1±.3	57.5±.5	58.5±.4	65.7±.4	30.9±.3	6.8±.4	17.0±.6	7.9±.2	7.9±.3
Sekota	40	26.6±.7	62.3±.6	62.2±.6	69.9±.5	33.5±.4	4.4±.5	19.9±.8	9.5.3	6.5±.5
Semien	33	26.9±.4	66.6±.6	64.7±.6	73.2±.6	35.9±.5	8.3±.5	12.8±.6	9.6±.2	8.2±.3
Afar	18	31.0±1	63.6±.8	58.3±.8	70.6±.6	35.6±.6	3.8±.4	19.1±.7	16±.9	3.2±.3
Tikur	34	25.4±.6	64.1±.6	63.6±.6	69.7±.6	35.9±.5	6.8±.5	17.3±.6	8.9±.3	7.4±.3
Washera	44	32.8±.9	69.4±.3	66.7±.5	74.1±.6	38.6±.3	10.6±.1	n.a	n.a	6.3±.3
BHS	22	27.9±.8	63.3±.6	59.9±.9	71.5±.6	35.1±.6	9.6±.4	14.7±.6	14±.9	4.0±.3
Wollo	37	21.7±.5	62.7±.6	61.2±.5	67.6±.5	34.3±.4	8.7±.3	20.4±.6	7.2±.2	7.9±.4

n.a.: data not available.

Figure 2. Highland long-fat-tailed ewe (e.g. here is Horro sheep).

Figure 3. Highland long-fat-tailed rams (e.g. here is Horro sheep).

Figure 4. Sub-alpine short-fat-tailed ewe (e.g. here is Menz sheep).

Figure 5. Sub-alpine short-fat-tailed ram (e.g. here is Simien sheep).

Figure 6. Lowland thin-tailed ewes (e.g. here is Gumz sheep).

Figure 7. Lowland thin-tailed ram (e.g. here is Gumz sheep).

Figure 8. Lowland fat-rumped ewe (e.g. here is BHS sheep).

long tapering end. The group is large-sized (Table 2), short-haired, predominantly brown and prolific (litter size = 1.29±0.06 - 1.55±0.12).

The group includes Horro (Figure 2 and 3), Arsi-Bale, Bonga and Adilo. An earlier study (MOA, 1975) described Horro as thin-tailed and Arsi-Bala as fat-tailed, while Galal (1983) and Epstein (1971) described Horro and Arsi-Bale as fat-tailed. Such inconsistencies could be due to the unique tail shape in this group which could be the result of influence from a thin-tailed ancestor.

Lowland fat-rumped

Afar and Black-Head-Somali (BHS) sheep constitute the lowland fat-rumped group (Figures 8 and 9). BHS has been classed with the fat-tailed (Hilzheimer cited by Epstein, 1971) and fat-rumped group (Epstein, 1971), while Galal (1983) described the tail as short and fat, with the rump being also fatty. Adal (Adal and Afar are synonymous) sheep are also traditionally described as fat-tailed, but categorized as fat-rumped (Epstein 1971). Our observation is that BHS be classified as fat-rumped and Afar as fat-tailed sheep. Here, BHS and Afar are classified under the same group as, from a systematic point of view, fat-rumped and fat-tailed sheep are more closely related than other sheep types (Epstein, 1971). Physical characteristics and distribution are given in table 1.

Lowland thin-tailed

This group is represented by a single population (Table 1) and is found adjacent to the thin-tailed sheep region of the Sudanese desert (Figures 6 and 7). They are moderately prolific (litter size = 1.28±0.06).

Sheep types and production systems

For this study, the classification of livestock production systems by Alemayehu (*www.fao.org*) was adapted. There appears to be a strong relationship between the sheep types and production systems (Table 3). Breeds with high growth rate and prolificacy, like Adilo and Bonga sheep, are associated with tethering systems where few breeding ewes and/or fattening males are kept. Good milking and long-legged Black Head Somali sheep are suited to the nutrition and nomadic habit of the pastoral community. Flock size and composition by sheep types and production system is presented in table 4.

Table 3. Sheep types and major sheep production systems in Ethiopia.

	Characteristic features of production systems			
Production systems	Environment	Main products	Scale of production and management	Sheep breeds
Sub-alpine sheep-barley system	Sub-alpine (> 3000 m)	Meat, fiber, manure, skin; unreliable, long-season barley	Medium scale sheep production; Semi-intensive, low-input[1]	Simien[2], Tikur[2], Menz[2], Wollo[2], Farta[3], Arsi-Bale[4], Horro[4]
Highland cereal-livestock system	Highlands (1 500-3 000 m)	Mainly cereal cropping; meat, manure, skin	Small scale sheep production; semi-intensive, low-input	Washera[2], Sekota[2], Horro[3], Arsi-Bale[3], Wollo[4], Farta[2], BHS[4]
Highland perennial crop system	Highlands (1 500-2 000 m)	Mainly perennial cash crops (coffee, inset, khat); meat, skin	Minor sheep production; semi-intensive, low-input; some practice tethering	Bonga[2], Adilo[2], Horro[3], Arsi-Bale[3]
Lowland crop-livestock system	Wet lowland (Up to 1 000 m)	Cereals, sesame, cotton; meat, skin	High level of livestock keeping; semi-intensive, low-input	Gumz[2], Afar[4], Arsi-Bale[4], BHS[4]
Pastoral/agro-pastoral system	Semi-arid/arid (up to 1 000 m)	Meat, milk, skin; minimal or no cropping	Rangeland-based large-scale sheep production; extensive, low-input	Afar[2], BHS[2]

[1]Based on feeding, veterinary care, housing.
[2]Major portion of or the whole sheep population is managed under the system.
[3]Significant portion of the sheep population is managed under the system.
[4]Minor portion of the sheep population is managed under the system.
Source: based on Alemayehu (*www.fao.org*).

Farmers' assessment of sheep types

The farmers'/pastoralists' assessment of their sheep is presented in table 5. Farmers owning large-sized sheep with uniform coat color, particularly brown, valued their breed as good or excellent. There is a tendency to select against black sheep among the heterogeneous sub-alpine wool breeds. This is due to a decreased market demand for black sheep and black wool. The sub-alpine sheep types were evaluated as highly adapted to the harsh natural environment and low input production systems. The socio-economic roles of most of the breeds were ranked as high. This is because of their high market value, including the export market for BHS and Afar, and their role as a source of family food like milk among pastoralists. The importance of these roles for a given breed, however, varies according to the production system. Under highland perennial/cash crop systems, for instance, sheep contribute less to the farm livelihood.

Conclusion

This study provided an overview of the characteristics of Ethiopian sheep. Four morphologically distinct categories of Ethiopian sheep were recognized: sub-alpine short-fat-tailed, highland long-fat-tailed, lowland fat-rumped/tailed and lowland thin-tailed. Morphological diversity in Ethiopian sheep is related to ecological zones, ethnic communities and production systems. Assessment of the genetic distinctness of the traditional sheep types is

Table 4. Average flock size and flock structure.

Sheep type/production system	No. of flocks	Average flock size	Average no. of ewes	Average no. of rams	Average no. of lambs
Alpine sheep-barley	50	23.32	13.95	1.22	5.91
Menz	19	25.89	16.94	1.45	4.71
Tikur	10	16.11	10.45	1.00	3.50
Wollo	12	16.40	10.40	1.20	6.00
Simien	10	9.21	5.80	0.25	2.50
Highland crop-livestock	53	10.37	5.90	0.47	3.01
Horro	29	9.43	5.31	0.34	2.10
Sekota	12	11.18	6.64	1.00	3.00
Farta	12	10.45	6.73	0.27	3.80
Washera					
Arsi-Bale	15	27.14	13.64	1.07	9.15
Highland perennial crop	53	3.45	1.77	0.02	1.64
Adilo	22	3.24	1.71	0.09	2.14
Bonga	31	3.60	1.80	0.07	1.44
Lowland crop-livestock	11	11.80	7.50	0.70	5.14
Gumz	11	11.80	7.50	0.70	5.14
Pastoral system	99	54.37	27.37	8.47	18.54
BHS	99	54.37	27.37	8.47	18.54
Afar	n.a.				

n.a.: data not available.

Figure 9. Lowland fat-rumped ram (e.g. here is BHS sheep).

Table 5. Farmers' assessment of sheep types on physical, production and adaptation traits and socio-economic importance.

Traits/types	Horro	Menz	Sekota	Simien	Farta	Tikur	Gumz	Washer	Wollo	Adilo	Arsi	Bonga	BHS	Afar
Color	4	2	3	4	4[1]	1	4	4	2	4	2	4	4	4
Appearance/size	3	1	4	4	4	2	3	4	1	4[2]	4	4	4	3
Growth rate	3	1	3	4	4	2	3	4	1	4	4	4	3	3
Fertility	4	4	4	3	3	4	2	4	4	3	4	4	3	4
Prolificacy	4	1	2	2	2	1	2	4	1	4	3	4	2	3
Meat quality	3	4	3	4	4	3	4	4	4	3	4	4	4	3
Skin quality	4	4	4	4	4	2	2	4	3	3	2	3	3	3
Wool	n.a.	2		2	2	1	n.a.	n.a.	1	n.a.	1	n.a.	n.a.	n.a.
Temperament	4	3	4	3	4	4	4	4	4	2	1	4	4	4
Mothering ability	4	3	2	3	4	2	2	4	4	4	4	4	4	4
Disease tolerance	2	3	3	4	4	3	2	3	3	2	4	2	4	4
Hardiness	2	4	4	4	4	4	3	2	4	2	4	2	4	4
Market value	4	4	3	3	4	1	2	4	2	4	4	4	2	3
Socioeconomic importance	H	H	H	H	H	I	N	H	H	N	H	N	H	H

1 = Poor, 2 = Average, 3 = Good, 4 = Excellent.
H = Highly important, I = Important, N = Not much important.
n.a. = data not applicable.
[1]All coat colors except black were preferred.
[2]Farmers prefer to have fattening males with long horns, which most Adilo rams lack.

important for developing rational conservation-based improvement programs. Molecular genetic assessment of the population structure is a follow up activity.

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