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Review

Characterization of productive and reproductive performances, morphometric and challenges and opportunities of indigenous cattle breeds of Ethiopia: A review

Teweldemedhn Mekonnen Weldegerima

Humera Agricultural Research Center, Tigray Agricultural Research Institute, Setit Humera, Tigray Regional State, Ethiopia.

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The aim was to review and summarize the fragmented characterization information of indigenous cattle breeds of Ethiopia in productive and reproductive performances, morphometric traits and their production challenges and opportunities. Cattle play vital role in ensuring food security of Ethiopia. They contributed milk which accounted above 80% of the total national annual milk production. Although Ethiopia has large indigenous cattle populations with massive diversity, breed level on-farm and on-station characterizations on lactation performance, reproductive performances, morphometric traits and identification of the major challenges and opportunities is very poor. Morphological markers particularly morphometric traits are very important for livestock characterization. Hence, on-farm and on-station characterization and improvement of indigenous cattle breeds should be practiced. Ethiopian Institute of Biodiversity Conservation, Domestic Animal Diversity Information system and Domestic Animal Genetic Resources Information System documented different types and numbers of indigenous cattle breeds of Ethiopia. Hence, the national, regional and global reporting systems should be standardized. This review also indicated that the critical challenge of the studied indigenous cattle breeds of Ethiopia is scarcity of feed which accounted 77.8% of the first ranked challenges; however, there are no reported production opportunities of each indigenous cattle. Therefore, every shareholder should solve the primary challenge and identify the opportunities. Indigenous cattle breeds of Ethiopia are adapted to harsh climatic conditions; limited and poor quality feed resources utilization and tolerance to a range of diseases. However, the current state of knowledge of indigenous scholars on each indigenous cattle breed is below 50%.

Key words: Indigenous cattle, calf crop, lactation performance, reproductive performance, morphometric traits.

INTRODUCTION

Agricultural sector of Ethiopia accounts for about 42% of the GDP, employs about 85% of the labour force, and

*Corresponding author. E-mail: teweldem2004@gmail.com. Tel: +251914195953.

contributes around 90% of the total export earnings of the country. The sector is dominated by over 15 million smallholders producing about 95% of the national agricultural production. Hence, the overall economy of the country and the food security of the majority of the population depend on smallholder agriculture (CSA, 2015, 2016). Ethiopia is rich in livestock population that owned 59.5 million cattle, 30.7 million sheep, 30.2 million goats and 59.5 million chickens (CSA, 2016, 2017). Major livestock species were imported to enhance livestock productivity of Ethiopia through crossbreeding. Accordingly, the number of breeds of cattle, sheep, goat and chicken imported so far to Ethiopia are 7, 7, 3, and 14, respectively (EIBC, 2012). Cattle are the most important species followed by goats, camels, and sheep in the pastoral livestock production system, and are source of food in the form of milk, meat and blood, and source of other products such as fiber and hides (FAO, 2009). Cattle herds are much larger in the pastoral areas and average about 75 head in Borena, Ethiopia. In the mixed farming areas, herds are much smaller being 5.7 head in East Harerghe, 8.6 in Illubabor and 11.8 in the central highlands (MoARD, 2007). In mixed farming system, cattle provide draught power and manure for cropland fertilization beside to milk production (Agajie et al., 2002), whereas the purpose of keeping cattle in pastoral production system is for breeding and selling, in agro pastoral production system for meat and draught power and in highland mixed crop-livestock production is for draught power and sale of culls (MoARD, 2007). Draft power is critical input in the central highlands of Ethiopia in the prevailing traditional mixed farming system. This is service of oxen and the oxen populations constitute 30% of the total cattle population and on average a household has two oxen (Goe, 1987). The highlands of Ethiopia are dependent on draft power of oxen in that on average an ox works for 900 h/year (Gryseels, 1988).

A more recent report indicated that 98.20% of the total cattle population in Ethiopia are local breeds while hybrid and exotic breeds accounted for about 1.62 and 0.18%, respectively (CSA, 2016/2017). FAO (1993) reported that cow milk constitutes 83.4% of the total milk produced in Ethiopia and CSA (2008/09) also indicated that cattle have the largest contribution (81.2%) of the total national annual milk output. CSA (2014/2015) report on milk utilization indicated that 46.36% of the total annual milk production was used for household consumption, 5.98% was sold, only 0.33% was used for wages in kind and the rest 43.33% was used for other products (could be for the production of butter, Cheese, and others). CSA (2014/15) also reported on beef cattle utilization in that 52.93% of the total annual production was used for household consumption, 33.18% was used sold, 0.71% was paid for wages in kind and 13.18% was used for other products.

40.02% of the total annual cattle hide production was used for household service, 53.94% of the total was sold, 0.27% was paid for wage in kind whereas 5.76% of the total annual production was used for other different products (CSA, 2014/2015). A review by Hedge (2002) indicated that cattle average daily milk yield of pastoral livestock production system varies with season which range from 0.5 to 5 kg per day. The main feed resources of pastoral production system are natural pastures; herbaceous vegetation composed mainly of grasses and forbs, and browses such as shrubs, tree leaves and pods (Adugna and Aster, 2007). Poor health services, feed shortage and low genetic potential of animals are the main constraints that restrain livestock productivity of Ethiopia (Ibrahim and Olaloku, 2000). However, adaptation to harsh climatic conditions, ability to better utilize the limited and poor quality feed resources and tolerance to a range of diseases make indigenous livestock breeds of Ethiopia to be valuable source of genetic material (DAGRIS, 2009).

The national average lactation period per cow was estimated to be about six months and average daily milk yield per cow was about 1.32 L (CSA, 2012/13). Characterization information is essential for planning the management of farm animal genetic resources at local, national, regional and global levels (FAO, 2011). On the contrary, although Ethiopia has large livestock population with massive diversity, breed level characterization and knowledge is inadequate (Workneh et al., 2004) and DAGRIS (2009) also reported that there is little attention given to characterize, identify and conserve the diversity of the various classes of livestock. There are different cattle populations in the country, however, the national cattle characterization work of each cattle population is not well summarized and the current state of knowledge on all indigenous cattle is not known. Moreover, it is obvious and many times reported that cattle productivity in Ethiopia is extremely low. This low cattle productivity is due to different cattle production challenges. Therefore, it is essential to know cattle challenges and opportunities at national level to be an input in the future research and development works. Therefore, the specific objectives of the review system comprised to review the productive and reproductive performances of indigenous cattle, to review the status of morphometric characterization of indigenous cattle and to review the challenges and opportunities of indigenous cattle of Ethiopia.

MATERIALS AND METHODS

Geographical location of Ethiopia

Ethiopia is located in the horn of Africa and is bordered by Eritrea in the north, Djibouti and Somalia in the east, Kenya in the south and Sudan in the west. It is located in 3°N of the equator to latitude 15°N and 33°E to 48°E longitude (MoA, 2004; EIBC, 2014). Ethiopia as a country has an area of 1,127,127 km^2. It is a country of great geographic diversity with wide altitudinal and physiographic variations. The altitude ranges from 116 m below sea level in the Danakil Depression in Afar national regional state to the highest peak of 4,620 m above sea level on Mount Ras Dashen in Amhara national regional state. The mean annual rainfall ranges from 500

to 2800 mm whereas the mean annual temperature ranges from below 10 to 30°C (EIBC, 2014).

Review method

The review system followed reviewing of all the available works concerned on indigenous cattle breeds of Ethiopia. The fragmented available information of indigenous cattle was summarized in tabular form for ease of understanding.

RESULTS

Indigenous cattle breeds of Ethiopia

FAO (2005) reported that cattle contribute 40% of the annual agricultural output and 15% of the total gross domestic product. Ethiopia has 59.5 million heads of cattle (CSA, 2016/2017). Ethiopian Institute of Biodiversity Conservation (EIBC) (2004) reported that Sheko, Fogera, Begait and Borena cattle populations were at decreasing trend. DAGRIS (Access date: November 2017) report indicated that the current number of indigenous cattle breeds of Ethiopia are 37 (Table 1). CSA (2016/2017) reported that about 98.2% of the total cattle population was indigenous cattle population, 1.62% of the cattle populations in Ethiopia were crossbred and 0.18% exotic cattle (Table 2).

Lactation and body weight performances of indigenous cattle of Ethiopia

The Ethiopian government was highly engaged to improve cattle productivity particularly to boost dairy productivity through crossbreeding program. CSA (2008/09) reported that exotic and indigenous cattle crossbreeding program was practiced with encouraging results, however, a strictly controlled breeding program has not been practiced and there has been no dairy herd recording scheme at national level. Zemenu *et al*. (2014) reported that the average daily milk yield (mean± SD) of local cattle at Debremarkos of Amhara national regional state, Ethiopia was 1.50±0.68 and that of cross bred cows (exotic x local cattle) was 7.30±4.65 liters. It was reported that the annual milk production of Ethiopia from cattle was 3,055,903,834 liters and the average milk yield per cow per day at country level is about 1.37 liters whereas the average lactation period per cow was estimated to be about six months (CSA, 2015/2016). The traditional milk production system, which is dominated by indigenous breeds of low genetic potential for milk production accounts for about 97% of the country's total annual milk production (Felleke, 2003). ILCA (1991) reported that indigenous cows produce only 1.5 to 2 liters of milk daily over a 150 to 180 days lactation period. Other national report indicated that the average lactation period per cow at country level is estimated to be about six months, and average daily milk yield (DMY) per cow is about 1.32 L (CSA, 2012/2013). It has also been well documented that, in breeding schemes, the raise in milk production through selection is about 1% per year or 3-4 kg per lactation (Zelalem and Inger, 2000). Moreover, the milk production potential of the zebu breed in the highlands of mixed crop-livestock system of Ethiopia cannot exceed 400-500 kilograms of milk per lactation per cow. Milk production potential of indigenous cattle of Boran, Horro, Barka, Arsi and Fogera is low, ranging from 494 to 809 kg per lactation (EARO, 1999; Zelalem and Inger, 2000). The reported on-station milk yield (Kg/day) performance of Arsi cattle (Kiwuwa et al., 1983), Barka (Goshu, 1981), Boran and Fogera (Gebrewold et al., 2000) was 2.97, 4.31, 2.84 and 4.49, respectively. Other reported on-farm milk yield studies on Fogera cattle (Zewdu, 2004) and Highland zebu (Solomon, 2000) revealed 2.56 and 1.91 Kg/day, respectively.

Reproductive performance of indigenous cattle breeds of Ethiopia

Ethiopia has high potential in livestock genetic resources; however, livestock productivity is below the African average. Total herd off take rate of cattle is estimated at about 7% annually; with carcass weight of 100 to 110 kg. Cows in Ethiopia do not reach maturity until 4 years of age, calve every second year (ILCA, 1991). Reproductive performance is commonly evaluated by analyzing female reproductive traits (Aynalem et al., 2011). The main indicators that would be considered in assessing reproductive performance are age at puberty, age at first calving, calving interval, days open and number of services per conception (Habtamu et al., 2010; Aynalem et al., 2011; Demissu et al., 2013).

Morphometric characterization of indigenous cattle breeds of Ethiopia

As per this review, morphometric characterization of indigenous cattle of Ethiopia is very poor (Tables 4 and 5). A descriptive comparison of the number of indigenous cattle reported and the number of indigenous cattle studied was evaluated. As of IBC (2004) report on the number of indigenous cattle, 44% of the number of indigenous cattle reported were studied their morphometric characterization, but according to DAGRIS (2007) report on the number of indigenous cattle, 34% of the number of indigenous cattle reported were studied their morphometric characterization (Table 7).

Characterization of majority of indigenous breeds and production systems of East Africa including Ethiopia has not yet been undertaken (Ntombizakhe, 2002). Live body weight of cattle is highly correlated with linear body measurements particularly of heart girth and body length (Hamayunm, 2003). On-farm phenotypic characterization of indigenous cattle populations of Awi, East and West Gojjam Zones of Amhara Region, Ethiopia indicated that

Table 1. Reported indigenous cattle breeds and/or strains of Ethiopia.

S/N	List of indigenous cattle breeds and/or strains of Ethiopia reported by local and international officials					
	EIBC (2004)	EIBC (n.d)	DADIS (n.d)	DAGRIS (2007)	DADIS (Access date: 20/11/2017)	DAGRIS (Access date: 21/11/2017)
1	Arsi	Adwa	Abergelle	Adwa	Abergelle	Baherie
2	Begait	Ambo	Abigar	Aliab Dinka	Abigar	Arsi
3	Ogaden	Arado	Abyssinian highland zebu	Ambo	Abyssinian Highland Zebu	Semien
4	Borena	Arsi	Abyssinian short horned zebu	Anuak	Abyssinian Short horned Zebu	Horro
5	Goffa	Bale	Adwa	Arado	Adwa	Harar
6	Arado	Barka	Ambo	Arsi	Ambo	Jijiga
7	Nuer	Danakil	Arado	Bale	Arado	Mahbere-Slassie
8	Guraghe	Dembia	Arsi	Barka	Arsi	Danakil
9	Jidu	Boran	Bambawa	Danakil	Bambawa	Bale
10	Karayu/ Afar	Fogera	Begait	Dembia	Begaria	Sheko
11	Harar	Goffa	Boran	Ethiopian Boran	Begait	Jem-Jem
12	Horro	Guraghe	Danakil	Fogera	Boran	Ogaden Zebu
13	Smada	Hammer	Ethiopian Boran	Goffa	Danakil	Qocherie
14	Fogera	Harar	Fogera	Guraghe	Ethiopian Boran	Danakil
15	Mursi	Horro	Goffa	Hammer	Fogera	Goffa
16	Raya–Azebo	Jem-Jem	Guraghe	Harar	Goffa	Ethiopian Boran
17	Adwa	Jijiga	Hammer	Horro	Gurage	Afar
18	Jem-Jem	Mahbere-Slassie	Harar	Jem-Jem	Hammer	Kuri
19	Sheko	Mursi	Holstein-Friesian	Jijiga	Harar	Anuak
20	Ambo	Ogaden zebu	Horro	Kuri	Holstein-Friesian	Mursi
21	Jijiga	Qocherie	Jem-Jem zebu	Mahbere-Slassie	Horro	Adwa
22	Bale	Raya-Azebo	Jidu	Murle	Irob	Dembia
23	Hammer	Semien	Jijiga zebu	Mursi	Jem-Jem Zebu	Aliab Dinka
24	Medense	Sheko	Medence	Ogaden zebu	Jiddu	Raya-Azebo
25	Abergelle	Smada	Mursi	Qocherie	Jijiga Zebu	Guraghe
26	-	Nuer	Nuer	Raya-Azebo	Medenece	Barka
27	-	Jidu	Raya-Azebo	Red Fulani	Mursi	Medenece
28	-	-	Red Bororo	Semien	Nuer	Somali Boran
29	-	-	Sheko	Sheko	Raya-Azebo	Arado
30	-	-	Smada	Smada	Red Bororo	Smada
31	-	-	Tigrey	Somali Boran	Sheko	Ambo
32	-	-	-	Wegera	Smada	Wegera
33	-	-	-	-	Tigrey	Fogera
34	-	-	-	-	-	Hammer
35	-	-	-	-	-	Murle
36	-	-	-	-	-	Red Fulani
37	-	-	-	-	-	Arado
Total	25	27	31	32	33	37

EIBC: Ethiopian institute of biodiversity conservation, DADIS: domestic animal diversity information system, DAGRIS: domestic animal genetic resources information system, n.d: no date

all the quantitative dependent variables (body length, chest girth, height at withers, pelvic width, mouth circumference, ear length, tail length, dewlap width, horn length) were significantly ($P < 0.0001$) affected by sex of the animal (Fasil and Workneh, 2014).

Production constraints and opportunities of indigenous cattle breeds of Ethiopia

Developing countries, such as Ethiopia, are restrained by different cattle production challenges which include technical, biological, socio-economic and institutional factors that are expressed in scarcity of quality and quantity of feed resources, low producing cattle genotypes, disease susceptibility, reproductive loss, inadequate health service, management and market access are some of the constraints (Ibrahim and Olaloku, 2000). Area and breed specific survey indicated that shrinkage of grazing land, polledness and aggressive behavior of the breed, scarcity of Sheko breeding bulls, misapprehension of importance and status of the Sheko cattle and lack of active intervention on the breed were the major constraints in Sheko cattle production (Takele et al., 2005). Other cattle breed specific survey indicated that constraints of Horro cattle owners were feed shortage, labor shortage, diseases and lack of exotic bull which ranked differently in the mid altitude and highland areas of the breed (Agere et al., 2012). According to Damitie et al. (2015), the major constraints of Fogera cattle were shortage of feed, disease outbreak and occurrences of drought, shortage of water during winter/healthy water, flooding during summer season, market and conflict by grazing land. A survey report indicated that availability of diversified breeds, good fattening weather, and good income generated, good indigenous knowledge of fattening, recent introduction of some improved forage varieties, popularity of fattened Harar bull in the country were opportunities for cattle production in the area (Abdi et al., 2013). Disease, lack of improved cattle breed and feed shortage were identified as first, second and third constraints for dairy cattle production in Debremarkos district of Amhara national regional state of Ethiopia (Zemenu et al., 2014).

DISCUSSION

Ethiopia has more cattle than other livestock species and cattle are substantially important in the livelihood of smallholder farmers and urban people. CSA (2010/11), CSA (2012/13) and CSA (2016/17) reports indicated that the proportion of indigenous cattle versus exotic and indigenous crossbreds and exotic cattle in Ethiopia was not significantly changed. Although Ethiopia has diversified cattle breeds, the Ethiopian Institute of Biodiversity Conservation (EIBC, 2004) reported that Sheko, Fogera, Begait and Borena cattle populations were at decreasing trend. Furthermore, Zerabruk et al. (2007), Mulugeta (2015), Teweldemedhn (2016) and Tewelde et al. (2017) reports revealed that Begait cattle population was at decreasing trend. DAGRIS reported that there were 37 indigenous cattle breeds. There is no recent local report which declares the number of indigenous cattle breeds of Ethiopia except EIBC (2014) report which indicated that there were 28 indigenous cattle breeds. EIBC, DADIS and DAGRIS used the words Begait and Barka interchangeably to name for one cattle breed in which Barka is the naming of Eritrean breeders whereas Begait is the naming of Ethiopian breeders.

The current review indicated that milk yield performance study on indigenous cattle is very poor (Table 3). A comparison of the number of indigenous cattle reported and breed specific milk yield performance study was made.

Taking IBC (2004) report on the number of indigenous cattle, 76% of the number of indigenous cattle reported were studied their milk yield performance but as of DAGRIS (21

November 2017) report on the number of indigenous cattle, 51% of the number of indigenous cattle reported were studied their milk yield performance (Table 8). Live body weight, which is the most economically important, measured at different ages of each indigenous cattle, is not available except in very few indigenous cattle breeds (Table 3). The current state of reproductive performance research work versus number of indigenous cattle reported is incomparable (Table 4). A descriptive comparison of the number of indigenous cattle reported and the number of indigenous cattle studied was evaluated. As of IBC (2004) report on the number of indigenous cattle, 48% of the number of indigenous cattle reported were studied their reproductive performance but according to DAGRIS (21 November 2017) report on the number of indigenous cattle, 32% of the number of indigenous cattle reported were studied their reproductive performance (Table 8).

As per this review, morphometric characterization of indigenous cattle of Ethiopia is very poor (Tables 5 and 6). A descriptive comparison of the number of indigenous cattle reported and the number of indigenous cattle studied was evaluated. As of IBC (2004) report on the number of indigenous cattle, 60% of the number of indigenous cattle reported, their morphometric characterization was studied, but according to DAGRIS (21 November 2017) report on the number of indigenous cattle, 41% of the number of indigenous cattle reported, their morphometric characterization was studied (Table 8). As indicated in Table 7, the production challenges of all indigenous cattle breed of Ethiopia are not identified. A descriptive comparison of the number of indigenous cattle reported and the number of indigenous cattle studied was evaluated. As of IBC (2004) report on the number of indigenous cattle, 32% of the number of indigenous cattle showed that their production challenges were studied, but according to DAGRIS (21 November

Table 2. Proportion of indigenous, crossbred and exotic cattle breeds in Ethiopia.

S/N	Cattle genotypes	Sources				
		CSA (2008/09)	CSA (2010/2011)	CSA (2012/2013)	CSA (2015/2016)	CSA (2016/2017)
1	Indigenous cattle (%)	99.28	99.26	98.95	98.59	98.2
2	Exotic X indigenous crossbred (%)		0.64	0.94	1.22	1.62
3	Exotic cattle (%)		0.1	0.11	0.19	0.18
-	-		100	100	100	100

Table 3. Lactation performance and body weight of indigenous cattle breeds of Ethiopia.

Cattle breed	Production parameters					Farm	Author(s)
	DMY (L)	LMY (L)	LL (month)	BWt (kg)	Adult Wt (kg)		
Horro	-	-	10.5 ± 3.03	-	-	On-farm	Laval and Assegid (2002)
Horro	1.65	475.85	9.57	-	-	On-farm	Agere et al. (2012)
Horro	-	-	-	19.9	-	-	Cited in Aynalem et al. (2011)
Horro	-	550	5.8	-	-	-	Cited in Aynalem et al. (2011)
Horro	-	-	-	-	250	On-farm	DAGRIS (2006)
Horro	-	-	-	-	320-480 M, 210-400 F	On-farm	Rege (1999)
Arsi	1.44±0.04	-	9.57±0.25	-	-	On-farm	Chali (2014)
Arsi	2.2	-		-	-	On-farm	Meseret et al. (2014)
Arsi	-	809	9.07	-	-	-	Gabriel et al. (1983)
Begait	2.52±0.29	-	6.38±0.026	-	-	On-farm	Mulugeta (2015)
Begait	2.7±0.3	-	6.6±0.9	-	-	On-farm	Teweldemedhn (2016)
Begait	2.1±0.04	433.2±3.4	4.9±0.03	-	-	On-farm	Tewelde et al. (2017)
Begait	-	-		22.6	-	-	Cited in Aynalem et al. (2011)
Begait	-	645	6.1	-	-	-	Cited in Aynalem et al. (2011)
Barka	-	-	-	-	360	On-farm	DAGRIS (2006)
Barka	-	869	-	-	-	On-farm	Million and Tadelle (2003)
Barka	-	-	-	-	335-490 M, 295-415 F	On-farm	Rege (1999)
Fogera	3.54±0.14	-	10.5±0.17	-	-	On-farm	Damitie et al. (2015)
Fogera	-	997.5	-	-	-	On-farm	Zewdu (2004)
Fogera	-	-	-	21.9	-	-	Cited in Aynalem et al. (2011)
Fogera	2.32	270	23.3	-	-	-	Cited in Aynalem et al. (2011)
Fogera	1.5	-	-	-	-	On-farm	Belete (2006)
Boran (lowland)	1.85*/0.35**	-	-	-	-	On-farm	Dejene (2014)
Boran (midland)	1.10*/0.95**	-	-	-	-	On-farm	Dejene (2014)
Boran	5.0	-	-	-	-	On-farm	Meseret et al. (2014)
Boran	1.8	520	10.1	-	-	On-farm	Solomon et al. (2011)
Boran	-	-	-	22.9	304	-	Cited in Aynalem et al. (2011)
Boran	1.7	507	8	-	-	-	Cited in Aynalem et al. (2011)
Boran	1.7 ± 0.1 kg	507± 39kg	8 ±0.13	23.3 ± 0.36	-	On-farm	Haile et al. (2009a, 2010)
Boran	-		-	-	268	On-farm	DAGRIS (2006)
Boran	-	867	-	-	-	On-farm	Million and Tadelle (2003)

Table 3. Contd.

Boran	-	-	8	-	-	*On-farm*	Aynalem et al. (2011)
Boran	-	-		-	300-385 M, 300-350 F	On-farm	Rege, 1999
Ogaden	-	682		-	-	On-station	Getinet (2005)
Ogaden	-	-		21.50±0.29	289.57	On-station	Getinet et al. (2005)
Ogaden	-	-		-	280.5 F, 321 M	On-farm	Ermias (2007)
Ogaden	-	-		21.0±0.31 F, 22.0±0.33 M	-	Haramaya University	Getinet et al. (2009)
Sheko		698.3	9.9	-	-	On-farm	Takele et al. (2005)
Sheko	2.79 ± 0.06	850.69± 24.16	10.26±0.2	16.12± 0.22	-	On-farm	Bayou et al. (2015)
Raya sanga	-	594	-	-	-	On-farm	Dereje (2005)
Kereyu	1.8	463.1	-	-	-	On-farm	Shiferaw et al. (2006)
Mursi	2.11±0.06	491.13±21.48	7.79±0.25	-	-	On-farm	Endashaw et al. (2011)
Kuri	-	-	-	-	480	On-farm	DAGRIS (2006)
Zebu	-	929	10.1	-	-	On-farm	Gabriel et al. (1983)
Arado	-	464.34±41.75	8.24±0.75	-	-	On-farm	Niraj et al. (2014)
Arado	-	-		-	205-430 M, 192-350 F	On-farm	Rege (1999)
Smada	1.54	203.54±1.40		-	-	On-farm	Getie et al. (2015)
Danakil	-			-	250-380 M, 200-305 F	On-farm	Rege (1999)
Jiddu	-			-	340-590 M, 325-430 F	On-farm	Rege (1999)
Abigar	-	720 kg	6	-	550 M	On-farm	DADIS
Abyssinian Shorthorned Zebu	-	-	-	-	295 M, 230 F	On-farm	DADIS
Arsi	-	240	3.9	21 (M and F)	280 M, 230 F	On-farm	DADIS
Begait	-	675 kg	6.13		380 M, 280 F	On-farm	DADIS
Boran*	-	1200 kg	5.67	25 (M and F)	700 M, 475 F	On-farm	DADIS
Danakil	-	225 kg	6.67		310 (M and F)	On-farm	DADIS
Boran (E)	3.5 kg	843 kg	7 (Max.)	23 M, 17.8 F	318 M, 225 F	On-farm	DADIS
Boran (E)		-	-	-	500	On-farm	DAGRIS
Fogera		920 kg	9.1	-	-	On-farm	DADIS
Horro		814 kg	5.77	-	-	On-farm	DADIS
Jem-Jem		-	-	-	275 (M and F)	On-farm	DADIS
Red Borroro	-	900 kg	-	-	430 M	On-farm	DADIS
Sheko	-	420 kg	7	-	-	On-farm	DADIS
National	1.32	-	6	-	-	-	CSA (2012/2013)

*Wet season milk yield, **Dry season milk yield, F: female weight, M: male weight, DMY: daily milk yield, LMY: lactation milk yield, LL: lactation length, BWt: body weight, Wt: weight, E: Ethiopian Boran, Max.: maximum.

Table 4. Reproductive performance of indigenous cattle breeds of Ethiopia.

Cattle breed	Reproductive parameters								Farm	Author(s)
	MAFM (month)	FAFM (month)	AFC (month)	CI (month)	RLTB (year)	RLTC (year)	CBRLTC (number)	DO (days)		
Fogera	-	-	50.8±0.36	19.6±0.2	-	-	-	285±4.3	Metekel Ranch	Melaku et al. (2011)
Fogera	-	-	47.61	18.63	-	-	-	-	Metekel Ranch	Addisu and Hedge (2002)
Fogera	-	-	59.90+0.83	25.52+0.52	6.79+0.1	11.30+0.17	4.94±0.17	-	On-farm	Damitie et al. (2015)

Table 4. Contd.

Fogera	-	42.24±0.05	51.4±0.05	21.18±0.70	-	-	-	-	On-farm	Assemu et al. (2016)
Fogera	-	-	50.8+ 0.36	-	-	-	-	-	On-farm	Menale et al. (2011)
Fogera	-	-	-	-	-	9.6	-	-	Andasa ranch	Gidey (2001)
Fogera	-	-	63	37	-	-	-	-	On-farm	Fasil et al. (2006)
Fogera	-	-	53.4	17.5	-	-	-	-	-	Cited in Aynalem et al. (2011)
Fogera	-	-	52.4	19.3	-	-	-	298.4	Metekel ranch	Almaz (2012); Gebeyehu et al. (2005)
Borana	-	-	36-45	-	-	-	-	-	Abernosa Ranch	Ababu Dekeba et al. (2006)
Borana (lowland)	-	-	58.8	16.8	9.86	11.5	7.1	-	On-farm	Dejene (2014)
Borana (midland)	-	-	57.6	13.8	7.68	10.9	6.6	-	On-farm	Dejene (2014)
Boran	-	-	22.56	11.8	-	-	-	-	On-farm	Meseret et al. (2014)
Boran	47.4	42.7	55.5	15.3	11.4	12.7	7.3	-	On-farm	Solomon et al. (2011)
Boran	-	-	42.8	14.9	-	-	-	-	On-farm	Cited in Aynalem et al. (2011)
Boran	-	32.4 ± 1.4	43.5 ± 1.5	14.63± 0.33	-	-	-	141 ± 7	On-farm	Haile et al. (2009b)
Boran	-	-	-	14.63	-	-	-	-	On-farm	Million and Tadelle (2003)
Boran	-	-	57.6	20.7	-	-	-	339	On-station	Yifat et al. (2012)
Ogaden	-	34.4±2.28	49.2±4.43	16.43±0.44	-	-	-	195	Haramaya university	Getinet et al. (2009)
Ogaden	-		49.18±4.43	-	-	-	-	-	-	Getinet et al. (2005)
Horro	46.56±0.06	48.42±0.05	58.08±0.07	21.08±0.3	3.72±0.10	13.67±0.31	6.46±0.13	286.8±9	On-farm	Agere et al. (2012)
Horro	47.52	53.3	-	-	-	-	-	-	On-farm	Jiregna (2007)
Horro	46.56	48.42	58.08±0.07	-	-	-	-	-	On-farm	Ayantu et al. (2012)
Horro	-	-	53	17.6	-	-	-	-	-	Cited in Aynalem et al. (2011)
Horro	-	-	50.0	12.2	-	-	-	152	On-farm	Hailemariam and Mekonnen (1996)
Arsi	36.3±0.6	41.8±0.8	55.4±0.7	-	7.4±0.2	12.1±0.2	7.0±0.2	-	On-farm	Chali (2014)
Arsi	-	-	3.39	14.2	-	-	-	-	On-farm	Meseret et al. (2014)
Arsi	-	-	-	14.63	-	-	-	-	On-farm	Gabriel et al. (1983)
Arsi	-	-	32.8	14.6	-	-	-	211	On-farm	Mulugeta et al. (2008)
Begait	-	35.5	48.68±0.16	17.06±0.11	-	8.20±0.07	-	-	On-farm	Mulugeta (2015)
Begait	42±6	38.4±7.2	50.4±7.2	-	4.2±1.2	11.0±0.8	7±1	229±36	On-farm	Teweldemedhn (2016)
Begait	42.75±0.5	43.97±0.3	52.68±0.4	19.36±0.2	-	-	6.32	-	On-farm	Tewelde et al. (2017)
Begait	-	-	60	15.3	-	-	-	-	-	Cited in Aynalem et al. (2011)
Barka	-	-	-	13.23	-	-	-	-	On-farm	Million and Tadelle (2003)
Barka	-	-	30.3	13.2	-	-	-	253	On-farm	Million and Tadelle (2003); Hailemariam and Mekonnen (1996)
Sheko	-	-	54.1	15.6	6.5	14.7	8.3	-	On-farm	Takele et al. (2005)
Sheko	-	-	-	17.40± 0.20	-	-	-	248.32± 6.02	On-farm	Bayou et al. (2015)
Gojjam Highland Zebu	-	-	49	24	-	-	-	-	On-farm	Fasil et al. (2006)
Highland zebu	-	-	53	15.1	-	-	-	148	On-farm	Niraj et al. (2014)
Zebu	-	-	-	15.03	-	-	-	-	On-farm	Gabriel et al. (1983)
Kereyu	49	47.5	54.1	18	9.2	13.2	7.1	-	On-farm	Shiferaw et al. (2006)
Mursi	43.32±0.96	42.12±0.96	57.48±1.08	14.64±0.56	-	14.08±0.32	10.97±0.22	-	On-farm	Endashaw et al. (2011)
Arado	-	-	39.4 ±1.7	14.4±2.6	-	-	-	431.08±78.03	On-farm	Niraj et al. (2014)
Smada	-	40.74±0.33	49.77±0.33	26.04±0.01	-	-	-	-	On-farm	Getie et al. (2015)
Horro	-	-	50	12	-	-	-	-	On-farm	DADIS

*Pasture feeding, MAFM: male age at first mating, FAFM: female age at first mating, AFC: age at first calving, RLTB: reproductive lifetime of bull, RLTC: reproductive lifetime of cow, CBRLTC: calves born in reproductive lifetime of a cow, DO: days open.

Table 5. On-farm morphometric characterization of indigenous cattle breeds (cows) of Ethiopia.

Cattle breed	Morphometric traits (unit=centimeter)											Author(s)
	BL	CG	HW	PW	RL	TtL	EL	HL	MC	HC	TL	
Ogaden	141.0	161.4	116.4	-	-	-	-	-	-	-	-	Ermias (2007)
Ogaden	121.09± 7.18	150.1±8.20	115.54±5.17	-	-	-	19.7±1.69	8.0±4.83	-	-	71.6± 5.04	Getinet et al. (2009)
Ogaden	121.09	150.11±8.20	115.54	-	-	-	-	-	-	-	-	Getinet et al. (2005)
Arsi	118±9.4	139±7.0	113±2.7	29.±2.3	35±2.5	-	16±1.7	21.0±7.4	37±2.2	-	-	Chali (2014)
Begait	128.1±0.16	159.6±0.24	131.5±0.25	40.0±0.31		11.5±0.03	18.4±0.34	21.1±0.11		-	97.7±0.37	Mulugeta (2015)
Begait	115.5±0.48	153.2±0.56	129.1±0.46	38.1±0.19	21.0±0.24	6.5±0.14	22.8±0.16	22.4±0.69	38.8±0.17	33.7±0.17	96.9±0.72	Teweldemedhn (2016)
Barka	-	-	120-133	-		-	-		-	-	-	Rege (1999)
Boran	120	149.2	114.8	-		-	-	14.3	-	-	-	Solomon et al. (2011)
Mursi	122.09±0.95	144.47±0.89	112.98±1.10	-	20.41±0.25	-	-	30.77±1.05	-	-	-	Endashaw et al. (2011)
Kereyu	121.6	141.6	113.2	-	-	-	-	48	-	-	-	Shiferaw et al. (2006)
Sheko	110.2	136.5	99.4	33.5	-	-	-	-	-	-	-	Takele et al. (2005)
Fogera	119.77	-	-	37.77	-	-	-	-	-	-	-	Zewdu (2004)
Fogera	-	-	100-121		-	-	-	-	-	-	-	Rege (1999)
Raya sanga	119	-	-	35.2	-	-	-	-	-	-	-	Dereje (2005)
Afar sanga	126	-	-	38.7	-	-	-	-	-	-	-	Dereje (2005)
Goffa	107.15±0.62	135.42±0.811	107.18±0.588	37.63±0.28	-	-	19.54±0.199	27.02±1.82	39.09±0.24	29.42±0.299	-	Belay *et al*. (2017)
Danakil	-	-	120-125	-	-	-	-	-	-	-	-	Rege (1999)
Arado	-	-	93-126	-	-	-	-	-	-	-	-	Rege (1999)
Jiddu	-	-	108-124	-	-	-	-	-	-	-	-	Rege (1999)
Abyssinian Short horned Zebu	-	-	105	-	-	-	-	-	-	-	-	DADIS
Arsi	-	-	110	-	-	-	-	-	-	-	-	DADIS
Begait	-	-	125	-	-	-	-	-	-	-	-	DADIS
Boran*	-	-	121	-	-	-	-	-	-	-	-	DADIS
Danakil	-	-	128	-	-	-	-	-	-	-	-	DADIS
Boran €	-	-	118	-	-	-	-	-	-	-	-	DADIS
Fogera	-	-	112	-	-	-	-	-	-	-	-	DADIS
Tigrey	-	-	111	-	-		-	-	-	-	-	DADIS

BL: Body length, CG: chest girth, HW: height at wither, PW: pelvic width, RL: rump length, TtL: teat length, EL: ear length, HL: horn length, MC: muzzle circumference, HC: hock circumference, TL: tail length.

Table 6. On-farm morphometric characterization of indigenous cattle breeds (bulls) of Ethiopia.

Cattle breed	Morphometric traits (unit=centimeter)											Author(s)
	BL	CG	HW	PW	RL	EL	HL	MC	HC	TL	SC	
Ogaden	141.5	161.3	118.0	-	-	-	-	-	-	-	-	Ermias (2007)
Ogaden	120.4 ±7.27	148.2±14.31	115.5± 7.71	-	-	19.6± 1.05	5.9± 3.26	-	-	71.9± 5.15	-	Getinet et al. (2009)
Ogaden	120.45	148.20±14.31	115.47	-	-	-	-	-	-	-	-	Getinet et al. (2005)
Arsi	125±9.8	152±11.0	115.0±3.0	30±3.6	37±3.5	16±2.3	22±8.3	40±3.2	-	-	-	Chali (2014)
Begait	136.0±0.09	168.9±0.10	137.0±0.10	41.5±0.06		18.1±0.07	19.9±0.07		-	100.3±0.06	-	Mulugeta (2015)
Begait	125.6±1.21	167.9±1.58	143.4±1.24	-	20.9± 0.62	23.2±0.49	26.8±2.28	43.1±0.48	35.3±0.61	106.9± 1.49	32.1± 0.46	Teweldemedhn (2016)
Barka	-	-	122-138	-	-	-		-	-	-	-	Rege (1999)

Table 6. Contd.

Boran	127.8	155	117.9	-	-	-	13.7	-	-	-	-	Solomon et al. (2011)
Kereyu	128.3	151.8	118.9	-	-	-	43.5	-	-	-	-	Shiferaw et al. (2006)
Sheko	114.6	141.2	103.6	32.8	-	-		-	-	-	-	Takele et al. (2005)
Goffa	108.05±1.03	138.01±1.57	109.054± 1.06	38.10±0.53	-	19.56±0.32	26.74± 1.747	40.157±0.41	30.83±0.423	-	-	Belay et al. (2017)
Danakil	-	-	130-145	-	-	-	-	-	-	-	-	Rege (1999)
Arado	-	-	117-144	-	-	-	-	-	-	-	-	Rege (1999)
Fogera	-	-	110-145	-	-	-	-	-	-	-	-	Rege (1999)
Jiddu	-	-	109-133	-	-	-	-	-	-	-	-	Rege (1999)
Abyssinian Short horned Zebu	-	-	105	-	-	-	-	-	-	-	-	DADIS
Arsi	-	-	110	-	-	-	-	-	-	-	-	DADIS
Begait	-	-	132	-	-	-	-	-	-	-	-	DADIS
Boran*	-	-	130	-	-	-	-	-	-	-	-	DADIS
Danakil	-	-	128	-	-	-	-	-	-	-	-	DADIS
Boran (E)	-	-	121	-	-	-	-	-	-	-	-	DADIS
Fogera	-	-	127	-	-	-	-	-	-	-	-	DADIS
Tigrey	-	-	122	-	-	-	-	-	-	-	-	DADIS

BL: Body length, CG: chest girth, HW: height at wither, PW: pelvic width, RL: rump length, EL: ear length, HL: horn length, MC: muzzle circumference, HC: hock circumference, TL: tail length, SC: scrotum circumference.

Table 7. Challenges of indigenous cattle production in Ethiopia.

Cattle	First ranked	Second ranked	Third ranked	Author(s)
Fogera	Feed scarcity	Disease	Drought	Damitie et al. (2015)
Fogera	Shrinkage of grazing land	Shortage of land for forage development	Absence of health follow-up and clinic	Assemu et al. (2017)
Fogera	Inbreeding	Uncontrolled inter- and crossbreeding	Diseases and drought	EIBC (2004)
Fogera	crossbreeding	-	-	EIBC (2014)
Mursi	Animal diseases and parasites	Seasonal water and feed shortage	Drought	Endashaw et al. (2011)
Horro (midland areas)	Feed shortage	Labor shortage	Disease	Agere et al. (2012)
Horro (highland areas)	Feed shortage	Disease	Labor shortage	Agere et al. (2012)
Horro (mid-altitude)	Feed shortage	Labor shortage	Disease	Agere et al. (2012)
Horro (highland)	Feed shortage	Diseases	Labor shortage	Agere et al. (2012)
Harar	Feed shortage	Animal health problem	Market problem	Abdi et al. (2013)
Arsi	Feed shortages	Grazing land shrinkage	Shortage of improved breed	Chali (2014)
Begait	Feed shortage	Diseases	Water shortage	Mulugeta (2015)
Begait	Rangeland and feed scarcity	Theft	Scarcity of water	Teweldemedhn (2016)
Begait	High off-take rate (during Ethio-Eritrea war)	-	-	EIBC (2004)
Sheko	Trypanosomiasis	Inbreeding	Interbreeding with other local breeds	EIBC (2004)
Sheko	Crossbreeding	Production system shift		EIBC (2014)
Borena, Afar and Ogaden	Feed shortage	Recurrent drought	Interbreeding and diseases	EIBC (2004)

Table 7. Contd.

Boran (highland)	Feed shortage	Disease and parasites	Grazing land scarcity	Seid (2012)
Boran (mid-altitude)	Feed shortage	Drought	Grazing land scarcity	Seid (2012)
Boran (lowland)	Feed shortage	Drought	***Disease and parasites***	Seid (2012)
Number of records	18	17	17	52
Major challenge	Feed shortage (77.8%)	-	-	-
Overall challenge	-	-	-	Feed shortage (36.5%)

Table 8. Percent of indigenous cattle breeds studied in their milk yield performance, reproductive performance, morphometric characterization and their major production challenges.

Categories	Number of indigenous cattle breeds studied	Percent of breeds studied in reference to EIBC (2004) report of indigenous cattle list	Percent of breeds studied in reference to DAGRIS report (Access date: 21/11/20177) of indigenous cattle list
Milk yield performance evaluation	19	76	51
Reproductive performance evaluation	12	48	32
Morphometric traits characterization	15	60	41
Cattle major challenges identification	8	32	21.6

2017) report on the number of indigenous cattle, 21.6% of the number of indigenous cattle showed that their production challenges were studied (Table 8). As presented in Table 7, the major challenge of the studied indigenous cattle breeds of Ethiopia is scarcity of feed which accounted 77.8% of the first ranked challenges.

CONCLUSION AND RECOMMENDATIONS

Ethiopia has diversified indigenous cattle genetic resources kept under hundreds of millions of poor smallholder farmers. However, most of the indigenous cattle populations of Ethiopia remained largely uncharacterized; characterization work is at its rudimentary stage and the characterized cattle breeds of Ethiopia are even not well characterized. Productivity per unit of animal is extremely poor and some indigenous cattle populations are at decreasing trend which is largely affected by scarcity of feed. This review system ensured that the major challenge of indigenous cattle breeds of Ethiopia is scarcity of feed which accounted 77.8% of the first ranked challenges of cattle production. However, the critical challenge of all indigenous cattle is not yet well identified. Therefore, identification of the major cattle production and breeding challenges of each indigenous cattle breed should be taken into account and further breed specific research and development works should be accomplished so as to enhance their productivity. There are many performance studies on cattle breeds of Ethiopia which entitled local or indigenous cattle productive and/or reproductive performances. Therefore, in this case, the performance study should be on specific cattle breed because local or indigenous cattle performance cannot reflect the performance of specific breed. Indigenous cattle production opportunities are not yet identified and need due attention in the future.

CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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