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On-Farm Phenotypic Characterization of Indigenous Cattle in its Production Environment in Sidama, Ethiopia

By Debir Legesse Belay & Bereket Zeleke
South Agricultural Research Institute

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ONFARMPHENOTYPICCHARACTERIZATIONOFINDIGENOUSCATTLEINITSPRODUCTIONENVIRONMENTINSIDAMAETHIOPIA

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On-Farm Phenotypic Characterization of Indigenous Cattle in its Production Environment in Sidama, Ethiopia

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I. Introduction

Ethiopia is known as a home to diverse cattle genetic resources that are adapted to and distributed in different agro-ecological zones of the country. The current livestock populations are estimated at a 59.5million, 30.7 million sheep, and 30.2 million goats. The majority of these cattle (98.2%) are local breeds that are kept undera low input system(CSA,2017).Among the livestock species, cattle have significant contributions to the livelihood of the farmers such as draught power, milk, meat, manure, cash income, social, and cultural values of the society. Indigenous livestock breeds in Ethiopia are a valuable source of genetic material because of their adaptation to harsh climatic conditions, their ability to utilize better the limited, and poor-quality feed resources, and their tolerance to a range of diseases found in these regions (Tadesse et al., 2014).Livestock contributes to about 30 percent of the agricultural gross domestic product in developing countries, with a projected increase of about 40 percent by 2030. This requires more efficient animal production systems, careful husbandry of natural resources, and measures to reduce waste, and environmental pollution (FAO, 2011).

The Domestic Animal Genetic Resources Information System (DAGRIS, 2007) database summarized 32 recognized indigenous cattle breeds in Ethiopia. Understanding the diversity, distribution, basic characteristics, comparative performance, and the current status of a country's animal genetics resources is essential for efficient, and sustainable use, development, and conservation (FAO,2007).It is difficult to design appropriate breeding programs for breeds that have not been adequately characterized either phenotypic/or genetically (Mwacharo et al., 2006).

Despite the significant contribution of livestock to the country, little attention is given to identify, characterize and conserve the diversity of the various classes of livestock (DAGRIS, 2009).The exploratory characterization approach is an important confirmatory or advanced characterization in breed identification and classification in ways that farming communities can relate(FAO, 2012).

Morphological descriptions are used to evaluate breeding goals, to assess the type, and function and to estimate the animals' value as potential breeding stock (Solomon, 20010; FAO, 2012). To ensure proper conservation and utilization of indigenous animals, it is necessary to evaluate phenotypic and genetic variation that exists within and among breeds. A large proportion of indigenous cattle in developing countries have yet to be characterized or evaluated at phenotypic and genetic levels (Hannotte, 2005). It is undertaken as a measure of genetic diversity between distinctly defined populations to understand the extent, distribution, characteristics, production and reproduction performance, utility value, and current status of the breed (Workneh et al., 2004).

Although the indigenous cattle population plays a leading role in the sustainability of livelihoods for its owners, there is no published information concerning the characteristics of this cattle type. As a result, the study was mainly focused on finding out basic

Author α σ: South Agricultural research Institute, Hawassa Agricultural research Center, Hawassa, Ethiopia. e-mail: debirlegese@gmail.com

information on the origin, ecology, physical and production characteristics, preferable traits of the indigenous cattle populations in Sidama.

II. Materials and Methods

a) Description of the study area

The study was carried out from January to June 2017 in three agroecological zones (from highland Hulla, midland Shebedino, and lowland Loka Abayaworeda) of Sidama zone. Geographically Sidama zone is situated between the coordinate of 5o 45''and 6045''N latitude and 380 39'' and 380 39''E with an altitude range of 1100 to 3500 meters above sea level. The rainfall pattern of the Sidama is a bimodal type. It has diverse agroecology classified as highlands, midlands, and semi-dry lowlands covering 30%, 60%, and 10%, respectively. The farming system is characterized as mixed crop and livestock farming and endowed with different livestock resources such as cattle, small ruminants, equines, poultry, and honeybee.

b) Sampling techniques and data collection

From each woreda, three rural kebeles which are known to keep typical and having a higher population density of indigenous cattle were purposely selected. At the same time, a random sampling technique was employed to select sample respondents. Primary data was collected using in-depth interviews and group discussions. About 180 households were randomly selected for a household interview to collect data on cattle performance, breeding practices, selection criteria, and 345 mature cattle (300 female and 45 male) sampled for morphological characterization.

c) Data analysis

Data were statistically analyzed using Software Package for Social Science (SPSS). Quantitative data were analyzed using the General Linear Model Procedure (univariate and non-parametric tests, chi square/$\chi 2$). An index method is used to calculate the overall rank. The index is the sum of (3 times first-order + 2 times second-order +1 times third-order) for individual variables divided by the sum of (3 times first-order + 2times second-order +1 times third-order) for all variables. The relationship between linear body measurement traits was estimated by simple correlation using the Pearson correlation method. The variation between groups was considered significant when the P-value was less than 0.05.

III. Results and Discussion

a) Phenotypic Description of Indigenous Cattle

Results from focus group discussions and field observations on physical features revealed that highland, midland, and lowland cattle types identified as their geographical. During the discussion, as some elders and the key informant were informed by their parents, indigenous Sidama cattle origin in the neighboring highland area of Arsi-Bale area and they were brought and reared over here by their ancestors before many years while midland and lowland cattle type they tend to associate origin with that of the ethnic group of Sidama. In all these places, indigenous cattle are used for multipurpose production functions (milk, beef, manure) and services (social value, savings). Indigenous cattle are small to medium size; both have well-developed humps, forward curved short-horned, long tail, and pigment muzzle. Earlier report Rege and Tawah (1999), indicated that cattle in Sidama is classified into Abyssinian short-horned Zebu (Ethiopian Highland Zebu) and descended from the recent introductions of zebu into Africa from West Asia, and probably developed from a group of small shorthorn Abyssinian Zebu by the highland Oromo people (DAGRIS, 2006).

The coat color patterns of indigenous cattle are variable and the most commonly observed coat color was plain (56.7%), Paid (31.2%), and spotted with different color combinations (11.6%) (Table1). The current finding of coat color pattern is somewhat comparable in Mursi cattle plain (52.0%), (paid, 36.0%), and spotted (12.0%) (Terefe et al., 2012).Cattle in midland location majority of their coat color pattern are uniform (dark red 27.8% followed by light red 24.3% and white and red paid (13.9%). The result further indicated the lowland cattle types' coat color patterns were light red (29.6%), dark red (20%), and whitish shiny (12.1%). Indigenous cattle in highland were black with white face (35.7%), black (28.7%), black and white paid (11.3%). The highland cattle coat color pattern was compatible with the result of Chali (2014) indicated that due to natural and artificial selection, black coat color type is dominating. Similarly, coat color is one of the means for cattle identification in both study locations. Similarly, coat color is used for the identification of cattle in most pastoral communities (FAO, 2009). In this regard, the study made by Tekele (2005) explained that preferred coat color patterns by the Sheko community are red, patchy red, and white. Tefere et al. (2012) also reported that multiple coat color pattern variations come from a preferential selection of the pastoral communities toward animals with variable coat color patterns and uncontrolled mating.

Table 1: Proportion of qualitative traits for indigenous cattle (N=345)

Variables	Agro-ecology			
	Highland (%)	Midland (%)	Lowland (%)	Total (%)
Hamped	100	100	100	100
Horn				
Presence	97.4	98.3	96.3	97.4
Absence	2.6	1.7	3.5	2.6
Horn orentation				
Forward curreved	69.7	65.2	67.8	67.5
Upward curved	21.7	23.5	21.7	22.3
Dawn ward	8.7	11.3	10.4	10.14
Tail				
Long	98.2	98.3	96.1	97.5
Medium	1.8	1.7	3.9	2.5
Muzile Pigment				
Pigment	100	100	100	100
Coat color patterns				
Plain	34.74	69.6	70.5	56.2
Paid	55.7	21.7	13	31.1
Spotty	9.5	8.6	16.5	11.6
Hair coat color				
Black	28.7	13	8.7	16.8
Black with white face	35.7	1.7	0.9	12.7
Black and white	11.3	6.1	3.5	7
Light red	1.7	24.3	29.6	18.6
Dark Red	2.6	27.8	20	16.1
Whitish	1.74	4.5	12.2	6
Red and white	8.7	13.9	8.6	10.4

Figure 1: Different coat colours of local cattle in highland, midland, and low land agro-ecologies

b) Quantitative Traits between Location

As a result, shown in Table 2,linear body measurements except RL and HL of indigenous cattle populations from the midland and lowland were not significantly different and has larger (P<0.001) measurements when compared to the highland, the variation could be due to agro-ecological different among the location, and types of the farming system. The similarity body measurements among midland and lowland study agroecology might be due to the equivalence of measurements between populations. Compared with other cattle breed characterization results, the body measurements of indigenous cattle types were superior to those of Kereyu cattle (Garoma, 2006) under the pastoral management system in Ethiopia, but still, its body frame is comparable with the highland area of Arsi cattle breed (Chali, 2014).

Table 2: Least square means of body measurements (cm) by agro-ecology (N=345)

Vaiables	Agro-ecologies			
	Hihland	Midland	Lowland	Over all
Body length	110.2±0.21^{b}	113.9±0.2^{a}	114.6±.2^{a}	113.2±0.21
Heart girth	111.2±0.21^{b}	116.9±0.2^{a}	117.5±.2^{a}	115.2±0.2
Ear Length	110.9±0.22^{a}	111.9±0.2^{a}	111.6±0.4^{a}	111.5±0.21
Pelvic width	143.2±0.12^{b}	151.8±0.2^{a}	151.0±0.2^{a}	148.7±0.11
Tail length	17.6±0.2^{a}	15.5±0.2^{b}	16.6±0.21^{b}	16.6±0.2

Horn length	32.5±0.2 ^{a}	34.0±0.15 ^{a}	34.7±0.16 ^{a}	33.7±0.11
Muzzle circumstance	91.6±0.23 ^{a}	90.9±0.16 ^{a}	92.5±0.2 ^{a}	91.7±0.13
Hook circumstance	26.4±0.18 ^{a}	25.6±0.2 ^{a}	25.9±0.17 ^{a}	26.4±0.18
Cannon length	38.7±0.17 ^{a}	35.2±0.2 ^{b}	35.5±0.2 ^{b}	36.5±0.18
Rump length	26.4±0.18 ^{a}	25.6±0.2 ^{a}	25.9±0.17 ^{a}	26±0.18
Neck length	28.9±0.2 ^{b}	30.1±0.18 ^{a}	30.4±0.18 ^{a}	29.8±0.14
Facial profile	34.4±0.2 ^{b}	33.8±0.2 ^{b}	36.4±0.16 ^{a}	34.9±0.12
Neck length	35.2±0.19 ^{a}	35.9±0.2 ^{a}	35.6±0.15 ^{a}	35.6±0.13
Facial profile	43.1±0.15 ^{a}	42.9±0.2 ^{a}	43.0±0.18 ^{a}	43±0.16

Significant at^{a-b} P≤0.01, HG= heart girth, BL= Body length, HW=Height at Wither, PW=pelvic width, TL=tail length, NL=neck length, RL=rump length, FL= Face length, ns=non-significant

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c) Quantitative Traits in Female and Male Cattle

The quantitative traits of the measured cattle population in the study areas are present in Table 3. The result showed that body measurements except for HL, NL, TL, and RL all had a P≤0.05 difference among the sex of the animals. Males have the highest body measurement values for variables of BL, HW, HG, EL, TL, MC, HC, and RL. This is consistent with a report by Dessalegn (2012) and Mulugeta (2015), higher mean values of body measurements in males than females, for Arado and Begait cattle. Fasil (2014) also reported that quantitative dependent variables (BL, HG, HW, PW, MC, EL, TL, DW, HL) indigenous cattle in the Amhara region were significantly affected by the sex of the animal. Taye (2005) also reported that morphological trait measurement of indigenous male cattle is usually greater than female groups. These linear morphometric traits difference was attributable to sensual demography (Mwacharo et al., 20006).

Table 3: Linear body measurements of male and female indigenous cattle

Variable	Male (N=45)	Female (N=300)	P-value
Body length	120±9.82^{a}	113.33±6.76^{b}	0.0001
Height at wither	116.67±17.2^{a}	110.9±0.1^{b}	0.001
Heart girth	154.4±39.85^{a}	141.88^{b}	0.0001
Ear Length	18±0.4^{a}	16.4±.01^{b}	0.001
Pelvic width	31.3±0.8^{b}	34.4±0.4^{a}	0.001
Tail length	93.6±0.8^{a}	91.5±0.3^{b}	0.0001
Horn length	17.9±0.4^{a}	18.9±0.1^{a}	NS
Muzzle circumstance	38.5±0.4^{a}	36.3±0.1^{b}	0.001
Hook circumstance	29.8±0.4^{a}	24.5±0.1^{b}	0.0001
Cannon bone length	30.1±0.4^{a}	29.8±0.1^{a}	NS
Neck length	34.2±0.4^{a}	34.2±0.11^{a}	NS
Facial profile	43.6±0.13^{a}	42.8±0.12^{a}	NS
ump length	36.7±0.3^{a}	34.7±0.2^{b}	0.0001

*HG= heart girth, BL= Body length, HW=Height at Wither, PW=pelvic width, TL=tail length, NL=neck length, RL=rump length, FL= Face length, ns=non-significant, Significant at $^{a-b}$*P≤0.01

d) Correlations

The phenotypic correlation coefficient estimates between the various traits for female and male indigenous cattle types are presented in Table 4. For females, low to moderate ₽0.001positive correlations were found among linear body measurements. HG (r=0.31), RL (r=0.312) and FL (r=0.30) showed low positive correlation with BL and HW (r= 0.42) and NL (r=0.40) had moderate positive correlation with BL. The findings on the correlation of coefficient of the current study agree with those of Chali, (2014) for Arsi female cattle. Regarding the male cattle, most of the linear body measurements are moderate, and a strong positive P≤0.001correlation was found between HG and BL (r=0.71). A similar result indicated by Andualem (2016) in males, all the linear body measurements have a positive correlation, and a strong association was found between HG. This could show the enhancement of one trait which, is a positive in correlation with other traits, that there is an opportunity to develop both traits. However, some traits of PW with TL and PW with NL were found to be weak and insignificant correlations.

Table 4: Phenotypic correlations between body measurments for female, and male cattle (N=345)

Traits	HG	BL	HW	PW	TL	NL	RL	FL
HG		0.31**	.27**	0.18*	0.10*	0.19ns	.20**	0.15*
BL	0.71**		0.42**	0.14*	0.21**	0.40**	0.312**	0.30**
HW	0.67**	0.59**		0.13*	0.15*	0.17**	0.291**	0.31**
PW	0.61**	0.57**	0.50*		0.347**	0.27**	0.388**	0.144*
TL	0.59**	0.57**	0.49*	0.17 ns		0.230**	0.153*	0.015 ns
NL	0.46*	0.61**	0.38*	0.25 ns	0.20 ns		0.292**	0.34**
RL	0.58**	0.56**	0.56**	0.58**	0.62**	0.41*		0.19*
FL	0.51*	0.56**	0.55**	0.53**	0.47*	0.47*	0.41*	

*Significant at*P<0.05, ** P<0.01 HG= heart girth, BL= Body length, HW=Height at Wither, PW=pelvic width, TL=tail length, NL=neck length, RL=rump length, FL= Face length, ns=non-significant*

Note: Diagonal line above for female and below for male Sidama cattle population

IV. Reproduction and Production Performance

a) Reproduction performance

The average age at first calving of the present study reported to be53±4.5. The finding, age at first calving of native cattle was longer than (39.4 months) that reported by Kumar et al. (2014) in the Tigray region. However, it was comparable with the result of Belay et al. (2012) (50.59 months) and Menale et al. (2011) (50.8 months). The average calving interval of indigenous cattle was 17.53±5.2, and there was no significant (P≥0.05) difference among the study agroecology. Reproductive lifetime productivity of male and female cattle was 7.7 ± 1.03 and 12.2 ± 1.7 years, respectively. The calving interval in the current case was shorter than reported by Shiferaw (2014)(18 months) for Kerryu cattle, but it was longer than End a shaw (2010) (14.3 months) for Mursi cattle and 15.6 months for Sheko cattle (Tekile, 2005).The longer calving interval might be due to the cows' age calving season, and forage availability of study location. The lifetime productivity of female cattle of the current result was shorter than Sheko cattle (14.7 years), as was reported by (Tekile, 2005).The findings of reproductive lifetime productivity of female cattle were in agreement 11.23 years for west Showa cattle Jiregna (2007), 11.5 years for Borana breed Dereje(2015), and 12.17 years for Arsi cattle (Chali, 2014).

Table 5: Reproduction Performance of Indignous cattle (N=180)

Variables	Agroecology			
	Highland	Midland	Lowland	Overall
Age at first calving	51.8±4.5[a]	52.0±6.5[a]	54.6±3.8[b]	53±4.5
Calving interval	17.7±4.4[a]	17.8±4.5[a]	18.1±6.2 [a]	17.53±5.2
Productive lifetime of male	8.2±1.0[a]	7.23±1.0[b]	7.1±0.8[b]	7.54±1.03
Productive life time of Female	12.8±1.7[a]	11.0 ±1.7[b]	10.7±1.6[b]	11.2±1.7

[a-b]*different letters significant between agro-ecologies, Significant was set as p<0.01 and p<0.05,*

b) Milk production performance

The mean daily milk yield, lactation length, and lactation milk yield of indigenous cattle were 1.93 liters, 221.0±55.9 days, and 429.8±61.52 liters, respectively (Table 6). The overall average daily milk yield performance of indigenous cattle in the study area was ranged from 1.62 liters in rural lowland to 2.43liters in highland area. The average daily milk yield and lactation length in highland had significantly (P<0.05) higher than those in midland and lowland study area. The average daily milk yield in the current study is slightly similar to that of Dereje (2015) reported that the on-farm daily milk yield of Wello highland zebu cattle was 1.9 liters per day. However, it was higher than the 1.37 liters national average (CSA, 2014), 1.5liters Demissu et al. (2014) for Horro cattle and 1.44 liters for Arsicattle of Ethiopia (Chali, 2014). The lactation length (LL) of the native cattle as observed in the study were shorter than those reported by Kumar(2014) (247.11±29.64 days) in Tigray, but it was longer than those reported by Gebrgziabher et al. (2013) for Boran breed (211.1±7.1), and Ngongoni et al. (2006) (201.1±21days) in Zimbabwe. The average lactation milk yield of this study was smaller than Borana (947 liters), and Horro (1201 liters) breeds Gebregziabher et al. (2013) and 645 liters for Begait breed. However, the lactation milk yield of the current result was higher than 238 liters in Yerer watershed Adalibeb woreda located in the Oromia region (Mulugeta, 2005).

Table 6: Milk yield production performance of cattle (N=180)

Variable	Agroecology			
	Highland	Midland	Lowland	Overall
Daily milk yield (liters)	2.41±0.8^{a}	1.8±0.9^{ab}	1.62±0.5^{ab}	1.95±0.85
Lactation length (days)	245±58.3^{a}	210±54.5^{ab}	204.4±46.4^{ab}	221.0±55.9
Lactation milk yield (liters)	589.39±87.3^{a}	378.1±96.5^{b}	330.3±1.0^{c}	429.8±61.5

$^{a-c}$*different letters significant between agro-ecologies, Significant was set as p<0.01 and p<0.05,*

c) Selection Criteria for Breeding Cattle

The ranking of traits for selecting breeding animals as perceived by farmers summarized in Table 7. High milk yield followed by high fertility and body size is the most highly rated trait in selecting breeding animals. Similar results indicated that cattle producers from different parts of Ethiopia select dairy cows based on milk yield (Godadaw et al., 2014. Some of the adaptive traits with disease tolerance character and coat color were mentioned as selection criteria but with a lower ranking. The adaptive traits need for the selection of their livestock, especially when the farmers have to face vagaries nature and depend on ethno veterinary medicines for treating the sick animals (Tsedeke and Edrias, 2011).

Table 7: Selection criteria for breeding of cattle in the study area (N=180)

Parameter	Agroecology											
	Highland				Midland				Lowland			
	1st	2nd	3rd	index	1st	2nd	3rd	index	1st	2nd	3rd	index
High milk yield	73.3	23.3	0	0.31	71.7	11.7	15	0.30	78.8	21.2	0	0.29
High fertility	21.7	58.3	18.3	0.27	16.7	81.6	0	0.27	13.5	59.6	26.9	0.26
Body size	0	16.7	76.7	0.2	11.7	5	68.3	0.21	7.7	9.6	42.3	0.15
Feeding behavior	5	0	1.7	0.1	0	0	3.3	0.1	0	9.6	23.1	0.1
Good temperament	0	0	1.7	0.04	0	3.3	13.3	0.04	0	0	7.7	0.03
Coat color	0	1.7	1.7	0.05	0	0	0	0.02	0	0	0	0.09
Disease resistance	0	0	0	0.03	0	0	0	0.06	0	0	0	0.08

Index=the sum of (3 times first order + 2 times second order + 1 times third order) for individual variables divided by the sum of (3 times first order + 2 times second order + 1 times third order)

V. Conclusion and Recomandation

Indigenous cattle in each study location dominant with forward and upward curved horn shape orientation and hamped. Animals in the study areas have variable coat color types, and the most dominant coat color patterns were plain, patchy, and spotted. This variability shows the absence of selection towards particular traits and may have contributed to their production environment. Sex of animals had a significant effect on linear body measurement traits, and males had higher linear body measurements than their female counterparts. Most of the linear body measurements of the male animals are moderate, and a strong positive correlation was found between HG and BL. Indigenous cattle play multi-functional roles and mostly kept milk for home consumption and income source. Owners preferred high milk yield, fertility, and body size traits. Natural uncontrolled mating is the most common system of mating due to the free grazing system practice of the area. More specifically, the cattle in Sidama area are similar to the Arsi-Bale breed in their body measurement traits. The productivity performance of indigenous cattle is comparable to some other zebu cattle in the country such as low milk yield performance, long age at first calving, long calving interval, and short reproductive lifespan. Phenotypic result of highland sample cattle populations varied from midland and lowland areas and therefore; to put specific characteristics' of the cattle type, further molecular characterization, and productivity evaluation is needed to fully describe the cattle type.

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