

Reproductive and Productive Performance of Fogera Cattle in Lake Tana Watershed, North Western Amhara, Ethiopia

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Abstract: A study was undertaken in three districts (Dembia, Libo Kemkem and Fogera) in north eastern Amhara Ethiopia. The objective was to evaluate the productive and reproductive performance of Fogera cattle in the Lake Tana watershed at smallholder farmers' level. The study areas were purposively selected based on their potentiality of Fogera cattle population. A total of 126 households were considered. A cross-sectional survey and structured questionnaire were used for the study. The data were analysed using the Statistical Package for the Social Sciences (SPSS) version 20 (SPSS 2001). The overall reported age at sexual maturity, age at first calving, lactation length and calving interval were 47.24 ± 0.85 , 59.90 ± 0.83 , 10.48 ± 0.17 and 25.52 ± 0.52 months, respectively. The reproductive life span was 11.30 ± 0.17 years. The age at puberty and reproductive life span for Fogera male cattle was 48.87 ± 0.77 months and 6.79 ± 0.1 years. The overall mean of lactation length of a cow and lactation length of first parity were 10.48 ± 0.17 and 10.44 ± 0.15 , respectively. The reported lactation length of the cow were less than 6 months (2.4%), 6-9 months (32.4%), 10-12 months (63.7%) and greater than 12 months (1.5%). The calving intervals (CI) of cow were 12 months (2.8%), 18 months (10%), 24 months (67.8%) and 36 months (19.5%). The second and third parity of early, mid and late stage daily milk yield of Fogera cattle were (3.31 ± 0.12 , 3.40 ± 0.14 and 2.41 ± 0.16), (4.29 ± 0.16 , 3.52 ± 0.12 and 3.39 ± 0.14) and (4.98 ± 0.18 , 3.8 ± 0.13 and 2.81 ± 0.14), respectively. The overall early, mid and late stages of daily milk yield were 4.19 ± 0.15 , 3.57 ± 0.13 and 2.87 ± 0.15 kg, respectively. The major constraints 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.

Key words: Fogera Cattle Breed • Lake Tana Watershed • Performances

INTRODUCTION

Ethiopia is believed to have the largest livestock population in Africa. This livestock sector has been contributing considerable portion to the economy of the country and still promising to rally round the economic development of the country [1]. The total cattle population for the country is estimated to be about 53.99 million. Out of this the female cattle constitute about 55.48 percent and the remaining 44.52 percent are male cattle. 98.95 percent of the total cattle in the country are local breeds and remaining are hybrid and exotic breeds that accounted for about 0.94 percent and 0.11 percent, respectively [2]. Despite the largest cattle population, productive and reproductive performance is very low. Productivity implies some relationship between inputs and outputs whereas production is merely an output function [3]. Feed shortage (Both in terms of quantity and

quality), lack of access to land, disease prevalence, low level of management, lack of proper follow up, poor breeding management such as lack of accurate heat detection and timely insemination might have contributed considerably to long days open (Postpartum anestrous), late age at first calving, long calving interval, short lactation length and low milk production [4].

In order to improve the low productivity of local cattle, selection as well as cross breeding of these indigenous breed with high producing exotic cattle has been considered as a practical solution [5]. Crossbreeding work in Ethiopia was initiated in the early 1950s but the crossbreeding activities, unfortunately, were not based on clearly defined breeding policy with regard to the level of exotic inheritance and the breed types to be used. The unplanned crossbreeding had also threatened the genetic resources base of the country. Although efforts were made at developing breeding program for various

livestock species in the country, all did not materialize due to lack of commitment and consultation with various stakeholders [6].

The Fogera cattle are among the 27 recognized indigenous cattle breeds in Ethiopia and it is found distributed around Lake Tana in south Gonder and west Gojjam zone of Amhara region [7] which is the major natural breeding tract of the breed. The breed is well adapted to the extremely harsh condition of the area, where milk production plays a considerable role in the traditional economy of agro-pastoral communities. They also serve as a source of draught power as well as beef. Recent information on productive and reproductive performance of Fogera cattle at on farm level is scanty. Hence, this study was carried out to evaluate productive and reproductive performance of Fogera cattle in their breeding tract at small holder condition in those particular districts.

MATERIALS AND METHODS

Study Area Descriptions: The study was conducted in 2014 in three districts (Denbia, Libo kemkem, Fogera) and in one ex-situ conservation site (Andassa Research Center).

Dembia is one of the districts of North Gondar Administrative Zone. This district covers an area of 148968 ha or 1270 km². The altitude of the district ranges between 1750 and 2100 meters above sea level. The topography of the district is 87 % plain, 8 % mountain 2.8 % plateau and 2.2 % covered by water. About 287 square kilometers adjacent to Lake Tana is subject to regular and extensive flooding. Major crops in the district (In order of importance) are teff, sorghum, finger millet and maize, respectively. The district receives an annual rainfall ranging from 700 mm to 1160. Temperature ranges from 18 to 28°C. The total human population of the district is estimated to be 27102, from these male and female accounts 139362 and 131664, respectively. According to Dembia District Agricultural office report 2014 the current livestock population of the district is estimated at 314423 cattle, 58601 sheep, 18659 goats, 58 horses, 20205 donkeys, 269 mules and 147720 poultry.

Libo Kemkem district is located in the South Gondar Administrative Zone of Amhara Region in North Western Ethiopia. It has an area of 108157 ha or 1,560 square kilometers. The topography of the district consists of plain land (42%), uneven (30%), mountains (21 %), watershed (6%) gorges (1%). Major crops in the district (In order of importance) are teff, peas, wheat and barley

respectively. The climate of Libo Kemkem district is divided into three agro-climatic zones: Woina Dega (72%), Dega (22%) and Kolla (5%). Based on the Ethiopian climatic division, it is characterized as Woina Dega because of it is mountainous and its high altitude (1,800 -3,000 meters above sea level). The temperature of the region is medium, ranging from 19°C to 30°C. This area receives a unimodal rainfall of approximately/ average 1233.7mm per year, the majority of which falls between June and August. The total human population of the Libo Kemkem district estimated to be 198433, from these male and female accounts 100987 and 97448, respectively. According to Libo Kemkem District Agricultural office 2014 the current livestock population of the district is estimated 115452 cattle, 17939 sheep, 36448 goats, 871 horses, 1220 donkeys, 461 mules and 327403 poultry.

Fogera district is found in the South Gondar Zone of the Amhara Regional State. The districts is located at 11°46 to 11°59 latitude and 37°33 to 37°52 longitudes. Fogera is one of the eight districts bordering Lake Tana and has an estimated water body of 23,354 ha. The total land area of Fogera district is 117,414 ha. Flat land accounts for 76%, mountain and hills 11% and valley bottom 13%. Major crops grown in the district are rice (33.6 %), maize (20.2 %), finger millet (16.07) and teff (13.1 %). The potential of the district for livestock production is high, including fish and honey production. Altitude ranges from 1774 to 2410 masl. Based on existing digital data, mean annual rainfall is 1216.3 mm and ranging from 1103 to 1336 mm. The average minimum and maximum temperature of the district vary between 10.3°C to 27.2°C. The total human population of the Fogera district estimated to be 231086, from these male and female accounts 118115 and 112971, respectively. According to Fogera District Agricultural office 2014 report the current livestock population of the district is estimated 182729 cattle, 15575 sheep, 25956 goats, 3 horses, 13782 donkeys, 568 mules and 379067 poultry.

Andassa livestock Research Center (ALRC) was established in 1964 as the Imperial Fogera Cattle Conservation Centre under the Ministry of Agriculture. It is located in 11°29' N and 37°29'E with 1,730 meters above sea level. It is located in Amhara regional state, western Gojjam zone, Bahir Dar Zuria district. It receives average annual rainfall of 1150mm with the mean annual temperature varies from 8.8°C to 29.5°C. In the last years the centre re-initiated pure breeding of the Fogera cattle for genetic improvement. In 2014, the centre maintained herd of 401 pure Fogera, 68 cross Fogera bred cattle and 2 Borena cattle breed.

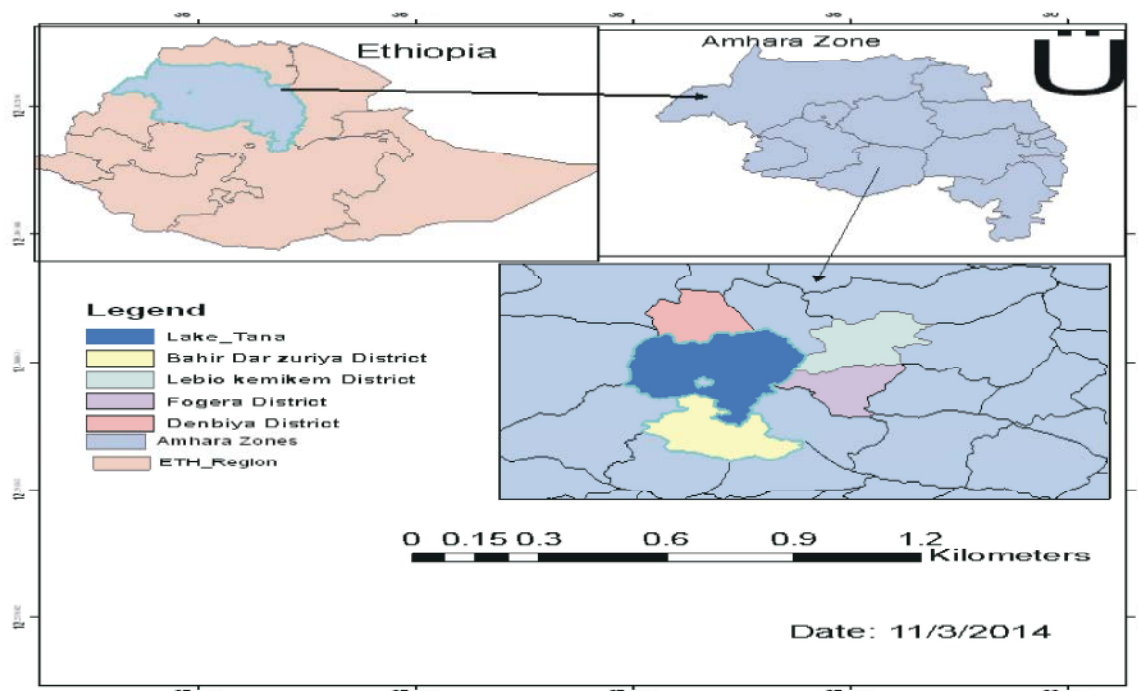


Fig. 1: Map of study districts distribution in Amhara Region

Sampling Methods and Data Collection: The survey was conducted in three districts (Dembia, Libo Kemkem and Fogera) of North and south Gonder Zone, from January to May, 2013, which are purposively selected based on their potentiality of Fogera cattle population production. Similarly a total of 9 peasant associations (Three from each district) were selected. A total of 126 households were selected purposively based on their Fogera cattle production experiences. A cross-sectional study design was used to carry out the study to collect data on all relevant information from the existing Fogera cattle management condition using well structured questionnaire. The questionnaire focused mainly on reproductive and productive performance as well as production constraints. The core data collected using questionnaires were analyzed by using descriptive statistics of SPSS version 20 [8].

RESULTS AND DISCUSSION

Reproductive and Productive Performance

Reproductive Performance: Age at sexual maturity of female and male cattle in the study districts were longer than the recent on-farm survey report Kereyu sanga cattle (45.7 and 49 months) [3]. Workneh A. and Rowlands [9] reported the overall mean sexual maturity of 39.6 months for female and 39.9 months for male of indigenous

cattle of Oromia Regional State. The same authors reported the mean age at sexual maturity of 41.7 for female and 42.5 months for male in pastoral production system and 43.3 months for female and 45.6 months for males in agro pastoral production system. Zewdu Wuletaw [10] reported age at sexual maturity of 55.6, 57 and 55.7 months for Semien, Wegera and Mahibere-Sillasie breeding bulls which are slightly longer than the reported age at sexual maturity for Fogera breeding bulls. Dejene Takele [11] reported age at sexual maturity of 45.6 and 52.8 months for Borana cattle and cattle type at Borana zone.

Age at first calving for Fogera breeding females was longer than [3] (54.1 months) for Kereyu cattle, Dejene Takele [11] (58.2 months) for Borana cattle and cattle type at Borana zone, Takele Taye [12] (54.1 months) for Sheko breed, Dejene Takele [11] (53.1 months) for Raya-Sanga cattle, Zewdu Wuletaw [10] (54.7 and 53.4 months) for Wegera and Fogera cattle. Mekonnen Haile-Mariam and Goshu Mekonnen [13] and Enyew Nigussie [14] reported a lot shorter age at first calving on-station of 32.8 and 38.8 months for Arsi and Fogera cattle, respectively. Haile-Mariam [15] and Kassa-Mersha and Arnason [16] reported average age at first calving of 41.5 and 45.2 months, respectively for Borana cattle. Zewdu Wuletaw [17] also reported 38 ± 2.24 months for Mahibere-Slassie composite cattle breed.

ZTable 1: Reproductive performance of Fogera breeds

Reproductive traits	Mean±SE			
	Dembia (N=36)	Fogera (N=45)	Libo (N=45)	Overall (N=126)
Age at sexual maturity female	44.8±1.23	46.9±1.47	49.6±1.55	47.2±0.85
Age at sexual maturity male	54.7±1.77	46.1±0.85	46.9±1.07	48.9±0.77
Estimated age at first calving	58.0±1.31	58.9±1.42	62.4±1.46	59.9±0.83
Number of calves born by cow	6.25±0.36	4.87±0.21	3.98±0.25	4.94±0.17
Lactation length of a cow	9.53±0.31	10.6±0.29	11.1±0.22	10.5±0.17
Calving interval of a cow	23.7±1.04	25.5±0.79	27.1±0.82	25.5±0.52
Lactation length of first parity cow	9.31±0.22	10.7±0.25	11.1±0.21	10.4±0.15

Table 2: Lactation length of first, second and third parity

Lactation length in month	Frequency	Percent
First parity		
<6 months	2	1.7
6-9 months	52	43.7
10-12 months	72	54.6
Second parity		
<6 months	1	0.7
6-9 months	44	37.0
10-12 months	78	60
>12 months	2	1.5
Third parity		
6-9 months	42	35
10-12 months	82	63.5
>12 months	2	1.5

Table 3: Daily milk yield (liter) of first, second and third parity cow at early, mid and late stage

District	N	Mean±SE			Overall
		Early stage (1-3 months)	Mid stage (4-6 months)	Late stage (> 7 months)	
First Parity cow	126	3.31±0.12	3.40±0.14	2.41±0.16	3.04±0.14
Second parity cow	126	4.29±0.16	3.52±0.12	3.39±0.14	3.73±0.14
Third parity cow	126	4.98±0.18	3.8±0.13	2.81±0.14	3.86±0.15
Overall	126	4.19±0.15	3.57±0.13	2.87±0.15	3.54±0.14

Table 4: Reproductive lifespan breeding female and male

District	N	Mean±SE	
		Cow	Bull
Dembia	36	12.1±0.33	6.83±0.15
Fogera	45	11.4±0.24	6.56±0.19
Libo	45	10.6±0.27	7.00±0.19
Overall	126	11.3±0.17	6.79±0.1

Calving interval obtained in the present study was higher than the value from previous findings (18 months) [3] for Keryu cattle, Dejene Takele [11] (15.3 months) for Borana cattle and cattle type at Borana zone, (15.6 months) [12] for Sheko cows, (16 and 19 months) [18] for Wello highland zebu cattle and Raya Sanga cattle respectively, (17.5, 17.3 and 22.4 months) [17] for Wegera, Fogera and Semien cattle and [17] (16±0.67months) for Mahibere-Slassie composite cattle breed. The mean

calving interval of this study was within the range of earlier estimates of calving interval for Ethiopian Zebu cattle of 12.2 to 26.6 months [19].

Lactation length for first and overall mean of all parities (Table 1), were longer than Boran in Ethiopia (8 months) and for Horro (5.8 months), Begait (6.1 months) and Boran (6.8 months) in Kenya [20] and Borana cattle and cattle type (8.6±2 months) [11]. However, the result of lactation length of the study was strongly lower than

Table 5: Ranking of major constraints of cattle production in each study Districts

Districts	Constraints	Rank (%) N=126							Index
		1	2	3	4	5	6	7	
Dembia	Feed shortage	86.1	13.9	0	0	0	0	0	0.24
	Disease	16.7	77.8	5.6	0	0	0	0	0.22
	Drought	0	0	75	25	0	0	0	0.17
	Shortage of H ₂ O	0	5.6	19.4	69.4	5.6	0	0	0.15
	Market problem	0	0	0	0	0	100	0	0.07
	Conflict	0	0	0	0	0	0	100	0.04
	Flooding	0	0	0	5.6	94.4	0	0	0.11
Libo	Feed shortage	71.1	26.7	2.2	0	0	0	0	0.24
	Disease	22.2	60	15.6	2.2	0	0	0	0.21
	Drought	2.2	4.4	66.7	24.4	2.2	0	0	0.17
	Shortage of H ₂ O	2.2	8.9	8.9	20	60	0	0	0.13
	Market problem	0	0	0	0	0	100	0	0.07
	Conflict	0	0	0	0	0	0	100	0.03
	Flooding	4.4	0	4.4	53.3	37.8	0	0	0.13
Fogera	Feed shortage	97.8	2.2	0	0	0	0	0	0.25
	Disease	2.2	55.6	37.8	4.4	0	0	0	0.20
	Drought	0	24.4	48.9	26.7	0	0	0	0.18
	Shortage of H ₂ O	0	0	4.4	8.9	86.7	0	0	0.11
	Market problem	0	0	0	0	4.4	95.6	0	0.07
	Conflict	0	0	0	0	0	4.4	95.6	0.04
	Flooding	0	15.6	11.1	60	8.9	0	4.4	0.15

Table 6: Ranking of major constraints of cattle production in all study Districts

Major Production constraints	Rank (Frequency (percent)) of the respondent							Index value
	1	2	3	4	5	6	7	
Feed	108(85.7)	17(13.5)	1(0.8)	0	0	0	0	0.24
Disease	17(13.5)	80(63.5)	26(20.6)	3(2.4)	0	0	0	0.21
Drought	1(0.8)	13(10.3)	79(62.7)	32(25.4)	1(0.8)		0	0.17
H ₂ O	1(0.8)	6(4.8)	13(10.3)	38(30.2)	68(54.0)		0	0.13
Market	0	0	0	0	2(1.6)	124(98.4)	0	0.07
Conflict	0	0	0	0	0	2(1.6)	124(98.4)	0.04
Flooding	2(1.6)	7(5.6)	7(5.6)	53(42.1)	55(43.7)	0	2(1.6)	0.13

Fogera (23.3 months) cattle. The mean of number of calves born by a cow for lifetime in the study districts was lower than Kereyu cattle (7.1 months) and Borana cattle and cattle type (6.84±0.27) reported by Shiferaw Garoma [3] and Dejene Takele [11], respectively.

Milk Production and Lactation Performance: The reported lactation length of the cow were less than 6 months (2.4%), 6-9 months (32.4%), 10-12 months (63.7%) and greater than 12 months (1.5%). The result of this study depicted that the calving intervals (CI) of cow were 12 months (2.8%), 18 months (10%), 24 months (67.8%) and 36 months (19.5%).

The first, second and third parity of early, mid and late stage daily milk yield of Fogera cattle (Table 3) were higher than the value from previous findings by Land O'Lakes, Inc. [21] which indicated the productivity of

dairy herd average milk yield was 1.3 liter – 1.54 liter per day for an average lactation period of 180 – 210 days. The overall early, mid and late stage daily milk yields were some related with Mahibere-Slassie composite cattle breed (4.22±1.85, 2.90±0.96 and 2.46±0.76) [17].

Reproductive Lifespan of Breeding Female and Male: The mean reproductive lifespan of female Fogera breeding cattle was lower than Keryu and Sheko (14.7years) breeds [3, 12]. However, the mean of lifespan of Fogera breeding male was higher than Sheko breeding male (6.5 years) [19]. Dejene Takele [11] (8.77 and 11.2 years) for Borana cattle and cattle type at Borana zone.

Major Cattle Production Constraints in the Study Area: The problems of cattle production (Table 5 and 6) in the study Districts were shortage of feed, disease outbreak,

occurrences of drought, shortage of water during winter/healthy water, flooding during summer season, market and conflict by grazing land with government ranked from 1 to 7 respectively. In addition to the respondents reported shortage of land because of rice production, population growth and the incensement of irrigation were the cause of feed shortage in the study Districts. Inadequate supply of improved cattle breeds, poor breeding system were additional listed by some respondents. The major constraints limiting live-stock production in Dandi districts, Oromia regional state, central Ethiopia were feed shortage, animal health, labour scarcity and lack of capital [22].

CONCLUSIONS

Fogera cattle breed has both regional and national importance. They are kept for multipurpose functions for farmers. It has been practically observed during the study period that farmers in the study areas, who maintain the breed, mostly rely on milk production for their diet and drought/power. From the result of this study, it can be conclude that lower reproductive performances were recorded, namely age at sexual maturity of both female and male, estimated age at first calving, number of calves born by cow and calving interval of a cow when compare to the various previous research reports. However, lactation length and reproductive lifespan of both female and males were higher. As a result their productive performance mainly in terms of daily milk yield was better than the other research reports conducted in different areas of the country. Generally, the observed daily milk yield and lactation length performance of Fogera cattle type is high as compare to other indigenous breeds under the prevailing stressful and very challenging environment, where the ability to survive under natural calamities (Drought, climatic extremes, flooding, disease feed and water shortage (Pure water)). Therefore, in order to improve the reproductive and productive performance of Fogera cattle, the responsible agents /government, research centers, NGOs and researchers should give high attention on better improvement of the routine management activities (Improvement of feed, water quality, disease control and control of flood) and apply pure-breed improvement strategies so as to further exploit the optimum level of reproductive and productive performance of Fogera cattle.

REFERENCES

1. Niraj Kumar, Alemayehu Eshetie, Berihu Gebrekidan and Endale Balcha Gurmu, 2014. Reproductive performance of indigenous and HF crossbred dairy cows in Gondar, Ethiopia. College of Veterinary Medicine, Mekelle University, Ethiopia. IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 7, Issue 1 Ver. V (Feb. 2014), pp: 56-61. www.iosrjournals.org.
2. CSA, 2013. Agricultural sample survey. Report on livestock and livestock characteristics. The Federal Democratic republic of Ethiopia, Central Statistical Agency (CSA). Private Peasant Holdings. Statistical Bulletin 570, Addis Ababa, Ethiopia, April, 2013.
3. Shiferaw Garoma, 2014. In-situ phenotypic characterization of kereyu cattle type in fentalle district of Oromia region, Ethiopia. M.sc. thesis in agriculture (animal genetics and breeding) Haramaya University.
4. Belay D., K. Yisehak and G.P.J. Janssens, 2012. Productive and Reproductive Performance of Zebu X Holstein-Friesian Crossbred Dairy Cows in Jimma Town, Oromia, Ethiopia. Global Veterinaria, 8(1): 67-72.
5. Tadesse, B., 2002. Reproductive performances of zebu (Fogera) breed in the central highlands of Ethiopia. DVM thesis, Addis Ababa University, Faculty of Veterinary Medicine, Debre Zeit, Ethiopia.
6. Aynalem, H., A. Workneh, K. Noah, D. Tadelle and T. Azage, 2011. Breeding strategy to improve Ethiopian Boran cattle for meat and milk production. IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper 26. Nairobi, Kenya, ILRI.
7. Addisu Bitew, Mengistie Taye, Adebabay Kebede, Getinet Mekuriaw, Asaminew Tassew, Tezera Mulugeta and Gebeyehu Goshu, 2010. Milk yield and calf growth performance of cattle under partial suckling system at Andassa Livestock Research Centre, North West Ethiopia.
8. SPSS (Statistical Procedures for Social Sciences), 2001. SPSS User's guide version 20.0. SPSS Institute Inc., Cary NC.
9. Workneh, A. and G.J. Rowlands, 2004. Design, execution and analysis of the livestock breed survey in Oromia Regional State, Ethiopia. OADB (Oromia Agricultural Development Bureau), Addis Ababa, Ethiopia and ILRI (International Livestock Research Institute), Nairobi Kenya, pp: 260.

10. Zewdu Wuletaw, 2004. Indigenous Cattle Genetic Resources, Husbandry Practices and Breeding Objectives in Northwestern Ethiopia. M. Sc Thesis. Alemaya University, Ethiopia.
11. Dejene Takele, 2014. Assessment of Dairy Cattle Husbandry and Breeding Management Practices of Lowland and Mid-Highland Agro-Ecologies of Borana Zone. *Animal and Veterinary Sciences*, 2(3): 62-69. doi: 10.11648/j.av.s.20140203.12.
12. Takele Taye, 2005. On-Farm Phenotypic Characterization of Sheko Breed of Cattle and Their Habitat in Bench Maji zone, Ethiopia. M.Sc Thesis. Alemaya University, Ethiopia.
13. Mekonnen Haile-Mariam and Goshu Mekonnen, 1987. Reproductive performance of Fogera cattle and their Friesian crosses. *Eth. J. Agric. Sci.*, 9(2): 95-114.
14. Enyew Nigussie, 1992. Reproductive Performance of Local and Crossbred Dairy Cattle at Asella Livestock Farm. M.Sc Thesis. Alemaya University of Agriculture, Ethiopia, pp: 104.
15. Haile-Mariam, M., 1994. Genetic analysis of Boran, Friesian and crossbred cattle in Ethiopia. Uppsala: Swedish University of Agricultural Sciences, Dept. of Animal Breeding and Genetics.
16. Kassa-Mersha, H. and T. Arnason, 1986. Non-genetic factors affecting growth of Ethiopian Boran cattle. *World Review of Animal Production*, 22(2): 45-55.
17. Zewdu Wuletaw, M. Wurzinger, Tadele Dessie and J. Sölkner, 2013. Potential of indigenous animal genetic resources as an adaptive mechanism on climate change: The case of Mahibere-Slassie composite. *Proceeding of Agricultural economics society of Ethiopia* (In press).
18. Dereje Tadesse, 2005. On-farm Phenotypic Characterization of Cattle Genetic Resources and their Production Systems in South and North Wello zones of Amhara Region, Ethiopia. MSc Thesis. Alemaya University, Ethiopia.
19. Mukassa-Mugerwa, E. and T. Azage, 1991. Reproductive Performance in Ethiopian Zebu (*Bos indicus*) Cattle: Constraints and impact on production. An invited paper presented at Fourth National livestock Improvement Conference, Addis Ababa, Ethiopia, 13 -15 Nov. 1991. In: Institute of Agricultural Research (IAR), pp: 16-18.
20. DAGRIS, 2006. Domestic Animal Genetic Resources Information System (DAGRIS).
21. Land O'Lakes, Inc., 2010. Ethiopia Dairy Value Chains, USAID CA No. 663-A-00-05-00431-Land O'Lakes, Inc. IDD.
22. Belay Duguma, Azage Tegegne and B.P. Hegde, 2012. Smallholder Livestock production system in Dandi District, Oromia Regional State, Central Ethiopia. *Global Veterinaria*, 8(5): 472-479.