Tiruneh Mossie
Graduate Student, Department
Of Animal Production and
Technology, Bahir Dar
University College of Agriculture
and Environmental Sciences,
Ethiopia

Taddie Wondmnew
Amhara National Regional State
Of Livestock Promotion And
Development Agency Animal
Health Directorate, Ethiopia

Evaluation of the reproductive performance of local dairy cattle breeds in Ethiopia

Tiruneh Mossie and Taddie Wondmnew

Abstract
Ethiopia is the home of large numbers of livestock due to having varied and extensive agro-ecological zones. From the total annual milk produced cattle milk, is the most prominent compared to other livestock species in Ethiopia. There are about six distinguishable, indigenous cattle types in Ethiopia mainly Arsi, Barca, Boran, Fogera, Horro and Ogaden There are about four dairy production systems in Ethiopia. These are; Pastoralist dairy Farming, Urban and Peri-Urban dairy farming, High land and Small holder or mixed dairy farming and intensive dairy farming system. Calving interval, Age at firs service, Number of Service per conception and age at first calving are the major measures of productive and reproductive performance parameters for dairy cattle production. Different reports indicated that productive and reproductive performances of cattle are very poor due to varied factors. The causes for low performances of dairy cattle were technical and non-technical constraints. The technical constraints include; genetic problem, feeding, disease and health care problems The non-technical constraints are; human population and livestock population. In Ethiopia most of (97.5%) cattle breeds are local breeds the remaining (2.5%) are hybrid and exotic breeds. Then, the genetic performances of these breeds are poor, even though they have good adaptation in harsh environmental conditions. According to this review locals have poor performances as compared to cross bred cows based on the reproductive performance indicators. There are also differences in production performances among and within local breeds according to the management practices. That means; for age at first Service Ethiopian Boran, for Age at first calving Arsi and Barka, for Number of Service per Conception Barka, for Calving Interval Arsi and Ethiopian boran, for Days open Fogera breed were better. So, research and studies, training and awareness creation should be given particularly to the farmers on major management practices like feeding, housing and health care and genetic improvement strategies should planned and practiced simultaneously.

Keywords: Breeds, dairy cattle, ethiopia, productive and reproductive performance, 2021

Introduction
Back Ground and Justification
Ethiopia has the biggest livestock number that estimated 65.35 million cattle, 39.8 million sheep, 50.5 million goats, 9.9 million donkeys, 2.1 million horses, 0.35 million mules, 7 million camels, 48.9 million chicken and 6.9 million beehives Among the cattle population 36.53 Million are Females and within this 12.57 million(19%) are Milking cows [1].

The 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. It is eminent that livestock products and by-products in the form of meat, milk, honey, eggs, cheese, and butter supply etc. provide the needed animal protein that contributes to the improvement of the nutritional status of the people. Livestock also plays an important role in providing export commodities, such as live animals, hides, and skins to earn foreign exchanges to the country [1]. The productivity of cattle depends largely on their reproductive performance and the rate of genetic progress in both selection and crossbreeding programs particularly in dairy and beef production. An important prerequisite for the sustainability of a dairy production system is that cows must have efficient reproductive performance [2].

Significance of the Review
As mentioned above, Ethiopia has huge number of Livestock population; despite the huge

Corresponding Author:
Tiruneh Mossie
Graduate Student, Department
Of Animal Production and
Technology, Bahir Dar
University College of Agriculture
and Environmental Sciences,
Ethiopia

Numbers of livestock resource and great potential for increased livestock production, productivity and commercialization of livestock is low due to numerous constraints [3]. The major constraint for livestock production in Ethiopia is mainly feed availability both in terms of quantity and quality [4].

Other factors are due to constraints of disease, poor management, inadequate animal health services, and poor performance of indigenous breeds [5]. Among livestock production system dairy production is one of the prevalent production systems in Ethiopia [6]. Ethiopia holds large potential for dairy development mainly due to suitable environment [7].

Even though there is large dairy cattle population and favorable climatic conditions, self-sufficiency in milk production is low [3]. Accordingly, they contribute an average of 1. 48 liters milk yield per cow per day and annually about 3.89 billion litters with the average lactation period of six months [1]. However, out of the total dairy cattle keepers in the country 97.5 percent keep on local breed types which are poor genetic potential for milk production. The remaining 2.2 and 0.3 percent are crossbreed and exotic cattle breeds respectively [1]. In addition, obtaining quality feeds is difficult which results low in quantity of milk [3].

The reproductive performance of the breeding female is probably the single most important factor influencing herd/flock productivity [8].

However, the reproductive performance does not usually refer to a single trait, but to a combination of many traits. Many authors indicate that the main indicators that would be considered in evaluating reproductive performance are age at first service, age at first calving, calving interval, days open and number of services per conception [8].

So, based on the above basic facts this paper is intended to review the main reproductive performance.

Objective: To review the reproductive performances of selected local cattle breeds according to basic measures of breeding practice and management.

Literature review
Dairy production systems in Ethiopia: Dairy production system is a biological efficient system that converts large quantities of roughage i.e. the most abundant feed in the tropics to milk, the most nutritious food to man. Dairy production is a critical issue in Ethiopia, a livestock-based society where livestock and its products are more important sources of food and income and dairying has not been fully exploited and promoted [9].

Based on climate, land holdings and integration with crop production as criterion, dairy production systems are recognized in Ethiopia; namely the rural dairy system which is part of the subsistence farming system and includes pastoralists, agro-pastoralists, and mixed crop–livestock producers, the peri-urban; and urban dairy systems and Intensive farming system [9]. The first system (pastoralist, agro pastoralist and highland mixed smallholder production system) contributes to 98%, while the peri-urban and urban and Intensive dairy farms produce only 2% of the total milk production of the country [10].

The rural system is non-market oriented and most of the milk produced in this system is retained for home consumption. The level of milk surplus is determined by the demand for milk by the household and its neighbors, the potential to produce milk in terms of herd size and production season, and access to a nearby market ([11]. Pastoralists raise about 30% of the indigenous livestock population which serve as the major milk production system for an estimated 10% of the country's human population living in the lowland areas. Milk production in this system is characterized by low yield and seasonal availability [12].

Pastoralist dairy Farming system:- Livestock owners who exploit natural grass lands mainly in the arid areas, even though information on both absolute numbers and distribution is vary; it estimated that about 30% of the livestock populations are found in the pastoral areas [10, 12]. The herd is dominating with unimproved Zebu animals and milk production is of subsistent type. It is mainly operating in the range lands where the peoples involved follow animal based life styles, which requires of them to move from place to place seasonally, based on feed and water availability. Livestock doesn't provide inputs for crop production but they are the very back bone of their owners providing all of the consumable and saleable outputs and regard as insurance against adversity, milk production is dependent on season due to the rainfall pattern that influenced feed availability [12].

Urban and Peri-urban Dairy Farming: - Urban dairy farming is a system involving highly specialized, state or businessmen owned farms, which are mainly concentrated in major cities of the country. They have no access to grazing land. Currently, a number of smallholder and commercial dairy farms are emerging mainly in the urban and peri-urban areas of the capital [13]. And most regional towns and districts [14]. Smallholder rural dairy farms are also increasing in number in areas where there is market access. According to [8] the urban milk system in Addis Ababa consists of 5167 small, medium and large dairy farms producing 34.65 million liters of milk annually. Of the total urban milk production, 73% is sold, 10% is left for household consumption, 9.4% goes to calves and 7.6% is processed into butter and *ayib* (cheese). In terms of marketing, 71% of the producers sell milk directly to consumers [11].

Almost all of the fluid milk supplied to major urban and peri-urban centers in Ethiopia, comes from urban and peri-urban smallholder and commercial dairy producers; land is the major challenges [8].

Highland Smallholder Dairy Farming: The highland smallholder milk production is found in the central parts of Ethiopia where dairying is nearly always parts of the subsistence, smallholder mixed crop and livestock farming. It becomes important source of house hold income in Ethiopia. However, the sector is affected by several problems like poor quality and quantity of feed resource, lack of appropriate feeding system, poor production and reproduction traits, low productive and reproductive performance and economic and technical problems. About 93% of the total milk production in Ethiopia is produced by the smallholder dairy farmers living in the villages and exercising, in most instances, traditional dairying [15].

Intensive Dairy Farming: - This is a more specialized dairy farming practiced in state sector and very few individuals on commercial basis. The urban, peri-urban and intensive reproduction influences the rate of genetic progress in both selection and crossbreeding programs particularly in dairy and beef production [16].

Reproductive performance of indigenous dairy cattle: In simple definition, reproductive performance is the number of cows that got pregnant divided by the number of cows that

were eligible to get pregnant. It is a measure of the speed at which cows get pregnant after the voluntary waiting period. But, it is the result of the effectiveness of basic measures of reproductive performances; Age at first service (AFS), Age at first calving (AFC), calving interval (CI), Days open (DO) and Number of Services per Conception (NSC).

There are about six distinguishable, indigenous cattle types in Ethiopia mainly Arsi, Barca, Boran, Fogera, Horro and Ogaden. They are evolved as a source of natural selection influenced by factors like; Climate, altitude, available feed supply, endemic diseases and functional objectives of conditions livestock owners, management techniques and market demands that make them adapted to harsh environmental conditions. Even if there is differences b/n breeds, agro ecological zone (AEZ) and management most Ethiopian Local dairy cattle have low reproductive performances due the following constraints [17].

Major constraints of dairy development system in Ethiopia: The livestock sub-sector in general and the dairy sub-sector in particular do not make a contribution to the national income considering with its size. The reasons for this, constraints can be categorized as nontechnical and technical constraints [10, 11].

Non-technical constraints: The non-technical constraints of dairy development generally include a variety of socio-economic and institutional considerations, which is most cases and are will common constraints to other agricultural sector in the country. These are human population and livestock population.

Human population: The high rate of population increase annually is reckoned to affect livestock development. The demand for livestock products directly related with the annual population growth, which the livestock production is lag behind with the rate of population growth.

Moreover, high population growth has forced people to cultivate more and more land. The necessity to extend the cropping areas to support the increasing population in the highlands, the carrying capacity of the land is stretched beyond its limits, which resulted in law production performance of the livestock.

Livestock population: One of the serious constraints to the livestock development in Ethiopia rest on the importance attached to the economic functions of the livestock found in various agro-ecological zones. Overall, livestock in Ethiopia are used as input function, asset and security function. Farming methods in Ethiopia have remained unchanged for centuries, cultivation is carried out using oxen drown traditional ploughs in the highland this demand high dependency on animal power (as an input function). High population growth has forced people to plough more land, which in turn demand more ploughing capacity. Therefore, to fulfill this demand more ploughing capacity requires for the presence of a higher cattle herd, which created pressure on grazing land and ultimately poor economies of peasant farm. In the law lands the pastoral nomads maximum benefit from livestock through milk and meat have huge number of Livestock Population. Furthermore, in order to overcome low productivity of their livestock and recurring draught large number of stock is maintained as security function as well [18].

Technical constraints
Animal health and disease prevalence: Animal health and improved management is also one of the major constraints of dairy development in Ethiopia, which cause poor performance across the productive system. Many of the problems result from the interaction among the technical and non-technical constraints themselves e.g. poorly fed animals develop low disease resistance, fertility problem, partly because the animal health care system relies heavily on veterinary measures, poor grazing management systems continue to cause high mortality and morbidity (e.g. internal parasites), many of the disease constraints which affect supply are also a consequence of the non-technical constraints e.g. insufficient money to purchase drugs or vaccines [19].

Feed and nutrition: In highland zones, high population growth and density are causing the shortage of grazing land on which livestock production by small holders depends. In the lowland areas, the shortage of feed and water during the dry season forces animals and livestock keepers to trek long distances in search of feed. The quality of feed also deteriorates during the dry season in both the mixed farming and pastoral system [19].

Genotype problems: The genetic of Ethiopia's livestock have involved largely as a result of natural selection influenced by environmental factors. This has made the stock better conditioned to with stand feed and water shortages, disease challenges and harsh climates. But the capacity for the high level of production has remained low [19].

Reproductive Performance Measurements
Age at first service: Age at first service (AFS) is the age at which heifers attain body condition and sexual maturity for accepting service for the first time. AFS signals are the beginning of the heifer's reproduction and production, and influences both the productive and reproductive life of the female through its effect on her lifetime calf crop. A substantial delay in the attainment of sexual maturity may mean a serious economic loss, due to an additional, non-lactating, unproductive period of the cow over several months [16]. Age at puberty is an important determinant of reproductive efficiency. Many heifers, especially Taurine, can reach puberty and breed fairly satisfactorily at one year old. However, the cost of achieving this varies among breeds and among heifers within the same breed.

Estimates of age at puberty in *Bosindicus (indigenous cattle)* in the tropics and subtropics range between 16 and 40 months. Bos-indicus cattle reach puberty later than *Bostaurus* x *Bosindicus* crossbreeds or purebred taurine cattle. This indicates that natives have longer Age at first service than Crosses. This is due to genetic and environmental or management factors, including nutrition, disease, temperature and season of birth. These factors affect heifer growth rates [16].

Age at first service was reported to be 44.8 months for Fogera breeds [20]. This result is lower than 53 months for Ethiopian highland Zebu [21], and 55 months for Horro cattle [21].

According to this study; the result of Fogera cattle for this parameter is higher than the report of 37.5±0.9 months [22], 29.6 months [23], 34.4±2.28 months for Ogaden breed [24], 33.3±0.83 [25], 28.7±0.7 months for Ethiopian Boran breed [26]. From this result Ethiopian Boran Bred has short age at First service.

Age at First Calving: Age at first calving (AFC) marks the beginning of a cow's productive life. Age at first calving is closely related to generation interval and, therefore, influences response to selection [16]. Under controlled breeding, heifers are usually mated when they are mature enough to withstand the stress of parturition and lactation. This increases the likelihood of early conception after parturition.

According to [27] indicated that the AFC of Fogera breed was 47.6 ±0.77 months at Metekel Ranch. The AFC of 50% Fogera-Friesian crosses was reported to be 40.46 ±0.93 years. This indicates that crosses have shorter age at first calving.

However, the result is significantly higher than 30.3 month for Barka breed [28]), 32.8±0.9 month for Arsi breed [29], 38±2.24 months for Mahibere-Sellasie composite breed [30], 43.8±4.2 months for local zebu [31]. The wide variation for AFC between different indigenous breed of Ethiopia might be due to the breed difference (genotype effect), management variation and adaptation variations of the breeds at their production environment. According to the above result, Barka breed has short age at first calving.

Calving Interval: Calving interval (CI) refers to a time elapsed between two consecutive successive parturitions [32]. It is probably the best indicator of a cow's reproductive efficiency and expresses the economic importance the reproduction. Twelve months calving interval is generally considered the most economically desirable period for dairy cows. However, such a standard lactation length might not work for smallholder dairy cows in which the lactation length is extended considerably in most cases [33].

Calving interval can be divided into three periods: postpartum anestrus period (from calving to first estrus), service period (first postpartum estrus to conception) and gestation length. Estimates of calving interval in zebu cattle range from 12.2 to 26.6 months [32]. In most modern dairies, the general practice is to breed cows early, with the aim of establishing a calving interval of 12 to 13 months, which is considered optimum; hence, calving interval is considered an important index of reproductive performance [34].

A study carried out on Fogera cattle breed at Andasa Livestock Research Center was 19.5±0.32 months, which is within the estimated calving interval for zebu cattle ranging from 12.2 to 26.6 months [16, 34].

This study was higher than the respective report of 13.7 and 13.9 months for Arsi and Zebu breed [29], 13.9 months [31], 14.6 months for Boran breed [26], under this parameter the Arsi and Ethiopian boran Breeds are better. They have shorter Calving interval than others.

Number of services per conception: The number of services per conception (NSC) is the number of services (natural or artificial), required for successful conception. It expresses the fertility level of the dairy herds. It is simple and easy to calculate and understand and it is a good measure of reproductive status, but still, it usually does not indicate reasons on heifers and cows that fail to conceive. The number of inseminations required to produce a live calf is one of the most useful parameters of reproductive efficiency which mainly depends on the breeding system used. It is higher under uncontrolled natural breeding and low where hand-mating or artificial insemination is used. The optimum recommended NSC for profitable dairy cow's ranges from 1 to 1.7 [35].

Although several studies estimated NSC in Ethiopia is poor.

Number of service per conception is significantly affected by season; that is related to availability of feed, placenta expulsion time, lactation length and milk yield and parity breeding system used. It is higher under uncontrolled natural breeding and low where hand-mating or artificial insemination is used. NSC values greater than 2.0 should be regarded as poor [32, 36].

At the same time NSC of the Fogera cattle breed at Andasa Research center was 1.2±0.01 Comparable result of 1.1 for Barka breed was reported by [28]; significantly higher result of 1.5 was reported [37], 1.5±0.69 [38], 1.8 [39]. For this measure Barka breed has lowest NSC.

Days open: Days open (also called calving-to-conception interval) is the period between calving and conception in cows. Days open is influenced by the length of time for the uterus to completely involutes, resumption of normal ovarian cycle, occurrence of silent ovulation, accuracy of heat detection, management, semen quality and skill of inseminator or efficiency of bull [25, 40]. Days open affect lifetime production and generation intervals, and hence the annual genetic gain [25].

According to [20] 280±3.4 days for Fogera breed at Andasa Reseach Center has been reported. On the other hand, [28] reported a mean DO of 151±13 days for the Fogera breed which was significantly lower [20, 41], reported 215 days and 250 days of DO for highland and lowland zebu cows, respectively. Based on this indicator the Fogera breed is better, which has shorter days open.

Conclusions

Dairy farming constitutes a major role for economic development of the country as a source of feed and income and making it one of the biggest references potential producers of milk and milk products. Dairy farm plugged with a number of challenges these includes; Non-technical and technical constraints. The non-technical constraints of dairy development, are common constraints to other agricultural sector in the country. Technical constraints are; Animal Health Disease, Feed and Nutrition and Genotype. From the review it is concluded that cross breed has short age at first service, calving interval, days open and have low return rate because of management and genetic factors. Even though, there is management and agro ecology differences within and among breeds; for age at first Service Ethiopian Boran, for Age at first calving Arsi and Barka breed; and for the Number of Service per Conception again Barka, for Calving Interval Arsi and Ethiopian Boran Breed, for Days open Fogera breed were better. Poor management of dairy cows have direct negative effect on low productivity by elongated age at first service, age at first calving, open days and maximization of return rate(less estrus). Therefore, according to this review locals have poor performances as compared to cross bred cows based on the reproductive performance indicators; Even though, there is differences in production performances among and within local breeds according to the management practices.

Recommendations

Reproductive performance of Ethiopian indigenous cattle is not only affected by genetic factors but also environmental factors (feeding, disease, and proper management system). Therefore;

- Governmental strategy has to be focused on improving non genetic factors in order to upgrade reproductive

performances of local dairy cows in addition to genetic factors.

- Research centers and other concerned professionals have to create a way to maximize the local dairy production and productivity.
- Genetically the blood level of locals should be improved by crossing with Exotics.

References
1. CSA 2019/20. Agricultural sample survey of E.C. report on livestock and livestock characteristics, volume II, Addis Ababa, Ethiopia 2012.
2. Nuraddis Ibrahim, Reta Hailu, Abidu Mohammed. Assessment of Problems Associated with Artificial Insemination Service in Selected Districts of Jimma Zone. Journal of Reproduction and Infertility 2014;5(2):37-44. ISSN: 2079-2166.
3. Mebrate Getabalew, Tewodros Alemneh, Dawit Akeberegn. Dairy Production in Ethiopia - Existing Scenario and Constraints. Biomed J Sci & Tech Res 2019;16:2019. BJSTR. MS.ID.002903.
4. Mengistu Alemayehu, Gezahegn Kebede, Fekede Feyissa, Getenet Assefa. Review on Major Feed Resources in Ethiopia. Acad. Res. J Agri. Sci. Res 2017;5:176-185.
5. Dawit Tesfaye, Ahmed Shambel. Reproductive health problems of cows under different management systems in Kombolcha, Northeast Ethiopia. Adv. Biolo. Res 2013;7:104-108.
6. Azage Tegegne, Gebremedhin Berhanu, Hoekstra Dirk, Belay B, Mekasha Yoseph. Smallholder dairy production and marketing systems in Ethiopia. IPMSexperiences and opportunities for market-oriented development, 2013. https://cgspace.cgiar.org/handle/10568/27914
7. Abebe Bereda, Zelalem Yilma, Ajebu Nurfeta. Dairy Production System and Constraints in Ezha Districts of the Gurage Zone, Southern Ethiopia. Global Veterinarian 2014;12:181-186.
8. Azage Tegegne and Alemu Gebre-wold. Prospects for Peri-Urban Dairy Development in Ethiopia. In: Fifth National Conference of ESAP (Ethiopian Society of Animal Production). ESAP, Addis Ababa, Ethiopia 1998.
9. Dereje Tadesse. On-farm phenotypic characterization of cattle genetic resources and their production systems in south and north wello zones of Amhara region Ethiopia. Master of Science Thesis, Presented to the School of Graduate Studies of Haramaya University, Ethiopia, 2005.
10. Ketema Hizkias. Dairy development in Ethiopia. In: The role of village dairy co-operatives in dairy development. Smallholder Dairy Development Project Proceedings, Ministry of Agriculture, Addis Ababa, Ethiopia, 2000.
11. Tsehay Reda. Small-scale milk marketing and processing in Ethiopia. In: Rangnekar D and Thorpe W (eds), Smallholder dairy production and marketing—Opportunities and constraints. Proceedings of a South–South workshop held at NDDB, Anand, India, NDDB (National Dairy Development Board), Anand, India, and ILRI (International Livestock Research Institute), Nairobi, Kenya 2001, 352–367.
12. Zegeye Yigezu. Challenges and opportunities of livestock marketing in Ethiopia. In: Proceedings of The 10 annual conference of Ethiopian Society of Animal Production (ESAP), August 22-24, 2002. Addis Ababa, Ethiopia. 2003, 47-54.
13. Azage Tegegne. Financing market-oriented dairy development. The case of Ada'a-Liben *Woreda* Dairy Association. Nether. Urb. Agri. Maga 20039:25-27.
14. Ike A. Urban Dairying in Awassa, Ethiopia. MSc thesis, University of Hohenhei, Stuttgart-Hohenheim, Germany 2002, 113.
15. Yoseph Mekasha. Impact of feed resources on productive and reproductive performance of dairy cows in the urban and peri-urban dairy production system in the Addis Ababa, milk shed and evaluation of non-conventional feed resources using sheep. An MSc Thesis presented to the School of Graduate Studies of Alemaya University. 1999, 3.
16. Mukasa-Mugrewa E. A review of Reproductive Performance of Female Bos indicus (Zebu) Cattle. ILCA Monograph N 6, ILCA, Addis Ababa, Ethiopia, 1989.
17. Getachew Felleke, Medhin Woldearegay and Getnet Haile. Inventory of Dairy Policy–Ethiopia, Target Business Consultants Plc, Netherlands Development Organization (SNV), Addis Ababa, Ethiopia, 2010.
18. Ketema Hailemariam, Tsehay Redda. Dairy production systems in Ethiopia. In: Proceedings of a workshop entitled: Kurwijila LR, Henriksen J, Aboud AOO, Kifaro GC. Strategies for Market Orientation of Small Scale Milk Producers and their Organizations. Morogoro, Tanzania, 1995.
19. Anteneh Addis. The role and performance of livestock in Ethiopia. In the 3rd National Livestock Improvement Conference. May. 1989, Addis Ababa, Ethiopia, 2010.
20. Giday Yifter. Assessment of calf crop productivity and total herd life of Fogera cows at Andassa ranch in North - western Ethiopia. MSc Thesis, Alemaya University, Alemaya, Ethiopia, 2001.
21. Zewdie Wondatir. Livestock Production Systems in Relation with Feed Availability in the Highlands and Central Rift Valley. M.Sc. Thesis, submitted to the School of Animal and Range Sciences, School of Graduate Studies, Haramaya University, Ethiopia, 2010.
22. Habib MA. Analysis of Red Chittagong Cattle Genotype in Nucleus Breeding Herd. Ph.D. Dissertation, Department of Animal Breeding and Genetics, Bangladesh Agricultural University, Mymensingh, 2011, 158.
23. Shiferaw Y, Tenhagen BA, Bekana M, Kassa T. Reproductive performance of crossbred cows in different production systems in the central highlands of Ethiopia. Trop. Anim. Health and Prod 2003;35:551-561.
24. Getinet Mekuriaw, Workneh Ayalew and Hegde B. P. Growth and reproductive performance of Ogaden cattle at Haramaya University, Ethiopia. Ethiopian Journal of Animal Production (EJAP) 2009;9(1):13-38.
25. Yosef Tadesse. Genetic and non-genetic analysis of fertility traits in holetta and ada'a berga dairy herds Ethiopia. MSc Thesis, submitted to facility of Agriculture, Alemaya University, 2006.
26. Aynalem Hailie. Genetic and economic analysis of Ethiopian Boran cattle and their crosses with Holstein Friesian in Central Ethiopia. A PhD dissertation, in Animal Genetics and breeding. Haryana, India, 2006, 196.
27. Addisu Bitew. Evaluation of reproductive and growth performance of Fogera cattle and their F_1 Friesian crosses at Metekel ranch, Ethiopia. M.Sc. Thesis, Alemaya University of Agriculture, Alemaya, Ethiopia. 1999.
28. Goshu Mekonnen and Mekonnen Haile-Mariam, 1996.

Reproductive performance of zebu, Friesian and Friesian-Zebu crosses. Tropical Agriculture 72(3), pp 13-38

29. Enyew N, Brannang E, Kebede B, Rottmann OJ. Reproductive performance of dairy cattle at Asella livestock farm, Arsi, Ethiopia. I: Indigenous cows versus their F1 crosses. J. Anim. Breed. Genet 1998;115:267-280.

30. Zewdu Wuletaw, Wurzinger M, Tadele D, Sölkner J. Potential of indigenous animal genetic resources as an adaptive mechanism on climate change: The case of Mahibere-Slassie composite cattle breed. Proceeding of Agricultural economics society of Ethiopia 2004.

31. Million Tadesse, Tadelle D, Gifawesen T, Tamirate D Yohanis G. Study on Age at First Calving, Calving Interval and Breeding Efficiency of Bostaurus, Bosindicus and their Crosses in the Highlands of Ethiopia. Ethiopian Journal of Animal Production 2006;6(2):1-16.

32. Gebrekidan Tsegaye, Zeleke Mekuriaw, Gangwar S. Reproductive and productive performance of dairy cattle in central Zone of Tigray, northern Ethiopia. Int. J Adv. Bio. Res 2012;2(1):58-63.

33. Msangi B, Bryant M, Thorne P. Some factors affecting variation in milk yield in crossbred dairy cows on smallholder farms in North-East Tanzania. Trop. Anim. Health Prod 2005;6:403-412.

34. Arbel R, Bigun Y, Ezra E, Sturman H, Hojean D. The effect of extended calving intervals in high lactating cows on milk production and profitability. J Dair. Scie. 600-608. Nairobi, Kenya 2001;84:35.

35. Evelyn C. Reproductive performance of crossbred cattle developed for milk production in the semi-arid tropics and the effect of feed supplementation. A PhD thesis submitted to University of Zimbabwe, 2001, 165.

36. Gebeyehu Goshu, Asmare Alemayehu, Asseged Bogale. Reproductive performances of Fogera cattle and their Friesian crosses in Andassa ranch Northwestern Ethiopia. Live. Rese. Rur. Deve 2005;17:131-135.

37. Kefelegn S, Ashenafi M, Kassahun M, Adey M. Assessment of Reproductive and Productive performance of Dairy cattle breed in three districts of East Shoa Zone, Central Ethiopia. Proceedings of the 21st Annual Conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia, August 2013, 28-30, 2013, 271-278.

38. Tewodros Bimerew. Assessment of Productive and Reproductive Performance of Indigenous and Crossbred Cattle under Smallholder Management System; in North Gondar, Amhara Region. MSc. Thesis, Mekele University, Ethiopia 2008, 136.

39. Hailemariam M, and Kassa-Mersha H. Genetic and environmental effects on age at first calving and calving interval of naturally bred Boran (zebu) cows in Ethiopia. Animal Production 1994;58:329-334.

40. Melaku Menale, Zeleke Mekuriaw, Getinet Mekuriaw and Mengistie Taye. Pre-weaning growth performances of Fogera calves at Metekel cattle improvement and multiplication ranch, North West Ethiopia. Livestock Research for Rural Development 2011, (9).

41. Ababu Dekeba. Evaluation of performance of Boran cows in the production of crossbred (dairy) heifers at Abernossa ranch Ethiopia. MSc Thesis, Harromaya, Ethiopia 2002.