Journal of Reproduction and Infertility 8 (3): 88-94, 2017
ISSN 2079-2166

DOI: 10.5829/idosi.jri.2017.88.94

Review on Reproductive Performance of Crossbred Dairy Cattle in Ethiopia

Nuraddis Ibrahim and Ahmed Seid

Jimma University, School of Veterinary Medicine, Jimma, Ethiopia

Abstract: The economy of livestock production largely depends upon the reproductive efficiency of the animals. This review is about the reproductive traits of crossbred cattle such as age at first service (AFS), age at first conception (AFC), number of services per conception (NSPC), days open (DO) and calving interval (CI) under Ethiopian conditions. All published materials cited in order to provide some information on values of reproductive traits of crossbred dairy cattle. Finally, factors affecting the reproductive performances of dairy cattle are also discussed.

Key words: Age At First Conception · Age At First Service · Calving Interval · Days Open · Factors · Number Of Services Per Conception

INTRODUCTION

The reproductive performance of dairy cows is the most important factor that is a prerequisite for sustainable dairy production system and influencing the productivity [1].

Underlying all animal breeding studies is the fact that neither all animals nor all breeds are equal. There are differences within and between breeds in production, reproduction, fertility, size, disease resistance and the ability to withstand stress. For instance, the indigenous cattle in the tropics (Bos indicus) are well adapted to the prevailing environmental conditions, but their milk production potential is less than the Bos taurus in temperate regions. Therefore, in tropics dairying on the basis of indigenous cattle alone would not be a quick and suitable option to meet the increasing demand for milk and milk products. The most favored alternative so far, has been cross breeding to incorporate the hardiness of Bos indicus type with the production capacity of Bos taurus animals [2].

Out of the total female cattle population in Ethiopia, only 0.61% and 0.11% heads are hybrid and exotic breeds, respectively. With an average lactation length of 6 months and an average daily milk production of 1.3 liters per cow, the total milk produced during the year 2014/15 in the country was recorded to be 2.765 billion liters [3]. This suggests that the total number of both exotic and hybrid female cattle produced through the crossbreeding work for many decades in the country is quite insignificant indicating unsuccessful crossbreeding work. This again suggests that Ethiopia needs to work hard on improving the work of productive and reproductive performance improvements of cattle through appropriate breeding and related activities.

Dairy cows reproduction is affected by a variety of factors and increasingly trend of intensification the role of the different aspects of management including nutrition and breeding become significant [4]. Reproductive performance traits include number of services per-conception (NSC), calving interval (CI) and days open (DO) are important criteria for profitable dairy farming [5]. However, information is limited about the productive performance of dairy cows in smallholder urban and peri-urban dairy farms in the tropics, particularly in Ethiopia [6].

This review article supports researchers to understand more the reproductive performance parameters and factors influencing reproductive performance under Ethiopian condition. It also helps policy makers to draw sound decisions in order to improve reproductive performance of cattle. The review paper gives information to farmers and bovine breeders regarding reproductive performances improvement of cattle.

Therefore, the objectives of this review paper are to highlight the overall aspects of reproductive performance parameters and to review factors influencing reproductive performance under Ethiopian condition.

Corresponding Author: Nuraddis Ibrahim, Jimma University, School of Veterinary Medicine, P.O. Box: 307, Jimma, Ethiopia. Tel: +251-0471116778, Mob: +251917808966, Fax: +251471110934.

Table 1: Values of age at first service (AFS) and age at first calving (AFC) of crossbred dairy cattle in Ethiopia

Breeds	AFS (months)	AFC (months)	Sources
Friesian x Zebu (F1)	-	29.1	Alberro [16]
Friesian x Arsi (F1)	-	38.1	Negussie *et al.* [18]
Friesian x Zebu (F1)	-	38.6	Negussie *et al.* [12]
Friesian x Horo	-	45.4	Asfaw *et al.* [19]
Friesian x Boran	-	46.8	Asfaw *et al.* [19]
Friesian x Fogera	-	40. 46	Bitew and Prabhagar [20]
Friesian x Zebu	-	35.4	Ermed [21]
Friesian x Zebu	29.58	40.6	Shiferaw *et al.* [22]
Friesian x Fogera	36.8	-	Gebeyehu *et al.* [23]
Friesian x Zebu	25.6	36.2	Mureda and Mekuriaw [24]
Friesian x Zebu	23.1	34.7	Ibrahim *et al.* [25]
Friesian x Zebu	24.30±8.01	36.6±7.6	Duguma *et al.* [26]
Friesian x Horro	33.44±0.7	43.69±0.7	Sisay [27]
Jersey x Horro	31.32±1.0	42.02±1.1	Sisay [27]

Reproductive Performances: The productivity of cattle depends largely on their reproductive performances [5, 7]. The reproductive efficiency of a breeding cow is determined by factors like age at first calving, calving interval and number of services per conception [8 - 10]. The average duration of reproductive life in the dairy cows is about 8-10 years of age, with the production of about 4-6 viable calves [11]. Age at first service (AFS), number of services per conception (NSPC), days open (DO) and calving interval (CI) are the main reproductive indicators aiding the base for a profitable dairy farming [12]. The heritability of these traits is low, so that environmental factors, including management conditions, play a significant role in the variability of the traits [13]. Reports indicated that calving interval of 12 to 13.5 months; number of services per conception of 1. 3 to 1.5 and days' open of 85 days are considered as standard values [14, 15]. In most developing countries, the improvement of productivity has been initiated through crossing of the indigenous breeds with some European breeds [14]. Delayed age at sexual maturity and first calving, high number of services per conception and longer calving interval are major areas of reproductive loss in cattle [5, 16].

Age at First Service (AFS) and Age at First Calving (AFC): The main concern to when young females should be inseminated or bred for the first time is size. The size at time of breeding influences the size of animal at the first parturition. Average age at puberty ranges from 8 to 10 months for European type dairy cows and 17-27 months for Zebu dairy cows. Recommended body weight of Holstein at the first service and the first calving are 340 kg and 500kg, respectively. The significance of size at the first parturition relates to both uncomplicated parturition and productivity of the female. Heifers of the dairy breeds' should reach the desired the first [t] breeding weight at an average of 15 months, so that they can calve at approximately 24 months of age. Heifers that calve at 24 months on the average will have a higher life time production than those calving later [17].

Alberro [16] reported that Ethiopian zebu (Bos indicus) cattle reach puberty at about 22.6 months of age than Bos taurus cattle and their crosses (F_1 crosses) which reach's puberty at about 17 months of age which are kept under tropics and subtropics (Table 1).

Calving to First Service Interval (CFSI) and Calving to Conception Interval (CCI): During pregnancy the high level of circulating progesterone and estradiol are associated with a marked reduction in the LH content of anterior pituitary and this is one of the initial limitation to the resumption of normal estrus cycle in postpartum cows. Removal of negative feedback at parturition affects the hypothalamic-hypophyseal axis, increasing the releasable pool of LH and the frequency of LH pulses. Pulse frequency increases gradually, leading to the final stage of follicular development and ovulation by 50 days postpartum in the majority of milked cows. Cows with extend postpartum intervals of anoestrus become cyclic late in breeding season or fail to exhibit estrus at all and thus have less opportunity to re-breed [28]. Dairy cattle resume cycling before uterine recovery is completed. Uterine involution refers to returning of uterus to pelvic area, returning to its non-pregnant size and recovery of normal uterine tone. The average time required for this is 45 days. However, histological studies have shown that another 15 days may be required before the endometrium is histologically normal. Based on this information researchers has for many years recommended that cows not be bred until the first estrus occurring 60 days postpartum [17] (Table 2).

Table 2: Values of calving to first service (CFSI) and calving to conception (CCI;days open)intervals of crossbred dairy cattle in Ethiopia

Breeds	CFSI (Months)	CCI (Months)	Sources
Friesian x Arsi (F_1)	-	6.3±0.3	Negussie *et al*. [17]
Friesian x Zebu (F_1)	-	7.2 ±0.37	Negussie *et al*. [12]
Friesian x Zebu	-	4.03±.29	Ermed [21]
Friesian x Zebu	5.4	7.3	Mureda and Mekuriaw [24]
Friesian x Zebu	-	4.4	Yifat *et al*. [29]
Friesian x Zebu	5.5	5.7	Ibrahim *et al*. [25]
Friesian x Zebu		5.19±1.72	Duguma *et al*. [26]
Friesian x Horro		3.05±0.04	Sisay [27]
Jersey x Horro		2.64±0.1	Sisay [27]

Table 3: Values of CI estimated for crossbred dairy cattle in Ethiopia

Breeds	Estimates (months)	Sources
Friesian x Arsi (F_1)	14.7±0.26	Negussie *et al*. [18]
Friesian x Zebu (F_1)	16.06± 0.37	Negussie *et al*. [12]
Friesian x Horo	17.1±0.82	Asfaw *et al*. [19]
Friesian x Boran	16.3 ±0.08	Asfaw *et al*. [19]
Friesian x Arsi (75%)	18.5	Abdinasir [36]
Bos taurus x Zebu	18.4	Shiferaw *et al.* [22]
Friesian x Zebu	13.45 ± .24	Ermed [21]
Friesian x Zebu	17.8	Mureda and Mekuriaw [24]
Friesian x Zebu	13.8	Yifat *et al*. [29]
Friesian x Zebu	13.93	Ibrahim *et al*. [25]
Friesian x Zebu	21.36±3.84	Duguma *et al*. [26]
Jersey x Horro	12.76±0.3	Sisay [27]
Friesian x Horro	13.43±0.2	Sisay [27]

Calving Interval: Calving Interval has been defined as the interval between two consecutive calvings [10] and has been considered as a very important index of a cow reproductive efficiency and herd performance [30]. Calving interval can be divided into three periods, gestation, post-partum anoestrus (from calving to first estrus) and service period (first postpartum estrus to conception). Length of postpartum anoestrus and service periods are sometimes called the "days open" period and is the part of the calving interval that can be shortened by improved herd management and "days open" period should not exceed 80-85 days if a calving interval of 12 months is to be achieved [31].

Cows bred in between 40 and 60 days postpartum will conceive to first service and those cows will have an average calving interval of 330 days. But, in high producing herds a calving interval as short as 330days should be avoided for optimum milk production. Furthermore, cows that become pregnant to the first service between 60 to 80 days have an acceptable level of calving interval [17]. Calving-to-Conception Interval (CCI) or days open is considered the most important component determining the length of the calving interval. Gestation length, which is more or less constant, varying slightly due to breed, calf sex, litter size, dam age, year and month of calving and little can be done to significantly manipulate the gestation length [32].

The calving interval affects both the total milk production of the dairy herd and the number of calves born. 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 [33, 34] (Table 3).

Number of Service Per Conception (NSPC): Number of services per conception has been defined as the number of services required for a successful conception [22, 36]. According to the authors, number of services per conception depends largely on the breeding system used. It is higher under uncontrolled, natural breeding than hand mating and Artificial Insemination (AI) and Values of NSPC greater than 2 should be regarded as poor [5]. The measurement of service per conception is determined on a herd or flock basis by dividing total services by the number of pregnancies (Table 4). Service per conception have little value for a large population of animals, but is a valid measurement for a single herd or an individual female. On herd basis unidentified sterile female make the calculation less meaningful [37].

Table 4: Values of NSPC estimated for crossbred dairy cattle in Ethiopia

Breeds	Estimates (no.)	Sources
Friesian x Arsi (F_1)	2.01±0.2	Negussie *et al.* [18]
Friesian x Zebu (F_1)	1.76± 0.2	Negussie *et al.* [12]
Friesian x Horo	1.69±0.25	Asfaw *et al.* [19]
Friesian x Boran	1.51± 0.25	Asfaw *et al.* [19]
Bos taurus x Zebu	1.76	Shiferaw *et al.* [22]
Friesian x Fogera	1.54±0.1	Gebeyehu *et al.* [23]
Friesian x Zebu	2.1±0.2	Ermed [21]
Friesian x Zebu	2.16	Mureda and Mekuriaw [24]
Friesian x Zebu	1.62	Yifat *et al.* [29]
Friesian x Zebu	1.29	Ibrahim *et al.* [25]
Friesian x Zebu	1.56±0.57	Duguma *et al.* [26]
Friesian x Horro	1.69±0.1	Sisay [27]
Jersey x Horro	1.75±0.1	Sisay [27]

Factors Affecting the Reproductive Performances of Dairy Cattle: The reproductive performances of animals depend not only on their genetic merits, but also on other factors such as nutrition, management, health and environment. Many factors influence the reproductive performances of lactating dairy cows. Management factors such as accuracy of heat detection, inseminating techniques, semen handling and herd health policies can directly influence the reproductive performances of a dairy herd. In addition other factors beyond the immediate control of management may impact fertility; these factors include milk production of the cow, age of the cow and season of year [18, 22, 32, 38].

Nutrition: Nutrition affects the age at puberty. Low nutrition intake will delay puberty because the time of onset of puberty appears more of size than age. In tropics under conditions of very poor nutrition and high degree of environmental stress, some heifers may in fact not attain puberty until 3 years of age. The duration of post-partum anoestrus is affected by season of the year and level of nutrition before and after parturition. Adequate nutrition before and during the postpartum period is even more critical in primiparous animals because of the nutritional requirements for growth in addition to those of lactation during the postpartum period. Inadequate or improper nutrition during postpartum period induce delayed postpartum estrus, silent estrus, delayed ovulation, decreased ovulation rate, low conception rate and increase embryonic mortality reported nutritional condition that vary seasonally and yearly have major effect on calving interval [28, 39-41]. Conversely long term feeding at high levels has been shown to reduce pregnancy rates, increasing the proportion of barren animals and increases the prevalence of dystocia [37].

Environment and Heat Stress: The environment in which a calf is reared (photoperiod) and temperature affects the age at puberty. Calves reared in spring to summer condition of high temperature and long photoperiod reach puberty at younger age than do those reared in fall to winter condition of low temperature and short photoperiod. In addition contact with mature bull also affects age at puberty [28].

Many studies have shown that conception rates are reduced when ambient temperature is high. The effect of heat stress is primarily up on the early embryo. Most studies showed a normal fertilization rate, but the embryonic death occured between fertilization and day 16. Heat stress causes significant impairments of many parameters of reproductive performances notably causing anoestrus and slower postpartum uterine involution [37]. Ability to detect estrus in Bos taurus declines during periods of heat stress. This decline occurs in large part because of the reduction in duration of estrous behavior. In contrast with Bos taurus, evidence for decreased duration of estrus in Bos indicus by heat stress is scarce. The proportion of ovulation without detected estrus is greater in winter than in summer. Potentially heat stress could cause pregnancy loss by exerting actions on the oocyte, embryo or reproductive tract. Furthermore, disruption of pregnancy could occur because of the direct effect of elevated temperature on cellular function or as an indirect consequence of physiologic changes for regulation of body temperature [42].

Herd Size and Housing: Confinement represents the most recent example of large scale, mandible alterations in the environment in which cattle exist. It is reasonable to assume that, as with any environmental change, confinement has increased the stress imposed on cattle. Concrete flooring reduces the expression of estrous intensity and lameness, which is one of the consequences of housing. Flies are abundant in confined housing and some data indicate that exposure to flies exacerbates problems of heat stress [42].

Closely associated with increased herd size, there is a reduction in the accuracy and efficiency of estrous detection. In large herds cows loss their individual identity, they are not so accurately identified and hence the slight changes in behavior, which in a small herd might warn the herd's man of approaching estrus are not seen. Confined spaces and muddy floors sometimes prevent cows from showing signs of estrus [7].

Breed: Both weight and age at puberty differs substantially among breeds of cattle and both are decreased by heterosis. Bos indicus heifers generally reach puberty at an older age than Bos taurus heifers [28]. Bos indicus, zebu or their crosses are more heat tolerant and have a higher fertility during spring, summer and fall months in countries near equator. They tend to be less fertile in the winter month. European cattle or cattle of the temperate zone are less adapted to hot climate [11].

Breeding System, Estrus Detection and Time of Insemination: Reproductive performance is influenced by cow and management/environment-related factors, such as method and efficiency of heat detection, type and efficiency of breeding service, the ability of the cow to resume regular ovarian cyclicity after calving and to display an overt heat signs and conceives with the given service [34]. The success of AI service is another important factor in determining the reproductive performance and that most common measure is non-return rate [28]. Inseminator effect was greater than the farm effect on the NSPC [43]. Number of service per conception depends largely on the breeding system used. It is higher under uncontrolled natural breeding and low where hand-mating or artificial insemination is used [5]. Some heifers fail to show overt signs of estrus yet have normal cyclical activity, a condition referred to as "silent heat". This may however, be due to failure of the herd's person to observe the signs rather than a failure of the cows to show signs [37]. Incorrect time of insemination, incorrect AI technique and inadequate handling and storage of semen are some of the causes of repeat breeding. The correct timing of AI is depend up on the true, accurate and early identification of estrus, the accurate identification of the individual animal and informing the AI organization at the correct time [7].

Reproductive and Non-Reproductive Health Problems: Obvious pathological lesions of the reproductive organs, infectious diseases, impaired uterine environment, luteal deficiency and chronic degeneration of endometrium causes impairment of reproductive performances [37]. Retained placenta and postpartum reproductive problems are more frequent after dystocia and results in uterine infection, delayed postpartum estrus, reduced fertility and extended CI. Infectious diseases such as vibriosis, leptospirosis, brucellosis, trichomoniasis and salmonellosis interfere with the reproduction of dairy cattle [17].

Level of Production and Suckling: The duration of post- partum anoestrus is affected by level of production and suckling as a distinction from milking, in that the interval from calving to 1st estrus was greater in cows with higher production and in cows nursing calves or being milked 4 times a day. A longer postpartum interval to 1st estrum occurred in nursed dairy cows because suckling reduced the supply of or release of gonadotropin hormones [11].

Parity Status: Involution of uterus is prolonged in pluriparous cows when compared to primiparous cows and the interval from calving to 1st estrus is greater in older pluriparous cows with 4 or more parturitions [11].

CONCLUSIONS

In Ethiopia, crossbred dairy cattle mainly are crosses of zebu with Holstein-Friesian. The mean CI was near to the optimum, however the mean values for CFSI and CCI were extended length which affect the period of productive life and extending the CI beyond the desired range. The mean values of NSPC are at the optimum. With efficient management of postpartum cows, it is possible to shorten the CFSI and CI. It is concluded that by improving the management system it is possible to improve the reproductive performances of the crossbred dairy cattle in the country.

REFERENCES

1. Kiwuwa, G.H., J.C.M. Trail, M.Y. Kurtu, G. Worku, F. Anderson and J. Durkin, 1983. Crossbreed dairy cattle productivity in Arsi region, Ethiopia. ILCA Research Report 11. International Livestock Centre for Africa, pp: 1-29.
2. Norman, G.A. and P.E. Felicio, 1981. Effects of breed and nutrition on the reproductive traits of Zebu, Charolais and cross bred beef cattle in South east Brazil. Meat science, 5: 425-430.
3. CSA (Central Statistical Agency), 2014. Federal Democratic Republic Of Ethiopia. Agricultural Sample Survey of 2014 (2007/2008 E.C). Volume II. Report on Livestock and Livestock Characteristics (Private Peasant Holdings), Central Statistical Agency, Addis Ababa, Ethiopia.
4. Galina, C.S. and G.H. Arthur, 1999. Review of cattle reproduction in the tropics. World Journal Agricultural Society, 72: 68-78.

5. Mukasa-Mugrewa, E., 1989. A review of Reproductive Performance of Female Bos indicus (Zebu) Cattle. ILCA Monograph N 6, ILCA, Addis Ababa, Ethiopia.
6. Lobago, F., M. Bekana, H. Gustafsson and H. Kindahl, 2007. Longitudinal observation on reproductive and lactation performances of smallholder crossbred dairy cattle in Fitche, Oromia region, central Ethiopia, Tropical Animal Health and Production, 39: 395-403.
7. Arthur, G.H., D.E. Noakes and H. Person, 1989. Veterinary Reproduction and Obstetrics.6th ed. Bailliere-Tindall. London, UK, pp: 344-442.
8. Falvey, L. and C. Chantalakhana,, 1999. Smallholder Dairying in the Tropics, pp: 255-256.
9. Belihu, K.D., 2002. Analysis of dairy cattle breeding practices in selected areas of Ethiopia. PhD thesis, Humbolt University of Berlin, Department of Animal Breeding in tropic, Berlin, Germany.
10. Haile, A., 2006. Genetic and economic analysis of Ethiopian Boran cattle and their crosses with Holstein Fresian in central Ethiopia. PHD thesis, division of dairy cattle breeding national dairy research institute (ICAR) Karnal-132001 (Haryana), India.
11. Stephen, J.R., 2002. Veterinary Obstetrics and Genital disease. 2nd ed. Skojain for CBS. Darya Ganj, New Delhi, India, pp: 96-376.
12. Negussie, E., E. Bränänag and O.J. Rottmann, 1999. Reproductive performance and herd life of crossbred dairy cattle with different levels European inheritance in Ethiopia. In: Proceedings of the 7th annual conference of Ethiopian Society of Animal Production (ESAP), Addis Ababa, Ethiopia, pp: 65-76.
13. Olori, V.E., T.H. Monwissen and H. Veerkamp, 2002. Calving interval and survival breeding values as measure of cow fertility in a pasture-based production system with seasonal calving. Journal of Dairy Science, 85(3): 689-696.
14. McDowell, R.E., 1985. Crossbreeding in tropical areas with emphasis on milk, health and fitness. Journal of Dairy Science, 68: 2418-2435.
15. Radostits, O.M., 2001. Herd Health: Food Animal Production Medicine. 3rd ed., Philadelphia, pp: 255-260.
16. Alberro, M., 1983. Comparative performance of F1 Friesian x Zebu heifers in Ethiopia. Animal Production, 37: 247-252.
17. Joe, H., W. John and T. Scott, 2004. Applied animal reproduction. 6th ed. Mississippi state university. Upper Saddle River, New Jersey, pp: 61-302.
18. Negussie, E., E. Brannang, K. Banjaw and O.U. Rottmann, 1998. Reproductive performance of dairy cattle at Assella livestock farm, Arsi, Ethiopia. I: Indigenous cows versus their F1 crosses. Journal of Animal Breeding and Genetics, 115: 267-280.
19. Asfaw, C., G. Gebreyohannes, G. Kebede, M. Kebede and A. Tola, 1999. Reproductive performance and lactation yield of F1 (Bos indicus X Bos taurus) animals at Bako. In: Proceedings of the 7th annual conference of the Ethiopian Society of Animal Production (ESAP), Addis Ababa, Ethiopia, pp: 386-396.
20. Bitew, A. and H.B. Prabhakar, 2003. Reproductive and growth performance of Fogera cattle and their F1 Friesian crosses at Metekel ranch, Ethiopian. In: Proceedings of the 10th annual conference of the Ethiopian Society of Animal Production (ESAP), Addis Ababa, Ethiopia, pp: 119-126.
21. Ermed, H., 2004. Evaluation of reproductive performance of F1 Friesian –Zebu crosses under small holder production systems in urban and peri-urban areas of North Gondar, Ethiopia. In Abstracts of DVM thesis (1985-2005), Faculty of Veterinary Medicine, Addis Ababa University, Debrezeit, Ethiopia.
22. Shiferaw, Y., B.A. Tenahegen, M. Bekana and T. Kassa, 2003. Reproductive performance of dairy cows in different production systems in central highlands of Ethiopia. Tropical Animal Health Production, 35(6): 551-561.
23. Gebeyehu, G., A. Asmare and B. Asseged, 2005. Reproductive performances of Fogera cattle and their Friesian crosses in Andassa ranch, Northwestern Ethiopia. Addis Ababa University, Faculty of Veterinary Medicine.
24. Mureda, E. and Z. Mekuriaw, 2007. Reproductive performance of crossbred dairy cows in Eastern Lowlands of Ethiopia. Agricultural College, ATVET, Holleta, Ethiopia.
25. Ibrahim, Nuraddis, Ashebir Abreha and Shiferaw Mulegeta, 2011. Assessment of reproductive performance of crossbred dairy cattle (Holstein Frisian X Zebu) in Gondar town. Global Veterinary, 6(6): 561-566.

26. Duguma Belay, Kechero Yisehak and G.P.J. Janssens, 2012. Productive and Reproductive Performance of Zebu X Holstein-Friesian Crossbred Dairy Cows in Jimma Town, Oromia, Ethiopia, Globalal Veterinaria, 8(1): 67-72, ISSN 1992-6197, © IDOSI Publications.
27. Sisay Eshetu Dabi, 2015. Productive and reproductive performance of dairy cows (Horro, Horro X Friesian and Horro X Jersey) at Bako agricultural research center, A Thesis Submitted to Department of Animal and Range Sciences, School of Graduate Studies, in Partial Fulfilment of the Requirements for the Degree of master of science in agriculture (animal production), Haramaya University, Ethiopia.
28. Perry, T., 1991. Reproduction in domestic animals. 4th ed. Academic press, INC. Santiago, New York, Boston, Toronto, London, Sydney, Tokyo, pp: 445-577.
29. Yifat, D., B. Kelay, M. Bekena, F. Lobego, H. Gustafsson and H. Kindahl, 2009. Study on the reproductive performance of cross breed dairy cattle under small holder conditions in and around Zeway. Livestock Research for Rural Development, 21: 6.
30. Masama, E., K.T. Kusine, S. Sibanda and C. Majoni, 2003. Reproduction and lactation performance of cattle in a smallholder dairy system in Zimbabwe. Trop. Anim. Hlth. Prod., 35: 117-129.
31. Peters, A.R., 1984. Reproductive activity of the cow in the postpartum period.1. Factors affecting the length of the postpartum acyclic period. British Veterinary Journal, 140: 76-83. Radostits, O. M., 2001. Herd Health: Food Animal Production Medicine. 3rd ed., Philadelphia, pp: 255-260.
32. Mukasa-Mugrewa, E., A. Tegegne, T. Mesfin and Y. Teklu, 1991. Reproductive efficiency of Bos indicus (zebu) cows under artificial insemination management in Ethiopia. Animal Reproduction Science, 24: 63-72.
33. Roberts, S. J., 1986. Veterinary Obstetrics and Genital Diseases. 3rd ed., Woodstock, VT., pp: 253.
34. Arbel, R., Y. Bigun, E. Ezra, H. Sturman and D. Hojean, 2001. The effect of extended calving intervals in high lactating cows on milk production and profitability. Journal of Dairy Sci., 84: 600-608.
35. Abdinasir, I.B., 2000. Smallholder dairy production and dairy technology adoption in the mixed farming system in Arsi highland, Ethiopia. PhD thesis. Humboldt University of Berlin, Department of Animal Breeding in the Tropics and Subtropics. Germany.
36. Shiferaw, Y., B.A. Tenhagen, M. Bekena and T. Kassa, 2005. Reproductive disorders of crossbred dairy cows in the central highlands of Ethiopia and their effect on reproductive performance. Tropical Animal Health and Production Journal, 37(5): 427-441.
37. Noakes, D.E., T.J. Parkinson and G.C.W. England, 2001. Arthur’s Veterinary Reproduction and Obstetrics. 8thed. Saunders. Edinburgh, London, New York, Oxford, Philadelphia, ST Louis, Sydney, Toronto, pp: 446-463.
38. Hillers, J.K., P.L. Senger, R.L. Darlington and W.N. Fleming, 1984. Effects of production, season, age of cow, days dry and days in milk on conception to first service in large commercial herds. Journal of Dairy Science, 67: 861-867.
39. Oliveira, F.E.B., 1974. Age at first calving, service period and calving interval in a Nellore herd. Thesis, Universidad Federal de Minas Gerais, Brazil, pp: 80.
40. Oyedipe, E.O., D.I.K. Osori, O. Akerejola and D. Saror, 1982. Effect of level of nutrition on onset of puberty and conception rates of zebu heifers. Theriogenology, 18: 525-539.
41. Hailemariam, M. and H. Kassamersha, 1994. Genetic and environmental effects on age at first calving and calving interval of naturally bred Boran (Zebu) cows in Ethiopia. Animal Production, 58: 329-334.
42. Young, Q.R.S. and F.W.R. Threl, 2007. Current Therapy in Large Animal Theriogenology. Sounders, USA, pp: 431-441.
43. Busch, W. and L. Furstenberg, 1984. The environmental influences upon the reproductive performance in cattle. In: 10th International Congress on Animal Reproduction and Artificial nsemination, 10-14 June 1984. University of Illinois, Urbana-Champaign, Illinois, USA. Paper No. 132. pp: 3.