J. Sylhet Agril. Univ. 4(1):27-34, 2017 ISSN: 2308-1597

REVIEW ON REPRODUCTIVE PERFORMANCES OF DAIRY COWS

M M R Howlader and M M Rahman

Department of Physiology, Faculty of Veterinary, Animal and Biomedical Sciences
Sylhet Agricultural University, Sylhet-3100, Bangladesh

(Available online at: www.jsau.com.bd)

Abstract

This work was conducted to review the reproductive performance of dairy cows based on the reports published elsewhere. The overall least square mean of age at puberty of crossbred dairy cow ranged from 748.71±22.5 to 752±10.9 days, overall least square mean of number of services per conception (NSC) of crossbred dairy cattle ranged from 1.33±0.2 to 2.44±0.58. Similarly, the overall mean calving interval (CI) varied from 488 to 612±4.56 days as reported by different researchers in the different agro-ecology of the country in different times. The season and year of calving had its own influence on caving interval. The least square mean of age at first calving (AFC) of crossbred dairy cow ranged from 661±14 to 1059±198 days. The age at first service correlated with the age at puberty and it depends on to the different agro-ecology of the country in different time. The overall least square mean of age at first service varied from 588 to 752±10.9 days. The overall least square mean of postpartum heat period ranged from 74.5±1.6 to 114.5±73.00 days. The duration of estrus varies according to the season, breed etc. The overall least square mean of duration of estrus ranged from 5.1±1.1 to 34±0.85 hour. Generally the reproductive performance of crossbred dairy cow in different region and different agro-ecology are relatively better than the values reported for indigenous cattle breeds.

***Keywords*:** Puberty, first service, first calving, services per conception, calving interval, estrus duration, postpartum heat period, gestation period.

Introduction

The livestock populations are distributed throughout the different countries of the world. This livestock sector has been contributing considerable portion to the economy of the different countries of the world and still promising to rally round the economic development of the whole world from the very beginning human civilization. The world cattle inventory was at 998.599 million head in 2016. India had the largest cattle inventory in the world in 2016 followed by Brazil and China. Roughly 63% of the world's cattle are in India, Brazil and China. The United States of America had the 4th largest cattle population in the world in 2016 (FAS/USDA, 2016; Table 1). Among the total cattle population, the total dairy cattle populations are 264,470,504. India constitutes the highest number of dairy cows 43.6 million which represents the 16.5% of the total dairy cows of the world. The Brazil and China are the third and fourth largest country of the world that contains 22.92 million and 14.97 million dairy cows, respectively. Though United States of America contains the fourth highest number of cattle population as mentioned earlier, but in case of dairy cows populations are on the seventh place that contains 9.11 million. Bangladesh contains a total of 4.047 million dairy cows which represents1.5% of the world dairy cows population (FAO stat, 2012).

Even some countries have a large cattle population such as Bangladesh, Egypt, Ethiopia, etc. but the reproductive performance and the productivity of the indigenous cattle breed is low. Usually, cows do not produce their first calf from than 35-53 months of age and calving interval is about two years. Cross breeding is a satisfactory procedure for profitable livestock production. It's widely used in the world in order to enhance production of milk, meat, particularly at commercial farms. Significant heterosis values were usually obtained under optimum conditions by combining indigenous and exotic (Abejehu *et al*., 2002).

***Corresponding author: M M R Howlader,** *Department of Physiology, Faculty of Veterinary, Animal & Biomedical Sciences, Sylhet Agricultural University, Sylhet-3100, Bangladesh, Email:howlader.sau@gmail.com*

Table 1.Country wise cattle population throughout the world

Name of the country	Cattle Population	Percentage of Cattle (%)
India	302,600,000	30.61
Brazil	219,180,000	22.17
China	100,275,000	10.14
United States	91,988,000	9.30
European Union	89,152,000	9.02
Argentina	52,565,000	5.32
Australia	27,413,000	2.77
Russia	18,838,000	1.91
Mexico	16,615,000	1.68
Turkey	14,127,000	1.43
Canada	11,995,000	1.21
Uruguay	11,950,000	1.21
New Zealand	10,033,000	1.01
Egypt	6,725,000	0.68
Belarus	4,356,000	0.44
Ukraine	3,875,000	0.39
Japan	3,824,000	0.39
Others	3,164,000	0.32
Total	988,599,000	100

Source: (FAS/USDA, 2016)

The reproductive performance of the herd or animal is a key indicator of sustainability of a dairy farming system. The better performance with regard to the reproductive efficiency of the heifers and cows incorporated age at first service and calving, parturition to the service, calving interval, gestation length, daily and total milk yield, age and body weight of cow influence the onset of estrus and the subsequent fertility after calving (Khan *et al*., 1998). However, assessment of productive and reproductive performance be influenced on composite parameters to assess overall performance evaluation (Islam *et al*., 2006). The important parameters that determine cattle reproductive performance are age at first service, age at first calving, calving to first service interval and calving interval (Dematawa and Berger, 1998). They also reported that these parameters are important in terms of economics of dairy management. Similarly, Mukasa-Mugerwa (1989) reported that the most important parameters to assess the farm economy are calving interval, age at puberty, service per conception, gestation length and among which calving interval is deliberated as probably the best index of a cattle herd to measure reproductive efficiency. Biologically, potential for milk production also depends on age at puberty, early first calving, number of parity and shorter calving interval (Islam *et al*., 2006).

However, in most of the developing countries such detail or comprehensive baseline information are not available, nor studies are being followed to understand and establish information relating to important reproductive performance of the existing dairy breeds and their crossbred. Thus, a need was felt to understand and document the important parameters relating to reproductive performance of dairy breeds and their crossbred in different countries of the world. This information could serve as the basis for the exploitation of genetic potential to further dairy industry development in the country and might also be useful for the policy makers in the process of planning and making accurate decisions pertaining to dairy development. Accordingly, this study was conducted to recognize and document detail baseline information on the reproductive performance parameters of the dairy cattle and their crossbred at the national level and at the international level.

Reproductive performance

Reproductive performance is a trait of outstanding importance in dairy cattle enterprise. The size of the calf crop is all-essential for herd replacement, and the production of milk depends heavily on reproductive activity. Possible genetic improvement in virtually all traits of economic importance is closely tied to reproductive rate. Reproductive traits describe the animal's ability to conceive, calve down and suckle the calf to weaning successfully (Davis, 1993); these traits are important since they affect the herd size. Reproductive performance is commonly evaluated by analyzing female reproductive traits (Aynalem *et al*., 2011) of a combination of many traits (Olawumi and Salako, 2010). Reproduction is an indicator of reproductive efficiency and the rate of genetic progress in both selection and crossbreeding programs particularly in dairy and beef production (Mukassa-Mugerewa and Azage, 1991). High reproductive efficiency is necessary for efficient milk production and has an important influence on herd profitability (Pryce *et al*., 2004). Reproductive efficiency is expressed by the extent of reduction of reproductive wastage and it affects lifetime milk and meat production (Nuraddis, 2011). The main indicators that would be considered in assessing reproductive performance are age at puberty, age at first calving, calving interval and number of services per conception (Yifat, 2009; Habtamu *et al*., 2010; Aynalem *et al*., 2011; Demissu *et al*., 2013). Differences in breeding efficiency are largely due to environment, although between breeds heredity also plays a part in the variation of reproductive performance.

Age at puberty

Puberty is defined in heifers as the time when they first ovulate and show an estrus or heat period. The process involves sensitivity to hormones and receptors in the brain (specifically the hypothalamus) and the ovaries in females (Steve Boyles).

As some researchers reported that the average age at puberty of heifers was found 612±36 days or 20.4±1.2 month in case of crossbred dairy cow in Bangladesh (Paul *et al*., 2013). Some researchers reported that average age at puberty of Jersey crossbred cows was different in various seasons of the year. According to them age at puberty in winter season was 988.5±14.58 days, while 968.77±7.43 days in summer, indicating short puberty age in winter than summer (Varade *et al*., 1997).

Table 2. Age at puberty of dairy cows

Types of dairy cow	Country	Age at puberty (days)	Reference
Shahiwal cross	Bangladesh	612±36	Paul *et al*., 2013
Jersey cross	India	988.5±14.58 (winter)	Varade *et al*., 1997
		968.7±7.43 (summer)	Varade *et al*., 1997
Holstein Friesian	India	466±115	Chaudhury , 1986
Holstein cross	Pakistan	752±10.9	Qureshi *et al*., 2000
Jersey	Pakistan	748.7±22.5	Ahmad *et al*., 2007
Exotic crossbred	Pakistan	752±38.5	Sayed *et al*.,1994
Brahman	U.S.A	582	Plasse*et al*., 1970

The age at puberty may vary due to the difference in climatic condition, inadequate feeding and management practices under field condition. The average age at puberty were 752±38.5 days (Sayed *et al*., 1994), 752±10.9 days

(Qureshi *et al*., 2000), 748±22.5 days (Ahmad *et al*., 2007) in crossbred cattle in Pakistan. In contrast, Chaudhury (1986) reported that a mean age at puberty in 50 percent Holstein Friesian heifers as 466.0±115 days in India. In United States of America, the average age at puberty of Brahman heifer was 19.4 month or 582 days (Plasse *et al*., 1970).

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.

Table 3. Age at first service of dairy cow

Types of cow	Country	Age at first service (days)	Reference
Jersey cross	Bangladesh	854.4±34.1	Nahar *et al*., 1992
Friesian cross		919.6±17.4	Nahar *et al*., 1992
Shahiwal cross	Bangladesh	876±192	Sarder, 2006
Exotic crossbred	Ethopia	722.24±36.4	Lemma *et al*., 2010
		568.8±36.4	Tadesse *et al*., 2014
		561±3.7	Genzebu *et al*., 2016
		729±8.01	Belay *et al.*, 2012
		747	Dinka *et al.*, 2012
		696	Nuraddis *et al*., 2011
Local	Bhutan	813±0.16	Wangdi *et al.*, 2014

As some researchers reported that the average age at first service of Jersey×Deshi, Holstein Friesian×Deshi were found 854.4±34.1 days, 919.6±17.4 days (Nahar *et al*., 1992), respectively in Bangladesh. Sarder (2006) reported that the average age at first service was 876±192 days in exotic crossbred in Bangladesh. In Bhutan, the age at first service of dairy cattle was 813 days (Wangdi *et al*., 2014). As some researchers reported that the average age of heifers at first service was 18.96 month/568.8 days (Tadesse *et al*., 2014), 24.1 month/722.24 days (SE=36.4) (Lemma *et al*., 2010), 561±3.7 and 561±3.5 days old for crossbred cattle reared by the farmers in Bishoftu and Akaki in Ethiopia, respectively, reported by Dessalegn Genzebu (2016), Belay *et al.* (2012) where the age at first service of crossbred dairy cows were 729±8.01 in Jima Town and 27.5 months /825 days of age at first calving crossbred dairy cows reported by Zewdie (2010) in the highlands and central rift valley of Ethiopia, 24.9 months/747 days (Dinka *et al*., 2012, Nuraddis *et al*., 2011), with 696 in Gonder town, Mureda and Mekuriaw (2007) with 768 days of age at first service in Dire Dawa for other crossbreds of exotic and local cattle.

Age at First Calving

Age at first calving is the age at which heifers calve for the first time. As some researchers reported that the average age at first calving of Jersey×Deshi, Holstein Friesian×Deshi were found 1002.3±49.4 days, 1201.4±29. 6days (Nahar *et al*., 1992), respectively in Bangladesh. The average age at first calving of crossbred and indigenous cows was 31.2 ± 1.3 and 37.6 ± 1.3 months, respectively (Paul *et al*., 2013), under rural context at Shirajgonj district of Bangladesh. In recent research, the age at first calving of crossbred cow and indigenous cow were 924.34±61.9 and 1090±192 days/animal, respectively (Manjusha *et al*., 2016) at Haryana in India. Some researcher reported that the average age at first calving was 661±14 days (Nawaz *et al*., 1993) in Jersey cow in Pakistan after importing from U.S.A. The average age at first caving (AFC) reported was 29.52 month in Debra Tabor town (Tadesse *et al*., 2014),1035 days (SE=12.59) (Lemma *et al*., 2010), 32.9 ± 0.3 was reported in Arsi region (Kiwuwa *et al*., 1983), Genzebu (2016) reported 26.9±5.4 and 27.0±3.7 months of age at first calving for crossbred cattle in Bishoftu and Akaki in Ethiopia, respectively, 31.9±0.22 months was reported by Yifat *et al*. (2009) for cross breed in Ziway, 34.8 months (range 27 to 46 months) reported under small holder condition in Ethiopia (Dinka *et al*., 2012). Age at first calving depends on various factors like the breed of animal, feeding, heat detection, animal health, breeding method etc. two and half years are considered as ideal for a crossbred cow to calve for first time. The higher age at first calving observed here may be related to environmental conditions and husbandry practices which may affect the cattle growth. These may retard growth rate, delay puberty, reduced fertility and conception, thus, the higher age at

first calving of the imported breed. Hence, there should be concerted efforts to improve the feeding and nutrient profile of feeds offered to the animals, housing, disease prevention and management especially during harsh climatic conditions in order to improve on age at first calving (Dessalegn Genzebu *et al*., 2016). Researchers stated that year of birth had significant effect on the age at first calving which means age at first calving increased as year goes (Melaku *et al*., 2011, Giday *et al*., 2001, Addisu *et al*., 1999).

Number of Service per Conception

Number of service conception^{-1} depends largely on the breeding system used. It is higher under uncontrolled natural breeding than hand-mating and artificial insemination (Gabriel *et al*., 1983). Number of service conception^{-1} higher than two should be considered as poor (Mugrewa, 1989). Some researcher reported that the number of service conception^{-1} in deshi and crossbred cow were 1.4±0.1 and 1.3±0.1 times, respectively (Paul *et al*., 2013) at Shirajgonj in Bangladesh. Haque *et al.* (2011) reported 1.52±0.14 times in crossbred cow at Sylhet in Bangladesh. Sarder (2006) reported that the number of service conception^{-1} was 1.6±0.63 in crossbred cow. The number of service conception^{-1} in case of indigenous milking cow and jersey cross was found 1.22±0.2 and 1.43±0.3 times, respectively (Hossen *et al*., 2012). The service conception^{-1} of crossbred cow and indigenous cow was 2.44±0.58 and 2.06±0.22 times per animal, respectively (Manjusha *et al*., 2016) at Haryana in India. Some researcher of Pakistan reported that the average number of service conception^{-1} was 1.52±1.5 times (Ahmad *et al*., 2007) in Jersey cattle, 1.6±0.1 times (Qureshi *et al*., 2000) in crossbred cow. The overall mean of the number of services conception^{-1} reported in Gondor was the average 1.8±0.3 (Kumar *et al*., 2014). Indigenous cows had the significantly higher number of service conception^{-1} (2.2±0.2) than that of Holstein Friesian crossbreds 1.5±0.3 (Kumar *et al*., 2014). Islam (2004) reported that the number of service conception^{-1} (NSC) is influenced by the quality of semen used in AI, improper detection of heat, failure to inseminate at proper time and skill of the inseminator and level of fertility, which could be enhanced by diseases, semen handling techniques and other environmental factors.

Calving Interval

The interval between the birth of a calf and the subsequent birth of a calf from the same cow called calving interval. The mean calving interval of Deshi, Shahiwal cross, Friesian cross and Jersey cross was 15.4 ± 0.7, 15.0 ± 3.0, 14.2 ± 0.5 and 14.1 ± 0.6 months, respectively (Paul *et al*., 2013) at Shirajgonj in Bangladesh. Sarder (2006) reported that the mean calving interval of crossbred cow was 438±49 days. As some researcher reported that the mean calving interval was 612±4.56 days (Qureshi *et al*., 2000) in Pakistan. Some researcher reported that the calving interval of crossbred cow and indigenous cow were 389.46±13.49 and 405.78±15 days per animal, respectively (Manjusha *et al*., 2016), 451±1.06 days (Hussain *et al*., 2012) in crossbred cows in India. The mean calving interval of local cattle, Jersey cross, Mithun cross, pure Jersey and Brown swiss cross were found 494, 491, 499, 457 and 494 days (Wangdi *et al*., 2014) in Bhutan. The mean calving interval of 450.09 days (SE=6.60) for Jersey was observed in Ethiopia and reported to be affected by the year of last calving, cattle source and parity of dam (Lemma *et al*., 2010).The mean calving interval was 459 ± 4 days reported in Arsi region (Kiwuwa *et al*., 1983), 439.03±66.34 days (Kumar *et al*., 2014) reported in Gondar, 390±2.1 and 398±1.9 days reported for crossbred cattle at Bishoftu and Akaki, respectively (Genzebu *et al*., 2016). The standard calving interval recommended for dairy cattle under tropical conditions was 430 days (Swai *et al*., 2014). The factors like the time of estrous, quality of semen and skill of inseminator, the difference in availability of feed and green fodder, nutritional and health status of animals, particularly the conditions that impact the conception rate in dairy animals, which in turn, affects the duration of calving interval in dairy animals was perceived by Babu (2007).

Estrus Duration

That portion or phase of the sexual cycle of female animals characterized by willingness to permit coitus; readily detectable behavioral and other signs are exhibited by animals during this period (Farlex Partner Medical Dictionary, 2012). The average estrus duration was 34±0.85 hours (Qureshi *et al*., 2000) reported in Holstein Friesian crossbred cow at Peshwar in Pakistan. As some researcher reported that the average duration of estrus was 19-32 hours (Shamsuddin *et al*., 2001) in case of crossbred cow. Some researcher reported that the average estrus duration was 12-19 hours (Oklahama State University Board of Regents, 1999). Some researcher reported that the estrus duration were 11.91±6.1 hours (Hall *et al*., 1959) in various cow in U.S.A, 10.5±3.2 hours (De Alba *et al*.,

1961) in Jersey cow in Costa Rica, 10.1±2.4 hours (Hernik *et al*., 1975) three in estrus in Holstein Friesian in Canada, 5.6±1.1 in cooler and hotter season, respectively, in Thailand.

Postpartum Heat Period

The average postpartum heat period of indigenous cow and Jersey cross was 133.23±1.51 and 154.08±2.67 days (Hossen *et al*., 2012), respectively, at Bagha-barighat in Bangladesh. The least square mean of postpartum heat period was observed 114.60±16.296 days (Haque *et al*., 2011) in Jersey×Local cow in the first lactation in Bangladesh. Sarder (2006) reported the postpartum heat period in crossbred cow was 139±47 days. As some researcher reported that the postpartum heat of crossbred cow and indigenous cow was 98.78±13 and 122.05±17 (Manjusha *et al*., 2016) days animal^{-1}, respectively, 265.06±1.87, 118.33±1.63 and 146±1.63 (Hussain *et al*., 2012) days in local, Jersey cross and Friesian cross cow in India. In U.S.A the average postpartum heat period was observed 74.5±1.6 days (Lucy, 2001). As postpartum heat period is a reproductive trait not directed by additive type of gene action, the management and disease factors might add to a greater than the hereditary causes. Breed, exotic inheritance level in crossbred cows, the environment along with nutrition and management, might bring about variation of results.

Gestation Period

The least square mean of gestation period in local, Jersey cross and Holstein Friesian cross was observed 274.12±0.53, 275.81±0.53 and 275.74±0.46 days (Hussain *et al*., 2012), respectively in India. Gestation period of exotic crossbred was reported 278.7±0.5 days (Sarder, 2006). The mean gestation period were observed 277 days, 281 days, 279 days, 280 days, and 276 (Wangdi *et al*., 2014) days for the LC, Jersey cross, Mithun cross, pure Jersey and Brown Swiss cross, respectively. There were no significant variations in the gestation period; however, a slight variation was detected among the different dairy breeds and crossbred. This variation may be ascribed to the maternal – i.e., age, nutritional status and body conditions of the dam and the fetal factors- i.e., sex of the fetus, twinning and hormonal functions of the fetus (Islam *et al*., 2006).

Conclusion

All crosses had significantly higher reproductive performance than the indigenous groups of cattle in respective country. The reproductive performance such as age at puberty, age at first service, age at first calving all comes at ideal time in case of crossbred dairy cow and giving the better performance than the indigenous cattle. Puberty in case of indigenous cow comes earlier than crossbred cow which have negative impact on future productive and reproductive trait. However, it is decreasing over time which indicates the breed prejudiced by environmental factors or poor management as the result of several researchers indicated in the range of timeframe.

Acknowledgement

First of all we would like to give thanks for the almighty Allah who enabled us to do this review paper.

References

Addisu B. 1999. Evaluation of reproductive and growth performance of Fogera cattle and their F1-Friesian crosses at Metekel Ranch, Ethiopia. MSc Thesis Alemaya University, Alemaya, Ethiopia.

Abejehu K B, Tesfaye B, Serbesa B, Adere and Kebede G. 2002. Evaluation of improved Dairy breeds around Zeway area.

Ahmad B, Khan S, A Manan and Abdullah. 2007. Production and reproduction of Jersey Cattle breeding and dairy farm Harichand Charsadda NWFP. Journal of Agricultural and Biological Science. 2 (1).

Aynalem H, Workneh A, Noah K,Tadelle D and Azage T. 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.

Babu P G. 2007. Study on performance of crossbred dairy cattle in Chittoor district of Andhra Pradesh – An extension perspective. M.Sc. Thesis (unpublished), NDRI Deemed University, Karnal (Haryana), India.

Belay Z. 2014. Estimation of genetic parameters for growth and reproductive traits of Fogera X Holstein Friesian crossbred cattle at Metekel ranch, Amhara Region, Ethiopia. MSc Thesis, Haremaya University; Haremaya, Ethiopia.

Chaudhury M Z. 1986. Productive and reproductive performance of crossbred cattle in India and Sri Lanka. A review: J. Dairy Sci., 42: 1086.

Davis G P. 1993. Genetic parameters for tropical beef cattle in Northern Australia: A review. Australian Agricultural Research. 44:179-198.

Dinka H. 2012. Reproductive performance of crossbred dairy cows under smallholder condition in Ethiopia**:** Artificial Insemination Institute, Adama Science and Technology University.

De Alba J, Corta E V and G Ulloa. 1961. Influence of natural service on length of estrus in the cow. Anim. Prod. 3:32-330.

Gabriel H K, John C M, Trail M Y, Kurtu G W, Frank M A, Jeffrey D. 1983. Crossbred dairy cattle productivity in Arsi Region, Ethiopia. ILCA Research Report No. 11

Genzebu D, Tamir B and Berhane G.2016. Study of productive and production performance of cross breed dairy cattle under small holders management system in Bishoftu and Akaki Towns. Int. J. Adv.Res. Biol. Sci. 3(2): 151-157.

Hall J G, Branton C and Stone E J.1959. Estrus, estrous cycles, ovulation time, time of service and fertility of dairy cows in Louisiana. J. Dairy Sci. 42:1086-1094.

Haque M N, Haque M R, Parvin A and Hussain M M. 2011. Productive and reproductive performance of different cross bred at Sylhet govt. dairy farm. Progress. Agric., 22 (1&2):47-54.

Hossen M S, Hossain S S, Bhuiyan A F K H., Haque M A and Talukder M A. 2012. Comparison of some important dairy traits of crossbred cows at Baghabarighat milk shed area of Bangladesh. Bang. J. Anim. Sci. 41 (1): 13-18.

Hussain J, Roychoudhury R, Das G C, Mili D C and Goswami R N. 2012. Reproductive performance of dairy cows under field condition of Assam state. Indian J. Anim. Res., 46 (2): 180-183.

Islam S K, Zhoque M A,Alam M R, Hassan M M and Rahman M A. 2006. A cross-sectional study on production performance of stall fed dairy cattle at central cattle breeding station (CCBS), Savar, Dhaka. Bangladesh J. Vet. Med. 4(1): 61-63

Khan M K I and Khatun M J. 1998. Performance of F1 crossbred cows Baghabari milk shed area. Bangladesh Animal Science. 2: 183-186.

Kumar N, Eshetie A, Gebrekidan B and Gurmu E B. 2014. Reproductive performance of indigenous and HF crossbred dairy cows in Gondar, Ethiopia (College of Veterinary Medicine, Mekelle University, Ethiopia) Volume 7, PP 56-61.

Lemma H, Belihu K andSheferaw D. 2010. Study on the reproductive performance of Jersey cows at Wolaita Sodo dairy farm, Southern Ethiopia Wolaita Sodo University, 14 (1):53-70.

Lucy M. 2011. Reproductive physiology and management of high-yielding dairy cattle. Proceedings of the New Zealand Society of Animal Production 61:120-127.

Manjusha J, Roy R, Kumar V and Gupta J. 2016. Productive and reproductive performance of dairy animals in Karnal District of Haryana. Indian Vet. J., 93 (06): 38-40.

Melaku M, Zeleke M, Getinet M and Mengistie T. 2011. Reproductive performances of Fogera cattle at Metekel Cattle breeding and multiplication Ranch, North West Ethiopia. J. Anim. Feed Res., 1: 99-106.

Mukasa-Mugerewa E. 1989. A review of reproductive performance of female *Bosindicus* (Zebu) cattle, International Livestock Centre for Africa (ILCA), monograph, Addis Ababa, Ethiopia.

Mureda E and Mekuriaw Z. 2007. Reproductive performance of crossbred dairy cows in eastern lowlands of Ethiopia. Livestock Research for Rural Development. Volume 19, Article number 161.

Nawaz M, Anwar M, Mirza M A and Nawaz R. 1993. Comparative milk production and Reproduction of Jersey cattle under U.S.A and Pakistan condition. Asian-Australasian J. Animal Sci. 6 (4):549-553.

Nahar N, Islam M and Hasnath M A. 1992. A comparative study on the performance of F_1 crossbred cows under rural conditions. Asian-Australasian J. Animal Sci. 5:435-438.

Nuraddis I, Ashebir A and Shiferaw M. 2011. Assessment of reproductive performance of cross bred dairy cattle (Holstein Friesian X zebu) in Gondar town. Global Veterinaia 6(6): 561-566.

Olawumi S O and Salako A E. 2010. Genetic parameters and factors affecting reproductive performance of White Fulani Cattle in Southwestern, Nigeria. Global Veterinaria 5(5): 255-258, 2010.

Paul A K, Maruf A A, Jha P K andAlam M G S. 2012. Reproductive performance of crossbred and indigenous (desi) dairy cows under rural context at sirajgonj district of Bangladesh. J. Emb. Trans., 28(4):319-324.

Pryce J E and Harris B L. 2004. Selecting for dairy cow fertility in New Zealand. ICAR Special Workshop entitled "Addressing the Decline in Reproductive Performance", Sousse Tunisia, June 1, 2004.

Qureshi M S, Khan A, Mirbhar K B and Samo M U. 2000. Productive and reproductive performance and their interaction in cross bred cattle under field conditions in district Bannu. Pakistan Vet. J. 20 (1).

Sarder M J U. 2006. Study on the influence of sire on reproductive and productive capability of dairy cows used for artificial insemination programme at greater Rajshahi district. Rajshahi University Studies, Part b. Journal of Science 34: 237-253.

Sayed M, Ali M and N Ahmed. 1994. Production efficiency of cross bred cattle at livestock research and development farm surezai NWFP University of Agriculture, Peshawar:12-29.

Tadesse S, Fesaha G, Abebe A, Hailu B and Dejen W. 2014. Department of animal science, Debre Tabor University assessment of productive and reproductive performances of Crossbred Dairycows in Debre tabor town. Vol. 4 No 23

Varade P K, Ali S Z and Malkhede P S. 1997. Age at puberty and age at first calving of Jersey crossbred as influenced by the season of their birth under central Vidarbha conditions, PKV Research Journal. 21(2): 163.

Yifat D, Kelay B, Bekana M, Lobago F, Gustafsson Hand Kindahl H. 2009. Study on reproductive performance of cross bred dairy cattle under smallholder conditions in and around Zeway, Ethiopia. Livestock Research for Rural Development 21(6):2009.

Wangdi J, Bhujel M,Karma P and Wangchuk S. 2014. Productive and reproductive performance of dairy cattle and their cross bred in Bhutan. Livestock Research for Rural Development 26(181):2014.