Milk yield and reproductive performance of pure Jersey dairy cattle in the Central Highlands of Ethiopia

Direba Hunde[1], Gábor Mészáros[2], Tadelle Dessie[3], Getnet Assefa[1], Million Tadesse[1] and Johan Sölkner[2]

[1] Holetta Agricultural Research Center, P. O. Box 31, Holetta, Ethiopia.
direbahu@yahoo.com ; getazb@yahoo.com ; mill_tadsse@yahoo.com
[2] University of Natural Resources and Life Sciences, Vienna, Austria. Department ofSustainable Agricultural Systems, Gregor Mendel str. 33, A-1180 Vienna, Austria
gbaorr@gmail.com ; johann.soelkner@boku.ac.at
[3] International Livestock Research Institute, P. O. Box 5689, Addis Ababa, Ethiopia
t.dessie@cgiar.org

Abstract

The reproductive and productive performances of dairy cows are essential for the profitability of dairy farmers. The aim of this study was to determine milk yield and reproductive performance of pure Jersey dairy cattle at Adea Berga Dairy Research Center in the central highlands of Ethiopia. General linear model was used to estimate the effect of fixed factors. Overall 3015 performance records were used. The least squares mean of reproductive performances were 30 months for age at first calving, 497 days for calving interval and 2 for number of services per conception. The least square mean of lactation milk yield was 2155 kg in 336 days lactation length. The influence of birth year and birth season were significant on age at first calving ($P<0.001$). Lactation milk yield, lactation length, calving interval and number of services per conception were significantly affected by year and parity ($P<0.001$). However, calving season did not have significant influence on calving interval and lactation milk ($p>0.05$). The results indicate that Jersey cows under the particular management of Adea Berga Farm produced reasonable amounts of milk. The value of age at first calving (30 months) recorded for a Jersey cow in this study was promising. The feeding and animal health intervention is essential to reduce the environmental stress. Since the farm is being used as genetic pool to recruit bulls for crossbreeding activities, better breeding schemes should be designed for further improvement of reproductive and productive performances of Jersey cattle.

Keywords: *age at first calving, calving interval, number of services per conception*

Introduction

In Ethiopia, the genetic improvement of dairy cattle is mainly based on cross breeding and adoption of improved exotic breeds. Even though there is a concern about adaptation of pure exotic dairy cattle to tropical environment (climate, feed and disease challenge), pure Friesian and Jersey dairy breeds have been raised by large scale private and state dairy farms in Ethiopia. Improved exotic breed would potentially serve selected niches in milk supply and have been also used as a genetic pool for the national artificial insemination center (NAIC) to recruit AI bulls for genetic improvement program in the country. Million and Tadelle (2003) reported 3183 kg milk yield in 362 days lactation length and 458 days calving interval for Holstein Friesian cows in Debrezeit area of Ethiopia. Similarly, 39.2 months age at first calving and 445 days calving interval were reported for Holstein Friesian herds at Holetta, Stella and Dinkity areas located in urban and peri-urban dairy production system in Ethiopia (Tadesse et al 2010).

There is limited information on reproductive and productive performance of pure Jersey breed in Ethiopia. Research reports in the tropics revealed that Jersey cows are characterized by small body size, hardy and adaptable, low maintenance requirement, high feed conversion efficiency, high milk fat content, and good reproductive performance and has been selected for tropical research and development programs (Cunningham and Syrstad 1987; Njubi et al 1992). Thus they could be a good alternative in Ethiopian highland environment to use as an additional option for intensive and large scale dairy farms as well as genetic pool for genetic improvement activities. Having information on performance of pure Jersey cows in Ethiopia will help to suggest the future genetic improvement options for this herd. The aim of this study was therefore to determine the reproductive and productive performance of pure Jersey dairy cattle at Adea Berga Dairy Research Center in the central highlands of Ethiopia

Materials and methods

Description of the study area

This study was conducted at Adea Berga Dairy Research Center in West Shewa Zone of Oromia Regional State of Ethiopia. Adea Berga wet land is situated in the central highlands of Ethiopia at 9^0 16' N latitude and 38^0 23' E longitude, 70 km West of Addis Ababa and 35 km North West of Holetta on the main road to Muger. It lies at an altitude of 2500 meter above sea level. It is characterized by cool sub-tropical climate with the mean annual temperature and rainfall of 18^0C and 1225 mm, respectively (HARC, 2010). The vegetation is mainly composed of perennial grasses and sedges. Clovers, Pennisetum and Andropogon are the most common species dominating the pasture in the area.

Description of the farm and data sources

Adea Berga Dairy Farm was established at Adea Berga wetland in 1986 for commercial milk production under government state farms by using 400 introduced pure Jersey pregnant heifers and two sires (foundation stock) from Denmark. The

farm had been engaged in the production and rearing of pure Jersey breed from imported foundation stock for milk production by the dairy development enterprise and also serving as a bull dam station for the National Artificial Insemination Center (NAIC). Then it was transferred to Holetta Agricultural Research Center for genetic improvement research program since 2007.

The data for this study was obtained from long-term records of pure Jersey breed that has been kept for dairy production in the farm. Recorded data for the last 24 years (1986-2010) on production and reproduction were used for this study.

Herd management

Herds are managed separately based on sex, age, pregnancy and lactation. Calves were allowed to suckle their dam until 5 days to obtain sufficient colostrum and then separated from their dams and offered fresh milk twice a day for about 6 months. Cows and heifers were allowed to graze natural pasture for about 4 hours a day and supplemented with hay and concentrate feeds up on return to barn during dry and small rainy season. The concentrate was usually composed of 60% wheat bran (sometimes with wheat middling), 38% noug seed cake (Guizotia abyssinica) and 2% salt. The amount consumed is not exactly known, since it depends up on the amount of feed available on stock. However, all animals were restricted from grazing and managed indoor during main rainy season. There was regular over flood of river in the pasture land as a result of heavy rains during this period and the farm has a regular plan to harvest and stock up hay for dry and short rainy season supplementation. Calves less than 6 months, bulls and late pregnant cows and heifers were usually isolated and managed indoor.

Milking was done twice a day at equal interval and the milk produced by each cow was measured and recorded on prepared format immediately after milking. Routine vaccination was conducted against Blackleg, Anthrax, Pasteurellosis, Foot and mouth disease (FMD) and Lumpy Skin Disease. Animals were de-wormed against internal parasites and treated against other infectious diseases by tentative diagnosis.

Breeding program

Pure breeding program was carried out starting on imported foundation stock of 400 pregnant heifers and two sires. Controlled mating program was practiced using both natural mating and artificial insemination. Mating was continuous and practiced throughout the year. NAIC rarely introduce new exotic Jersey semen since this farm has been used as a bull dam station for semen production to dispatch Jersey semen for national crossbreeding activities. Thus, very few young bulls were recruited based on dam performance and physical conformation for NAIC semen collection and on station breeding activities through natural mating. The rest of the male calves were culled from the farm at an early age.

Data analysis

A retrospective type of study was conducted to evaluate productive and reproductive performances of the cows. Abortion and still birth records were removed from analysis of age at first calving and calf crop. General linear model were used for analysis of the fixed effects (SAS 2002). The fixed effects fitted were animal group (imported and farm bred; farm bred animals were the progeny of imported animal that were raised in the farm); year period (grouped in to 5-7 classes based on birth,

service and calving years; each year period represent three years); season; grouped in to three classes, based on pattern of annual rain fall distribution as dry period (October to February), light rain (March to May) and main rain (June to September); and parity (grouped in to eight classes 1,2,3,4,5,6,7and 8+). Lactation records of eighth and above parities were pooled. Preliminary analysis showed that interaction effects of the fixed factors were not significant and thus not included in the model. The statistical model is described as follows:

Experimental models

1. Reproduction traits
1.1. Age at first calving
$Y_{ijk} = \mu + Y_i + S_j + G_k + e_{ijk}$

Where, Y_{ijk} is the age at first calving trait; μ is the overall mean; Y_i is the fixed effect of i^{th} year period of birth; S_j is the fixed effect of j^{th} season of birth; G_k is the fixed effect of k^{th} animal group; e_{ijk} = random residual term.

1.2. Calving interval
$Y_{ijk} = \mu + Y_i + S_j + P_k + e_{ijk}$

Where, Y_{ijk} is the calving interval trait; μ is the overall mean; Y_i = the fixed effect of i^{th} year period of calving; S_j is the fixed effect of j^{th} season of calving; P_k is the fixed effect of k^{th} cow parity; e_{ijk} is random residual term.

1.3. Number of services per conception
$Y_{ijkl} = \mu + Y_i + S_j + G_k + P_l + e_{ijkl}$

Where, Y_{ijkl} is the number of service per conception trait; μ is the overall mean; Y_i is the fixed effect of i^{th} year period of service; S_j is the fixed effect of j^{th} season of service; G_k is the fixed effect of k^{th} animal group; P_l is the fixed effect of l^{th} cow parity; e_{ijkl} is random residual term.

2. Production traits (Lactation milk yield and lactation length)
$Y_{ijkl} = \mu + Y_i + C_j + S_k + P_l + e_{ijkl}$

Where, Y_{ijkl} is milk yield and lactation length trait; μ is the overall mean; Y_i is the fixed effect of i^{th} year period of birth; C_j is the fixed effect of j^{th} year period of calving; S_k is the effect of k^{th} season of calving; P_l is the effect of l^{th} cow parity; e_{ijkl} is random residual term.

Results and discussion

Age at first calving (AFC)

Age at first calving is an economically important trait that determines the age when an animal begins its economic return from milk production and reproduction. The

overall least squares mean and standard error for AFC of pure Jersey breed in this study was 29.9 ± 0.17 months.

The result obtained in this study is comparable with 31 months reported for pure Jersey in humid areas of Kenya (Njubi et al 1992). However the value of present finding is inconsistent with the report of Makuza et al (2000) and Banga et al (2009) who found higher AFC (54 months) in Zimbabwe and lower AFC (25 months) in South Africa, respectively for Jersey cows. This could be due to environmental difference associated with management condition. On the other hand, Demeke et al (2004) reported higher AFC (38 months) for Boran and its crosses with Friesian and Jersey breed in tropical highlands of Ethiopia. This could also indicate better potential of Jersey cattle with regard to AFC.

The least squares means and standard errors of AFC for fixed effects of birth year period, birth season and animal group are summarized in Table 1. Analysis of variance revealed that AFC was significantly affected by birth year periods ($p< 0.01$), birth season ($p< 0.01$) and animal group ($p< 0.05$). The result also indicated that trend of AFC is increasing in recent born animal. This may be due to management fluctuation among years and seasons as a result of feed shortage. It might be also related with sires used for mating that breeding value of recently used sire could increase AFC.

The result showed that cows born during dry and main rainy seasons, respectively attained AFC 3 and 2.4 months earlier than those born during light rainy season. This might be due to post weaning stress of main rainy season on calves born during light rainy season because of shortage of feed during rainy season as the pasture land is restricted from grazing. The significant effect of birth year and birth season obtained in this study is in agreement with various other reports (Amani et al 2007; Ahmad et al 2007; Gebeyehu 1999; Kefena et al 2004). Imported heifers were pregnant when introduced to the country. Imported animals attained AFC 9 months earlier than the farm bred cows. Similarly Lateef (2007) observed a significant difference between imported and farm bred animals in Pakistan. These could be attributed to the difference of environment (management condition and climate) where the animals were kept.

Table 1. Least squares means and standard error of age at first calving

Effect	N	Mean ± SE (months)
Overall	751	29.92 ±0.17
Birth year group		p< 0.0001
1985 - 1987	326	31.0 ± 2.33^{abcd}
1988 - 1990	78	28.9 ± 2.38^{ce}
1991 - 1993	39	30.5 ± 2.43^{bc}
1994 - 1996	76	25.4 ± 2.38^{d}
1997 - 1999	63	27.9 ± 2.32^{de}
2000 - 2002	62	29.1 ± 2.39^{ce}
2003 -2005	77	32.3 ± 2.38^{ab}
2006 - 2008	28	33.6 ± 2.47^{a}
Birth season		p< 0.0001
Dry	452	28.6 ± 1.74^{a}
Short rain	100	31.7 ± 1.80^{b}
Main rain	197	29.2 ± 1.77^{a}
Animal group		p < 0.05
Imported	327	25.2 ± 4.05^{a}
Farm bred	422	34.5 ± 0.63^{b}

N= number of observation, Least squares means with same superscripts in the same fixed effect indicate non significance.

Calving interval (CI)

Calving interval is a fertility trait which refers to the period between consecutive calving and is a function of open period and gestation length. Longer calving interval could reduce number of lactation initiated in total life and the total number of heifers in the herd which would consequently reduce the chances of producing adequate replacement herd.

The least squares means and standard errors of CI for fixed effects of parity, calving year period and calving season are summarized in Tables 2. The overall mean CI of pure Jersey cattle in this study was found to be 497± 3.69 days.

The value of CI recorded in this study is lower than the value (549 days) reported for 50% crossbred in Northern Ethiopia (Teferi 1994). However, it is higher than the findings of several authors from tropical countries (Mostert et al 2010; Rahman et al 2007; Njubi et al 1992; Sattar et al 2004; Demeke et al 2004). The variation may be attributed to the difference in the levels of management and genetic improvement programs among the countries or farms.

Analysis of variance revealed that CI was significantly affected by the fixed effects parity and calving year period ($p<0.0001$), but not significantly affected by calving season ($p>0.05$). The influence of fixed effect observed in this study is in line with the findings of several authors (Tadesse et al 2010; Amani et al 2007; Yosef 2006). The increasing trend of CI with parity observed in this study is in agreement with the report of Rege et al (1994) who concluded that CI was steadily increased to the 7th parity. Longest CI (670±12.4 days) was observed for cows calved between 1991 and 1993. These could be attributed to management problems like shortage of feed and health problems, because these years were the period of regime change and hence might be attributed to financial scarcity as the farm was funded by government.

Table 2. Least squares means and standard errors of calving interval by parity, calving year group and calving season

Effect	N	Mean ± SE (days)
Overall	2024	497±3.69
Parity		p<0.0001
1	678	470±7.54^{c}
2	492	516±8.21^{a}
3	334	518±9.45^{a}
4	218	513±11.5^{ab}
5	137	531±14.5^{a}
6	90	473±17.8^{bc}
7	37	489±27.5^{abc}
8	38	529±27.4^{ab}
Calving year group		p<0.0001
1988-1990	625	514±10.7^{b}
1991-1993	251	670±12.4^{a}
1994-1996	216	513±12.4^{b}
1997-1999	243	443±11.3^{cd}
2000-2002	287	428±10.7^{d}
2003-2005	231	458±11.6^{c}
2006-2008	171	508±13.3^{b}
Calving season		p>0.05
Dry	1089	495±7.14

Short rain	438	508±9.41
Main rain	497	510±8.87

N= number of observation. Least squares means with same superscripts in the same fixed effect are not significantly different (p>0.05).

Number of services per conception (NSC)

Numbers of service per conception is a measure of reproductive efficiency of a cow and also reflects the efficiency of farm management. The overall mean and standard error of NSC of Jersey in this study was 2.02±0.02. The result of the present study is similar with the report of Yosef (2006) who found 2.01 NSC for Holstein breed in central highland of Ethiopia. But it is lower than the report of Lateef (2007) who found 3.30 for Friesian in Pakistan and higher than 1.80 for Friesian reported by Tadesse et al (2010) and 1.58 for Boran and its crosses with Friesian and Jersey (Demeke et al 2004) in Ethiopia.

NSC was significantly affected by fixed effect of parity ($p<0.0001$), service year period ($p<0.0001$), service season ($p<0.001$) and animal group ($p<0.05$).The significant effect observed in the present study is in agreement with the finding of Asimwe and Kifaro (2007) and Ahmad et al (2007). The report of some other studies like Gebeyehu et al (2007), Hammoud et al. (2010) and Tadesse et al (2010) are also in line with the present finding that year and parity had significant effect on NSC but contradictorily they revealed that season did not significantly influence the NSC in Friesian cows in Ethiopia and Egypt respectively.

Animal served during dry (2.06 ± 0.05) and light rainy (2.02 ± 0.05) season had fewer service for conception than those served during main rainy season (2.23 ± 0.05). These could reflect management problems like shortage of feed during the main reason because the pasture land was protected from grazing during this season. The least square mean of NSC showed that imported Jersey cows require more service per conceptions (2.20 ± 0.07) than farm born cows (2.00 ± 0.05) which could be associated with adaptation problem for imported generation. Similar result was reported by Lateef (2007) who revealed that imported cows required more service (3.18) than farm born cows (2.51).

Lactation milk yield (MY)

Increasing milk production is the ultimate goal of dairy sectors to attain milk self-sufficiency and to maximize the profitability of dairy industry. Thus, most genetic improvement programs of developing countries have focused on improving production performance of dairy cattle. Results of the least squares means and standard errors for fixed effects of birth year period, calving year period, calving season and parity are summarized in Table 3. The overall lactation milk yield and lactation length of pure Jersey cows were found to be 2155±16.4 kg and 336± 2.35 days respectively.

The result obtained in this study (2155 kg) is similar to the reports of Yosef (2006) and Lateef et al (2008). They found lactation milk yields of 2200 and 2229 kg for Jersey cattle in Ethiopia and Pakistan respectively. On the other hand, Njubi et al (1992) reported a milk yield ranging from 1257 kg to 1788 kg for Jersey cattle per lactation which was lower than the figure obtained in the current study. The result of this study is lower than the finding of Borland and Moyo (1996) who found 3504 to 5141 kg lactation milk yield in Zimbabwe.

Calving year period and parity had significant effect on MY ($p<0.0001$), but birth year period and calving season did not have significant effect ($p> 0.05$). Trend of lactation milk yield associated with period of calving had no clear pattern. This could be attributed to the inconsistent management practices across years and cows were not fed according to recommended amount. However, some progressively increasing trend observed in lactation milk yield over the period of calving is an indicative of improved management and adaptation of this breed to the prevailing environment through time. Low performance of cows which calved in between 1991 and 1993 could be related to financial problems of the farm to avail sufficient feed due to regime change. The pregnant heifers imported for foundation stock gave their first calf in between 1988 and 1990 and their milk yield was lower as compared to other calving period. This might be attributed to adaptation problem as the animals were exposed to new environment which could create more difficulty to express their genetic potential.

Lactation milk yield seems linearly increasing from 1st to 5th parity. But Milk yield recorded at 2nd parity was greater than that of 3rd parity which is contradictory with several literatures. The lactation milk showed a declining trend after the 5th parity. Similar observations were reported by several authors (Tadesse et al 2004; Yosef 2006; Lateef 2007; Njubi et al 1992; Tadesse et al 2010). Amimo et al (2007) and Amani et al (2007) also found that Ayrshire and Friesian cows attained their peak milk yields at the 4th parity. Season of calving did not have a significant effect on lactation milk yield in the present study.

Table 3. Least square means and standard error of milk yield and lactation length for fixed effects of birth year group, calving year group, calving season and parity

Effect		**Variable**	
	N	**Milk Yield (kg)**	**Lactation length (days)**
overall	2658	2155± 16.4	336±2.3
Birth year group		p > 0.05	p< 0.001
1985-1987	1193	2241±85.5	353±12.3^{a}
1988-1990	266	2185±73.2	332±10.5^{b}
1991-1993	168	1995±74.7	314±10.7^{b}
1994-1996	362	2143±63.5	312±9.1 ^{b}
1997-1999	335	2100±86.3	328±12.4^{ab}
2000-2002	189	1978±133.5	326±19.2^{ab}
2003-2005	145	1872±169.5	356±24.3^{ab}
calving year group		p< 0.0001	p< 0.0001
1988-1990	751	1759±166.2^{d}	275±23.9^{c}
1991-1993	374	1395±138.1^{e}	337±19.8^{ab}
1994-1996	301	2253±111.8^{ab}	348± 16.1^{ad}
1997-1999	327	1996±79.2^{cd}	319± 11.4^{be}
2000-2002	344	2212±59.1^{b}	320± 8.5^{bcd}
2003-2005	291	2526±64.4^{a}	332± 9.2^{ab}
2006-2008	223	2229±94.9^{bc}	356± 13.6^{ae}
2009-2010	47	2216±155.2^{bcd}	367± 22.3^{ab}
Calving season		p > 0.05	p > 0.05
Dry	1380	2101±46.9	330±6.7
Short rain	595	2067±54.4	334±7.8
Main rain	683	2052±50.6	332±7.3
Parity		p< 0.0001	p< 0.0001
1	803	2067±41.2^{b}	355±5.9^{a}
2	649	2363±41.1^{a}	355±5.9^{a}
3	442	2073±47.3^{b}	323±6.8^{b}

4	309	2262±57.7[a]	350±8.3[a]
5	190	2303±75.9[a]	350±10.9[a]
6	127	2006±94.3[b]	314±13.5[bc]
7	73	1986±125.2[b]	324±18[ab]
8	65	1528±141.1[c]	282±20.3[c]

N= Number of observation. Least squares means with same superscript in the same fixed effect indicate non significance.

Conclusions

- The value of age at first calving recorded for Jersey cows in this study (30 months) was promising under Ethiopian conditions. This could be attributed to better fertility and adaptive potential of Jersey cattle. The overall results indicate that Jersey cows under the particular management of Adea Berga farm produced reasonable amounts of milk. However, it was noted that the significant effects of years and seasons indicate inconsistent management across the years and seasons. The need of feeding and animal health intervention is essential to reduce the environmental stress. Since the farm is being used as genetic pool to recruit bulls for crossbreeding activities, better breeding schemes should be designed for further improvement of reproductive and productive performances.

Acknowledgment

The authors are grateful to European Master in Animal Breeding and Genetics (EMABG) for funding this research as a scholarship grant to the first author. The authors would like to thank also Ethiopian Institute of Agricultural Research for allowing us to use data.

References

Ahmad Bashir, Sirzamin Khan, Abdul Manan and Abdullah 2007 Production and reproduction performance of Jersey cattle at cattle breeding and dairy farm hichand charsadda NWFP . Journal of Agricultural and Biological Science. http://www.arpnjournals.com/jabs/volume_01_2007.htm

Amani Z, Abdel Gader, Mohamed Khaira. Ahmed, Lutfim A, Musa and Kurt J, Peters 2007 Milk yield and reproductive performance of Friesian cows under Sudan tropical conditions. Humboldt-Universität zu Berlin, Germany, Dummerstorf 50 (2007) 2, 155-164.

Amimo J O, Wakhungu J W, Inyangala B O and Mosi R O 2007 The effects of non-genetic factors and estimation of genetic and phenotypic parameters and trends for milk yield in Ayrshire cattle in Kenya. http://www.lrrd.org/lrrd19/1/amim19013.htm

Asimwe L and Kifaro G C 2007 Effect of breed, season, year and parity on reproductive performance of dairy cattle under smallholder production system in Bukoba district, Tanzania. http://www.lrrd.org/lrrd19/10/asim19152.htm

Banga C B, Neser F W, Van der Westhuizen and Garrick D J 2009 Economic values for dairy production traits under different milk payment systems in South Africa. South African Journal of Animal Science 2009, 39 (Supplement 1). http://www.ajol.info/index.php/sajas/article/view/61162

Borland P and Moyo H 1996 Country papers on dairy development and status of the dairy sector, Zimbabwe dairy sector: Milk production, Marketing and processing. FAO corporate document repository. http://www.fao.org/3/a-w3199e/W3199E02.htm

Cunningham E P and Syrstad O 1987 Types and breeds of tropical and temperate cattle. In: crossbreeding *Bos indicus and Bos taurus* for milk production in the Tropics. FOA, Rome. Paper 68.

Demeke S, Neser F W C and Schoeman S J 2004 Estimates of genetic parameters for Boran, Friesian, and crosses of Friesian and Jersey with the Boran cattle in the tropical highlands of Ethiopia: reproductive traits. J. Anim. Breed. Genet. 121 (2004), 163–175

Gebeyehu Goshu 1999 Reproductive and Productive Performance of Friesian-Boran Crossbred Cattle at Chaffa State Farm, Wollo, Ethiopia. M. Sc. Thesis, Alemaya University, Dire Dawa, Ethiopia

Gebeyehu Goshu, Kelay Belihu and Abebe Berihun 2007 Effect of parity, season and year on reproductive performance and herd life of Friesian cows at Stella private dairy farm, Ethiopia. http://www.lrrd.org/lrrd19/7/gosh19098.htm

Hammoud M H, El-Zarkouny S Z, Oudah E Z M 2010 Effect of sire, age at first calving, season and year of calving and parity on reproductive performance of Friesian cows under semiarid conditions in Egypt. Archiva Zootechnica 13:1, 60-82, 2010 61

Holetta Agricultural Research Center (HARC) 2010 Agro-Metrology and GIS weather data of west shewa zone for the period of 2001-2010. Unpublished report, Holetta Research Center, Ethiopia.

Kefena E, Hegde B P and Tesfaye K 2004 Lifetime production and reproduction performances of *Bos taurus x Bos indicus* crossbred cows in the central highlands of Ethiopia. MSc. Thesis. Haramaya University. Ethiopia.

Lateef M 2007 Production performance of Holstein Friesian and Jersey cattle under sub tropical environment of the Punjab, Pakistan. Department of Livestock management University of Agriculture, Faisalabad, Pakistan. Ph.D. thesis

Lateef M Gondal K Z, Younas M, Sarwar M, Mustafa M I and Bashir M K 2008 Milk production potential of Pure bred Holstein Friesian and Jersey cows in sub tropical environment of Pakistan.University of Agriculture, Faisalabad, Pakistan. Pakistan Vet. J., 2008, 28(1): 9-12.

Makuza S M, Muchenje V and Chiyanike S 2000 Genetic evaluation of grade, appendix and pedigree cow classes in Holstein, Jersey and crossbred dairy breeds in Zimbabwe. Proceedings of the regional conference held at Malawi Institute of Management, Lilongwe, Malawi 30 - October to 1 November 2000.

Million Tadesse and Tadelle Desse 2003 Milk production performance of Zebu, Holstein Friesian and their crosses in Ethiopia. Debrezeit, Ethiopia. http://www.lrrd.org/lrrd15/3/Tade153.htm

Mostert B E, Van Der Westhuizen R R and Theron H E 2010 Calving interval genetic parameters and trends for dairy breeds in South Africa South African. Journal of Animal Science 2010, 40 (2) Animal Production Institute, Private Bag X2, Irene 0062, South Africa.

Njubi D, Rege J E, Thorpe W, Collins Lusweti E and Nyambaka 1992 Genetic and environmental variation in reproductive and lactation performance of Jersey cattle in the coastal lowland semi-humid tropics. Tropical Animal Health Production.24 (4):231-41.

Rahman Rahman, Rejoanoul Islam, Ohammad Mubinu Rahman, Mamunul Haque and Tanuza Das 2007 Estimation of genetic parameters for economic traits in dairy cattle of Bangladesh. Gene BD, 5/7 Lalmatia, Block E, Dhaka-1207, Bangaldesh.

Rege J E, Aboagye S, Akah and Ahunu B K 1994 Crossbreeding Jersey with Ghana shorthorn and Sokoto Gudali cattle in a tropical environment: Additive and hetrotic effects for milk production, reproduction and calf growth traits.Anim.Prod.59:21-29.

Sattar A, Mirza R H and Ahmad I 2004 Reproductive efficiency of Jersey cows under subtropical conditions of the Punjab. Pakistan vet. J., 24(3): 2004 129.

Statistical Analysis system Institute (SAS) 2002 SAS guide for personal computers. Version 9. SAS Institute, Kary, NC. USA.

Tadesse Million, Tadelle Dessie and Egbert Kanis 2004 Genetic and Non-genetic Effects on Productive and Reproductive Parameters of Arsi Cattle and Their Holstein Friesian Crosses in Ethiopia. Eth. J. Anim. Prod. 4(1)- 2004: 70-79

Tadesse M, Thiengtham J, Pinyopummin A and Prasanpanich S 2010 Productive and reproductive performance of Holstein Friesian dairy cows in Ethiopia. http://www.lrrd.org/lrrd22/2/tade22034.htm

Teferi D 1994 Reproductive and Milk Yield Performance of Crossbred Dairy Cattle at the Co-operative Farm in the Arsi region, Ethiopia. M.Sc. thesis, Alemaya University of Agriculture, Dire Dawa, Ethiopia.

Yosef Tadesse 2006 Genetic and non- genetic analysis of fertility and production traits in Holetta and Adea Berga dairy herd. M.Sc. Thesis. Faculty of Agriculture Department of Animal Science, School of Graduate studies. Alemaya University. Ethiopia.

Received 24 February 2015; Accepted 29 May 2015; Published 2 July 2015

Go to top