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EFFECTS OF PERIOD OF CALVING, SEASON OF CALVING AND PARITY ON MILK PRODUCTION PERFORMANCE OF HOLSTEIN FRIESIAN DAIRY COWS IN ALAGE ATVET COLLEGE, ETHIOPIA

Destaw Worku

Salale University, College of Agriculture and Natural Resource, Department of Animal Science, P.O.Box 245, Salale, Ethiopia

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ABSTRACT: The study was conducted to evaluate milk production performance of Holstein Friesian and associated factors in dairy farms of Alage Agricultural Technical and Vocational Education Training College. The productive traits' data gathered from 1987 to 2015 were analyzed using general linear model procedures of SAS version 9.2. The result revealed that the overall least square means and standard errors for daily milk yield (DMY), 305 days milk yield (305DsMY), lactation milk yield (LMY) and lactation length (LL) were 8.06±0.119 kg, 2473.3±34.78 kg, 2395±61 kg and 323±5.34 days, respectively. Period of calving and parity had significant effect (P<0.001) on productive traits (DMY, 305 DsMY, LMY, and LL) of Holstein Friesian cows. Whereas, season of calving was not significant on all productive traits of HF cows. The overall value obtained for DMY, 305 DsMY, LMY and LL were very disappointing and below the standard set for commercial dairy farm. Furthermore, the milk production performance of Holstein Friesian found was lower than the milk production performance reported in many tropical regions. Poor management and climatic condition combined with a poor adaptation of Exotic breeds in Ethiopia were the most probable factors accounted for this poor overall value of the breed. Therefore, giving attention to the poor management of the breed and improving the level of genotype by environment (GXE) interaction is required for optimal production performance of Holstein Friesian breed in the area.

Keywords: Alage dairy farm, Productive performance, Holstein Friesian

INTRODUCTION

Food insecurity is an appearance of famine challenging in many developing countries, especially those found in Sub-Saharan Africa (SSA) and South Asia. Ethiopia is one of sub-Saharan Africa with its huge livestock population and is estimated to have 59.5 heads of cattle, about 98.59% of local cattle breeds; the remaining are hybrid and exotic breeds with 1.22 and 0.19%, respectively (CSA, 2016/17).

In Ethiopia's increasing human population, urbanization trends and rising household incomes are leading to a rapid increase in the demand for milk and milk products, and the demand has been met by increased production (Ranawana, 2008). More effective approach to increase production can be improving environmental condition and management practices coupled with improving genetic potential of dairy animals (Lateef, 2007). At the same time, the government has an ambitious target for improvement in the dairy production environment to increase towards 50% self-sufficiency in milk products by 2020. But, increasing the number of animals is not a desirable proposition as the land resources of the country are very limited and cannot afford to allocate more land under fodder production.

Due to the very important role that the livestock sector plays in the economy of the country, formulation of development plan regarding the sector is indispensable. Furthermore, livestock sector has a significant contribution to the Ethiopian economy, but production per animal is extremely low (Kumar and Tkui, 2014). It is therefore imperative that performance evaluation of dairy cattle should be formulated on the basis of reliable statistical data, and hence, timely and accurate dairy cows data are required for the formulation, implementation, monitoring, and evaluation of performances of dairy cattle in the sector.

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 the adaptation of pure exotic dairy cattle to the tropical environment (climate, feed and disease challenge), pure Holstein Friesian dairy breeds have been raised by large-scale private and state dairy farms in Ethiopia in general and that of Alage ATVET College in particular. But, the performance of these animals and factors affecting it has not been systematically studied and documented.

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Therefore, the periodical evaluation of factors affecting the productivity of animals is very crucial for future planning and management. Furthermore, comprehensive information on milk production performance of Holstein Friesian dairy cows in Alage ATVET College is limited. Thus, the present study designed to evaluate the milk production performance of Holstein Friesian dairy cattle and factors affecting their performance.

MATERIALS AND METHODS

Description of the Study Area

The current study was conducted at Alage Agricultural Technical Vocational Educational Training (ATVET) College, which is located at 217 km southwest of Addis Ababa, in the vicinity of the Abijata and Shala lakes of the Ethiopian Rift Valley. The farm rests on 4200 ha of land and geographically located at a longitude of 38°30 east and a latitude of 7°30′north, with an altitude of 1600 m.a.s.l. The area has a minimum and maximum temperature ranging from 11 to 32°C and the mean annual rainfall of 800 mm. Based on agro-climatic condition and rainfall pattern, Alage ATVET College has three distinct seasons; a short rainy season (March-May), a long rainy season (June – September) and a dry season (October – February) (NMSA, 2015).

Farm Establishment and breed groups

Alage dairy farm started its dairying activity in 1980 with foundation stock of Holstein Friesian origin brought from the Stella dairy farm, Holetta and individual farms around Addis Ababa. The farm was consisted mainly of Holstein Friesian cattle population to produce milk and milk products to fulfill the ever-increasing demand for milk and milk products in the area.

Herd management

Animals were maintained under an intensive feeding and production systems and herds were managed separately based on sex, age, pregnancy, time of calving and lactation. Animals were stall-fed individually with green fodders and roughages, concentrates were also fed to the animals according to the need for different categories of animals. Heifers and dry cows were mainly fed on green fodder and other roughages throughout the year. During the day of the rainy season, cows were grazed on native pastures from 1:00-3:00 A.M local time. Later on the day, animals were tied and fed with dry and green fodder, concentrates and mineral licks under the shade. Animals were fed according to calculated requirements with concentrate feeds and mineral licks during late pregnancy and lactation. Lactating cows were fed 1 kg concentrates per 2.5 kg of milk produced before each milking. Concentrates are prepared by mixing maize with wheat bran, noug cake (*Guizotia abyssinica*), salt and limestone. Hay produced from various types of annual and perennial plants of *graminaceous* and *leguminous* species were used for feeding animals.

Semen of purebred Holstein Friesian bulls from the National Artificial Insemination Center was used for insemination. Insemination was carried out by artificial insemination (AI) technicians. Detection of estrus was carried out twice a day, early in the morning and late in the afternoon. Pregnant cows were managed separately during the last trimester and calving was in well-constructed calving pens. Lactating cows were hand-milked twice daily, early in the morning (8:00-9:00 A.M) and late in the afternoon (3:00-4:00 P.M) and daily milk yield from individual animals were weighed and recorded. Newborn calves were taken away from their dams shortly after birth and were given colostrums for the first five days of age. Fresh milk was offered twice a day in a bucket until the age of 6 months. They were kept in individual pens. Animals were regularly vaccinated against anthrax, pasteurellosis, blackleg, foot and mouth disease, lumpy skin disease, and contagious bovine pleura pneumonia. Internal and external parasitic infestation were dewormed and sprayed regularly.

Data collection

Data collected from the period 1987-2015 (28 years), from the history sheet kept on each individual animal record book maintained at the farm was used for the study. Records have an identification number, Dam and Sire ID number, sex of animal, date, and reason of exit, dates of birth, calf ID, service date and calving dates, parity number and drying dates. The variables considered were average daily milk yield (DMY), 305 days milk yield (305 DsMY), lactation milk yield (LMY) and lactation length (LL). The compiled record cards were checked for its completeness and unclear and incomplete data were cleaned out.

Data analysis

The data on productive traits (DMY,305DsMY,LMY, and LL) were interred into Microsoft Excel spreadsheet and analyzed using general linear model (GLM) procedures of SAS version 9.2 (SAS, 2008). The model used includes fixed effects of period of calving, season of calving and parity. Based on rainfall distribution, months of the year

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were classified into three seasons; a short rainy season, which extends from March to May, a long rainy season, which extends from June to September and a dry season that extends from October to February and periods having 4 years each. Only a few numbers of animals completed more than 7 lactations and also the estimated least square means for parity numbers 7 and greater than 7 were almost similar. Therefore, all parities above 7 were pooled together in parity 7^{+}.

The following statistical model was used to analyze the data.

Yijk= μ + Bi +Sj+ Yk + eijk

where, Yijk = Observation on DMY, 305DsMY, LMY and LL

μ = Overall mean

Bi = Fixed effect of i^{th} season of calving (long rainy, short rainy and dry season)

Sj = Fixed effect of j^{th} period of calving (P1;1990-1993, P2;1998-2001,...P6;2010-2015)

Yk = Fixed effect of k^{th} parity (1, 2, 3 ...7)

eijk = Residual random error

RESULTS AND DISCUSSIONS

305 days milk yield (305 DsMY)

In this study, the overall least square mean and standard error of 305 days milk yield of Holstein Friesian dairy cows was estimated to be 2473.3±34.78 kg, which is lower than the least square mean for 305 days milk of 3689±45.0 kg for Holstein Friesian cows in Holleta Bull Dam farm (Ayalew et al., 2015). In contrast, lower 305 days milk yield (1707.25±13.25 kg) was reported for Holstein-Friesian × Deoni-Crossbred cows (Zewdu et al., 2013). Furthermore, the present finding is higher than 2015 kg for Holstein Friesian cows in Zimbabwe as reported by Ngongoni et al. (2006) and lower than 3408 kg for Holstein-Friesian in Turkey as reported by Katok and Yanar (2012). Such variation could be due to differences in a production environment, herd management, quality and quantity of forage and data structure, editing and adjustment procedures.

The overall least square means (LSM±SE) of 305 days milk yield as affected by period of calving, season of calving and parity are given in Table 2, respectively. The statistical analysis revealed that the observed differences of 305 days milk yield due to period of calving and party effect (P<0.001) were significant, while the variations due to season of calving were not significant (Table 1). This concurs well with the report of Zewdu et al. (2013) and Ayalew et al. (2015). But, a study by Ajili et al. (2007) and Katok and Yanar (2012) reported a significant effect of season of calving on 305 days milk yield. The present study revealed that mean 305 days milk yield was significantly (P<0.001) lowest during the earliest period (1990-97), while a dramatic increasing trend was observed from the animals that calved from 1998-2015 (Figure 1); showed progressive improvements in periods. The overall increasing trend of 305 days milk yield over the years might be due to improvements in management, better adaptation of Holstein Friesian breed to climatic, management condition as well as environmental effects. In other cases, mean 305 days milk yield increased from 1^{st} parity to 6^{th} parity, while decreased when the parity of cows goes beyond 7^{th} parity (Table 1). This difference could be due to the fact that cows calving in the first parity were not mature enough to produce more milk due to different physiological conditions like udder development and energy reserve for both body maintenance and milk production.

Lactation milk yield (LMY)

The overall least square mean and standard error of LMY of Holstein Friesian dairy cows was estimated to be 2395±61 kg with a coefficient of variation 39.7% (Table 1). The estimates of LMY found in this study was lower than the reports of several authors, 2704 Kg per lactation of Holstein-Friesian cattle (Krishantan and Sinniah, 2014), 3438±887.19 kg for Holstein-Friesian cattle under subtropical conditions of China (Usman et al., 2012), 3604±38.4 kg for Holstein-Friesian cattle at Holleta Bull Dam farm (Ayalew et al., 2015), 3710±111 kg for Holstein Friesian dairy cows in Ethiopia (Tadesse et al., 2010) and 4097±1491.2 liters for Holstein Friesian at Holleta Bull Dam Station and Genesis Farms (Alewya, 2014), 5519 L of Up-Country Exotic dairy cattle breeds of Sri Lanka (Kollalpitiya et al., 2012). On the other hand, the value obtained in the current study was higher than the Mean±SE of 2149.19±143.8 liter of Holstein Friesian in Hossana town Ethiopia (Haftu, 2015). These lower LMY of Holstein Friesian in the present study might be an indication of poor adaptation of this exotic breed to climatic and management condition in the study area. Furthermore, most of the cattle in tropics have on average an extremely low level of milk production. This is in good agreement that, there are many reasons for lower productivity, notably, these includes unfavorable environmental conditions of climate, low standards of animal husbandry and prevalence of parasites and diseases (Abdel Rahman and Alemam, 2008).

The overall least square mean (LSM±SE) of lactation milk yield for the fixed effects of period of calving, season of calving and parity are summarized in Table 1. The result confirmed that significant effect (P<0.001) of period of

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calving and parity on LMY in agreement with the report of Tadesse et al. (2010), Ayalew et al. (2015), Usman et al. (2012) and Alewya (2014), whereas season of calving did not have significant effect (P > 0.05) on LMY of Holstein-Friesian. Unlike the present study, Zewdu et al. (2013) and Hammoud and Salem (2013) reported season of calving had a significant effect on LMY of Holstein-Friesian. In contrast, Bilal et al. (2008) and Usman et al. (2012) found non-significant effect of season of calving on lactation milk yield. The result in the current study revealed that lactation milk yield was significantly decreased from animals that calved during the period from 1990-1997, while progressively increased during 1998-2005 (Figure 1). However, LMY showed decreasing trend from the animals that were calved during 2006-2015 (Figure 1). Thus, the variation in milk yield observed in different years reflected the level of management as well as environmental effects (Javed et al., 2004). The progressively increasing trend of lactation milk yield over the later period of calving (1998-2015) is an indication of better management, better adaptation of Holstein Friesian breed to climatic and management condition or environment through time or both. Furthermore, lower milk yield at the period from 1990-97 is due to the poor adaptation of Holstein Friesian breed in the country. Cows with 1st parity had lowest milk production, and highest milk production recorded in 3rd parity followed by 6th and 4th parity. However, decreased LMY at the 7th parity concurred well with the findings of Tadesse et al. (2010) and (Alewya, 2014). While, LMY at the 1st, 2nd, and 5th parity was not statistically significant as compared to 3rd, 4th, and 6th parity.

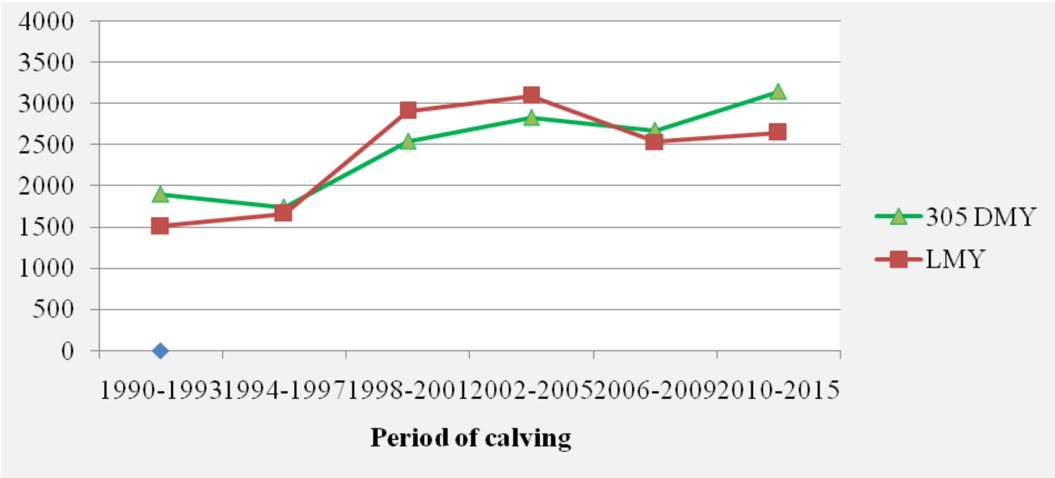

Figure 1 - The trend of 305DsMY and LMY of Holstein-Friesian over period of calving at Alage ATVET College

Table 1. Least square means and standard error of lactation milk yield and 305 days milk yield for the fixed effect of period of calving, season of calving and parity

Source	LMY (kg)		305 days milk yield (kg)	
Overall Mean (LSM±SE)	N	2395±61	N	2473.3±34.78
CV (%)	774	39.7	761	24.4
Period of calving		***		***
1990-1993	77	1511±139c	80	1901.5±77.43d
1994-1997	88	1666±123c	90	1739.88±69.03d
1998-2001	176	2911±96ab	176	2545±54.23c
2002-2005	192	3093±88a	200	2832.24±49.11b
2006-2009	95	2539±117b	96	2675±66.06bc
2010-2015	146	2650±95b	119	3145±58.95a
Season of calving		NS		NS
March-May	180	2498±93	177	2474±53
June - September	214	2308±87	203	2480±50
October-February	380	2378±70	381	2466±40
Parity		**		***
1	236	2465±72ab	237	2040.64±40.6b
2	196	2464±79ab	190	2407.2±45.36ab
3	146	2777±91a	143	2573.79±51.8a
4	98	2558±111a	93	2625.53±64.93a
5	54	2303±149ab	56	2600.15±83.03a
6	23	2443±225a	22	2655.48±129.86a
7+	21	1754±235b	20	2410.25±136.46ab

Means separated by different superscript letters under the same variable in one column are significantly different. *** = significant (P<0.001), ** = (p<0.01), NS=Not significant, N =number of records, LMY= lactation milk yield.

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Average daily milk yield (DMY)

The overall least square mean and standard error of DMY of Holstein Frisian dairy cows was estimated to be 8.06±0.119 kg with a coefficient of variation of 25.8%. The overall value obtained in this study is in close agreement with 8.38±0.47 liters for Holstein-Friesian (Haftu, 2015), 8.52±3.04 liters for Zebu × Holstein-Friesian (Belay et al., 2012) and 8 liters for Holstein-Friesian Ethiopia (Kebede, 2009), respectively. Whereas, the overall value of DMY found in this study was lower than the highest milk production per day (17 L/day) for Up-Country Exotic dairy cattle breeds of Sri Lanka (Kollalpitiya et al., 2012) and 15.8 liters of Cameroon Holstein Friesian dairy cows (Gwaza et al., 2007). While, the overall value of DMY found in this study was higher than 5.65±0.04 kg (Zewdu et al., 2013).

The overall least square means (LSM±SE) of lactation milk yield for the fixed effects of period of calving, season of calving and parity are summarized in Table 2. The result revealed that period of calving and parity had significant effect (P<0.001) on DMY, while season of calving had no significant effect on DMY of Holstein-Friesian dairy cows. Furthermore, period of calving, season of calving and parity showed source of variation for DMY of Holstein-Friesian × Deoni-crossbred cows (Zewdu et al., 2013). In this study, the lowest value of DMY was observed from the period 1990-1997, while increased at the period from 1998-2015 (Figure 2). Interestingly, a progressively increasing trend was observed from the cows that calved from 1997-2015; this might be an indication of improved management combined with a better adaptation of Holstein Friesian dairy cows in the farm. The results of the current finding confirmed that daily milk yield was highest at 4th parity, lowest at 1st parity. Besides, an increasing trend of daily milk yield was observed from 1st parity to 6th parity, while decreased when the cows go beyond 7^{+} parity (Table 2).

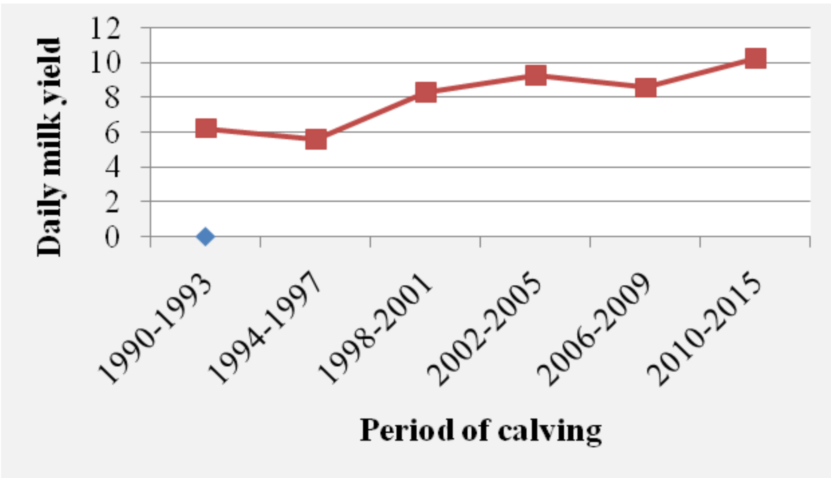

Figure 2 - The trend of daily milk yield of Holstein-Friesian over a period of calving at Alage ATVET College

Lactation Length (LL)

The overall least square means and standard error of lactation length for pure Holstein-Friesian in this study was found to be 323±5.34 days with a coefficient of variation of 24% (Table 2). This is comparable with LL of 319±1.91 days for Holstein-Friesian cattle breeds at Holleta Bull Dam farm (Ayalew et al., 2015), 314 days for Holstein-Friesian in Turkey (Sandhu et al., 2011) and 325 days for Holstein-Friesian in Ethiopia (Niraj et al., 2014). However, the result was longer than the average lactation length of 301±91days at Holleta Bull Dam Station and Genesis Farms (Alewya, 2014), 252.25±5.31 days for Holstein-Friesian at Hossana town (Haftu, 2015), 278.4±90.17 days (Javed et al., 2004), 294 days in Sudan (Abdel et al., 2007) and 291.86±6.55 days for Holstein-Friesian in Pakistan (Sattar et al., 2005), respectively. In contrast, the LL obtained in this study was lower than 342 days lactation length of Holstein-Friesian dairy cows (Krishantan and Sinniah, 2014), 366.5±76.71 days under sub-tropical conditions of China (Usman et al., 2012) and 356.97±76.32 days of Holstein-Friesian (Rameez Raja Kaleri et al., 2017) and 358 days in Mexico (Utrera et al., 2013). In most modern dairy farms, a lactation length of 305 days commonly accepted as a standard. This standard allows for calving of every 12 months with a 60 day dry period and this standard considered as ideal for many years. Therefore, the value of LL reported in the present finding was not advantageous to produce calves each year with a lactation period of about 10 and ½ months. Moreover, longer lactations prolong the calving interval thereby decreasing the number of calves that could be obtained during the life span of a cow.

The least square means and standard error of lactation length for the fixed effects of period of calving, season of calving and parity are summarized in Table 2. The significant effect of period of calving and parity (P<0.001) in agreement with the report of Alewya (2014) on LL of Holstein-Friesian cows. The significant effect of

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parity coincides with the report of Sattar et al. (2005) for Holstein-Friesian cows in Pakistan, Tadesse et al. (2010), Alewya (2014) in Ethiopia and Gader et al. (2007) in Sudan. On the other hand, season of calving did not have a significant effect (P>0.05) on LL of Holstein-Friesian dairy cows. In contrast to this, Lateef et al. (2008) reported a significant effect of season on lactation length of purebred Holstein-Friesian and Jersey cows in a sub-tropical environment of Pakistan. The present study confirmed that comparatively lactation length was longest at the period from 1998-2005, while shortest LL was observed during the period from 2010-2015 (Figure 3). In other cases, the longest LL was observed at 1st parity, while shortest at 7^{+} parity. The lowest lactation length of Holstein-Friesian in the 7th parity was different from the report of Kaleri et al. (2017).

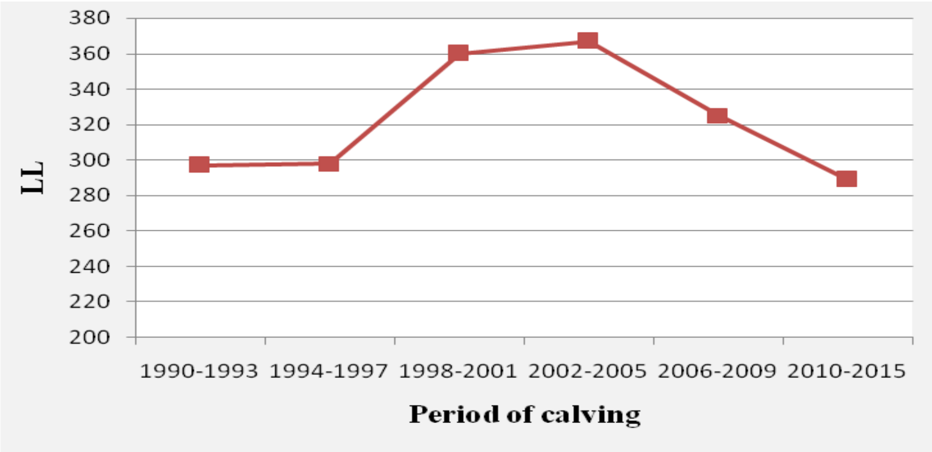

Figure 3 - The trend of lactation length (LL) of Holstein-Friesian over a period of calving at Alage College

Table 2 - Least square means and standard error of daily milk yield and lactation length for the fixed effect of period of calving, season of calving and parity

Source		DMY (kg)		LL (days)
Overall Mean	N	8.06 ± 0.119	N	323 ± 5.34
CV	766	25.8	665	24
Period of calving		***		***
1990-1993	80	6.25 ± 0.26^{d}	62	297 ± 12^{bc}
1994-1997	92	5.61 ± 0.235^{d}	77	298 ± 11^{bc}
1998-2001	176	8.34 ± 0.186^{c}	161	360 ± 8^{a}
2002-2005	200	9.29 ± 0.169^{b}	159	367 ± 8^{a}
2006-2009	98	8.59 ± 0.225^{bc}	85	325 ± 10^{b}
2010-2015	120	10.28 ± 0.202^{a}	121	289 ± 8^{c}
Season of calving		NS		NS
March-May	178	8.07 ± 0.18	152	319 ± 8
June-September	204	8.1 ± 0.17	174	322 ± 8
Oct-February	384	8 ± 0.13	339	326 ± 6
Parity		***		***
1	237	6.6 ± 0.14^{c}	205	357 ± 6^{a}
2	193	7.76 ± 0.155^{cb}	176	334 ± 7^{ab}
3	143	8.43 ± 0.17^{ab}	126	334 ± 8^{ab}
4	94	8.6 ± 0.22^{a}	84	311 ± 10^{cb}
5	56	8.59 ± 0.28^{ab}	39	329 ± 13^{cab}
6	23	8.54 ± 0.43^{ab}	19	330 ± 20^{cab}
7^{+}	20	7.84 ± 0.47^{cab}	16	263 ± 21^{c}

Means separated by different superscript letters under the same variable in one column are significantly different. *** = significant (p<0.001), NS=Not significant, N =number of records, DMY= daily milk yield, LL= lactation length, CV= coefficient of variation.

CONCLUSIONS AND RECOMMENDATIONS

The overall milk production performance of Holstein Friesian and associated factors in Alage ATVET College, Oromia Ethiopia was stated. Based on that, the results conclude towards the idea that the milk production performance of Holstein-Friesian dairy cows; daily milk yield, 305 days milk yield, lactation milk yield is comparably low and far below their potential, which is lower than the performances reported in the tropics.The productive performance of Holstein-Friesian in Alage ATVET College showed variation among a different period of calving and differences in parity. In all aspects, productive traits were not significantly (P>0.05) influenced by season of calving. The variation in productive traits observed during different periods of calving reflected the level of feeding, climatic condition and management differed between periods. Low milk production of Holstein-Friesian is achieved by paying attention to management factors and adjusting genotype environment interactions. Since the period of calving had shown to influence the performance of the existing breed, great attention should be given to the inconsistent management practice across different periods. The result would, therefore, provide very useful information and assist decision making particularly regarding the level of management at different periods. Poor husbandry and breeding practices and genotype-environmental interactions might be some of the reasons for the results of the lower value of this study.

DECLARATIONS

Corresponding Author

E-mail: destawworku@gmail.com; Phone number: +251-934098425

Authors' Contribution

D Worku was participated on proposal preparation, data collection, data analysis and gathering all relevant information and writing of the manuscript. The author read and approved the final manuscript.

Conflict of interests

The authors have not declared any conflict of interests.

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