Global Veterinaria 12 (2): 207-212, 2014
ISSN 1992-6197
© IDOSI Publications, 2014
DOI: 10.5829/idosi.gv.2014.12.02.82119

Production Performance of Dairy Cows under Farmer's Management in and Around Mekelle, Ethiopia

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Abstract: The study was conducted on altogether 475 milch animals comprising of 223 indigenous and 252 Holstein-Friesian (HF) crossbred cows, maintained under farmer's managemental system in and around Mekelle (Ethiopia), were analyzed according to Least Squares Analysis to study the magnitude as well as direction of variation in their lactation length (LL), lactation milk yield (LMY) and peak-yield (PY) due to genetic and some non-genetic factors. The overall Least Squares Means for LL, LMY and PY were estimated to be 292.53±24.09 days, 1320.64±94.68 liters and 7.89±0.14 liters respectively. Genetic group and lactation order had significant effect ($P \leq 0.01$) on LL, LMY and PY. Season of calving had significant effect ($P \leq 0.01$) on LMY and PY but its effect on LL was non-significant. Effect of herd-size was significant ($P \leq 0.05$) on LMY while its effect on LL and PY was non-significant. Variation in all the traits due to location of herd and farming system were statistically non-significant.

Key words: Lactation length · Lactation milk yield · Mekelle · Peak yield

INTRODUCTION

Ethiopia holds the largest cattle population in Africa estimated at about 49.33 million heads of cattle [1] of which 10 million is dairy cows yielding 3.2 billion liters per year. About 99 percent of the dairy cattle are non-descriptive indigenous animals. The national average milk yield per cow per day is 1.54 liters for indigenous cows [1]. In Ethiopia, milk production is predominantly the domain of small and marginal farmers keeping 1-3 milch animals under mixed farming system. For augmentation and sustainability in milk production, it is imperative to strengthen the small dairy units in private sectors where animals are managed under farmer's managemental system without adequate facilities/ infrastructures including various services and market.

The introduction of modern agriculture enforces to introduce modern breeding practices targeted to improve livestock productivity [2]. The increase in productivity could be obtained through crossing of *Bos taurus* and *Bos indicus* (local Zebu). The aim has been to combine adaptability, hardiness, disease resistance and heat tolerance of local zebu with the high milk producing potential and faster growing rate of exotic breed [3]. Genetic improvement of indigenous breeds is possible by way of selective breeding and/or strategic cross breeding, some effort has been exerted to date to improve any of the indigenous breeds [4]. Increase in milk yield in the F1 generation, compared with local stock, crossbred females reach age of puberty (age at first service) at a much younger age and also calved at younger age than their local herd mates. Furthermore, cross breeds have slightly shorter calving intervals and in general cross bred exhibit increase fertility rate more than indigenous cattle [5, 6].

The success of dairy production in general and crossbreeding programmes in particular needs to be monitored regularly by assessing the productive performance under the existing management system. 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 [7].

Lactation period, quantity of milk produced per unit time and input as well as peak yield of a milch animals are the directly observed indicators of their economic worth. A relative determination of magnitude as well as direction of variation in these economic traits due to different causes are necessary to formulate and recommend an

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appropriate breeding strategy for economic milk production in a particular agro-climatic region. The present investigation was undertaken to study the magnitude as well as direction of variation in lactation length, lactation milk yield and peak yield due to genetic and various non-genetic cases in indigenous and crossbred cattle reared under private dairy unit in and around Mekelle (Ethiopia).

MATERIALS AND METHODS

Study Area: The study was conducted in and 10 Km around Mekelle city of Tigray Region in the semiarid highlands of northern. Mekelle is the capital city of Tigray Region and located in the northern extremes of Ethiopia extending from 33°25[1] to 39°38[1] north latitude and from 36°27[1] to 40° 18[1] east longitude at an average altitude of 2000 to 2200 meters above sea level. The mean annual rain fall ranges from 11.3mm to 39.1mm and the temperature varies from 12°C (in November and December) to 27°C (in January and March). Mekelle enjoys humid and hot climate and 783 km from Addis Ababa [8].

Study Population and Sampling Procedure: A total of 72 smallholder dairy farmers were interviewed randomly with scheduled questionnaire which was mainly based on the productive performance information of indigenous and HF crossbred dairy cows. Altogether 475 milch animals comprising of 223 indigenous and 252 HF crossbred cows were included in this study, maintained under farmer's managemental system, located in a radius of about 10 kms in and around Mekelle (Ethiopia). The questionnaire was developed in accordance with the objectives of the study and designed in a simple manner to get accurate information from the dairy farm owners. Each respondent was given a brief description about the nature and purpose of the study. The questions were asked in a very simple manner with explanation where necessary and the responses were recorded directly on the survey schedule. The farmers under the study areas maintained cows under intensive management system in back-yard operation utilizing whatever space was available in the residential compound. The cows were managed in closed houses with different types of floor structure throughout the day. The feed on which the animals were fed include natural pasture (cut and carry), hay, milling by-products, concentrate mix and none-conventional feeds. Cows were hand milked with twice per day milking frequency.

The entire study area was divided into two zones viz. urban which constitute the city area and peri-urban constitute in a radius of 10 Km around city. The private dairy units were grouped into four groups on the basis of number of milch animals they possessed and delineated as herds of sizes 1-3, 4-6, 7-9 and 10 and above. To study the influence of season of calving on different economic traits, the year was divided into three seasons viz. Hot-dry (March-June), Hot-humid (July-October) and Cold (November-February). Performance records of milch animals in first to fifth lactation were only included. On the basis of the farming system adopted by the farmers, the units were classified into two types i.e. household exclusive doing animal husbandry and those doing animal husbandry integrated with crop-production. Lactation length (LL), lactation milk yield (LMY) and peak yield (PY) were the economic traits taken as the measures of production efficiency in this study. Stratified random sampling with proportional allocation [9] was adopted for selection of respondent units.

Data Analysis: Data collected were subjected to Least Squares Analysis [10] for which the following mathematical model was utilized:

$$Y_{ijklmnp} = \mu + G_i + Z_j + F_k + HS_1 + S_m + P_n + e_{ijklmnp}$$

Where,

$Y_{ijklmnp}$ = the value of pth individual under ith genetic group, jth zone, kth farming system, 1th herd size, mth season of calving and nth parity.

μ = the population mean.
G_i = the effect of ith genetic group (i=1, 2)
Z_j = the effect of jth zone (j=1, 2)
F_k = the effect of kth farming system (k=1, 2)
HS_1 = the effect of 1th herd size (1=1, 2, 3, 4)
S_m = the effect of mth season of calving (m=1, 2, 3)
P_n = the effect of nth parity (n=1, 2, 3, 4, 5)
$e_{ijklmnp}$ = the random error associated with individual which is randomly and independently distributed with mean zero and variance σ^2.

The statistical significance of various effects was tested by "F" test. Whereas, the "F" value was significant, the Duncan's Multiple Range (DMR) Test modified by Kramer [11] was utilized for pair wise comparison of the Least Squares Means at 5 and 1 percent level of probability. Relevant phenotypic correlation among the economic traits was estimated utilizing standard statistical procedure [9].

RESULTS AND DISCUSSION

Lactation Length: The overall Least Square Means for LL in dairy animals of the different genetic groups viz. indigenous and HF crossbred cows was estimated to be 292.53±24.09 days (Table 2). Genetic-groups had significant ($P \leq 0.01$) influence on LL and its contribution to the total variation in the traits was 61.11% (Table 1). The HF crossbreds had the longest average LL (331.57±12.77 days), which differ significantly from the average LL for Indigenous cows (247.11±22.64 days). It was in agreement with the findings of Singh *et al.* [12] and Kumar [13] whereas Belay *et al.* [14] recorded LL for crossbred cattle to be less (9.13±1.99 months) than the present findings. In this study, the estimate of average LL in crossbred cows were longer than the standard lactation period (305 days), It could be explained as, indeed the crossbred cows continued to yield 3-4 liters of milk even in their late gestation and the dairy farmers did not practice force drying of their animals even beyond eight month of gestation to meet their sole objective of more and more milk.

The contribution of zone-effect to the total variation in LL was statistically not significant (Table 1) which may be attributed to the fact that experimental area was limited in a radius of 10 km. only, which was divided into two zones in and around Mekelle and as such there was not much variation in agro-climatic condition of the different zones. The influence of herd size and farming system adopted by the farmers on LL was statistically non-significant. Kumar [13] recorded the same result but Singh *et al.* [15] and Shrivastava *et al.* [16] recorded the effect of herd size on LL in crossbred cows to be significant. Such variation in result may be attributed to the difference in genetic constitution of the experimental animals, agro-ecological condition of the study area and the class-nterval of the herd size of this study from that of other workers. Effect of seasons on LL was also non-significant statistically. Singh *et al.* [12], Kumar [13], Shrivastava *et al.* [16], Deshmukh *et al.* [17] and Rao *et al.* [18] also reported the influence on season of calving on LL in cows to be non-significant.

Order of lactation had significant influence ($P \leq 0.01$) on LL, its contribution to the total variation on LL being 2.45 % (Table 1). There was gradual increase in average LL from first (293.35±24.11 days) to fourth lactation (310.34±22.25 days) followed by a significant decrease in fifth (275.68±30.32 days) lactation. DMRT revealed that the average LL was longest in fourth order of lactation, which did not differ significantly from 1st, 2nd and 3rd LL, but differ significantly from 5th one. It was more or less similar to that recorded by Singh *et al.* [12], Kumar [13] and Shrivastava *et al.* [16] in indigenous and crossbred cattle.

Lactation Milk Yield: The overall Least Squares Means for LMY of animals under different genetic groups viz., indigenous and HF crossbred cows was estimates to be 1320.64±94.68 liters (Table 2). Genetic-group had significant ($P \leq 0.01$) influence on LMY and its contribution to the total variation on LMY was maximum (91.87 %). HF crossbred had significantly higher average LMY (2069.16±78.44 liters) than indigenous cows (464.34±41.75 liters). It was in agreement with the findings of Singh *et al.* [12], Kumar [13] and Singh [19]. Rao *et al.* [20] also recorded similar trend for variation in LMY in HF crossbred and indigenous cow. The findings indicated that for relatively higher milk production in the agro-socio-eco-system prevalent in and around Mekelle, the most suitable animal was HF crossbred cow. The animals in different zones did not differ significantly among themselves with respect to their LMY (Table 1).

Table 1: Least Square analysis of variance showing effects of genetic and non-genetic factors on lactation length, lactation milk yield and peak yield of milch animals in and around Mekelle (Ethiopia).

		Lactation Length	Lactation Yield	Peak Yield
Source of variation	d.f.	M.S.S. (R^2)	M.S.S. (R^2)	M.S.S. (R^2)
Genetic group	1	25834.77** (61.11)	30112320.00** (91.87)	833.15** (83.65)
Zone	1	262.77 (0.75)	23998.03 (0.06)	1.99 (0.13)
Herd-size	3	199.65 (0.63)	38985.16* (0.17)	2.16 (0.22)
Season of calving	2	195.33 (0.42)	20001.55** (0.42)	20.11** (1.30)
Lactation order	4	604.44** (2.45)	600114.22** (2.46)	42.99** (5.99)
Farming system	1	14.48 (0.01)	2141.16 (0.01)	0.01 (0.00)
Residual	462	119.76 (34.63)	12367.14 (5.01)	0.76 (8.71)

** $P \leq 0.01$, * $P \leq 0.05$. Figure mentioned in parenthesis indicates R^2 value.

Table 2: Least Squares Mean of Lactation length, Lactation milk yield and peak yield for the animals of different genetic groups.

	Lactation length (Days) Mean±S. E.	Lactation milk yield (Liters) Mean±S. E.	Peak yield (Liters) Mean±S. E.
Overall mean (μ)	292.53±24.09	1320.64±94.68	7.89±0.14
Factors :			
Genetic Group			
Indigenous cow	247.11^{a}±22.64	464.34^{a}±41.75	2.79^{a}±0.31
HF crossbred	331.57^{b}±12.77	2069.16^{b}±78.44	12.15^{b}±0.82
Zone			
Urban	291.16±15.87	1329.32±70.12	7.93±0.86
Peri-urban	301.77±12.99	1309.18±98.76	7.74±0.60
Herd-size			
(Up to 3) animals	291.88±19.73	1258.66^{a}±60.77	7.76±0.65
(4-6) animals	298.76±12.63	1345.43^{b}±58.73	7.90±0.87
(7-9) animals	301.45±21.04	1384.68^{b}±87.98	7.96±0.40
(10 & above) animals	293.85±11.97	1254.76^{a}±64.79	7.78±0.75
Season of calving			
Mar. – June	294.66±11.78	1263.88^{a}±57.27	6.98^{a}±0.58
July – Oct.	292.07±15.65	1294.57^{a}±64.54	7.12^{a}±0.35
Nov. – Feb.	293.06±19.33	1416.49^{b}±87.71	8.78^{b}±0.95
Parities			
1st	293.35^{a}±24.11	1217.44^{ab}±92.67	6.83^{a}±0.22
2nd	297.65^{a}±19.76	1293.51^{a}±56.77	8.22^{b}±0.21
3rd	301.71^{a}±11.99	1492.29^{c}±58.22	9.78^{c}±0.12
4th	310.34^{a}±22.25	1401.66^{d}±80.04	8.88^{d}±0.13
5th	275.68^{b}±30.32	1234.81^{b}±67.45	7.16^{a}±0.19
Farming system			
Only animal husbandry	294.12±21.39	1330.44±77.11	7.94±0.17
Mixed farming	292.01±19.56	1313.51±53.33	7.81±0.12

 # Values superscripted by similar latter were not significantly different from each other.

Herd-size contribute significantly (P≤0.05) to the variation in LMY (Table 1), the magnitude of contribution being 0.17 %. As evident from Table 2, the animals in a herd of 7-9 animals had the highest average LMY (1384.68±87.98 liters) followed by those in herd of 4-6 animals (1345.43±58.73 liters), 1-3 animals (1258.66±60.77 liters) and more than 10 animals (1254.76±64.79 liters) animals. Kumar [13] also reported the effect of herd size on lactation mile yield to be significant. The animals in group of 7-9 did not differ significantly in LMY from those maintained in group of 4-6. The LMY for the animals in either smaller (up to 3 animals) or bigger (10 and above) herd were significantly lower than the LMY of the animals in herd of 4-6 and 7-9 animals (Table 2). It was indicate of the fact that the managemental technology, available in private dairy units in around Mekelle, was able to sustain 4-9 milch animals in a group for highest LMY.

Season of calving had significant (P≤0.01) influence on LMY (Table 1). The average LMY was significantly higher (Table 2) in the animals calved during November–February (1416.49±87.71 liters) as compared to those calved during March–June (1263.88±57.27 liters) and July–October (1294.57±64.54 liters). The latter two averages did not differ significantly from each other. Kumar [13] also found the effect of season of calving on LMY to be significant. Significantly higher LMY in animals calved during November–February might be due to availability of quality green fodder in abundant quantity in study area during November–February i.e. first 3-4 months of their post-calving.

Parity had significant (P≤0.01) influence on LMY (Table 1). There was linear increase in average LMY from first to third order of lactation and then after it decreased gradually up to fifth one. The animals in third lactation had significantly higher (1492.29±58.22 liters) average LMY followed by those in fourth (1401.66±80.04 liters), second (1293.51±56.77 liters). Singh *et al.* [12], Kumar [13] and Shrivastava *et al.* [16] also found more or less similar trend of variation in LMY due to variable order of lactation. The farming system did not have significant influence on LMY (Table 1).

Peak Yield: The overall Least Squares Means for PY of animals of the different genetic groups, included in the study, was estimates to be 7.89±0.14 liters (Table 2). Genetic-group had significant ($P \leq 0.01$) influence on PY and its contribution to the total variation therein was 83.65% (Table 1). The HF crossbred (Table 2) had significantly higher average PY (12.15±0.82 liters) than that of indigenous cows (2.79±0.31 liters). The trend recorded in this study was in accordance with the expectation because Friesian crossbred cows are the highest milk producer in the world and the indigenous cows were mostly non-descript having the lowest potency to produce milk among the animals of different genetic-grades. The findings were in corroboration with the finding of Singh *et al.* [12], Kumar [13], Rao *et al.* [20] and Dutt and Bhushan [21]. The animals in different zones did not differ significantly among themselves with respect to their average PY.

Animals in herd of different sizes and constitutions were not significantly different in respect to their peak milk yield (Table 1). Kumar [13] also reported non-significant influence of herd size on PY in indigenous and crossbred cows. However, Shrivastava *et al.* [16] found this effect to be significant in the crossbred cows of same origin. Such variation may be due to variation in sample size, size of the herds and genetic constitutions of the experimental animals and/or agro-climatic condition of the experimental area in different studies.

Season of calving had significant ($P \leq 0.01$) influence of PY (Table 1). The average PY was significantly higher (Table 2) in the animals calved during November–February (8.78±0.95 liters). It was the lowest in the animals calved during March–June (6.98±0.58 liters) that did not differ significantly from those calved during July–October (7.12±0.35 liters). Kumar [13] also reported significant influence of season on PY in indigenous and crossbred cows.

There was gradual increase in the average PY (Table 2) from first to third order of lactation and then after it decreased up to fifth one. The animals in third lactation (9.78±0.12 liters) had significantly higher PY followed by those in fourth (8.88±0.13 liters), second (8.22±0.21 liters) and fifth (7.16±0.19 liters) lactation. The shortest PY was recorded in first (6.83±0.22 liters) lactation, which did not differ significantly with that in fifth one. The trend of variation in PY recorded in this study was in agreement with the findings of Singh *et al.* [12] and Kumar [13]. The farming system did not any significant influence on peak milk yield (Table 1).

CONCLUSION

On the basis of the findings of the study, it could be suggested that HF crossbred cows in a herd of 4 to 9 animals in their third lactation had relatively better production efficiency in agro-climatic condition of Mekelle of Ethiopia.

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