Kasetsart J. (Nat. Sci.) 40 : 58 - 68 (2006)

# Comparative Performances of Holstein-Friesian Cows under Smallholder and Large Scale Farmers' Management in Central Rift Valley, Ethiopia

**Nega Tolla[1] *, Pravee Vijchulata[2], Pornsri Chairatanayuth[2] and Suwapong Swsdiphanich[3]**

## ABSTRACT

A study was conducted in Central Rift Valley of Ethiopia to assess comparative productive and reproductive performances of graded Holstein Friesian cows under small and large scale farmers' management. A total of 28 animals from both small (14) and large scales farms (14) in different parity classes were used for data collection for a period of 28 weeks. Significant differences were observed in daily intakes of dry matter, crude protein and P ($p<0.001$) as well as metabolizable energy and Na ($p<0.01$) between the two farming scales. Daily milk yield and fat corrected (FC) milk yields were also significantly ($p<0.001$) different. The differences in the composition of milk and postpartum reproductive parameters measured were not statistically significant ($p>0.05$) between the farm scales. However, the longer days open (171) was observed for small scale farms than the large scale farms (148). Days from calving to the first sign of estrus (115d) and numbers of services per conception (2.1) were higher on large scale farms than on the small scale farms (96 and 1.6 respectively). Milk yield, milk composition and reproductive efficiencies did not significantly ($p>0.05$) differ between parity classes. Generally, the productive and reproductive performances of graded Holstein Friesian cows in this study were under their expected genetic potential, as compared to other parts of the tropics. This might be attributed mainly to poor nutritional qualities of the available feed resources, in terms of protein, energy and mineral balance which needed further investigation.

**Key words:** farm scales, parity, productivity, dairy cows, Ethiopia

## INTRODUCTION

The productivity of indigenous cattle breeds in Ethiopia is far below the world's standard. This is due to their inherent low genetic capability for milk production, poor nutritional management, environmental stresses and diseases (Preston and Leng, 1987; Mukasa, 1989; Goshu and Mekonen, 1997). The efforts towards developing modern commercial dairying in Ethiopia was started before the second World war, when some Channel Island and Holstein Friesian breeds were introduced by some individuals and religious organizations (Abaye *et al.*, 1991). But the productivity of these cattle breeds was far below expectation. Sendros and Kumssa (1998)

1 Adami Tulu Agricultural Research Center P.O. Box 35, Ziway, Ethiopia.
2 Department of Animal Science, Faculty of Agriculture, Kasetsart University, Bangkok 10900, Thailand.
3 Departement of Agronomy, Faculty of Agriculture, Kasetsart University, Bangkok 10900, Thailand.
* Corresponding author, e-mail: raggatu@yahoo.com.

Received date : 12/10/05 Accepted date : 05/01/06

reported that lactation milk yield of Holstein-Friesian cattle on large-scale commercial state dairy farms could not exceed 3000kg. Under some other tropical feeding and management conditions ? or pure Holstein Friesians could produce over 4,000 kg milk per lactation (Combellas, *et al.*, 1981; McDowell, 1985). Leng (1999) reported that Friesian cattle imported into India had produced an average of 6000kg milk in 300-days of lactation with appropriate nutritional management practices.

In Ethiopia, market oriented small and large scale farms in the peri-urban and urban centers are the two categories of milk production systems (EARO, 1998). These sectors rely on crossbred and exotic cattle breeds under intensive and semi-intensive management with production goal of cash income. They are dependent on purchased roughage and concentrate feeds with limited grazing for milk production. Lack of appropriate nutritional management, health care, marketing system, extension and training are the major constrains for their low productivity (Goshu and Mekonen, 1997; Azage and Alemu, 1998). However, information on comparative production and reproductive performances of this genotype under large scale and small scale farmers' management in Ethiopia is limited. Therefore, the main objective of this study was to compare the performance of graded Holstein Friesian dairy cows under large scale and smallholder dairy farms in the urban and peri-urban centers of Central Rift Valley of Oromia region, Ethiopia.

## MATERIALS AND METHODS

This study was conducted in the Central Rift Valley (CRV) of Oromia, at Arsi Negelle, Ziway, Wonji Kuriftu and Lume districts of East Shoa Zone. The area is characterized with different altitude ranges of 1550 and 1900 meters above sea level and average minimum and maximum temperature of 20°C and 27°C respectively. It has an erratic and unreliable rainfall, ranging from 500 to 900 mm per year.

A rapid exploratory survey was undertaken to identify and locate the existing large and small scale dairy farms in the urban and peri-urban centers of the study area. Based on the willingness of the farm owners, the presence of dairy cows of graded Holstein-Friesian genotype, known parity and stage of pregnancy, 3 large peri-urban farms having 170 to 195 heads of dairy animals and 21 small scale urban farmers in the secondary towns having 1 to 10 heads of cattle were identified. The farms were categorized based on the existing herd size as small scale (≤10 animals) and large scale (>10 animals). Accordingly, two large scale farms and 12 smallholder farmers were randomly selected. A total of 28 animals from both large scale (14 animals with 426±85 kg average body weight) and small scale (14 animals with 363±8.5 kg average body weight) with the parity ranging from 1 to 6 and in the last trimester of pregnancy were used for data collection. Animals in different parities were classified as early parity (1-2 lactation) and advanced parity (3-6 lactation). Seven animals were used in each parity class. In the urban small scale production system the animals were entirely confined at home utilizing whatever space was available in the residential compounds. There were no sufficient exercising areas. Animal houses were normally small structures of corrugated metal sheeting or mud and floored with blocks of stone or cemented floor. Purchased cereal crop residues, such as maize stover, haricot bean straw, tef (*Eragrostis abyssinica*) straw were the major basal feed resources. Green forages of maize and native grass were also used seasonally. The utilization of agro-industrial by-products such as nougseed cake (*Guizota abyssinica*), linseed cake, cotton seed cake and wheat bran was minimal. In the peri-urban large scale production units animals were housed in sheds with well ventilated corrugated metal sheet and cemented floors. Their major basal feed source was based on purchase or very few harvested native grass hay. Green feeds of alfalfa and elephant grass were also used. There was regular supply of mixed concentrate diet.

Data collection was started from about one week postpartum. The utilization of available feed resources and daily milk yield of each selected farm was monitored and recorded every five days for 210 days. Daily milk yield of individual animal was monitored and recorded for both AM and PM using portable spring balance. The amount and type of feed offered to individual animal was also weighed and recorded for each monitoring date. Both daily feed intake and milk yield for none collection days were estimated from average values of the preceding measurements. Accordingly the refusal of any feed type offered was weighed and recorded. The amount of daily nutrient intake over a given period was estimated by multiplying the nutrient contents of the feeds (per kg dry matter) by the daily dry matter intake of the respective feed. Dry feed samples from each farm were collected fortnightly and bulked. They were thoroughly mixed, sub sampled and delivered to laboratory for chemical analysis. Milk sample was collected three times, at 4, 16 and 27 weeks of lactation period using 100ml sampling bottle preserved with potassium dichromate and delivered the same day to the laboratory. On the large scale farms, any sign of estrus manifestation was visually observed and recorded by barn attendants and the veterinarian daily in the morning and after-noon. On the small scale farms the enumerators assigned for data recording visually observed and recorded any sign of estrus. In both cases mating practice was by artificial insemination (AI). However, on the small scale farms several skipped mating were observed due to shortage of AI facilities and/or unavailability of AI technicians.

**Chemical analysis**

Feeds were analyzed for dry matter (DM), organic matter (OM) and nitrogen (N) using standard procedures of AOAC (1990). Neutral detergent fiber (NDF) was determined as described by Van Soest and Robertson (1985). The *in vitro* organic dry matter digestibility (IVDOMD) was determined using the procedures described by Tilley and Terry (1963). Metabolizable energy (ME) content (MJ/kg DM) of feed was estimated from *in vitro* digestibility (IVDOMD × 0.016) as suggested by Barber *et al*. (1984). Metabolizable energy intake (MEI) was estimated by multiplying dry matter intake (DMI) of the feed with the values of their respective energy concentration, i.e.; MEI (MJ/d) = DMI (kg/d) × ME (MJ/kg DM) according to Kearl (1982) and MAFF (1985). Calcium and sodium contents of the feeds were analyzed using atomic absorption spectrophotometers according to Perkins (1982), and phosphorus content was determined according to AOAC (1990). The daily crude protein (CP) and ME requirement for the animals was estimated based on actual average daily milk yield and fat content according to NRC (1989) recommendation. The composition of milk fat and protein were analyzed using Gerber method and formaldehyde titration respectively and total solid was determined by oven drying the milk sample according to O'Mahoney (1988).

**Statistical analysis**

Data on daily milk yield, milk compositions, postpartum reproductive efficiencies and nutrient intake were analyzed for farm scale, parity class and lactation period differences using the General Linear Model and multivariate analysis procedure of SPSS (1997). Mean differences between subjects under study were tested by pairwise comparison and least significant difference (LSD) method. The model used to analyze the effects of farm scale and parity classes on milk yield, reproductive traits and nutrient intake was:

$$Y_{ij} = \mu + S_i + P_j + SP_{(ij)} + e_{(ijk)}$$

Where, $Y_{ijk}$ = the means of daily milk yield or reproductive traits or nutrient intake measured.

$\mu$ = the overall mean

$S_i$ = effect of $i^{th}$ farm scale (i = 1, 2)

$P_j$ = effect of $j^{th}$ Parity class (j = 1, 2)

$SP_{(ij)}$ = interaction between farm scales and parity classes

$e_{(ijk)}$ = error term

The Model used to analyze effects of farm scale, parity class and period on milk composition was:

$$Y_{ijk} = \mu + S_i + P_j + T_k + e_{(ijk)}$$

Where, $Y_{ijk}$ = the means for milk composition

$\mu$ = the overall mean

$S_i$ = effect of $i^{th}$ farm scale (i = 1, 2)

$P_j$ = effect of $j^{th}$ Parity class (j = 1, 2)

$T_k$ = effect of $k^{th}$ period (k = 1, 2, 3)

$e_{(ijk)}$ = error term (assumed independently and normally distributed)

## RESULTS AND DISCUSSION

### Chemical composition of feed resources

Mean chemical compositions (% DM) of the available feed resources utilized on different farms are presented in Table 1. Some of the small scale farmers used cereal crop residues after soaking them with home-made brewers' grain by-products. It was observed that soaking tef and wheat straws with brewer's grain by product substantially increased the CP, ME, Ca compositions and IVDMOD of the feeds.

### Feeds and nutrient intake

Significant differences were observed between the large and small scale farms in daily

**Table 1** Mean chemical compositions of feed resources available for graded Holstein Friesian cows in central Rift Valley, Ethiopia.

| Feed types | (% DM) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | DM | CP | ME(MJ) | NDF | EE | ASH | IVOMD | Ca | P | Na |
| Native grass hay | 92 | 4.4 | 5.7 | 76.9 | 1.2 | 8.0 | 35.9 | 0.3 | 0.15 | 0.54 |
| Native grass forage | 13 | 9.1 | 7.2 | 75.9 | 1.4 | 9.3 | 45.0 | 0.43 | 0.3 | 0.01 |
| Alfalfa forage | 35 | 17.4 | 8.6 | 50.9 | 1.8 | 11.8 | 53.9 | 1.0 | 0.3 | 0.22 |
| Elephant grass | 15 | 13 | 8.1 | 50.9 | 1.9 | 17.1 | 50.3 | 0.2 | 0.3 | 0.1 |
| Maize forage | 35 | 10.4 | 10.0 | 62.3 | 1.3 | 9.2 | 62.4 | 0.24 | 0.33 | 0.2 |
| Maize stover | 91 | 5.6 | 8.85 | 81.2 | 0.7 | 8.2 | 55.3 | 0.35 | 0.10 | 1.7 |
| Wheat straw* | 62 | 13.1 | 10.4 | 59.0 | 8.4 | 6.5 | 65.1 | 0.4 | 0.4 | 0.22 |
| Wheat straw | 92 | 2.7 | 5.81 | 81.6 | 0.9 | 8.2 | 36.3 | 0.09 | 0.05 | 0.001 |
| Tef straw* | 73 | 12.7 | 9.7 | 59.9 | 5.1 | 6.1 | 60.9 | 0.33 | 0.4 | 0.03 |
| Tef straw | 92 | 4.3 | 6.2 | 83.1 | 1.1 | 6.6 | 38.6 | 0.2 | 0.09 | 0.08 |
| Haricot bean straw | 91 | 5.2 | 6.8 | 71.0 | 0.7 | 8.1 | 42.5 | 0.18 | 0.05 | 0.26 |
| Molasses | 74 | 3.5 | 15.9 | - | 5.9 | 5.9 | 98.7 | 1.8 | 0.10 | 0.26 |
| Brewers grain residue | 13 | 21.4 | 11.0 | 57.4 | 3.5 | 4.0 | 69.0 | 0.61 | 0.59 | 0.004 |
| Noug seed cake | 91 | 29.7 | 9.3 | 36.4 | 6.2 | 10.9 | 58.1 | 0.69 | 0.99 | 0.03 |
| Linseed cake | 90 | 29.1 | 10.6 | 24.3 | 9.1 | 8.1 | 66.3 | 0.51 | 0.92 | 0.22 |
| Cotton seed cake | 90 | 22.3 | 7.6 | 48.7 | 6.6 | 5.6 | 47.5 | 0.19 | 0.74 | 0.08 |
| Wheat bran | 88 | 17.1 | 11.6 | 38.4 | 4.6 | 4.4 | 72.4 | 0.11 | 1.0 | 0.05 |
| Mixed concentrate | 89 | 21.3 | 10.6 | 37.4 | 4.7 | 7.1 | 66.3 | 0.34 | 1.2 | 0.25 |

* Soaked in home-made brewers grain residues (Atala)

intake of DM, CP, ether extract (EE), P ($p<0.001$), ME, and Na ($p<0.01$) (Table 2). Animals on the large scale farms had higher intake of DM (39%), CP (38%), ME (23%), P (60%) and Na (33%) than those on small scale farms. The intake of CP for the small and large scale farms was above the estimated requirement (Table 2) level (27 and 28% respectively) and that of ME for small and large scale farms was (10 and 6% respectively). Calcium intake for animals in small scale farms was under the recommended range (0.43 to 0.77 %DMI) of NRC (1989) while that of large scale farms was marginal. The intake of P was within the recommended marginal level of 0.33 - 0.48% of DMI for small scale farms while it was sufficiently higher for the large scale farms. The ratios of Ca:P were 0.8:1 and 0.6:1 in small scale and large scale farms respectively while dietary Ca:P ratio between 1:1 and 2:1 was assumed to be ideal (McDowell, 1983). Sodium content of the feeds was critically below the required level of 0.18% (NRC 1989) in both farm scales. Chenost and Sansoucy (1991) and Chesworth and Guérin (1992) reported that voluntary feed intake of ruminants essentially depended on the rate of degradation of its digestible matter. In this study, the crop residues of low digestible matter such as maize stover, tef straw, wheat straw and haricot bean straw used by smallholder farmers (Table 1) were low in nitrogen and true protein content which might limit the intake of DM and other nutrients. About 43% of the total DM consumed

**Table 2** Mean daily feeds and nutrient intake of Holstein Friesian cows in urban and peri-urban centers of central Rift Valley under two farm scales.

| Daily nutrients intake | Farm scales | | | |
|---|---|---|---|---|
| | Small | Large | SE | P |
| Number of animals | 14 | 14 | | |
| Total DM (kg) | 11.4 | 15.8 | 0.47 | *** |
| Roughage | 4.9 | 6.3 | 0.33 | ** |
| Supplement | 6.5 | 9.5 | 0.44 | *** |
| Total CP (g) | 1704 | 2343 | 123.00 | *** |
| Roughage | 259 | 477 | 45.85 | ** |
| Supplement | 1445 | 1866 | 104.63 | ** |
| CP (%) | 14.5 | 15.4 | 0.59 | NS |
| Total ME (MJ) | 115 | 141 | 5.66 | ** |
| Roughage | 34 | 41 | 2.26 | * |
| Supplement | 81 | 100 | 6.31 | * |
| Total NDF (%DMI) | 45 | 50 | 2.35 | NS |
| Total EE (%DMI) | 4.2 | 3.4 | 0.14 | *** |
| Roughage NDF (%total NDF) | 71 | 53 | 2.26 | *** |
| Ca (%DMI) | 0.40 | 0.43 | 0.02 | NS |
| P (%DMI) | 0.48 | 0.77 | 0.04 | *** |
| Na (%DMI) | 0.03 | 0.04 | 0.001 | ** |
| CP requirement (g/head/d)[1] | 1238 | 1696 | 89.00 | - |
| ME requirement (MJ/head/d)[1] | 103 | 133 | 3.78 | - |

*** =p<0.001; **=p<0.01; *=p<0.05; NS=not significant.

[1] CP and ME Requirements were estimated based on the actual average milk yield (kg/d) and body weight of animals (NRC , 1989).

by animals on the small scale farms was roughage feed as compared to 38.6% of daily DMI on large scale farms. Similarly about 71% of NDF intake of animals on the small scale farms was roughage feeds vs. 53% of DMI on the large scale farms. The utilization of agro-industrial by-products such as nougseed cake (*Guizota abyssinica*), linseed cake, cotton seed cake and wheat bran was minimal (7.76% DMI). A home-made brewer's by-products (39% DMI) mixed with crop residues or alone was also used. Mixed concentrate in the daily dietary DMI of animals in small scale farms was only 9.6%. Since the potential intake of forage was inversely related to its NDF content, the DM intake and consequently that of other nutrients were limited for animals in small scale farms. Feeds and nutrient intake were not significantly (p>0.05) different among parity classes (Table 4).

**Milk yield, milk composition and reproductive efficiency**

The mean daily milk yield and composition, and postpartum reproductive efficiencies of Holstein Friesian cows on large and small scale farms are presented in Table 3. Difference in actual and fat corrected daily milk yield was highly significant (P<0.001) between the two farm scales. There were higher daily milk yield and FCM yield on the large scale farms (15.8 and 14.7 kg respectively) than on small scale farms (11.5 and 11.1 kg respectively). The higher milk yield of animals on large scale farms might be attributed to higher intake of DM, CP, ME, Ca and P relative to the small scale farms.

The utilization of conserved grass hay, green forages and mixed concentrate on large scale farms were about 26.6, 12 and 59% of daily DMI respectively as compared to only 6.4, 5.4 and 9.6% respectively on small scale farms. This reflects that the productivity of ruminants is influenced primarily by quantity and quality of feed intake (Preston and Leng, 1987). The quantity of CP and ME might not be the limiting factors for low performances of the animals under this study.

Possible reasons for the low milk yield performances of animals in small scale farms might be due to poor nutritional quality of crop residues used (about 36.4% of daily DMI), the CP intake from home-made liquor residues which was about 39% of daily DMI and provided about 76% of the total CP intake might be heat damaged during the long time boiling of alcohol distillation. Therefore, its CP might be unusable or poorly digested in the lower digestive tract as well as in the rumen. This might resulted in too low ammonia levels in the rumen which could not meet the requirement for efficient growth of rumen micro-organisms (Preston and Leng, 1987). Source of supplemental CP is an important factor to influence the response of animals, due to their variation in type and levels of essential amino acid (EAA) contents (Christensen *et al.*, 1993). In addition, the minimal and inconsistent use of protein sources from mixed concentrate and agro-industrial by-products might result in lower nutrient intake and consequently low productivity of the animals. On both farm scales the ratio of Ca: P observed was very low. McDowell *et al.* (1983) reported that with dietary ratios below 1:1 and over 7:1 growth and feed efficiency decreased significantly. Simon (2005) in Tanzania reported that there was high milk yield in large scale farms compared to smallholder farms. Differences in milk production between the two management systems were attributed mainly to the level of management. Like small scale farmers in other developing countries (Leng, 1991), small scale farmers in this study could not be able to select quality basal diet, than using whatever was available at no or low cost.

Lactation curve over weeks for animals in the two scales of management and parity classes are comparatively presented in Figures 1and 2. On the large scale farms, there was fast increase of milk yield up to the peak at week 3, but continuously declined thereafter (Figure 1). The trend of increase on the small scale farms was relatively slow and short. The peak yield was attained at week 4 and thereafter declined continuously as well. Although the differences were not significant (P>0.05) animals in advanced parities (3-6) on both farm scales performed better than those in early (1-2) parities (Figure 2). On large scale farms animals in early parity (1-2) attained peak yield at week 4 and the trend of decline was slower than for those in advanced parities (3-6). Animals in advanced parities attained peak yield at week 3 and the trend of decline was relatively faster than that of their counterparts. On the small scale farms and animals in both parities, trend of milk yield increased was slower and shorter. Animals in advanced parities attained peak yield at week 7 and the trend of decline was also slower relative to those in early parities, which attained very short peak yield at

**Table 3** Mean daily milk yield, milk composition and reproductive efficiency of Holstein Friesian cows under two farm scales.

| Daily nutrients intake | Farm scales | | | |
|---|---|---|---|---|
| | Small | Large | SE | P |
| Number of animals | 14 | 14 | | |
| Milk yield (kg) | 11.5 | 15.8 | 0.73 | *** |
| FC milk yield (kg)[a] | 11.1 | 14.7 | 0.67 | *** |
| Fat (%) | 3.8 | 3.6 | 0.17 | NS |
| Protein (%) | 2.9 | 2.8 | 0.08 | NS |
| Total solid (%) | 11.3 | 11.3 | 0.24 | NS |
| Calving to first sign of estrus (d) | 96 | 115 | 14.60 | NS |
| Days open | 171 | 148 | 23.50 | NS |
| Services/conception | 1.6 | 2.1 | 0.24 | NS |

***=p<0.001; NS=not significant.

[a] FC = fat corrected.

**Table 4** Mean daily milk yield and composition, nutrient intake and reproductive efficiency of Holstein Friesian cows under two parity classes.

| Daily nutrients intake | Parity scales | | | |
|---|---|---|---|---|
| | Small | Large | SE | P |
| Number of animals | 14 | 14 | | |
| Milk yield (kg/d) | 13.3 | 13.9 | 0.73 | NS |
| FC milk yield (kg/d) | 12.6 | 13.2 | 0.67 | NS |
| Fat (%) | 3.7 | 3.6 | 0.17 | NS |
| Protein (%) | 2.8 | 2.8 | 0.08 | NS |
| Total solid (%) | 11.3 | 11.3 | 0.24 | NS |
| DM intake (kg/d) | 13.7 | 13.5 | 0.73 | NS |
| CP intake (g/d) | 2092 | 1956 | 123.19 | NS |
| ME intake (MJ/d) | 130 | 126 | 5.66 | ** |
| Calving to first sign of estrus (d) | 105 | 106 | 14.50 | NS |
| Days open | 163 | 156 | 23.50 | NS |
| Services/conception | 1.8 | 1.7 | 0.19 | NS |

**=p<0.01; NS=not significant.

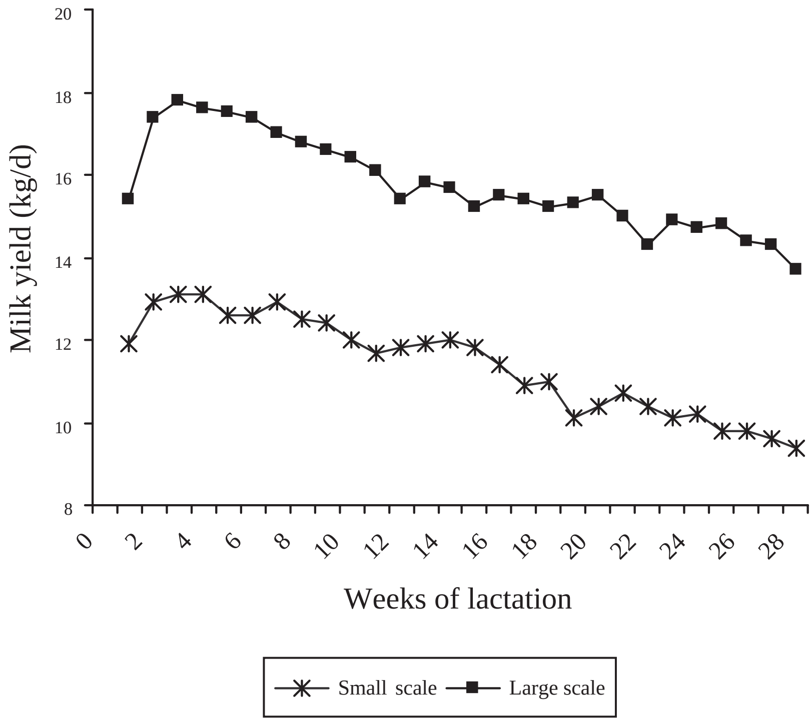


**Figure 1** Mean daily milk yield of cows in two different farm scales during 28 weeks of lactation.

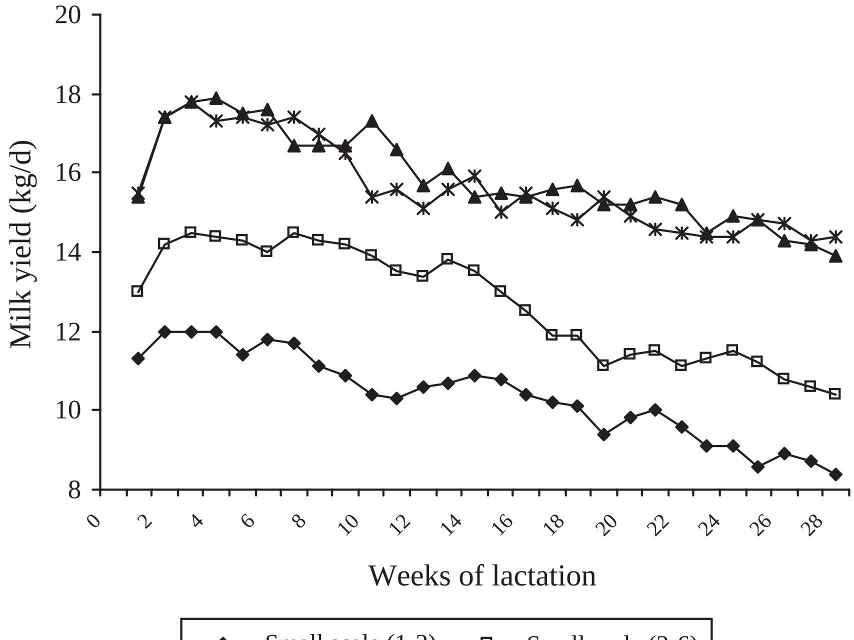


**Figure 2** Mean daily milk yield of Holstein Friesian cows in two different farm scales and parity classes of 1-2 and 3-6.

**Table 5** Effect of lactation period on milk composition of Holstein Friesian cows in two farm scales.

| Farm Scales | Compositions | Lactation periods | | | | |
|---|---|---|---|---|---|---|
| | | Week 4 | Week 16 | Week 27 | SE | P |
| Small | No of animals | 28 | 28 | 28 | | |
| | Fat (%) | 3.8 | 3.7 | 3.9 | 0.19 | NS |
| | Protein (%) | 2.6 | 2.4 | 3.5 | 0.13 | *** |
| | Total solid (%) | 10.7 | 11.5 | 11.8 | 0.28 | ** |
| Large | Fat (%) | 3.6 | 3.4 | 3.7 | 0.19 | NS |
| | Protein (%) | 2.5 | 2.4 | 3.5 | 0.13 | *** |
| | Total solid (%) | 10.6 | 11.5 | 11.8 | 0.27 | ** |
| | Fat (%) | 3.7 | 3.6 | 3.8 | 0.17 | NS |
| Overall | Protein (%) | 2.5 | 2.4 | 3.5 | 0.10 | *** |
| | Total solid (%) | 10.7 | 11.5 | 11.8 | 0.23 | ** |

***=p<0.001; **=p<0.01; NS not significant.

week 4. Milk composition was not significantly (P>0.05) different among the two farm scales and parities, (Tables 3 and 4). There was significant effect of period on the content of milk protein (P<0.001) and total solid (p<0.01) (Table 5). But milk fat content did not differ (p>0.05) between periods. Higher milk protein content was observed in period 3 (week 27 of lactation). This might be due to increased CP concentration in the dietary feed intake during the period coupled with advanced stage of lactation of the animals. DePeters and Cant (1992) reported that following calving up to weeks 5 to 10 milk protein content decreases, and then after, gradually increases through the end of lactation.

The days from calving to first estrus (CFE), days open (DO) and the number of services per conception (S/C) was not significantly (P>0.05) different between the farm scales (Table 3) and parity classes (Table 4). But the value of DO on small scale farms was longer (171) than on the large scale farms (148). This might be due to lack of regular AI services and several skipped mating observed. The days to first estrus (115) and S/C (2.1) were higher on the large scale farms than on the small scale farms (96 and 1.6 respectively), which might be due to poor heat detection practices. Since the numbers of animals on small scale farms were very few, farmers could be able to observe estrus manifestation of their animals more closely than in the large scale farms where there were relatively large numbers of animals and could not be easy to closely observe estrus manifestation of individual animal.

## CONCLUSIONS

The productivity of animal on both farm scales was below their expected genetic potential, but that of small scale farm was critically low as compared to some parts of the tropics. The amounts of CP (g/d/head) and ME (MJ/d/head) consumed were above the requirement for the observed actual milk out put. However, the proportion of rumen degradable to undegradable CP and that of structural and none structural carbohydrate needs further investigation. In both small and large scale farms the NDF content in the daily DMI was above the recommended level of 28% (NRC, 1989). Regardless of its biological availability, calcium intake was also at marginal level. There was also lower ratio of Ca: P in both farm scales. Sodium intake (%DMI) was also critically lower than the recommended level of 0.18% (NRC, 1989). The large variation among individual animals and within the farm scales showed the opportunities for further improvement. There will be a need to investigate the nutrient balance of available feed supply for both farm scales. The ratio of rumen degradable to that of un-degradable protein must be assessed and adjusted to the recommended level. The nutritional values of the home-made liquor residues used by most small scale farmers have to be further assessed. The need of technical and institutional support will be indispensable to ensure sustainable supply of nutritionally balance feeds, AI and veterinary services which are the major areas of research and development intervention. This may need establishment of dairy farmers cooperatives in the study area, where other farmers elsewhere were successful in getting access to regular animal feed supply and market out-let for their products.

## ACKNOWLEDGEMENTS

The authors would like to appreciate Oromia Agricultural Research Institute (OARI) and the Ethiopian Agricultural Research Organization (EARO) for financially supporting this study.

## LITERATURE CITED

Abaye T., T.G. Meskel, A.G. Wold, B. Yemane and C. Philip. 1991. Status of dairying in Ethiopia and strategies for future development, pp. 25–36. *In* **Proceedings of 3rd National Livestock Impovement Conference,** 24–26 May 1989, Institue of Agricultural Research (IAR), Addis Ababa.

AOAC (Association of Official Agricultural Chemists). 1990. **Official Methods of Analysis**. Washington, DC.

Azage, T. and A.G. Wold. 1998. Prospects for peri-urban dairy development in Ethiopia, pp. 28-39. *In* **Proceedings of 6th National Conference of Ethiopian Society of Animal Production (ESAP),** 15–17 May 1997, Addis Ababa.

Barber,W.P., A..H. Adamson and J.F.B.Altma. 1984. New methods of forage evaluation, pp.161-176. *In* W. Hareisgn and D.J.B. Cole (eds.). **Recent Advances in Animal Nutrition.** Butterworth, London.

Chenost, M. and R. Sansoucy. 1991. Nutritional characteristics of tropical feed resources, pp. 66–81. *In* A. Speedy and R. Sansoucy (eds.). Feeding Diry Cows in the Tropics. **Proceedings of the FAO expert consultation held in Bangkok, Thailand,** 7–11 July 1989. Food and Agricultural Organization of the United Nations, Rome.

Chesworth J. and H. Guérin. 1992. **Ruminant Nutrition**. Macmillan Education Ltd. London. 170 p.

Christensen, R.A., G.L.Lynch and J.H. Clark. 1993. Influence of amount and degradability of protein on production of milk and milk components by lactating Holstein cows. **J. Dairy Sci.** 76: 3490–3496.

Combellas, J., N. Martinez and M. Compariles. 1981. Holstein cattle in tropical areas of Venzuella. **Trop. Anim. Prod**. 6 (3): 214–220.

DePeters, E.J. and J.P. Cant. 1992. Nutritional factors influencing the nitrogen composition of bovine milk: a review. **J. Dairy Sci.** 75: 2043–2070.

EARO (Ethiopian Agricultutral research Organization). 1998. **Anim. Sci. Research Strategy.** Short Term Plan, EARO, Addis Ababa. 46 p.

Goshu, M. and H.M. Mekonen. 1997. Milk production of Fogera cattle and their croses with Friesian at Gonder, Northern Ethiopia. **Ethiopian J. Agr. Sci.** (EJAS) 16(2) 61–74.

Gould, C.M. 1969. Unifying hypotheses – fertility status, palatability, ketosis, and protein intake. **Vet. Rec**. 85: 662.

Kearl, L.C. 1982. **Nutrient Requirement of Ruminants in Developing Countries**. International Feedstuff Institute, Utah

Agricultural Experiment Station. Utah State University, Logan. 381p.

Leng, R.A. 1991. Feeding strategies for improving milk production of dairy animals managed by small farmers in the tropics, pp. 82 – 104. *In* A. Speedy and R. Sansoucy (eds.). Feeding Dairy Cows in the Tropics. **Proceedings of the FAO expert consultation held in Bangkok, Thailand,** 7–11 July 1989. Food and Agricultural Organization of the United Nations, Rome.

Leng, R.A. 1999. Feeding strategies for improving milk production, pp. 403-416. *In* L. Flavey and C.Chantalakhana (eds.). **Smallholder Dairying in the Tropics.** ILRI (International Livestock Research Institute), Nairobi.

McDowell, L.R. 1985. **Meeting Constraints to Intensive Dairying in Tropical Areas**. Cornell International Agriculture Memeograph No. 108, Ithaca, New York. 41 p.

McDowell, L.R., J.H. Conrad, G.L. Ellis and J.K. Loosli. 1983. **Minerals for Grazing Ruminants in Tropical Regions**. Center for Tropical Agriculture, University of Florida, Gainesville. 86 p.

Ministry of Agriculture, Fisheries and Food. 1985. **Energy Allowance and Feeding Systems for Ruminants.** Reference Book No. 433, London. 73 p.

Mukassa, M.E. 1989. **A Review of Reproductive Performance of Bos indicus (*Zebu*) Cattle.** International Livestock Center for Africa (ILCA), Monograph No. 6, Addis Ababa. 136 p.

National Research Council. 1989. **Nutrient Requirement of Dairy Cattle**. 6th ed., National academy Press, Washington, D.C. 157p.

O'Mahony, F. 1988. **Rural Dairy Technology–Experience in Ethiopia.** Dairy technology unit, manual No.4. International Livestock Center for Africa, Addis Ababa. 64p.

Perkins E. 1982. **AAS Manual Model 2380.** Norwalk, Connecticut.

Preston, T.R. and R.A.Leng. 1987. **Matching Ruminant Production Systems with Available Resources in the Tropics and Sub-Tropics,** Penambul Books Ltd. Armldale, NSW. 245p.

Sendros D. and T. Kumssa. 1998. Factors to be considered in formulation of livestock breeding policy, pp. 26-35. *In* **Proceedings of the 5th National Conference of Ethiopian Society of Animal Production (ESAP).** Addis Ababa.

Simon, S. 2005. Comparative performance of dairy cattle under large scale and smallholder dairy farms in Tanzania: a review. Available Source htt://www.husdyr.kvl.dk/htm/php/ Tanzania/ Index2.htm, August 1, 2005.

SPSS. 1997. **Statistical Procedure for Social Science**. SPSS Inc, version 10.

Tilley, J.A.M. and R.A. Terry. 1963. A two-stage technique for the *in vitro* digestion of forage crops**. J. Brit. Grassland Soc.** 18: 104–111.

Van Soest, P.J. and J.B. Robertson. 1985. Analyses of forage and fibrous foods. **A Laboratory Manual for Anim. Sci.** 613: 98–110, Cornell University, Ithaca, New York.