

Herd Structure and Dairy Performance on Smallholder Dairy Farms in Uasin Gishu County

Mabonga, G. N¹ and L. Ogallo²

University of Eldoret, School of Agriculture & Biotechnology, PO BOX 1125, Eldoret¹,
Email: gnakokonya@yahoo.com

Great Lakes University of Kisumu, Department of Agribusiness Management, Kisumu²
Email: ogalloleo@gmail.com;

Abstract

A cross-sectional proportional and stratified random sample survey of sixty four smallholder dairy farms in Uasin Gishu County was carried out to characterize the herd structure and determine performance. Data to elicit information on the herd structure and performance were recorded using a structured questionnaire that was developed, pre-tested and used for collecting quantitative data for the study. The results showed that the dominant improved breeds kept comprised exotic cattle-zebu crosses (62.3%), Friesian 15.3%, Ayrshire 11.6%, Guernsey 5.3%, Local 3.1% and Jerseys 2.4% with significant differences ($p < 0.05$) in milk yields. A range recorded was 1 – 3 cows per household. The milk yield /cow/day was 27% producing between 6-8 litres with 13% and 5% of the respondents producing 11 and 12 litres of milk/cow/day respectively; 7% and 12% others producing 1-3 and 4-5 litres of milk/cow/day respectively. The results also showed the reasons of dairy farming at 53% profit, 41% hobby, 3% and 3% for household consumption and family insurance respectively. The study also ascertained experience in dairy farming at 16%, 31%, 10%, 3% and 4% at less than 5, 6-10, 11-16, 17-20 and 21 and above years respectively. The study further sought to ascertain factors such as age at first service, age at first calving, days open, calving interval, lactation length, milk yield per cow per day and method used in breeding as factors influencing herd structure and performance. This study further observed that level of education, monthly income and the size of the farm influenced herd structure and dairy performance. It is recommended that management skills, strong institutional linkages, support for commercial rearing of dairy breeding stock, and feeds diversification programme should be developed to improve performance of dairy herds in the study area.

Key words: Herd structure, dairy breeds, milk production, lactation period, calving interval, age at first calving.

INTRODUCTION

The Kenyan economy is highly dependent on agriculture and contributes about 25% of the GDP (KIPPRA 2009). It provides not only food for the growing population but also employment to over 75% of the population, raw materials for industries and accounts for around 65% of the total export earnings as foreign exchange earnings (CBS, 2007). For this reason, agriculture has the potential to transform Kenyan economy. Yet, this is a function, to a large extent, of agricultural productive efficiency. Further, the Kenyan phenomenal high levels of urbanizations, unprecedented population growth and expansion of urban areas presents an apparent disparity between the rates of food production and its demand (FAO, 2003). One of the major causes of food discrepancy is the inability to provide the required amount of livestock protein in the diets of the many people, especially those in the rural

areas that constitute about 80% of the population (Kenya Census, 1999). The dairy sector plays a vital role as source of not only quality nutrients for the Kenyan population, but also as a source of income, services and foreign exchange to the Kenyan economy. Moreover, the sector is closely linked to the social and cultural life of several millions of smallholders' farmer for whom animal ownership ensures varying degree of insurance against vagaries of nature with other agricultural enterprises (Azage *et al.*, 1994). Thus, it is mainly critical in supplementing the family insurance against the notions for the poor rural households. The dairy industry contributes about 4% Gross Domestic Product (GDP) (FAO, 2011). Since the colonial times when exotic breeds were introduced the government has been making conscious efforts to promote the dairy sector. Milk production in the country is estimated at more than 4.5 billion litres annually which is mainly from cattle comprising 3.5 million head of Friesian, Ayrshire, Jersey and Guernsey breeds and their crosses, and 9.3 million indigenous local cattle and, camels that are 1 million, and goats approximately 13.9 million (FAO, 2011).

The dairy sector in Kenya is predominantly run by smallholders who are generally described as resource constrained. They own over 80% of the 3.3 million heads of dairy cattle, producing about 56% of the total milk production and contributing 80% of the marketed milk (GOK, 2010). Several research workers have reported that dairy production in Kenya is predominantly by small scale farmers, and they own one to three dairy animals, less than one hectare and market milk through a dualistic system either to processors or through the informal channel directly to consumers, traders or through cooperatives (Staal *et al.*, 2003; Omore *et al.*, 2004). The smallholder group is also divided into four sub-groups which are resource poor, small scale intensive, part time dairy farmers and crop oriented dairy farmers (IFAD, 2006). These groups have different characteristics which make them have different constraints. Their production is done by a number of systems, which include intensive and extensive grazing. Intensive grazing is used where the land sizes are less than 2.5 hectares and therefore farmers feed their animals in stalls with very minimal movement. There are those who practice extensive production where mostly the animals graze and they are not stall fed. The third method is where the farmers have a hybrid system such that the animals are fed in the stalls and also are allowed to graze on their own. These systems are normally referred to as free, semi-zero and zero grazing representing increasing intensification (Bebe *et al.*, 2003a).

Smallholder dairy farming in the country has continued to portray a successful venture in nature in comparison to other African countries carrying out dairy farming (Staal *et al.*, 2008b). According to Conelly (1998) concerning the development of the dairy sector 2 time periods can be considered as a basis on which dairy farming has emerged as a success. Firstly, the colonial period (1900 – 1962) marks entry of the European settlers who introduced exotic livestock breeds in Kenya in 1902. By 1930 the programme had shown success after the government supported farmers through financial and policy advice. The success has been attributed to mainly a 1954 Swynnerton Plan when a colonial policy paper allowed Africans to engage in commercial agriculture using cross-bred cattle. This was also the start of market oriented farming. Secondly, soon after independence in 1963, government policy to support small scale farmers marked the beginning of smallholder domination of the dairy industry (Muriuki *et al.*, 2004). The post-independence government continued the supportive policies inherited from the previous colonial government, including the provision of extension, tick control, credit, veterinary and breeding services.

Despite the noble objectives of the Dairy Development Policies, it has been unable to adequately address the challenges posed by a liberalised dairy market environment. This sector is faced by various production constraints such as low reproductive performance, calf mortality, low growth rate and weight. The private sector has in fact miserably failed to adequately fill the gaps in the provision of support services and the supply of inputs, including breeding, veterinary, and clinical and credit services. As a result, inadequate quantity and quality feed, prevalence of diseases, inadequate access to quality replacement stock, low adoption of technologies, high cost of farm inputs and low milk value addition among dairy producers has led to dairy sector coming into a deep dip. There was, therefore, need to analyse the extent to which production constraints affected the herd structure and performance of smallholder dairy farms in Uasin Gishu County. Moreover, the study sought to ascertain the associated factors that are key in influencing herd structure and performance. Therefore, the objective of this study was to characterize the herd structure and performance on smallholder dairy farms in Uasin Gishu County. In view of this, knowledge on the region's herd composition, performance and associated factors are critical in developing strategies for improvement on smallholder dairy cattle farms.

RESEARCH METHODOLOGY

Study Area

The study was carried out in Uasin Gishu County, Kenya. The region has an estimated 99000 smallholder dairy farmers keeping about 192300 improved dairy cattle (FAO 2011). Uasin Gishu County lies between longitudes 34 degrees 50' east and 35 degrees 37' West and latitudes 0 degrees 03' South and 0 degrees 55' North. The county shares common borders with Trans Nzoia County to the North, Elgeyo Marakwet County to the East, Baringo County to the South East, Kericho County to the South, Nandi County to the South West and Kakamega County to the North West. It covers a total area of 3,345.2 Sq. Km. Uasin Gishu County is a highland plateau with altitudes falling gently from 2,700 metres above sea level to about 1,500 metres above sea level. Farmers practice mixed livestock-crop farming, in which maize, sunflower, wheat, pyrethrum, potatoes and barley are the main staples. Uasin Gishu experiences high and reliable rainfall which is evenly distributed throughout the year. The average rainfall ranges between 624.9 mm to 1,560.4mm with two distinct peaks occurring between March and September; and May and August. The temperatures range between 7 degrees Celsius and 29 degrees Celsius. Uasin Gishu County is divided into six sub-: Turbo, Soy, Ainabkoi, Moiben, Kessess and Kapseret. The sub- are further subdivided into fifty one locations and ninety seven sub-locations. According to the 2009 Population and Housing Census, the total population of Uasin Gishu County stood at 894,179. At an inter-censal population growth rate of 3.8%, the total population is projected to grow to 1,211,853 by 2017. Dairy farming is a prominent activity in Uasin Gishu County.

Data types, data sources and data collection method

In this study, data were collected on all herd structure and dairy performance of smallholder dairy farmers. Structured questionnaire was prepared to collect quantitative data for the study. Primary data sources were the sample farm households both male and female headed from different key informants. The questionnaire was pre tested to evaluate for consistency, clarity and to avoid duplication and to estimate the time requirement during data collection. To achieve the stated objectives, the study used descriptive methods. The study used mainly primary data from individual smallholder dairy farmers and data obtained from livestock officer.

Data analysis

Data obtained was coded and uploaded in Microsoft Excel 2007 spread sheet computer program and analyzed using SPSS version 19. Analysis of herd characteristics entailed use of frequency counts, percentages and means to produce tables and pie charts, while Univariate Analysis of Variance (ANOVA) was used to test differences in milk yield between breeds.

Sampling frame, target population and research sample size

The target population or population of interest of the study was made up of all smallholder dairy farmers in entire Uasin Gishu County. The sampling frame was identified using all smallholder dairy farmers based on ownership of 1 to 3 dairy cows. This was those farmers who own at least a piece of land measuring not more than 2.5 acres, or, those who are living in rental houses but rearing dairy cattle and those who have no land but depend on road reserves as their grazing fields in the study area. The sample farm households were taken from 64 farm households with a total of 64 farm households.

Study Variables

Four categories of variables were investigated in this study. These included: Herd structure (size, composition); herd performance (Milk production, lactation length, calving interval and age at first calving); and Breeds kept (sources, their performance and associated problems).

RESULTS AND DISCUSSION

Socioeconomic characteristics of respondents

Family size of respondents

Literacy level

Large fractions of respondents (29.7%, 26.6%, 23.4% and 14.1%) were having college, secondary, primary and university education, respectively (Table 1). About 6.3% of the sample households were illiterate. This may probably mean that farmers with primary and above level of education have more exposure to the external environment and extension contact. Generally, it is assumed that educated farmers can efficiently use the modern technology in dairy sector because of having better capacity to visualize the relationship between input, technology and outputs.

Table 1: Demographic characteristics of sample household heads

	Respondents (N=64)	
Characteristics	N	%
Sex:		
Male	48	75.0
Female	16	25.0
Literacy level:		
Illiterate	4	6.3
Primary	15	23.4
Secondary	17	26.6
College	19	29.7
University	9	14.1
Marital Status:		
Single	11	17.2
Married	47	73.4
Divorced	3	4.7
Widowed	3	4.7
Religion:		
Christians	55	85.9
Muslims	2	3.1
None	7	10.9
Income from non-dairy activities:		
Small business		
TSC	25	39.1
Civil servants	6	9.4
Private employee	22	34.4
	11	17.2
Income from non-dairy:		
< 30,000/=	8	12.5
31,000/= - 50,000/=	7	10.9
51,000/= - 80,000/=	4	6.3
81,000/= - 100,000/=	5	7.8
>101,000/=	40	62.5

Source: Computed from the field survey data, 2013

Gender distribution

Gender distribution of smallholder dairy farmers is also an important factor that should be taken into consideration in introducing a dairy development programme to a rural community. Of the household heads, 75% were males while 25% were females (Table 1).

Marital status and religion

Of the total sample respondents 17.2%, 73.4%, 4.7% and 4.7% of respondents were for single, married, divorced and widowed, respectively (Table 4.2). This may imply that married farmers are more stable and focused than other groups. According to the survey result, 85.9% of the sample respondents were Christians, and 3.1% Muslims and 10.9% none Christians (Table 4.1). The percentage difference between religions in household heads

in terms of faith mean that it could probably be influenced by their strong hope in succeeding.

Income from non-dairy activities

It was apparent in the results of the study that other sources of income were embraced to compliment income from dairy production. The survey result found out that 39.1 per cent of sampled households also carried out small business. On the other hand, 9.4 per cent of sampled households were dairy farmers who were also teachers (Table 1).

Farm size and land tenure

The study revealed that the established smallholder farms, which most smallholder resource-poor farmers rely upon, ranged between 0.125 to 0.5 acres (Table 2). This is hardly enough to maintain one livestock unit throughout the year.

Table 2: Land ownership characteristics of sample household heads

	Respondents (N=64)	
Characteristics	Frequency	%
Land ownership:		
Yes	62	96.9
No	2	3.1
Size of land in acres:		
0.5	2	3.1
0.6-1	6	9.4
1.1-1.5	6	9.4
1.6-2	19	19
2.1-2.5	31	59.1
Type of tenure:		
Traditional	24	37.5
Freehold	34	53.1
Leasehold	6	9.4

Source: Computed from the field survey data, 2013

Extension contact

The results of the survey indicated that the respondents had extension contact covering different aspects of dairy production and management (Table 4.3). Housing as a dependable variable indicated 22%, 45% and 33% of regular, occasion and never, respectively. This probably comprises sanitary condition awareness and healthy environment, thus leading to fatal deaths. 26% did not have any contact with extension agents, while 38% had regular extension contact which had a very close range with occasion contact at 36% for forage management and this can easily be associated with slightly higher milk yields than studies contacted by other workers. An average number of extension contact percentage of 52% regular was reported, while 18% and 30% for credit user represented never and occasion contact, respectively. On the other hand, from the sampled respondents only 6% of the respondent households had no extension contact and 55% of respondent households were provided extension services and 39% had occasionally had extension services in regard to disease awareness and management. The number of respondents who participated in the extension package programme was 58% regular, 25% occasion and 17% never participated

in AI services, which is in agreement with research work by Ongadi *et al.* (2007) of smallholder dairy farmers that practice AI. In addition the participation of smallholder dairy farmer households in the extension package programme during the surveyed year was 52% regular, 26% occasion and 22% that never participated for clean milk production awareness (Table 3). This difference may mean that the high-level participation in the extension package programme may enhance clean milk production and higher milk yield. Extension contact is also related to better dairy productivity for smallholder dairy farmers. It was hypothesized that farmers who have frequent contact with extension agents were expected to have more information that will influence farm household's demand to adopt modern technology in dairying. Extension contact therefore refers to the number of contacts with extension agents that the respondent made in the month. Farmers who have a frequent contact with extension agents are expected to have more information that will influence herd structure and dairy productivity.

Table 3: Extension services to smallholder dairy farmers

	Frequency	Percentage
Housing:		
Regular	14	22
Occasion	29	45
Never	21	33
Forage management:		
Regular	24	38
Occasion	23	36
Never	17	26
Feeding management:		
Regular	33	52
Occasion	19	30
Never	12	18
Diseases:		
Regular	35	55
Occasion	25	39
Never	4	6
AI services:		
Regular	37	58
Occasion	16	25
Never	11	17
Clean milk production:		
Regular	33	52
Occasion	17	26
Never	14	22

Source: Computed from the field survey data, 2013

Performance Indicators

Cattle breeds

According to the results of current research in Table 4 from the total of 317 dairy cows included in the study, 61.20% were exotic cattle-zebu crosses, 16.40% Friesian, 11.36% Ayrshire, 5.36% Guernsey, 3.15% locals and 2.52% Jersey (Table 4.4). The mean herd size was 2.5, while a proportion of 59.31% and 40.69% of the animals were lactating cows and

heifers respectively. The findings about common breeds kept for milk in the study area is in agreement with the findings of Staal *et al.* (1997a).

Table 4: Cattle breeds in the study area

Breed	Total	Percent
Local	10	3.15
Dairy crosses	194	61.20
Friesian	52	16.40
Guernsey	17	5.36
Ayrshire	36	11.36
Jersey	8	2.52
Total	317	100

Source: Computed from the field survey data, 2013

Milk Production

The findings in the research area showed the mean milk yield/cow/day was 7.3 litres with 10.9 % of the farms producing less than 1 – 5 litres of milk/cow/day, while 18.8%, 42.2% and 20.3% produced 4 – 5, 6 – 8 and 9 – 11 litres, respectively. Only 7.8% of the farms produced more than 12 litres /cow /day (Table 5). The low average milk yields could be attributed to lack of ability to purchase adequate feeds and of high quality to meet the dietary needs of lactating cows. Studies have generally shown that milk yields are affected by genetic, management and environmental factors (Msanga *et al.*, 2000). The mean milk yield /cow/day is higher than that of Staal *et al.* (1997a), which reported mean milk yield of 3 litres /cow /day, but in agreement with farms producing more than 12 litres /cow /day.

Calving Interval

The mean calving intervals observed were an average of 591 days with a range of between 273 to 1,308 days (Table 5), which implied a long calving interval that be caused by factors like silent estrus, missed estrus due to weak symptoms, frequency and timing of estrus detection, feeding season and milk production. Calving is one of the important factors contributing to economic return and is determined partially by farmer policy. From the above results, it is implied demanding for a reduction in calving will minimize the raising costs and shorten the generation interval and subsequently maximize the number of lactations per head. The prolonged calving intervals are in agreement with findings with Katiku *et al.*, (2011).

Lactation Length

Lactation length (days in milk) is related closely to dry period length and is a good indicator of reproductive efficiency and herd management. The study found that the mean lactation period was 388 days with a range of 30-1004 days (Table 4.5), which is in agreement with the report of Omore (*et al.*, 1999). The low yields and short and long lactation periods observed in this study could be attributed to inadequate nutrition characterised by low quantity and quality of feeds. The association between yield and lactation length has been reported in various studies (Chamberlain and Wilkinson, 2002).

Table 5: Average milk yield, calving interval and lactation length

	n	Mean	Range
Average milk yield (litres)	64	7.3	1.0-24.0
Calving intervals (days)	115	591	273-1308
Lactation length (days)	29	388	30-1004

Source: Computed from the field survey data, 2013

Aggregate changes in herd composition

According to Table 6, offtake was lowest for female animals (heifers 1%, pre-weaners 1.6% and 2.7%), while 4.1% bulls, 4% castrated males and 35% post weaners. Another source of exit was annual slaughter rate at 1% cows, 1% heifers and, while 4.1% bulls and 25% post weaners (males). Studies further reveal that entries into the herd were annual purchases which constituted 5.9% cows and 8.5% heifers. Notably, annual births were restricted to pre-weaners and constituted 54.8% females, while 10.6% males. A mortality rate of 12.8% was recorded for the cows, 7% heifers, 1.6% pre-weaners (females), while the sucklers (males) had an average mortality rate of 7.6%. A striking feature is about the strategy in the acquisition of cows and heifers as entry in the herd. More cows, heifers and female calves are being acquired into the herd either through purchases or even births impliedly requiring working capital for sustenance. This precedence suggests that herd dynamism was being highly influenced by selling/purchasing strategies and losses through deaths threaten herd profitability.

Table 6: Aggregate changes in herd composition reported over the previous 12 months by the survey respondents

CHANGES	FEMALES				MALES				
	Cows	Heifers	Prew.	Total	Bulls	Castr.	Postw.	Prew.	Total
Births	0	0	34	34	0	0	0	7	7
Purchases	11	11	0	22	0	0	1	0	1
TOTAL ENTRIES	11	11	34	56	0	0	1	7	8
Sold	5	1	1	7	2	2	7	0	11
Died	24	9	1	34	0	0	0	5	5
Slaughter	1	1	0	2	2	0	5	0	7
TOTAL EXITS	30	11	2	43	4	2	12	5	23
NET CHANGE	-19	-0	-32	-13	-4	-2	-11	-2	-19
Herd composition	188	129	62	379	49	54	20	66	189
PERCENTAGE (%)									
Annual births	0	0	54.8	9	0	0	0	10.6	3.7
Annual purchases	5.9	8.5	0	5.9	9.09	0	5	0	1
Annual sales rate	2.7	1	1.6	1.8	4.1	4	35	0	5.8
Annual mortality rate	12.8	7	1.6	9	0	0	0	7.6	2.6
Annual slaughter rate	1	1	0	1	4.1	0	25	0	3.7

Source: Computed from the field survey data, 2013

Factors causing mortality/off take in the herd

The causes of deaths are shown in Table 7. Slaughter due to disease constituted 16.67% female while males 6.45%. Further, female 55.56%, while males 45.16 died due to disease. Death due injury, accident sustained was reported at 1.85% females and 0% males. Animals were also lost due to poisoning where 3.7% females and 3.23% males. Research results also revealed bloat caused death at 3.7% females and 6.45% males. Unknown cause of animal death described as others was reported at 11.11% females and 19.35% males. The death rates of stock are high with both male and female classes of the animals. Mortality rates were strongly related to the high incidence of disease (Table 7), suggesting that there is need for smallholder dairy farmers to access credit for purchase of drugs and veterinary services.

Table 7: Reported factors causing mortality/off take in the herd

Cause of mortality	Female					Male				
	Cows	Heifers	Prew.	Total	Percentage	Bulls	Postw.	Prew.	Total	Percentage
SDD	7	2		9	16.67	1		1	2	6.45
SDI	1			1	1.85					0.00
DDD	20	4	6	30	55.56	2	2	10	14	45.16
DDI	1	1		2	3.70					0.00
DDP	1	1		2	3.70			1	1	3.23
BL	2			2	3.70			2	2	6.45
OT	1	4	1	6	11.11	2	2	2	6	19.35
Total	35	12	7	54	100	8	6	17	31	100

Source: Computed from the field survey data, 2013

Notes:

SDD - Slaughter due to disease

SDI - Slaughter due to injury, accidents sustained

DDD - Died due to disease

DDI - Died due injury, accident sustained

DDP - Died due to poisoning

BL - Bloat

OT – Others

Herd Structure

The survey respondents reported that a herd of cattle consisting male and female individuals were kept (Figure 1). A study of the numbers and proportions of animals in each age group of class of stock reveal that female herd was kept in higher proportions than male herds. The 64 households kept small numbers of males. The findings of the study regarding herd structure of smallholder is in agreement with the findings of (Ongadi *et al.*, 2007) The possible reason is that smallholder dairy farmers can afford to access information on modern technology. Aspects of land sizes, with a mean holding of 1 hectare per household and productivity of herd influenced the herd structure in which breeding females were kept in a higher proportion than males.

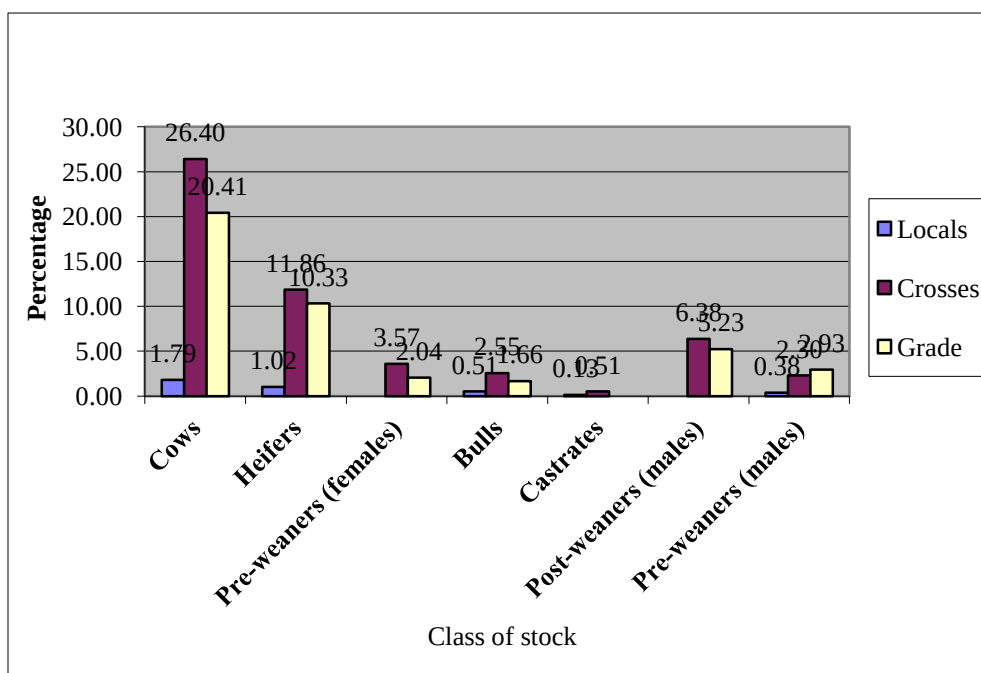


Figure 1: Herd structure

CONCLUSIONS

This study sought to investigate the type of breeds, herd structure and production performance which characterize the dairy herds in Uasin Gishu County and, also the average number of lactating cows. The study found that the mean lactation period was 388 days with a range of 30-1004 days. The average herd structure of smallholder is in agreement with other research findings (Ahmed, 2003). Ownership of other classes in low proportions implies that the farmers' management objectives are dairying for milk production (Wanjala *et al.*, 2014). The herd structure was therefore, another important variable which had strong positive correlation with productivity. The mean milk yield /cow/day was 7.3 litres with only 7.8% of the farms producing more than 12 litres/cow/day (Msangi *et al.*, 2005). This result is higher than that of Staal (*et al.*, 1997a) which reported mean milk yield of 3 litres/cow/day, but in agreement with farms producing more than 12 litres/cow/day (Arbel *et al.*, 2001). Average days in milk greater than 200 indicates a reproductive problem as a large days in milk value results in a lower lifetime milk production per cow due to long lactations and milking of late lactation cows. A short lactation reduces the lifetime milk production because of long dry periods. The extended lactations are consistent with performance when the nutrition of lactating cows is inadequate, a conclusion in line with the feed shortage constraints reported by the majority of dairy-cattle owning households in the survey. The absence of a lactation peak and the rapid decline in daily milk yield over the early months of lactation strongly suggest that feeding levels to lactating cows, particularly during the first months of lactation, are low (Baltenweck *et al.*, 1998). The low yields and lactation length observed in this study could be attributed to inadequate nutrition characterized by low quantity and quality of feeds. Further, the average number of lactating cows is in agreement with the findings of Staal (*et al.*, 2003). The mean calving intervals observed were an average of 591 days with a range of between 273 to 1,308 days which reveals a long calving interval that denies a chance of obtaining one calf per cow per one year. This strategy

apparently suggests that unfavourable consequences like loss of milk production, increased costs due to treatment and/or slow herd dynamism are enhanced. Yet, a longer calving interval is not justifiable unless a cow produces a large amount of milk. Calving interval is probably the best index of a cattle herd's reproductive efficiency. Days open is part of the calving interval that can be shortened by improved herd management. Long day open and consequently prolonged calving interval may affect the overall economic revenues of the dairy herd (Karanja, 2003). The interval in many herds could be reduced by breeding cows on first heat after 45 days postpartum, after first examining the cows for normal reproductive tracts. The study concluded that the low performance of dairy herds experienced in the region may be attributed to low numbers of lactating cows and replacement heifers, type of breeds kept and long lactation period among other factors. From the results, also socio-economic determinants influenced smallholder dairy farmers to purchase in-calf heifers, dairy feeds or land operations, thus assisting to promote increased productivity and dairy production. The study therefore concluded that socio-economic factors also played key role in determining herd structure and performance among the dairy farmers.

RECOMMENDATIONS

From the research findings, low levels of education could sometimes be associated with failure to perform some basic managerial tasks. Perhaps government agencies including extension services can make a meaningful contribution by addressing skills in their training programmes. Observations and elicited information show that most of the respondents are farming for commercial reasons. It is therefore recommended that issues related to farm management, keeping of farm records, agricultural technology and production skills should be emphasised in the training programmes by the government through relevant ministry. Further recommendations are as follows:

- a) Strategies and tactics of sales, purchases and respective sources of various classes of animals need to be investigated.
- b) The importance of different levels of mortality rates in different classes of animals should be tested by a suitable simulation model.
- c) Fertility and breeding management, particularly seasonal calving strategies should be compared by use of a simulation model.
- d) Seasonal feeding regimes and their implication on herd performance need to be investigated.

For this reason, the immediate task is an attempt to expand knowledge in the unknown part of the smallholder dairy production system so that predictions of the results of various management alternatives can benefit smallholder dairy enterprises. Initial work approach may require collection, assembly, and interpretation of existing data from secondary literature and, eventually, employment of mathematical modelling of particular parts of the system to identify areas that require investigation and quantification to enhance productivity.

REFERENCES

- Ahmed MAM, Ehui S, Yemesrach A (2003). Dairy development in Ethiopia. Paper presented at the 'Successes in African agriculture' conference In: WEnt, IFPRI, NEPAD, CTA conference Paper No. 6. 1–3 December, 2003, Pretoria, South Africa.
- Arbel, R., Bigun, Y., Ezra, E., Sturman., H. & Hojean, D., 2001. The effect of extended calving intervals in high lactating cows on milk production and profitability. *Journal of Dairy Science* 84, 600–608.
- Azage T, Geleto A, Osuji P, Kassa T, Franceschini R (1994). Influence of dietary supplementation and partial suckling on body and on lactation and performance of primiparous boran (*Bos indicus*) cows in Ethiopia. *J. Agri. Sci. Cambridge*, 123: 267-273.

- Baltenweck, I., S.J. Staal, M. Owango, H. Muriuki, B. Lukuyu, G. Gichungu, M. Kenyanjui, D. Njubi, J. Tanner and W. Thorpe, 1998. Intensification of dairying in the greater Nairobi Milk-shed: Spatial and housing analysis. Smallholder dairy (Research and Development) Project. MoA/KARI/ILRI. Collaborative Research Report. ILRI (International Livestock Research Institute), Nairobi, Kenya.
- Chamberlain AT, Wilkinson JM (2002). Feeding the dairy cow. Lincoln, UK: Chalcombe Publications.
- FAO (2011). Dairy development in Kenya, by HG Muriuki. Rome: Food and Agriculture Organization of the United Nations.
- Government of Kenya (2010). Kenya National Dairy Masterplan. Nairobi: Ministry of Livestock Development, Nairobi.
- Karanja M., Andrew, (2003). The dairy industry in Kenya: The post-liberalization agenda, Paper presented at a dairy industry stakeholders workshop held in Nairobi, Kenya (27th August 2002).
- Katiku PN, Gachuri CK, Mbugua PN (2011). Characterization of dairy cattle farming in Mbeere District of Eastern Kenya. *Livest. Res. Rural. Dev.*, Vol. 23: 11.
- Kenya Economic Report, 2009, Kenya Institute for Public Policy Research and Analysis
- Msanga, Y.N., Bryant, M.J., Rutam, I.B., Minja, F.N. & Zylstra, L., 2000. Effect of environmental factors and of the proportion of Holstein blood on the milk yield and lactation length of crossbred dairy cattle on smallholder farms in North-east Tanzania. *Tropical Animal Health and Production* 32, 23–31.
- Msangi, B.S.J., Bryant, M. J. & Thorne, P.J., 2005. Some factors affecting variation in milk yield in crossbred dairy cows on smallholder farms in North-east Tanzania. *Tropical Animal Health and Production* 37, 403–412.
- Muriuki H, Omore AO, Hooton N, Waithaka M, Staal SJ, Odhiambo P (2004). The policy environment in the Kenya dairy sub-sector: a review (Research Report). MoA/KARI/ ILRI Smallholder Dairy Project, International Livestock Research Institute: Nairobi, Kenya.
- Omora A, Muriuki H, Kenyanjui M, Owango M, Staal S (2004). The Kenya Dairy sub sector: A rapid appraisal (Research & Development) Project Report. Ministry of Agriculture / Kenya Agr. Res. Inst.
- Omora, A., Muriuki, H., Kenyanjui, M., Owango, M and Staal, S. (1999). The Kenya Dairy Sub-Sector: A Rapid Appraisal. Smallholder Dairy (Research & Development) Project Report. 51p.
- Ongadi PM, Wakhungu JW, Wahome RG, Okitoi LO (2007). Characterization of grade dairy cattle owning households in mixed small scale farming systems of Vihiga, Kenya. *Livest. Res. Rural Dev.*, Vol. 19: 3.
- Staal, S., Chege, L., Kenyanjui, M., Kimari, A., Lukuyu, B., Njubi, Owango, M., Tanner, J., Thorpe, W. and Wambugu, M. (1997a). Characterisation of dairy systems supplying the Nairobi milk market. KARI/ILRI/MALDM Collaborative Dairy Research Programme, ILRI, Nairobi, Kenya, 41 pp.
- Staal, S., Waithaka, M., Njoroge, L., Mwangi, D.M., Njubi, D., Wokabi, A. 2003. *Costs of milk production in Kenya (draft)*. MoA/ KARI/ILRI Collaborative Research Report. Smallholder Dairy (Research and Development) Project, Nairobi, Kenya.
- Wanjala SPO, Njehia B, Ngichabe C (2014). Assessment of the Structure and Performance of the Milk market in Western Kenya. *IJCR.*, Vol. 6(3): 5652-5656.