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## Characterization and Profitability Assessment of Dairy Farms in Central Kenya

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### **Abstract:**

*A study to characterize and document information on dairy farms and their profitability in central Kenya was carried out with the view to addressing concerns raised by stakeholders on the country's inability to supply affordable milk at both the local and export market. Data were collected from 135 randomly selected farms in Central Kenya. The statistical package for social sciences (SPSS) was used for data analysis. Results revealed that farmers owned cattle of high milk production potential in terms of their genetics, but which produced low (9.2 kg) quantities daily. The reasons attributed to underperformance were; overstocking, underfeeding, poor housing and sub-optimal animal husbandry. The size of land owned could not supply enough roughages, and both the concentrates and mineral supplements were inadequate. Farms averaged about 2 acres on which mixed livestock-crop farming was practiced. They employed 2.2 hours per cow per day against the standard 1.6, a situation attributed to ownership and management of small land parcels in different places. Only 23.7% of the farms had chaff-cutters. Animals were uncomfortable in the feeding area resulting from poorly constructed zero-grazing units. Extension service was inadequate. Among the entire farmer characteristics assessed; age, education level, experience, group membership, and attendance to business related courses; none showed a significant relationship with milk yield. The average cost of milk production (Ksh. 37) was higher than its farm-gate price (Ksh. 25.5), a condition that was attributed to relatively high input prices and farm level resource utilization inefficiency. Only a few farms made any profits from dairy farming. It was recommended that a policy regarding minimization of household land sub-division be put in place. Additionally, there was a felt need for providing inducements that encourage agricultural enterprises specialization. Dairy farmers require improving on dairy and fodder crop husbandry, as well as farm level feed resource utilization efficiency. Policies targeting reductions in the cost of farm inputs were also recommended. Researchers require developing drought resistant fodders.*

**Keywords:** Characterization, Profitability, Dairy farms, Fodder

### **1. Introduction**

Livestock provides over half the value of global agricultural output (Moran, 2009) with milk demand growing by 15 million tons per year, mostly in developing countries (FAOSTAT, 2010) driven by population growth and rising incomes. In Kenya, dairy production is a major farm activity accounting for about 3.8% of the National GDP, and contributes to the livelihoods of many farmers through income, employment and food (Omiti *et al*, 2006). The country's dairy herd size stands at 3.5 million (MoSPND, 2009) while the national per capita milk consumption is about 76 kg, which is far below the World Health Organization's (WHO) recommendation of 200 kg (FAO, 2007).

Kenyan products enjoy preferential market access within the Eastern and Southern Africa region, but it is only negligible quantities of milk that are available for export. The country's actual milk production per cow has remained at only 6 kg for a period of more than three decades (MoLD, 2010) while the World average is 20 kg (Karanja, 2003). When milk production volumes increase during the rainy season, potential consumers in the country cannot access it due to relatively high prices. As the liberalization of world trade

continues and the international competition for markets accelerates, dairy farmers must consider their competitiveness (Roche and Newman, 2008). Reviewed literature on dairy productivity in Kenya lacked information on the possible reasons for the subsector's poor performance. This study examined both the farm and farm owner characteristics of smallholder dairy farms in central Kenya. Their relative profitability was also assessed. The study results would contribute to the improvement of dairy productivity and the development of policies to support smallholder producers in the country.

## 2. Materials and Methods

### 2.1. Description of Study Site

Embu and Meru Counties were randomly sampled amongst the seven dairy farming counties in central Kenya. The two Counties lie on the Eastern Central highlands of Kenya. Embu County is at 0030<sup>0</sup> S, 37 30<sup>0</sup> E and Meru at 0<sup>0</sup>, 38 00<sup>0</sup> E. They cover an area of 2826.4 and 6924 km<sup>2</sup>, respectively. They have two rain seasons; March to May and October to December. Their annual rainfall totals range in-between 600-2200 and 500-2600mm, respectively. The temperature ranges for the respective counties are; 12-27 and 11.4-28<sup>0</sup>C (Jaetzold *et al.*, 2007). The two counties border Mt. Kenya and the region is ideal for dairy farming. Their human populations according to the 2009 census data were 516,212 and 1,356,301, respectively (RoK, 2009).

### 2.2. Data Collection and Analysis

The sample for this study was drawn from Embu East and Igembe South sub-Counties within the respective Counties. A descriptive survey technique using semi-structured questionnaires was used in data collection, with respondents sampled randomly. The following were recorded as data: total herd size (counted); milking herd size (counted as the total number of lactating cows); breed (observed and compared to photo card); roughages (kg) (amount per cow per day); average amount of concentrate (kg) (ascertained by re-weighing the amount in a vessel used by the farmer in feeding a cow per day); average amount of mineral supplements (kg) (obtained from farmer's response); average number of labour hours spent on herd per day (hours) (average time taken on dairy farming activities in a day by either a family member or hired or both); land size owned (acres) (obtained from the farmer's response) and chaff-cutter ownership (presence or absence of chaff-cutter in a farm, obtained by observation and/farmer response). Data on milk output per cow was collected. Further data were collected on the cost of roughage, concentrate, mineral supplements and labour per day. Data were analyzed using statistical package for social sciences (SPSS).

## 3. Results

### 3.1. Farm Based Socio-Economic Characteristics

**Herd Size:** Seventy one point one (71.1) percent of the farmers had between 2 and 5 animals (table 1). The number of lactating cows per farm ranged between 1 and 5. Eighty two point three (82.3) percent of those lactating was either 1 (55.6%) or 2 (26.7%). The average herd size was 4. There was a positive and significant correlation between the milking herd size and the total farm milk yield ( $r = 0.463$ , sig. (2-tailed) = 0.000, sig. level = 0.01, N=135). Table 1 below provides a summary of herd sizes in the study area.

No. Animal	Embu and Igembe combined (Percentage)	Embu E (Percentage)	Igembe South (Percentage)	Embu: Milking (Percentage) N=94	Igembe: Milking (Percentage) N=36
0	0	0	0	2.08	7.69
1	9.6	7.3	15.4	59.38	43.59
2	22.2	21.9	23.1	29.17	20.51
3	13.3	14.6	10.3	7.29	15.38
4	21.5	25.0	12.8	1.04	10.26
5	14.1	13.5	15.4	0	2.56
6	7.4	7.3	7.7		
7	4.4	5.2	2.6		
8	2.2	1.0	5.1		
9	4.4	4.2	5.1		
10	0	0	0		
11	0	0	0		
12	0.7	0	2.6		

Table 1: Number of Animals per farm and their percentage distribution in Embu and Igembe districts

### Feeds and supplements

(a) **Roughage feed:** this averaged 52.15 kg (SD= 11.47) per cow per day, ranging between 25 and 90 kg, with Embu East and Igembe South averaging 51.88 and 52.82 kg, respectively (Table 2). Ninety five point six (95.6) percent of farmers used Napier grass as the

main roughage for most of the year followed by maize stover. There was a significant correlation ( $r = .311$ ,  $\text{sig.} = .01$ ,  $N = 135$ ) between the amount of roughage fed and milk yield.

	N	Minimum	Maximum	Mean	Std deviation
Both study sites	135	25	90	52.15	11.47
Embu East	96	25	80	51.88	11.55
Igembe South	39	30	90	52.82	11.40

Table 2: Summary of the quantities of roughage fed per cow per day

(b) **Concentrate feed:** This averaged 2.18 kg ( $SD = 1.38$ ) per cow but ranged between 0.5 and 7 kg with a few farmers not using any. The correlation coefficient ( $r = .661$ ) between the amount of concentrate fed and the milk yield was highly significant ( $\text{sig. (2-tailed)} = .000$ ). Only 5.5% of the farmers made own rations. Use of dairy meal to feed the cows was most common, closely followed by bran, a milling by-product.

(c) **Mineral supplements:** This averaged 4.43 kg ranging between 0.5 kg and 22 kg per herd per month, implying each animal had 1.1 kg over the period.

(d) **Grazing mode:** This constituted: zero-grazing, 84.4%; semi zero grazing, 11.9%; tethering 3%; and open-grazing with supplementation, 0.7%. Farms practicing different grazing modes had different milk yield averages. Zero-grazing mode had 15.73 kg ( $N = 114$ ) semi-zero-grazing mode had 8.75 kg ( $N = 14$ ), tethering with 3.5 kg ( $N = 2$ ) and open-grazing with supplementation had 10 kg ( $N = 1$ ). Many zero-grazed cattle were however poorly housed. The cow unit was; not well shaded, poorly drained, having a poorly finished floor, and smaller than the recommended housing dimensions. Such housing units harboured many biting flies that kept on disturbing the feeding cow.

**Breed:** Friesians constituted 47.4% and Ayrshires 25.9% (table 3). There was a negative correlation between the total milk produced per farm per day with the dairy cow breed ( $r = -.395$ ,  $\text{sig.} = .000$ ;  $\text{sig. (2-tailed)} = .01$ ).

Breed	Sites combined (%)	Embu East (%)	Igembe south (%)
Friesian	47.4	52.1	35.9
Ayrshire	25.9	21.9	35.9
Guernsey	8.1	11.5	0
Jersey	2.2	3.1	0
Dairy crosses.	16.3	11.5	28.2

Table 3: Cow breeds distribution in Embu and Igembe districts

**Land:** Over ninety percent of the farms had land sizes ranging between 0.4 and 5 acres (table 4). About 47% of the farmers had part of their land situated about 3.3 km away from the dairy farm.

	Less than 1 acre	1 and 2 acres	between 2 and 5 acres	Over 5 acres
Embu east	26.0%	34.4%	31.30%	8.30%
Igembe south	17.9%	35.9%	38.5%	7.7%
Both sites	23.7%	34.8%	33.3%	8.1%

Table 4: A summary on percentage distribution of owned land sizes by dairy farmers in Embu and Igembe districts

The dairy herd among other livestock owned, the homestead, and various crop enterprises were in one plot. The other plots had crops that in some cases included Napier grass.

**Herd labour:** The number of labour hours per day per farm ranged between 2 and 30, with a mean of 8.71 ( $SD = 5.01$ ). The average per cow labour per day was 2.22 (Table 5). There was a positive correlation between farm milk yield and the amount of labour ( $r = .518$ ,  $\text{sig.} = .000$ ; 2 tailed;  $N = 135$ ).

	Minimum	Maximum	Mean	Std deviation	Labour hours/animal
Two sites combined	2	30	8.71	5.01	2.2
Embu East	2	15	8.17	3.43	2.1
Igembe South	4	30	10.69	7.34	2.66

Table 5: A summary on average the time period spent on a dairy enterprise per day

**Chaff-cutter ownership:** Only 23.7% ( $N = 135$ ) of dairy farms had chaff-cutters.

**Milk yield:** The average milk per cow was 9.2 kg, with a range of between 1 and 29 kg. Milk yield per cow within the two sites was different, with Embu having a mean of 9.6 and Igembe 8.2 kg. The average daily household milk yield was 14.9 kg with a range of between 1 and 68 kg.

The average calving interval was 588 days with a range of between 370 and 1300 (N = 114; SD = 214), but varied in the two sites. Embu East had a mean of 606 days ranging between 370 and 1300 (N = 83; SD = 228) while Igembe South had an average of 547 days with a range between 380 and 970 (N = 35; SD = 145).

**Extension service:** Thirty two point six (32.6) percent of the dairy farmers obtained dairy extension service. Livestock messages were mainly disseminated by public livestock extension personnel. The ratio of smallholder farms to the number of extension service providers averaged 1: 4,000 in the two sub-Counties.

### 3.2. Farmer-Related Socio-economic Characteristics

**Formal Education Level:** Forty (40) percent had primary and 32% had secondary education. There was a positive correlation between farm milk yield and the farmers' formal education level ( $r=.200$ , sig.  $=.020$ ;  $N=135$ ). There was no noticeable difference in education level between the two groups of dairy cow farmers in the two study districts (Table 6).

Education level	2 sites combined (N = 135)	Embu E (N = 96) (N=96)	Igembe South (N = 39)
None	0.7	1	0
Primary	40	41.7	30.8
Secondary	37	34.4	48.7
Middle-level college	19.3	20.8	15.4
University	3	2.1	5.1

Table 6: Descriptive statistics on the education level attained by dairy cow keepers in Embu East and Igembe South districts.

**Farmer's age:** Most of the dairy farmers were middle-aged. Thirty five point six (35.6) percent were within 36 and 45 years and 20% were within 46 and 55 years of age. Dairy cattle farmers in Igembe were younger than those in Embu, but the 36 to 45 years age bracket had the highest percentage of farmers in both districts (table 7).

Age bracket (Years)	Combined data (N = 135)	Embu East (N = 96)	Igembe South (N=39)
Below 25	1.5	1	2.6
26-35	12.6	9.4	20.5
36-45	35.6	34.4	38.5
46-55	20.0	18.8	23.1
56-65	17.8	20.8	10.3
66-75	7.4	9.4	2.6
Over 76	5.2	6.3	2.6

Table 7: Distribution of sampled dairy farmers by age bracket

**Experience:** Results indicated that about 90% of the farmers had dairy farming experience of more than 5 years, with 8% of them having experience above 35 years.

**Group membership:** Only 34.8% of dairy farmers were members of groups (general).

**Farmer attendance to Business course:** Only 22.2% of the farmers had attended at least one business related course. A positive correlation between milk yield and attendance to business course was established, but was not statistically significant. Most smallholder farmers viewed dairy farming as a subsistence undertaking resulting in low enterprise performance.

### 3.3. Other Farmer-Related Socio-Economic Characteristics

**Milk Production Cost and Profitability:** The average farm-gate milk price per kilogram was KSh.25.5 (SD = 7.22), with a range between KSh.15 and Ksh. 40. In Embu the mean price was Ksh.20.4 (range; Ksh. 15 to Ksh. 30, SD =2.48, N = 96), while the mean for Igembe was Ksh. 35.18 (range; 25-40, SD = 4.45, and N = 39). There was a positive and significant correlation between milk yield and the price of milk. The lowest prices were on average in Embu, with the lowest price being KSh.15. Milk prices in Igembe were higher, with the lowest price being Ksh. 25. The highest prices in both sub-Counties were Ksh. 30 and Ksh. 40 respectively. This study found the average cost of producing a litre of milk being Ksh. 37. Most farmers were not aware that their production costs were above their selling prices. It was on a small fraction (about 20%) of the farms that achieved positive gross margins.

**Reported farmer constraints:** Several constraints were highlighted and are presented in order of importance: (a) High cost of breeding stock- 32.6%, (b) High cost of animal feeds- 31.1%, (c) High rate of weather fluctuations- 10.4%, (d) Unsupportive government policies, 9.6%; and (e) Expensive breeding services- 8.1%. Farmers in both study sites rated the cost of breeding stock highly (Embu East, 28.1% and Igembe South, 43.6). Challenges faced within the two sites appeared to be perceived differently. About 41% of farmers in Embu felt the cost of concentrate feeds to be high while only 7.7% in Igembe felt the same.

## 4. Discussion and Conclusion

### 4.1. Dairy Farm and Farmer Socio-economic Characteristics

In this study, over 95% of the dairy farmers zero-grazed their animals. They owned land sizes averaging two acres; cows being relatively overstocked and underfed. They practiced mixed farming where dairy cows, among other livestock were reared alongside crop farming. Competition for land resource allocation among the different farm enterprises was stiff, fuelled by the differences in the relative prices of inputs and outputs. The probable reasons for practicing mixed crop-livestock farming were that the farmers were more food secure in this kind of practice or because they lacked incentives to specialize.

The crop-livestock system has the advantages of allowing diversification of risks, and recycling wastes thus preventing nutrient losses, adding value to crops and crop products while providing cash for purchasing farm inputs. The crop-livestock farming system buffers against climate fluctuations, offers diversified income sources and alternative use for low-quality roughage. However, it requires 'double' expertise and it is hard to upscale either of the two (livestock or crops) because there occurs increased demand for area of land required for a given Production (Lungu, 2000). The challenges of crop-livestock systems are such enormous due to inadequate land and correspondingly high population of humans and livestock (Adamu and Odion, 2000). Most Kenyan communities have traditionally kept livestock for subsistence, prestige, and as a form of insurance against drought. The animals also served other social needs like paying the bridal price and traditional ceremonies (RoK, 2008). To many farmers, dairy farming was an innovative way of growing wealth through keeping animals that utilized farm-by products such as maize stovers and bean straw, which would have otherwise end up being wasted.

There were other several factors that made farmers to increase their herd sizes. About 20% of the farms kept bulls that were used on ox-carts to transport the farm products and by-products from far-off plots. The ox-carts were also hired to households who did not have their own, earning some extra income to the owners. In addition, about 5% of farms had breeding bulls, further raising the number of none milking dairy animals in the herd. Manure from the animals was used on crops, which indirectly motivated an increase in the number of cattle. Selective culling of some adult animals should be encouraged in an effort to keep only an economically productive herd size. Record keeping would play a major role in identifying animals for culling, but this action was not common among the dairy keepers.

In this study, roughages represented all types of dairy cow feeds such as hay, stover, straw, napier grass (used in over 90% of the farms), farm weeds, and edible tree cuttings, but excluding water, mineral supplements and concentrate feeds. Roughages constitute the bulk of the feeds to dairy cattle. The average amount of feed per cow was 52 kg against a recommended average of 100 (MoLD, 2003). Inadequate dairy feeding in the study area partly led to reduced individual cow milk yields, relative to their genetic potential. The amount of roughage fed to a dairy cow was a major factor in milk production in the region. Among the many possible reasons leading to low roughage quantities was the farmers' dependence on rain-fed fodders and pastures. It was reported that weather in the study area had become irregular in terms of timeliness, quantities and regional spread in the preceding years. This kind of weather behaviour is part of the climate change threats to food production. There is a need for the policy makers to come up with mitigation measures mainly on rain water catchment, storage and use.

When short-term feed alternatives such as farm-weeds during the rainy season were available, farmers in the study area did not harvest Napier; it remained as standing hay. The recommended height of Napier at harvesting is 3 feet, for this is the growth stage when it is most nutritious (MoLD, 2009). Similarly, Njarui *et al.* (2011) found farmers in semi-arid Kenya failing to feed Napier grass to animals when natural and other cultivated pastures were available, instead feeding it during the dry season. In these two cases (the study area and the semi-arid Kenya), farmers did not take advantage of the excess quality fodder; storing it at the recommended maturity stage. According to Njoka-Njiru *et al.* (2006), Napier grass contains moderate crude protein (CP) content (6-12%) during the wet season, but declines to less than 5% during the dry season. The implication of this finding is that Napier quality and its harvestable quantity were lost particularly when the number of harvesting times reduced, in effect leading to a loss in economic gains from the plot.

A further finding was that losses of roughage feeds occurred at the farm level, during transportation and the dairy feeding point. Losses occurred when cutting of feed materials was above the ground at a higher point than the recommended two inches level, some materials were left at the farm during transportation and some other materials were lost by falling off to the ground where they were left or irredeemably soiled. Further losses occurred when such materials were poorly chopped and ingestion by the animals became difficulty. Soiling of feeds was also common among poorly constructed zero-grazing units. It is important minimize these kinds of losses to improve on the economic efficiency of a farm. Knowledge on how best to harvest the feed materials, use of efficient transportation means and improving on the dairy housing structures could offer some remedy.

Milk yields followed the feed quantity trend, with the average milk output being 9.2 kg against a potential of 20 kg per day (MoLD, 2003). Although breed improvement has a significant impact on dairy production (Staal *et al.*, 2008), there is a need for dairy farmers to match a breed with its feed requirements. Owuor and Ouma (2009) found inadequate feeds being a major constraint in dairy productivity among smallholder farmers in western Kenya.

The roughage feeds contributed the highest proportion of the total cost of milk production in the study farms. Many other studies including Alvarez *et al.* (2005, 2008) and Lucila *et al.* (2005) had similar findings. The roughages were found to contribute 53.9% of the total dairy farming cost per day which rose to about 73% when concentrates and mineral supplement costs were added. Lucila *et al.* (2005) in Thailand showed feed (all feeds together) costs to smallholder dairy accounting for an average of 63% of the total costs. The implication of this finding is that dairy farming will depend on adequate and affordable roughages, which could be better achieved where farm sizes are not severely limited.



About 23.7% of dairy farmers owned chaff-cutters; use of a chaff-cutter was expected to increase the efficiency of forage utilization, thus reducing wastage and increasing milk yields. Statistical results showed insignificant results. This was a curious result because other studies provided contrary outputs. Cabrera *et al.* (2009) suggests that an increase in use of technology leads to an increase in total dairy farm yield. Staal *et al.* (2008) adds that improved technology reduces production costs and induces shifts towards more commercial systems. Further, Short (2000) and El-Osta and Johnson (1998) found improved technology to positively correlate with dairy farms' profitability.

This study's finding was that the number of labour hours invested in dairy farming was 37% above the minimum requirements per cow per day. This period of time was much more than the recommended 1.6 hours (5 cows per workman per day) (MoLD, 2003). In Pakistan, FIAS (2006) found labour input on dairy cattle to be approximately 50% above the minimum recommendation. Nivievskiy and Taubadel (2008) indicate that labour intensity in dairy farms increases the cost of milk production making it uncompetitive in the market. It was noted that labour productivity in the area was low relative to the realized milk yields. This finding indicates an urgent need to reduce the amount of labour to the dairy herd. Although labour productivity on smallholder dairy farms is currently low, it could be easily improved by adopting better farm management practices (efficiency improvement), expanding dairy herd sizes (increase in operational scale) and increasing milk yields (mainly per cow milk yields).

The proportion of the total dairy farming cost arising from the cost of labour was large. This labour cost contributed to increased cost of milk production, raising it higher than its farm-gate price. The farmers were price takers for both labour input as well as milk price. The long distances (averaging 3.3 km) between the dairy farm and the other owned plot(s) could be probable cause of exaggerated labour input. The implication of this finding is that farmers can only benefit by increasing on their labour use efficiency and/ consolidate their land plots.

Farmers in both sub-Counties reported threats to the dairy enterprise in relation to labour requirements. Miraa (*Catha edulis*), for example, was reported as increasing in popularity in Embu East District where it was reported to demand less labour while paying more returns than the dairy sector. This already is the norm in Igembe South. Miraa crop once mature requires no weeding costs, with the only labour requirement being harvesting. The payments for Miraa products are on cash basis while those of competing enterprises such as dairy and tea are not. There is a risk that eventually Miraa will displace dairy farming in the area. According to Staal *et al.* (2008) dairy farming is a labour intensive venture that would be a casualty to any new enterprise that is less laborious and with better returns. In view of the fact that dairy farming directly offers food, incomes and employment at the farm level, there is need to ensure its continuity. Concerted effort by the industry stakeholders targeting increases in household land sizes, labour use efficiency, decreased taxation on the ingredients for concentrate making, improved rural access roads and easing access of loans to the farmers, could ensure competitiveness of dairy farming.

Most dairy farmers (96%) used concentrate feeds to supplement the roughages. They used an average of 2.2 kg of dairy meal per cow per day. It was not clear why dairy farmers used almost equivalent concentrate quantities. Lukuyu *et al.* (2011) found farmers in central province and Northern regions of Rift valley province providing concentrates based on a flat rate of 2 kg per cow per day. Njarui *et al.* (2011) in the semi-arid tropical Kenya found farmers providing an average of 2 kg dairy meal per cow per day, irrespective of the cow's lactation stage. Extensionists indicated that concentrate quantities should increase with increasing milk yields, so that a high milk yielder gets more and vice versa.

Although some minerals are present in roughages and concentrates, dairy cows require regular supply of additional minerals (*ad libitum*). This is done by offering on a daily basis access to commercial mineral supplements (Lukuyu *et al.*, 2007). Dairy cattle require about 21 minerals in order to optimize on both milk production and reproduction. A calcium or phosphorus deficiency for instance, can cause a drop in milk yield, slowed growth, lack of appetite and poor conception (Louw, 2009). There is a felt need for farmers to provide their dairy cattle with enough and quality mineral supplements with the view to increasing milk yields.

The average calving interval of the dairy cows in the study area was 588 days. Other past studies in the country obtained different but close intervals to that of this study. Such studies include; Staal *et al.* (1998) around Nairobi obtaining 591 days and Ongadi *et al.* (2006) in Vihiga coming up with 560 days. The most plausible cause for long calving interval by a dairy cow is underfeeding. Dairy farmers are advised to have their cows served between the sixtieth and the ninetieth day after calving down which ensures a calf once a year per cow (MoLD, 2003). Prolonged calving intervals imply fewer calves and less peak milking periods in an animal's life-time, thus reduced economic gains by the farmer.

The most popular breed in the study area was Friesian, closely followed by Ayrshire. These two breeds were preferred by majority of the farmers due to their perceived high milk production potential (Lukuyu *et al.*, 2011). This finding is in agreement with Bebe's (2003) finding in the Kenya highlands. These breeds are heavy feeders taking an average of 100 kg of fresh roughage per day, including about 3 kg mineral supplements per month (MoLD, 2009). The finding that farmers were unable to provide enough feeds and supplements to the kept animals, imply that cows whose demands are lower such as Jersey, should be adopted. It is only a negligible number of farmers who kept Jerseys, owing to their perceived lower milk production potential. Unless cow feed resources are plentiful and cheap, economic efficiency would favour cows with moderate size (Van Oijen *et al.*, 1993).

#### 4.2. Dairy Farmer Characteristics

Most dairy farmers in the study area were literate. However, there was no relationship between formal education and milk yields. The *a priori* expectation on formal education is that it would make farmers less conservative and more receptive to new technology and innovation (Oluwatusin, 2011). Formal education may achieve this by improving on the quality of labour, enable farmers to adjust to the existing situations and through its effect on input utilization (Moock, 1981). In the same vein, Udonsak and Khanna (2004)

attributes Thailand's low dairy production efficiency to the farmers' lack of formal education. McBride and Greene (2007) associate dairy farm operators having less than a high school education with higher economic costs. However, Makokha *et al.* (2007) indicates that although education is important, specialized information is more critical to adoption than just formal education.

This study's finding indicates that the farmers depended on farmer-to-farmer extension, regardless of the education level. This dependency is supported by the finding that most farmers shared many operational errors such as poor milking methods and poor feed storage and utilization. Additionally, the small scale dairy farming operation probably was not motivating enough to arouse the intellectual demand of those formally school-educated.

This study found no significant relationship between the dairy farmers' age and experience and farm milk yields. This was an unexpected finding because one would be expected to continue learning by doing with advancement in age, therefore becoming more efficient; a common finding of many studies. Edirisinghe (2007) for instance, indicate that advancement in operator's age increases efficiency and thus productivity. Similarly, Lucila *et al.* (2005) found experienced farmers being more cost efficient than their younger counterparts. Bhuyan and Postel (2009) found the operator's age having a positive correlation with net farm income. Further, Battese and Coelli (1995) reports a decrease in inefficiency with respect to farming experience for farmers in two villages in India. They interpreted this as implying that these farmers gained more years of farming experience through "learning by doing," thereby becoming more efficient.

Most dairy farmers in the study areas were middle-aged. Igembe South District had younger farmers compared to Embu East. This aspect on Igembe indicates some relationship with the proportionately many cross-bred animals they kept, as compared to Embu East. New dairy farmers feel safer with less vulnerable animals such as cross-breeds as opposed to the pure stock. Probably due to the high deficit and consequently the attractive price of milk in Igembe South, a new generation was venturing into dairy farming. There was no identifiable motivation for indulging in the same in Embu East sub-County. Milk prices were lower than the cost of production, after all the inputs including the family labour were costed. On average, both the older and the younger farmers were fewer than those at the middle age in the two study sites. This however, would be expected in most third world communities where the older are fewer and the youth have many options.

In this study, availability of extension service had no effect on the farm's milk yields. The probable reasons leading to this could be ineffective extension service or poor extension message adoption, a fact related to the question of smallholder dairy profitability. Adoption of extension messages involve extra costs that farmers may not afford. This study's finding is similar to that of Binici *et al.* (2006) in Burdur province of Turkey that extension programs explained little on the variation in farm production efficiency.

In the study area, extension messages were largely disseminated by public livestock extension personnel. According to the Department of Livestock Production personnel on the ground, the ratio of smallholder livestock farms to the number of government livestock extension providers was 1: 4,000 in the two study Districts against the FAO's recommendation of 1: 400. This is an indication that farmer-extension staff contact was inadequate. The high number of small-scale farmers against the few qualified and available personnel was a major constraint to extension service provision.

Poor adoption of extension service was evidenced by several observations. The amount of labour utilized was above the required levels, feeds were poorly utilized leading to costly wastage, cows had long calving intervals, animals were overstocked and farmers did not keep records which made the analysis of the enterprise performance difficult. The other indicators included poor agronomic fodder and pasture management, late or early harvesting of farm fodder materials, cutting and drying of napier as a method of conservation, feeding cows with uncut or long pieces of feed materials, poor milking methods and generally poor animal living environments (most farmers had poorly designed zero-grazing units, making the animals uncomfortable for optimal production).

Membership in agricultural activity-related farmer groups affords farmers the opportunity of sharing information on modern production practices by interacting with their peers (Idiong, 2007), which partly implies farmer-to-farmer extension. This is anticipated to improve on the farmers' performance on condition that the shared information is correct and superior. This study found no statistical significance of farmer group membership in milk yields, indicating that such membership is not relevant to dairy farming efficiency among dairy cow farms in the study area. This finding is related to that of Nchare (2007) that productive efficiency of farms decreases when the owners join farmer groups. This could be possible in cases where the farmers are self employed, such that whenever one left the farm for group meetings, the farm is neglected and consequently efficiency decreases. However, this finding contradicts Owuor and Ouma's (2009) finding which showed farmers belonging to groups being more efficient than those not.

This study found over half of the farms utilizing family labour. The implication here is that when other activities such as attendance to group meetings compete for time resource with the dairy farming activities, consequently its performance decreases. Further, attendance to any assignments outside the farm implies the dairy attendant is left unsupervised which could lead to decreased labour productivity, and consequently reduced efficiency.

Short courses in business education to dairy farmers had no effect in milk production efficiency among farms in the study area. The *a priori* expectation on business management courses is that they would unlock the participants' potential, enabling them to diagnose problems affecting the performance of dairy farming. Studies by Wubeneh and Ehui (2006), and Owuor and Ouma (2009) found business management information playing some role in decreasing management errors. It is expected that viewing any venture as a business could lead to seeking for information on how best to carry it out. Poor dairy farming management leads to lower milk yields relative to potential. Low production implies low income, preventing investment in good feeds and animal health (EADD, 2008). There are several probable reasons why business courses to farmers did not significantly contribute to dairy farming efficiency. The period of attendance was short making it hard for the trainers to cover enough material. Extension service providers basically trained

in agricultural sciences were facilitated by government supported programmes for short entrepreneurship and agribusiness courses, after when they trained farmers under 'common interest (enterprises) groups'. Probably they were not good enough.

## 5. Conclusion

The findings of the study, pointed out that the region has potential for increased milk production based on the existing large number and type of dairy breeds, farmer experience and a growing large human population that could offer market for milk. Dairy farming continued being an important farm activity in the region. However, farms lacked enough land to grow fodder, a basic requirement in dairy farming. Buying of roughage from outside the farm limited its use and further, increased the cost of milk production. Although the contribution of land to milk yields was statistically insignificant, contradicting the surveyed literature, the amount of roughage available in the farm was its proxy. Prices offered for milk at the farm gate level were not motivating. Only a few dairy farms made profits.

It was revealed that the dairy farms were small-sized and practiced mixed crop-livestock farming where large breeds were overstocked and underfed. Although this was not a new finding, the levels were. Land sub-division had reached its lowest levels that expensive alternative sources of roughage were sought, exaggerating the cost of milk production. The extent of land fragmentation and the distance between each plot and its effect on the amount of labour employed had not yet been documented. The level of dairy cow underfeeding (roughage, concentrate and mineral supplements) at about 50% had a direct influence on milk yields, where the simple average was about 9.2 kg which was about half of the potential.

The indication of the dairy breed as being insignificant in milk production was unexpected, and contradicted other studies such Staal *et al.* (2008). Further, contrary to past recommendations on the need to continue on dairy farming intensification and upgrading to larger breeds, this study's finding was that such actions were untenable. This was in part due to the uncontrolled increase of concurrent land sub-division and new smallholder dairy farm start-ups, leading to increased operational costs, and consequently raising costs of the produced milk.

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