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EFFECT OF MINERAL MIX AND CONCENTRATE FEEDS ON MILK REVENUE OF SMALLHOLDER DAIRY FARMERS IN KAPSERET SUB-COUNTY

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ABSTRACT

Dairy farming contributes about eight percent of National Gross Domestic Product with an annual milk production of 3.43 billion litres. It supports the livelihood of approximately four million Kenyans through food provision, income generation and employment. However, milk production per individual animal in Kenya, averaging six to seven (6-7) litres/cow/day, is low compared to the world's best at 10,133 litres/cow/year (28 litres/cow/day) mainly due to factors including poor feeding. This means that Kenya produces an average of 20 litres of milk less per cow per day compared to the world's best. The objective of this study was to determine the effect of mineral mix and concentrate feeds on milk revenue of smallholder dairy farmers in Kapseret Sub-county. The study was conducted between the months of January-March, 2020. Primary data was collected using closed and open ended questionnaires. Karl Pearson's product moment correlation was used to show the strength of the relationship between the variables. Multiple regression model was employed to assess the effect of supplementation on milk revenue. Results were presented in tables, and descriptive statistics such as percentages and frequencies. The results indicated a positive and statistically significant relationship between the variables (concentrate feeds and mineral mix) and milk revenue at (r=0.414, p=0.000) and (r=0.302, p=0.000), respectively. The relationship between mineral mix and concentrate feeds was positive and statistically significant (r=0.922, p=0.000). Subsequent feeding of homemade or commercial concentrates such as dairy meal and mineral mix to dairy animals also influenced milk revenue. The study concluded that mineral mix and concentrate feeds increased milk revenue of smallholder dairy farmers in Kapseret Sub-county. The study recommended the use of mineral mix, commercial concentrates or quality homemade concentrates in order to increase farmers' milk revenue.
Keywords: Concentrates, Feeds, Milk revenue, Mineral mix, Smallholder Farmers, Supplementation.

INTRODUCTION

The world's dairy sector is fast growing and is projected that milk production will increase by 177 million tonnes by 2025 (FAO, 2017). Global milk production in 2019 was estimated at 852 million tonnes, an increase of 1.4% from 2018 (FAO, 2020). However, world's exports of dairy products are forecast to contract by four percent to 74 million tonnes (in milk equivalent) in 2020, which would likely mark the sharpest year-on-year decline in three decades. This is as a result of likely declines in imports mainly by China, Algeria, Saudi Arabia and United Arab Emirates attributable to the Covid-19 pandemic which has resulted to economic slowdowns in countries (FAO, 2020).

Sub-Saharan Africa (SSA) produces approximately 3.5% of global milk output despite the fact that it accounts for nearly 21% of milking cows globally (FAO, 2020). This indicates low milk yields per cow on the continent. The average daily milk production in most dairy farms in Kenya is estimated to be averagely six to seven (6–7) litres per cow per day; this is approximately 70% lower than the level of production of cows in the developed countries (Muraya et al., 2018). This level of production in Kenya is low compared to world's average best of 10,133 litres per cow per year (28 litres per cow per day) (FAO, 2012). With improved management and better feeds and feeding practices, the production potential could be much higher than the milk currently produced per cow per day in Kenya (KDB, 2019). According to Uasin Gishu County Government reports (2018) milk production stands at 5.2 billion litres and is

projected that milk production will be at 7.9 billion litres by 2022 despite high expectation of a shortfall. There is need, therefore, to find mitigations of solving the expected shortage.

Feed Supplementation

In Kenya, low quality and quantity of feeds is one of the constraining factors of milk production among smallholder farmers despite the fact that they make up almost 80% of the dairy producers producing 56% of the total milk (Odero, 2017). Most smallholder farmers in Kenya do not have information on feed conservation technologies (Amuge, 2017). Generally, dairy animals in Kenya are underfed, resulting in low milk production (FAO, 2011).Components involved in dairy feeds for better production include dried and green forages, concentrates, minerals, vitamins and by-products (Miller et al., 2017). Milk production in Kenya is mainly based on forage, with very little use of concentrate or commercial feeds (Muriuki, 2003). According to Odero (2017) smallholder farmers in Kenya on average owning one to four acres of land and one to five heads of cattle are largely reliant on forage and

only use small quantities of concentrate to feed their cattle. Most households in Kenya fed their cows with nappier grass supplemented by commercial concentrates (ILRI, 2018). In Kenya, dairy animal feeds account for between 60 to 80 percent of the production costs, depending on the intensity and method of production used by the farmer (Njarui et al., 2016). Dairy farmers also store crop residues such as maize stalks for their livestock, however, the storage methods are inappropriate to maintain the feed quality; hence, smallholder farmers experience seasonal fluctuation of feed availability, resulting to milk production fluctuations (Njarui et al., 2011). In Central Kenya, dairy farmers either purchase commercially produced concentrates or use homemade concentrates made using purchased ingredients (Andreas et al., 2020). However, animal feeds access and cost is one of the main problem facing cattle rearing in all agro ecological zones in Kenya (Ng'eno, 2017).

Adequate trace minerals supplementation and its absorption are required for various metabolic functions including reproduction and growth, which affect farm productivity (Ojha et al., 2018). Milk producers in most developing countries often do not feed adequate quantities of mineral mixture to their dairy cows due to non-availability, lack of knowledge on the benefits of feeding mineral mixtures (Garg et al., 2013). The average proportions of concentrates from maize germ/ban and mineral supplements in total diets in Kenya are higher on zero-grazing farms and semi zero grazing farms than on free grazing farms (Andreas et al., 2020). The objective of the study, therefore, was to determine the effect of feed supplementation on milk revenue of smallholder farmers in Kapseret sub-county.

METHODOLOGY

The study employed correlation research design. Correlation design enables the researcher to observe two variables or more at the point in time and is useful for describing the relationship between the two or more variables (Ary et al., 2018). The research design was appropriate since the study aimed at analysing the relationship between variables. The assessment of the magnitude of the relationship was based on the coefficient of determination, p- values and effect size of the coefficient.

Location of the Study

The study took place at Kapseret sub-county, located in Uasin Gishu County. The study was carried out between the months of January-March, 2020. The county covers an area of 3,345.2 square kilometres and lies between longitude 34^0 50′ east and 35^0 37′ west and latitude 0^0 03′ south and 0^0 55′ north. The county borders Trans-Nzoia County to the north, Elgeiyo Marakwet and Baringo counties to the east, Kericho County to the south, Nandi County to the south west and Kakamega County to the west. According to the 2019 national census; Uasin Gishu County had a population of approximately 1,163,186 people with a population density of 390/km^2. According to (KNBS) 2019 Kapseret sub-county has a population of 196,883. The county experiences high and reliable rainfall evenly distributed throughout the year. The average rainfall ranges between 624.9mm to 1,560.4mm per year with two distinct peaks in April and August. The area is a highland plateau with an altitude of 1,500-2,700 metres above sea level with four major soil types; red loam, red clay, brown clay and brown loam soils. Generally these conditions are favourable for livestock keeping, crop and fish farming. Uasin Gishu County consists of six sub-counties which act as extension units where activities for livestock and crop production are planned and implemented (Uasin Gishu County Integrated Development Plan 2018 -2022). Kapseret sub-county has five wards; Ngeria, Megun, Langas, Simat and Kipkenyo. Kapseret sub-county is located to the south west of Eldoret town, and borders Kesses sub- county to the east and Turbo sub-county to the west. The sub-county borders Nandi County to the south.

Population, Sample Size and Sampling Procedure

The target population in this study was 4,226 smallholder dairy farmers in Kapseret sub-county. The sample size was drawn from smallholder dairy farmers in the following wards; Ngeria, Megun, Simat, Kipkenyo and Langas. The following formula by Morgan (1970) was used to calculate the sample size for the study,

$n = \frac{X^2 Np(1-p)}{d^2(N-1)+X^2p(1-p)}$	$n = \frac{1.96^2X4226X0.8X0.2}{0.05^2(4226-1)+1.96^2X0.8X0.2} = 232$

where,
N= Total population,
n= Sample size,
X^2= Table value of Chi-Square with one degree freedom and at 95% confidence interval, giving 1.96,
p = the proportion in the target population estimated to have characteristics being measured and
d = the degree of accuracy expressed as a proportion (0.05)

Cluster sampling was used to select individual households proportionate to the population size in Kapseret sub- county. Smallholder dairy farmer respondents were chosen randomly from each cluster. The clusters included all the wards in Kapseret sub-county; Ngeria, Megun, Langas, Simat and Kipkenyo.

Ward (Cluster)	Number of Farmers	Sample Size
Ngeria	1015	56
Kipkenyo	1005	55
Megun	1011	55
Simat	733	41
Langas	462	25
Total	4226	232

Data collection and Analysis

Primary data was collected using a structured questionnaire. The data was cleaned, coded before being analysed. Quantitative data was analysed using Statistical Package for Social Sciences (SPSS) version 25 for both descriptive and inferential statistics. In order to effectively analyse the primary quantitative data, descriptive statistics including percentages and frequencies were generated. Multiple regression analysis was conducted to show the relationships between the dependent and independent variables. Karl Pearson product moment correlation showed the strength of the relationship between variables in the study. Values close to +1 indicate a high-degree of positive correlation, and values close to -1 indicate a high degree of negative correlation. Values close to zero indicate poor correlation of either kind, and 0 indicates no correlation at all. While correlation is useful in discovering relationship between variables, it does not prove or disprove any cause-and-effect relationship (Michael Berthold, 2003).

Models

Multiple Regression Model

Regression analysis was conducted to show the strength of the relationship between dependent and independent variables. Multiple regression analysis showed the relationship between dependent and independent variables.

Model Specification

The regression model was: $Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \varepsilon$

where,

Y = Milk revenue

β_0 = Constant Term , β_1, β_2 and β_3 = Regression coefficients

X_1= Free grazing only, X_2= Concentrate feed, X_3= Mineral mix, ε = Error term

Ethical Consideration

Before data collection was embarked on, an introductory letter was obtained from the university introducing the purpose of the study. A permit to carry out the study was also acquired from the National Council for Science, Technology and Innovation (NACOSTI). All matters linked to the respondents were considered confidential.

RESULTS AND DISCUSSION

Response Rate

This research used questionnaires as the research tool for a total sample size of 232 farmers in Kapseret sub-county. Out of the 232 farmers, a total of 220 questionnaires were returned and fit for the analysis, representing a return rate of more than 90%. Nachmias, (1992) stated that 80 to 90% return rate is appropriate for a descriptive research.

Table 17: Response Rate

Respondents	Sample	Returned	Percentage
Ngeria	56	52	92.8
Megun	55	52	94.5
Kipkenyo	55	52	94.5
Simat	41	39	95.1
Langas	25	25	100.0
Total	232	220	94.8%

Gender Distribution

The study sought to establish the gender composition of the smallholder dairy farmers in Kapseret sub-county. The results were analysed and tabulated in Table 2 below.

Table 18: Distribution of Gender of Smallholder Dairy Farmers in Kapseret Sub-County

	Frequency	Percentage
Male	152	69.1
Female	68	30.9
Total	220	100.0

Education Background of Smallholder Dairy Farmers in Kapseret Sub-County

The study sought to establish what levels of education were involved in the study among smallholder dairy farmers in Kapseret sub-county. The respondents were requested to indicate the highest level of education they attained. The researcher categorized levels of education into; primary, secondary and tertiary. Those who never pursued education were also considered. From the findings, 96.4% of the respondents had attained at least basic education. Only 3.6% of the respondents did not attend school at all.

Table 19: Education Level of the Respondents

	Frequency	Percentage
Tertiary	45	20.5
Secondary	61	27.7
Primary	106	48.2
None	8	3.6
Total	220	100.0

Dairy Farming Importance

The study went further to determine the importance of dairy farming to the livelihoods of smallholder dairy farmers in Kapseret sub-county compared to other sources of livelihood earnings. Using the linkert type questions, farmers were asked to indicate the importance of dairy farming to their household income. The results are in Table 4.

Table 20: Dairy Farming Importance among Smallholder Dairy Farmers in Kapseret Sub-County

	Frequency	**Percentage**
Very Important	176	80.0
Important	40	18.2
Not Important	4	1.8
Total	220	100.0

Majority of the respondents (98.2%) indicated that dairy farming played a key role in supporting their livelihoods in terms of household income while only 1.8% underrated its importance. This meant that a high percentage of the smallholder dairy farmers in Kapseret sub-county mainly depended on dairy farming as their main source of income for sustaining their livelihoods. According to Uasin Gishu County Government reports (2018) several wards in Kapseret sub-county, including Ngeria received milk cooling plants with capacity of 5000 litres of milk in October 2018 from the county government, indicating the importance of dairy farming in the location.

Milk Distribution by Farmers

The researcher sought to understand how smallholder dairy farmers in Kapseret sub-county distributed milk produced in their farms. The computed descriptive statistics were as tabulated in table 5 below;

Table 21: Descriptive Statistics on Milk Distribution by Smallholder Dairy Farmers in Kapseret Sub-County

	N	Mean	Std. Deviation
Amount of milk produced	220	9.67	5.179
Amount of milk sold	220	7.31	4.570
Amount of milk consumed	220	2.313	1.1131
Valid N (listwise)	220		

The results showed that the amount of milk sold by farmers was very high (MN=7.31 and SD=4.570) compared to the amount of milk used by farmers for their home consumption (MN=2.313 and SD=1.113). This meant that dairy farming played a significant role in determining the earnings for improving livelihoods of the smallholder farmers in Kapseret sub-county. This was consistent with findings by Kurgat et al. (2019) that farmers carried out dairy farming for commercial purposes which were a clear step towards improving productivity and marketing. Farmers sold 79% of the milk, while 16% of the milk was for home consumption and 5% of the milk was given out. It was also established that the relationship between milk volume and the prices were negative and statistically significant (p=-0.108, r=0.000). This was similar with findings by Olwande et al. (2010) that the prices of milk did not significantly influence the quantity of milk produced. The study established a positive and statistically significant relationship (p=0.983, r=0.000) between amount of milk produced and the amount of milk sold. This indicated that more milk was sold (supplied) in instances of increased production.

Feed Supplementation Effect on Milk Revenue

The study sought to establish the effect of cow supplementation on milk revenue of smallholder dairy farmers. The computed descriptive statistics on the importance of free grazing only, concentrates supplementation, and mineral mix supplements use towards increased milk revenue of smallholder farmers in Kapseret sub-county were as illustrated in Table 6 below;

Table 6: Descriptive Statistics on Feed Supplements Effect on Milk Revenue of Smallholder Farmers in Kapseret Sub-County

Statement on Animal Feeding		VI	I	NI	Totals
Importance of free grazing only in increased milk revenue	F	79	40	101	220
	%	35.9	18.2	45.9	100
Importance of concentrate feeding in increased milk revenue	F	150	22.0	48.0	220
	%	67.9	10.1	22.0	100
Importance of mineral mix in increased milk revenue	F	145	24	51	220
	%	65.6	11.0	23.4	100

VI- Very Important I- Important NI- Not Important

The findings deduced the importance of feed supplementation in dairy farming. Majority of the respondents indicated that they preferred supplementing their dairy cows with concentrates which was clearly reflected by 67.9% of the respondents who considered concentrate feeding as a very important practice. Additionally, 10.1% of the respondents indicated it as important, making a total of 78% of the respondents who preferred the use of feed supplements in attaining increased milk revenue. This was consistent with findings by Richards et al. (2015), that supplementation of feeds to dairy cattle led to increased milk production among smallholder dairy farmers in Kenya. The current results were also highly related to the findings by Richards (2017) that feeding dairy meal to a cow before calving period was associated with milk production increase by approximately 1.4 kg/day during the first 60 days of lactation. Makau et al. (2020) also indicated that the mean milk production for cows increased by 0.8% per cow per day with every kg increase in maize silage fed.

Majority of the farmers also showed the benefits of mineral mix with 65.6% of the respondents indicating that it had a very important contribution towards increased milk revenue. Moreover, 11% of the respondents considered mineral mix as important adding up to 76.6% of the respondents who agreed on the significance of mineral mix in attaining increased milk revenue. This was consistent with findings by Richards et al. (2016), that daily mineral mix use was positively correlated to daily milk production in Nyeri County, where every 100 grams of mineral fed was associated with 0.82 kg higher milk production per day. Further, this was consistent with findings by Ojha et al. (2018) that adequate trace minerals supplementation was required for various metabolic functions including reproduction and growth, which affected dairy animals productivity in the long run.

In support to the need for feed supplementation, 45.9% of the respondents indicated that free grazing only was not of importance in determining increased milk revenue. However, 35.9% of the respondents indicated that free grazing only was very important in determining increased milk revenue while 18.2% of the respondents showed that free grazing alone was important. This was further supported by 22% and 23.4% respondents who indicated that concentrates and mineral mix were not important in determining increased milk revenue, respectively. This supported the findings by Richards (2017) that smallholder dairy farmers literally lacked the knowledge and resources on how to adequately provide better feeds for their cow(s), which ultimately limited the dairy cow

productivity. Further, VanLeeuwen et al. (2012) in his study reported that the productivity of traditional dairy crossbred cows remained low on many farms at approximately 5-10 kg/cow/day because of farmers' lack of knowledge resources like feeding, that favoured increased productivity in smallholder farming.

Table 7: Karl Person's Correlation between Feed Supplements and Milk Revenue of Smallholder Dairy Farmers in Kapseret Sub-County

		Revenue	Free Grazing	Concentrates	Mineral Mix
Revenue	Pearson Correlation				
	Sig. (2-tailed)				
	N	220			
Free Grazing	Pearson Correlation	0.272**			
	Sig. (2-tailed)	0.001			
	N	220	220		
Concentrates	Pearson Correlation	0.414**			
	Sig. (2-tailed)	0.000			
	N	220		220	
Mineral Mix	Pearson Correlation	0.302**		0.922**	
	Sig. (2-tailed)	0.000		0.000	
	N	220		220	220

**. Correlation is significant at the 0.01 level (2-tailed)

The positive and statistically significant relationship (r=0.414, p=0.000) between concentrate feeding and milk revenue was indicative that feed concentrates offered to cows affected milk revenue of the smallholder dairy farmers in Kapseret sub-county. Kimenchu et al. (2014) in his study established a highly statistically significant relationship (r=0.661, p=0.000) between the amount of concentrate fed and milk yield. This further meant that feeding animals with concentrates, either homemade or commercial concentrates resulted to increased milk revenue.

The study also established a positive and statistically significant relationship (r=0.302, p=0.000) between the mineral mix use and the milk revenue of smallholder dairy farmers in Kapseret sub-county. It also meant that mineral mixes were very important in determining the level of milk revenue. Kashongwe et al. (2017) in his study established a positive and statistically significant relationship (r=0.78, p=0.009) between milk yield and supplement feeds in dairy animals in Kenya. The results indicated a statistically significant and positive correlation between mineral mix and concentrates use (r=0.922, p=0.000). The concentrates included dairy meal and homemade concentrates from maize talks while the minerals included commercial salts rich in calcium, phosphorus among other components that improved production.

Regression Model Summary

Model	R	R Square	Adjusted R^2	Std. Error
1	0.325[a]	0.105	0.083	5083.26438

a Predictors: (Constant), Free grazing, mineral mix, concentrate feed
b Dependent Variable; Revenue

The regression model summary shows R value of 0.325 which indicated positive association between milk revenue and feed supplementation in dairy farms. The R^2 value of 0.105 meant that approximately 10.5% of the resultant changes in milk revenue among smallholder farmers in Kapseret sub-county explained by feed supplementation.

One-Way ANOVA Summary for Free Grazing, Concentrates and Mineral Mix

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	351906621.935	3	117302207.312	7.532	.000[a]
	Residual	3332794937.698	214	15573808.120		
	Total	3684701559.633	217			

a Predictors: (Constant), Free grazing, mineral mix, concentrate feed
b Dependent Variable: Revenue

The multiple linear model significance was evaluated using ANOVA. Regression results indicated that the linear association between milk revenue and feed supplementation has an F value of F=7.532 which is significant with p value p=.000. This implies that the overall model is significant in forecasting the effect of milk revenue and feed supplements at 5% level of significance.

Significance of the Regression of Milk Revenue on Concentrate feeds, Mineral Mix and Free Grazing

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	12.664	1020.828		5.400	0.000[a]
	concentrate feed	3.658	836.377	0.046	0.273	0.010
	mineral mix	7.806	822.581	0.120	0.711	0.009
	free grazing	2.040	315.162	0.013	0.091	0.520

a Dependent Variable: Revenue

The regression coefficients results for the model revealed that the beta coefficient of the resulting regression model were β_0= 12.664, β_1= 3.658, β_2= 7.806 and β_3= 2.040, respectively. Using the value of the coefficients from the regression coefficient, the accepted regression equation took the form: *Milk Revenue* = $12.664+3.658X_1+7.806X_2+2.040\ X_3$, where X_1 was the concentrate feeds, X_2 the mineral mix and X_3 free grazing. The study showed that all the independent variables had a positive relationship with the dependent variable. The results stipulated that a unit change in concentrate feeds led to 3.658 changes in milk revenue while with a unit change of mineral mix changed the milk revenue by 7.806. The findings further stipulated that for every unit change in free grazing there was a 2.041 increase in milk revenue.

The findings showed that concentrates and mineral mix had a positive and significant effect on milk revenue of smallholder farmers, P = 0.010 and 0.009, respectively. This implied that an increase in the concentrate feeds and mineral mix had a major impact on milk revenue. Only free grazing alone was found to have a positive insignificant effect on milk revenue of smallholder dairy farmers. However, the contribution of concentrate feeds in increased milk revenue was low compared to that of mineral mix. This could be explained by the low nutritional value of common homemade concentrates especially from maize stalks. Commercial dairy meals are mostly out of reach as they are not affordable by most of the smallholder farmers in the study area.

CONCLUSION

The study concluded that dairy animal feed supplements were very essential in determining milk revenue of smallholder dairy farmers. Commercial dairy meal, homemade concentrates and mineral mix were vital in achieving increased milk revenue for smallholder dairy farmers in Kapseret sub-county and thus better incomes. Therefore, more emphasis should be given to feed supplementation as it was found to have a significant effect on milk revenue.

RECOMMENDATIONS

i. The study recommended the use of commercial concentrates, homemade concentrates and mineral mix in order to increase production for improved milk revenues. However, high nutritional value of homemade concentrates needs to be met.
ii. There is need to utilize farm residues such as green or dry maize stalks and bean husks which are available in the smallholder farms to make quality homemade concentrates of less cost. This will contribute towards increased milk revenue.

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