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IMPACT OF MARKETING CHANNELS, FEED SUPPLEMENTS AND CREDIT ACCESS ON MILK PRODUCTION AMONG SMALLHOLDER DAIRY FARMERS IN CHUKA SUBCOUNTY, KENYA

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ABSTRACT
Kenya dairy farming contributes approximately 17% of the Gross Domestic Product. Kenyan milk production has been projected to be between seven to nine litres/cow/day, way below international standards whereby a cow produces 25 to 28 litres/cow/day. Low yield of milk is attributed to lack of adequate information on relationship between age, education level, training, experience, marketing channels, feed supplements, credit access and milk production by the majority of the smallholder dairy farmers. This study determined the relationship between age, education level, training, experience, marketing channels, feed supplements (concentrate and minerals), credit access and milk production among smallholder dairy farmers in Chuka Sub County. The research design was correlational and stratified random sampling technique was used, with 238 respondents from a target population of 7396 farmers. Data was analysed using simple and multiple regression models. The study revealed that age education level, experience, were not significant predictors for milk yield. However, training in dairy farming was significant related to milk production. Inclusion of feed supplements was a significant predictor mineral mix provision; concentrate provision of milk yield. Marketing channels, credit access, were insignificant predictors of milk yield. Concentrate and mineral mix were significantly and positively correlated to milk yield. However, marketing channels and credit access were not significantly correlated to milk yield. The study concludes that feed supplements and mineral mix are important in predicting variations in milk yield.
Keywords: Feed supplements, mineral mix, milk yield

INTRODUCTION
The dairy sector is growing at a fast rate and it has significant economic returns and employment opportunities in developing economies (FAO, 2018). The dairy sector is an important contributor to the economic development of both developing and developed countries in the whole world (Alonso, *et al.,* 2018). There exists, big variations in developed and developing countries with regards to the production systems and productivity. According to Thorsøe, *et al* (2020), production in the developed countries, is largely by large scale enterprises with advanced and competitive systems of management, in addition, their technology uptake is high and capital expenditure is big. However, when developing countries are considered, dairy production is largely practiced by farmers in small scale who have limited technical and management skills, access to capital and information is limited. Thus there are large differences in production in developing and the advanced developed economies (Shine, *et al* 2018).

In Africa, South Africa is considered to produce milk efficiently due to its advanced production system, producing 2,500 L per cow per year compared to 1,800 litres per cow per year in Kenya, 1,000 L per cow per year in Uganda and 800 L per cow per year in Tanzania (FAO, 2019). Eastern Africa is the leading producer of the continent's milk yield representing 68% of the total production in Africa. In East Africa, Kenya is much ahead although this production is not as high as that observed in developed counties. Milk produced by a cow has remained unchanged at 7 L on average when many years are considered (FAO, 2019), although the potential is more than 18 L.

In Kenya's a population of 70-80% is approximated to reside in rural areas and is dependent fully on agricultural activities including dairy farming as main food source and also the main income source (Marshall *et al*., 2014). The WHO's recommended milk consumption per country's per capita is 200 kg and when considered against Kenyan per capita milk consumption of about 76.7 kg (FAO, 2017). Kenya has the largest dairy subsector in Eastern Africa with a per capita production of approximately 90 litres (Murage & Ilatsia, 2011). The dairy production is an important sub-sector as it contributes in the strengthening of food production, household-economy, employment and poverty relief among other benefits. In addition, households which are resource-poor and vulnerable groups particularly women who do not own land are allowed to own assets and build their asset base (Mutavi *et al.*, 2016).

Faye & Konuspayeva, (2012) noted that of the total milk marketed in the country. 70% is from smallholder milk producers. The milk market in Kenya is bi-sectoral meaning that it is both formal and informal and recent growth in the formal sector has been fuelled by the growth in production. Thus, the formal milk industry has been growing at a faster rate than all other agricultural sub-sector in Kenya (Wambugu *et al*., 2011). Schneider (2018) observed that estimates showed that in Kenya, for all marketed milk, about 86% was sold directly by producers in raw form to consumers or using informal milk market. The informal sales included %), milk sold by mobile traders (23%), direct sales to consumers (42milk bars, shops and kiosks (15%).

Since KCC was revived and numerous processors in small scale emerged, milk the challenge of milk marketing reduced significantly as it was when KCC had gone under (Kiveu, 2013). The major constraints include poor road infrastructure and lack of appropriate milk delivering means to the processors (Lemma, 2018). These constraints affect milk marketing given the perishable nature of milk. In addition, there is limited interaction among core value chain actors in the sector, which has led to inefficiencies within the marketing chain, resulting in reduced remuneration to the producer and hiked prices to the consumer (Osei-Amponsah, 2020). There is preferential access of Kenya's milk to the Eastern African markets, although export quantities are low (MoLD, 2010).

A major component in milk production in Kenya is feed, but is expensively produced thus making it unaffordable. The feeding system mainly comprise of stall-feeding which is carried out through cutting and carrying, however, 40% of households in the regions consisting of smallholder farmers keeping dairy cattle feed them on improved or preserved fodder and add some supplements (Muia *et al*., 2011). The examples of fodder planted by farmers include Napier grass, maize stalks, grass weeds and crop residues are used to feed the cows (Njarui *et al.,* 2011) and some farmers sometimes supplement the cow feeds with grain millings or compounded dairy feeds as concentrate feeds (Njarui *et al*., 2011). Thus, it is noteworthy that farmers get fodder in large proportion from gathering it from public or common land or through purchase and, therefore, the feed resources used by farmers are by no means limited to those produced on their farm.

It has been reported by Njarui *et al.* (2011) that 95 % of dairy farmers stored crop production residues as livestock feed but the methods of storage are inappropriate for quality maintenance. Njarui *et al.* (2011) reported also that about 93% smallholder farmers had some seasonal fluctuation of availability of feed and, suffered milk production fluctuation. A balanced ration for dairy cows includes; bulk forage, supplementary forage, concentrates, and mineral supplement and water (Wright, 2017). It is, important, therefore, that the nutritional requirements of a dairy cow is known by the farmer, so as to provide adequate rations to meet its production and reproductive requirements. Despite feeding system and feeds accounting for a substantial cost in dairy farming, most farmers do not have sufficient information on the economics of feeding cost. Cutting down supplement feeding and maintaining high milk production makes dairy production sustainable and profitable.

Researchers have conducted various dairy farming studies in Kenya, about the milk production status, marketing, feeding and credit access with an aim of capacity increase to leverage the existing market opportunities. The researchers covered the study areas including: milk at farm-level (Gamba, 2006; Baltenweck, 2006; Kimenju and Tscherley, 2008); adoption of production technologies by farmers (Makokha *et al*, 2007); profitability in smallholder dairy units (Omiti *et al*, 2006) and milk marketing and production (Ngigi, 2002; Karanja, 2003 and Staal *et al*, 2008). However, in spite of their many recommendations, there has been no improvement in the milk yield average per cow and in cost reduction per production unit. This study aimed at to determine the relationship between feed supplements and milk yield among smallholder dairy farmers in Chuka Sub County.

MATERIALS AND METHODS

Location of the Study

The study was done in Chuka Sub-County, Tharaka-Nithi County, Kenya. Chuka Sub-County lies on latitude and longitude of 0°17'60.00" N, and 38°00'0.00" E, respectively. According to Betty (2016) the County lies 175 Km due North of Nairobi City. In the Northern side it borders Meru County; in the East it is bordered by Kitui County. In the South it is bordered by Embu County and the slopes of Mount Kenya on the Western side. According to MoLD the county has about 85,000 dairy cows (Fleming, 2016).

Research Design

Correlational research design is the one employed in this study. The design enables the observance of two or more variables at a time point and is important for describing a relationship between two or more variables (Ary *et al.*, 2018). The research design was appropriate for this study since the aim of this study was analysing the relationship between independent variables and dependent variables. The population targeted composed of 7396 farmers who supply milk to 7 milk collection centres in Chuka sub- County. Stratified sampling was employed to get the sample size that would well represent the population. The farmers of Chuka sub County were partitioned into subpopulations which were the milk collection centres. The milk collection centres were homogenous but mutually exclusive such that a farmer could only belong to that milk collection centre (stratum) and not any other. To get representative farmers from each milk collection centre, simple random sampling was applied to improve precision of the sample and reduce sampling error.

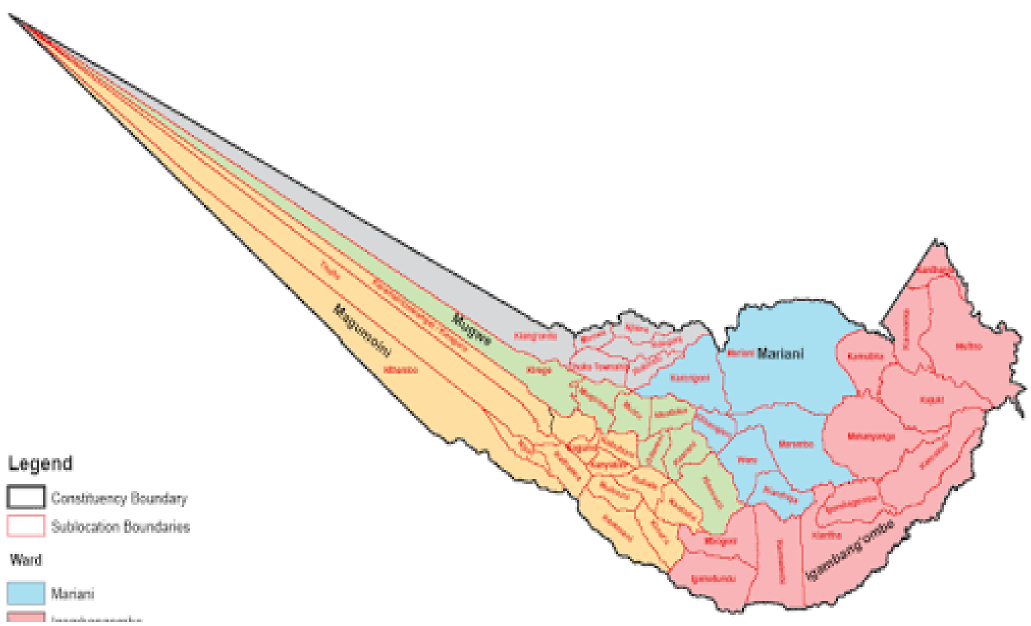

Figure 1: Study area

A sample of the smallholder dairy farmers was obtained using Morgan (1970) finite formula:

$$n = \frac{X^2 Np(1-p)}{d^2(N-1) + X^2 p(1-p)}$$

where,

n = sample size

X = table value of Chi- square at degree of freedom as one and at 95% confidence interval giving (1.96)

N = population size in this case the dairy farmers in Chuka Sub County (7396)

p = population proportion assumed to be 80 % (those who practice dairy farming in Kenya)

d = proportion of the degree of accuracy expressed i.e. 0.05

$$n = \frac{(1.96)^2(7396)(0.8)(0.2)}{(0.05)^2(7395) + (1.96)^2(0.8)(0.2)} = 238$$

This gave a sample size of 238 farmers allocated proportionately to each stratum (Table 1).

Table 1: Sample size of farmers

Milk collection centre	Number of registered members	Number of members to be sampled
Kamukondi	2640	84
Ndagani	250	8

Muthiru	3550	114
Thuita	150	5
Kiracha	532	17
Mukuuni	75	3
Ciangoi	200	7
Total	7396	238

Research Instruments

A questionnaire was the tool for data collection with both open ended and close ended questions. Mugenda & Mugenda (2009) noted that a questionnaire present stimulus of even potential to a large number of people simultaneously and enables and provides the investigation with an easy accumulation of data. In 2014, Gay posited that questionnaire gives a respondent freedom for expressing their views or opinions of generalized information amongst any population. The questionnaire was composed of well-structured open ended and close ended questions. Such questionnaire gives a high response, more accurate data and is easy in coding and analysis (Mugenda and Mugenda 2009). A section was outlined on dairy cow feeding (provision of concentrates and supplement).

Validity of Research Instruments

Research instruments are used to measure exactly and precisely what they are out to measure. Validity of the instrument as well help in noting ambiguous questions so as reformulate them and to have a base for refining and reviewing the questions to be used in the final study (Mugenda & Mugenda, 2013). Validity can be defined as the accuracy and meaningfulness of the instruments; the degree to which an instrument measures what it purports to measure (Mugenda & Mugenda, 2013). Further validity represents the degree to which the analysis results obtained the data actually represent the phenomenon under study (Zohrabi, 2013). Thus, Content validity was determined by giving the questionnaires to experts and farmers in the dairy sector to vet on the items. Corrections were made according to the supervisor's and other expertise in the area guidelines for ensuring that the content in the questionnaire are further in accordance with objectives investigated in this study.

Reliability of Research Instruments

Reliability testing was used to measure the internal consistency of variables and to investigate whether every individual question used in the investigation of the variable measured in the same way. Mugenda & Mugenda (2013), posited that reliability is the measure of the degree to which a given research instrument yields consistent, stable and uniform results or data after repeated trials under similar conditions. Items in the questionnaire were pretested to check if the respondents would interpret the questions in the same way if all the response choice were relevant. Cronbach's alpha (α)-a statistical coefficient was used as a measure of internal reliability and consistency. Items that attained a reliability level of 0.7 or above were included since such values indicated an acceptable reliability level. This is in line with requirement of 0.7 or more which according to Heale & Twycross, (2015) indicates high reliability of the data. The instrument after pilot study was resolved to be clear and reliable for the study as it addressed what was targeted without problems and no modifications were made to the questionnaire.

Data Collection

Structured questionnaire was used in primary data collection. A research assistant conversant with the local dialect was recruited to assist in data collection by administering the questionnaires to the respondents. The administration of questionnaires to every respondents using a face to face technique and explanation on the instructions given done. The respondents were assured that their privacy was assured since no identification was being required.

Data Analysis

Questionnaires filled were checked for consistency and completeness, followed by coding and checking for any errors and omissions after which data analysis was done using SPSS Version 25. Both inferential and descriptive statistics were applied in data analysis. Descriptive statistics on percentages and frequencies for the collected quantitative data were generated. Linear regression analysis was used to analyse the relationship between feeding supplements (concentrates and mineral mix) and milk yield. Chi-Square test was used to tell whether the relationships were statistically significant. The F- statistic was used to assess the significant difference of the linear regression model. Spearman correlation was applied to show the relationship between variables in the study. The study sought the combined relationships between education level, age, training, experience, marketing channels, feed supplements (concentrate mineral mix provision), credit access and milk yield.

Multiple Regression Model

Multiple linear regression was used to analyse the relationship between supplement feeding (concentrate and supplement provision) and milk yield was computed by use of the following model:

$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon$

Where: Y= milk yield

β_0 = Constant

β_1 = coefficient of concentrate provision; and mineral mix provision

X= concentrate provision; and mineral mix provision
ε = error term

Model Diagnostics

Diagnostic tests are applied for model specification since the consequences of failing to adhere are adverse. Misspecification in regression results to adverse effects on sampling properties of both estimation and tests. This results to wrong implications for forecast and other inferential measures.

Normality Test

One assumption of ordinary least square (OLS) is that error the term should be normally distributed for accurate and reliable conclusion. Data is unbiased and normal when skewness statistic is in between the ranges of ±3. A skewness goodness of fit test was used in determining the normality of the data.

Heteroscedasticity Test

Heteroscedasticity is defined a situation where the error terms do not contain a constant variance. It can arise due to error measurement and where there are sub-population differences. One of the assumptions of Classical linear regression model is that the error term is of constant variance. The assumption makes sure that each observation is reliable so that the estimates of the coefficient of determinations and test of hypothesis is unbiased. If some important variables are omitted heteroscedasticity can occur. heteroscedasticity was tested in this study by use of Breusch-pagan test. Hypothesis was formulated on the presence of heteroscedasticity and absence of the same. The decision criterion was if $p > 0.05$, then the null hypothesis of no heteroscedasticity was accepted at 5% level of significance. Correct model specification will ensure the problem is dealt with at primary stage.

Multicollinearity Test

Ordinary Least Square estimation requires no correlation of the independent variables in the given regression. Multicollinearity is a violation of this assumption. In presence of multicollinieartity, analysis will result in spurious results. Variance Inflation Factor (VIF) and Coefficient of determination (R^2) are used to detect multicollinieartity. Multicollinearity is observed when the value of R^2 value is high and there is few significant t- ratios and the (VIF) is greater than 10. The study employed VIF to test for multicollinearity. The decision was to accept the presence of multicollinearity if the VIF >10.

RESULTS AND DISCUSSION

Questionnaire Response Rate

In this study there was a 100% response rate (Table 2). This indicated that all targeted participants of 238 smallholder dairy farmers (Table 2) respondent to the questionnaire in this study. This rate of response could be mainly attributed to the technique used in data collection, whereby the respondents were filling and returning the questionnaires the same day and also a face to face method of meeting the respondents. Mugenda & Mugenda (2003) observed that a fifty percent response rate is adequate, while 70% rate is good for data analysis and reporting. In this case there was 100% response rate, indicating adequate reliability and validity of the study findings. In this study there was no non-response bias, hence it can be argued that the findings of the study reflected elements of the population with breadth and depth.

Table 2: The questionnaire response rate by the respondents

		Providing minerals	Providing concentrates
N	Valid	238	238
	Missing	0	0

Relationship between Feed Supplement and Milk Yield

This study sought to establish the relationship between feed supplements (concentrate and mineral mix provision) and milk yield. Majority of the farmers (87%) provided supplement feeds for their dairy cattle and only a few (13%) did not (Table 3). This showed that majority farmers were providing supplements to their dairy cows and only a few did not. The findings agreed with Portillo et al. (2018) who in a study conducted on concentrate provision in Mexico found out that most smallholder dairy farmers supplied concentrates. Similarly, Odero (2017), observed that smallholder farmers in Kenya use quantities of concentrate to feed their dairy cows. Multiple regression model was appropriate ($F = 184.253$, $p = 0.000$; Table 4) for showing the relationship between feed supplement and milk yield.

Table 3: Farmers provision of feed supplement to dairy cows

	Frequency	Percent	Valid Percent
No	31	13.0	13.0
Yes	207	87.0	87.0
Total	238	100.0	100.0

Table 4: Analysis of variance summary for concentrates and mineral mix

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2228.252	2	1114.126	184.253	0.000[b]
	Residual	1420.979	235	6.047		
	Total	3649.231	237			

a. Dependent Variable: YIELD
b. Predictors: (Constant), provide concentrate, mineral mix provided

Table 5: Regression model summary statistics for feed supplements

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.781[a]	0.611	0.607	2.4590

a. Predictors: (Constant), provide concentrate, mineral mix provided

The findings established adjusted, R^2, values of 0.607 (Table 5), which indicated that approximately 60.7% of the total variations in milk yield in smallholder dairy farmers in Chuka Sub County was explained by variations in feed supplements. This showed that feed supplements were very important in milk production in dairy farming.

Table 6: Regression analysis for supplement feeding, mineral mix and milk yield

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.742	0.442		13.001	0.000
	mineral mix provided	5.536	0.363	0.641	15.270	0.000
	provide concentrate	3.664	0.489	0.315	7.496	0.000

a. Dependent Variable: YIELD

In predicting milk yield the findings established that feed supplements were statistically significant predictors (mineral mix provision ($\beta1 = 0.641$, 0.000; concentrate provision $\beta2 = 0.315$, 0.000; Table 6). Coefficient of regression showed that a unit change in provision of mineral mix would lead to a 0.641 change in milk yield units and provision of concentrates would lead to 0.315 units change in the level of milk yield units. A farmer should therefore consider supplying these supplements in the right quality and quantity for an increased milk yield.

Multiple regression was statistically significant model ($F = 184.253$, $p = 0.000$; Table 4) in analysing feed supplements and milk yield. Thus in explaining the role played by feed supplements in variations in milk yield, the findings showed that feed supplements were significant predictors of milk yield. Feed supplements explains a large proportion (60.7%) of variations in milk yield. Thus if feed supplements were provided in right proportion milk yield would increase. These observations agrees with those of Lazzarini et al (2019) that improved milk production could be achieved through quality feeds. Moreover, Baramurugan et al (2017), recommended mineral mixes in nutritional management of dairy cows for optimum milk production. Smallholder dairy farmers would increase milk yield if they provided mineral mix and concentrates to dairy cows. Stakeholders in making dairy cow feed supplements should ensure quality is maintained so that yield is not affected by feed quality. However concentrate and mineral mix provision were significant predictor in variations of milk yield units. Feed supplements if supplied in the right quantity and quality would result in and increased milk yield. This finding is collaborated by Lazzirini *et al*., (2019), that proper feed supplements improve milk production. Also mineral mixes inclusion in feeding dairy cows helps in achieving optimum milk production Baramurugan *et al*., (2017)

Correlation Analysis

There was a positive and statistically significant relationship between feed supplement and milk yield which implied that feed supplement was a key variable in milk yield. The smallholder farmer would have an increased milk yield through increased supplement feeding. This finding is collaborated by Williams *et al*., (2018) findings that feed supplements are significant to milk yield.

Table 7: Correlations for mineral mix, and yield

			Mineral mix is provided
Spearman's rho	Yield		0.733**
		Sig. (2-tailed)	0.000
		N	238

CONCLUSIONS

Feed supplements (concentrate and mineral mix) were important predictor of variations in milk yield. The two variables concentrate and mineral mix variables were statistically significant predictors of milk yield. The study observed that the relationship between feed supplement and milk yield was significant.

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