How commercialization rate impacts the profits of dairy farms in Kenya

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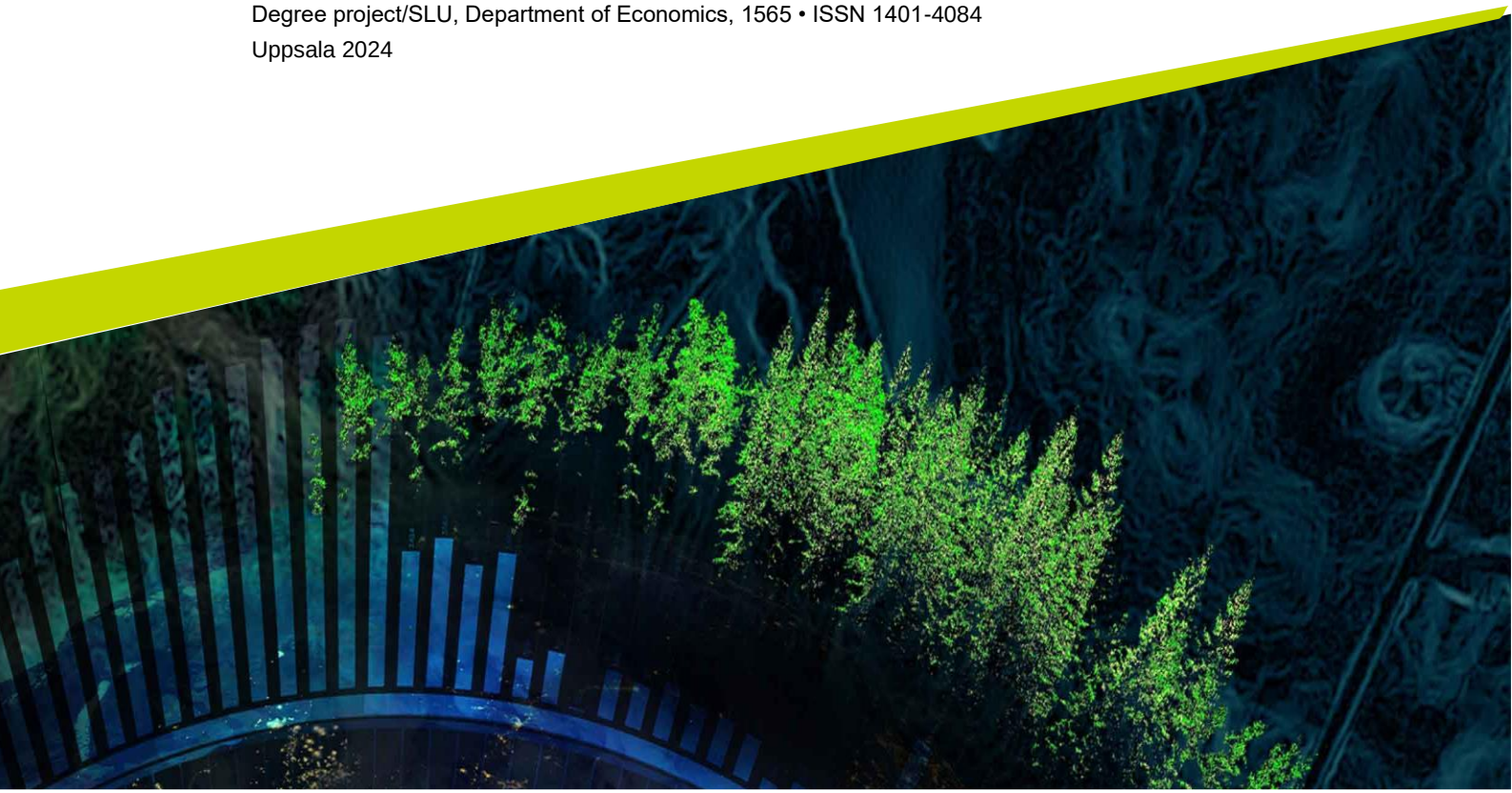

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Hur kommersialiseringsgraden påverkar vinsten hos mjölkbönder i Kenya

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Abstract

This study investigates the relationship between farm profitability and commercialization rates among smallholder farmers in Kenya. Through an analysis of data from 453 farms, the research examines several factors, including milk production, household size, education level, and livestock ownership, that can affect commercialization rate and dairy profit. The study found that commercialization rate is associated with high dairy profit among smallholder dairy farmers in Kenya. The study has shown that the commercialization rate is affecting the profit of the farms. The findings shed light on the dynamics of smallholder farmers and offer valuable insights for enhancing dairy production and promoting economic development in Kenya. The study aligns with Sustainable Development Goals that prioritize poverty reduction, hunger eradication, and agricultural productivity. By understanding the factors influencing farm profitability and commercialization, policymakers and stakeholders can design targeted interventions to improve the livelihoods of smallholder farmers and contribute to the overall sustainable development of the country.

Keywords: Smallholder farmer, Milk production, Economic development, Agricultural productivity, Poverty reduction, Livestock management

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Abbreviations

FAO	Food and Agriculture Organization of the United Nations
KES	Kenyan Shilling ~ 0,007 USD
WFP	World Food Programme

1. Introduction

Agriculture as a sector is a major contributor to the Kenyan GDP and employment especially in the rural areas, the sector also has spillover effects on other sectors such as manufacturing (FAO 2023, World Bank 2020). With most of the dairy production coming from smallholder farmers from poor conditions, the economic effect from increased commercialization would be very effective because growth in agriculture has the double effect in poverty reduction in comparison to other sectors (Ettema 2013, World Bank 2007). Milk production needs to increase in order to meet the growth in both population and consumption of dairy per capita which the government of Kenya has already initiated in order to boost production and economic growth in the agricultural sector where commercialization is a key action (Ministry of Livestock Development 2010). Previous studies have looked into this however these have either focused on increasing or optimizing the milk production or by using a qualitative method, therefore this study would be the first to look into the problem in a quantitative way (Ettema 2013, Odero-Waitituh 2017, Nganga et al. 2010, Henriksen & Rota 2014).

To better understand the correlation between commercialization rate and profit this paper will try to identify what makes the farmers come to the decision to commercialize their production, and how the commercialization rate impacts the profit. This is done by comparing correlations, with farm data from 453 smallholder farmers in Kenya. By comparing the correlations then we could not determine if the variables are endogenous which would be expected with the method, however the significant variables in the regression are similar as in previous studies. The study could have seen a couple of improvements in two different ways, the method is faulty in the ability to prove endogeneity, and the other one is the data in two different matters, firstly it only has one time period which makes seasonality hard to account for, which is of a significant matter (Rademaker et al. 2016, FAO 2014). Secondly, without the geographical location of the farms then the study can't consider the distance to the end market nor the off-farm income opportunities (Apind 2015, van der Lee et al. 2020)

FAO (2023) mentions that the agricultural sector is a major contributor to the Kenyan economy being responsible for 33% of the GDP and 40% of the employment, especially in rural areas where over 70% of the population is employed in the sector and at the same time the sector is the main economic driver for other sectors such as manufacturing and construction in the country. Out of the Kenyan population, it is mostly rural and non-educated and poor people which are the ones employed in the sector (World Bank 2020). With a poverty rate of 29.4 % and widespread stunting of 26.4% and wasting of 4.2% which emphasize the vital

role of agriculture in Kenya (FAO 2023, Global Nutrition Report 2023, The World Bank 2023). In a report from the World Bank (2007), it is mentioned that because agriculture is a sector where the output of GDP share and the input of labour share is not directly correlated, this together with the big share of the poor population working in the agricultural sector resulted in GDP growth in the sector makes more than the double effect for the poverty reduction than GDP growth in other sectors.

As seen in India and China the economic growth has been wide, but the share of poverty in rural areas stayed the same which has resulted in the divide between urban and rural incomes increasing (World Bank 2007). On a similar note, World Bank (2007) also mentions that farmers are careful regarding the adoption of new technologies due to high costs and/or uncertainty, which in turn results in a big advantage for those who wait for others to learn from their mistakes which results in either very slow adoption rates or that the farmers stay with the status quo when no one is willing to take the risk. There are also problems with farmers having problems saving which results in them not being able to buy inputs for the next season (World Bank 2007). This is even more important currently due to several years of droughts which have led to slower development and worse conditions than before because Kenya and other sub-Saharan countries' production of crops is very dependent on rain (WFP 2022, World Bank 2007).

As the per capita milk consumption is predicted to grow to twice the amount because of increased income, as well as the population projected to grow by 40% by 2030 means that there will be a substantial increase in demand for dairy within Kenya (Ministry of Livestock Development 2010). The improvement of production and commercialization rate would be one way to achieve the current economic development plan Vision 2030 (Ministry of Livestock Development 2010). With the most recent years growth in the agricultural sector with higher and more intensive land use have resulted in social conflicts, decline of wildlife and overall loss of plant biodiversity (FAO 2018). Encouraging smallholder dairy farmers to participate in dairy marketing can play a significant role in reducing food poverty, thus ensuring food security (Ettema 2013). This suggests that facilitating the expansion of market participation or commercialization by smallholder farmers can be beneficial in helping households transition out of food poverty (Ettema 2013). By increasing the income of farmers you would also improve their nutritional status and food security because their cash reserves would make it possible for them to add food from the market as a part of their diet which would complement the food they produce themself (Ochieng Ogutu et al. 2020). In addition to this the gains of increased commercialization would lead to increased assets, livestock ownership and income (Tabe Ojong et al. 2021).

The commercialization of milk production among smallholder dairy farmers in Kenya is very low while smallholder dairy farmers contribute 80% of total milk produced in Kenya (Ettema 2013)**.** Given the low commercialization rate among

these smallholder dairy farmers, there is a need to identify ways of improving commercialization. By doing this food and nutritional insecurities can be reduced as well as job creation within the agricultural sector (Meissner et al. 2013). This composition of producers is causing some challenges, mainly production costs, willingness to invest in dairy production and service and training delivery, in addition there are also challenges in the low knowledge levels of farmers, high cost of collection and suboptimal cool chain (Rademaker et al. 2016). Mawa et al. (2014) Research has focused on how to increase milk production and barriers to increasing milk production (Odero-Waitituh 2017, Wambugu et al. 2011). There has also been research on the market participation of farmers in Kenya, but this has been focusing on the distance to the end market and how this will impact the ability to sell your milk (van der Lee et al. 2020). Henriksen & Rota (2014) mentions in their study where they mention that smallholder farmers have the greatest potential for increasing their production and these people would also be faster in adapting new methods because they would like to improve their family's livelihood. The study also mentioned that smallholder systems have not been proven to be less efficient than large scale farms, the increased efficiency in smallholder farms would have more spillover effect on the supply chain than larger farms (Henriksen & Rota 2014).

To address the problem above, previous research has focused on different development measures and how to improve the production of milk in a variety of ways (Ettema 2013) and risk reduction strategies for farmers having livestock (Odero-Waitituh 2017). Dairy farmers have been the focus of research on profit efficiency, which has studied how improvements in the farm's operations can make them more efficient (Nganga et al. 2010). My paper will therefore be one of the first to connect profitability with commercialization rate, while at the same time having the focus on Kenya by having first hand data from dairy farms.

The study aims to better understand how smallholder dairy farmers operate and how their decisions to commercialize their milk production are made and to what extent does commercialization affect their farm profits. The main objective of the study is to look at how the profit of smallholder farmers in Kenya is correlated with the commercialization rate, which is defined as the amount of milk sold divided by the amount of milk produced in the summer or autumn of 2022. The specific objectives are:

1. To identify determinants of smallholder dairy farmers' decision to commercialize their milk production.

2. To investigate how commercialization affects profitability of dairy production.

2. Literature

Out of all the milk produced within Kenya, over 80% is produced by small-holder farmers which represent 26% of all the households in Kenya, the dairy cattle population is about seventeen million and produces approximately 3.1 million tonnes of milk (FAO 2014). Dairy as an agricultural sector in Kenya shows high levels of growth which could be explained by an increasing number of commercial farms which are willing to invest and innovate (Rademaker et al. 2016). The study also concluded that the Kenyan dairy sector has some weaknesses where one of the main problems is the low amount of knowledge regarding how to produce and store quality fodder, which in turn makes milk production more expensive to produce and more prone to seasonality (Rademaker et al. 2016). There is also a difficulty in the development that smallholder farmers are not mainly dairy farmers but have other types of occupations which they are focusing on (Rademaker et al. 2016). FAO (2014) mentions that milk production varies significantly between the seasons, where during the rainy season Kenya is a net exporter of dairy but during the dry season, they become net importers to meet the domestic demand. In addition, the report also stated that there are losses during the supply chain, mainly on farms with spoilage of the evening milk due to insufficient cooling facilities on farms, which is needed because most dairy companies only accept milk during the morning collection, this is especially problematic due to dairy being the only year-round income for some farmers (FAO 2014).

Out of the milk produced in Kenya, 80% is produced by the 800 000 small-holder farmers and the rest of the milk produced is produced by the 3500 middle and large farms, on the farms, approximately 50% of the cows are milking cows and the others are heifers or female calves (Ettema 2013). The average herd size among small-holder farms is three cows, meaning an average farm has one or two milking cows (FAO 2018). In Bosire et al. (2022), they indicated that milk production in Kenya is low and the production of milk in Kenya needs to increase to meet the domestic demand for dairy products both now and in the future, otherwise this could lead to food and nutritional insecurity. To ensure food and nutritional security as well as job creation within the agricultural sector the dairy farms need to be highly commercialized (Meissner et al. 2013).

Commercialization rate is defined in this paper as what in other papers are referred to as commercialization index, which is the percent of the produced goods which is sold, therefore this does not take the size of the farm in to consideration and makes a reasonable comparison between farms possible (Dureti et al. 2023).

This is a definition which is widely used in studies looking into commercialization or market participation because this definition does not account for the sizes of farms which could be an important factor when looking into smallholder farms (Dureti et al. 2023).

The study from van der Lee et al. (2020) concluded a correlation between a higher market participation rate and higher land-use intensity in smaller households, this correlation had more to do with competition with off-farm jobs than having fewer mouths to feed. The same study also showed that a more intense production does not seem to have any effects on the marginal profits from dairy (van der Lee et al. 2020). This was the opposite of the conclusion of Cheruiyot (2016) who argued that the commercialization rate hurts milk consumption at home.

Bonilla et al. (2018) have studied how the Smallholder Dairy Commercialization Programme in Kenya, which is a development program where they have enhanced competencies within management, organization, and corporate skills for farmers, has affected the involved farmers. The report shows that the treatment group has seen an improvement in the milk production, this was because of higher levels of; adaptation of best practices, use of different types of animal health services and investments in recommended measures. In addition to this, the treatment group managed their fodder more effectively by wasting less of the potential fodder resulting in less seasonality, this was also seen in the milk sold but not to the same extent as the production (Bonilla et al. 2018).In addition the farmer's access to market information was also increased for the treatment group but still low (Bonilla et al. 2018). Commercialization among smallholder farmers is assumed to lead towards more specialized production systems, which are based on comparative advantages in resource use. Consecutively, specialization leads to higher productivity through scale economies, greater learning by doing, regular interaction and exposure to new ideas through trade, and better incentives in the form of higher income, which can achieve welfare gains for smallholder farmers (Jaleta et al, 2009; Mathenge et al, 2010).

The study from Otieno (2020) showed that farm operation costs, daily milk production, consumption levels, and household size were significant with the commercialization rate. According to the paper written by Apind (2015), there is a positive trend regarding market participation when the household has an off-farm income and a negative impact connected to increasing household size. Like other studies, Randela et al. (2008) also showed significant results regarding a negative correlation between household size and the commercialization rate as well as between livestock ownership and the commercialization rate. They also concluded that the education level, level of experience in farming, and size of the farms impacted the commercialization rate. They also showed that age hurt the profit effectivity, older considered to be past the age of fifty-one.

However, there are some problems with this, such as the need for land and water which is already in short supply therefore (Bosire et al. 2022) recognize one of the solutions is to increase the yield and the conversion rate from feed to milk and meat, through extension officers and R&D . This is even more problematic when you also consider that every fourth year there is a drought which results in the produced fodder is not enough, this has resulted in 50% of the deaths of livestock (Lung 2021).

3. Method

Two classes of theoretical models have been employed to examine the production decisions of dairy farmer household: separable and non-separable farm household models (Vance et al. 2004). The separable model assumes perfect market and independent household production and consumption decisions (Singh et al. 1986; Vance et al. 2004). The relevance of this model is questionable in the context of developing countries that are usually characterized by market failures in both input and output markets (Shiferaw et al. 2014; Woldeyohanes et al. 2017). The non-separable model, on other hand, recognizes the existence of market failure in most rural areas, making smallholder farmer households to undertake production and consumption decisions simultaneously (Shiferaw et al. 2014). In developing countries such as Kenya, smallholder farmers' production decisions (i.e., choice of inputs and output) are inherently entangled with its consumption requirements, resource endowment, ecological condition, and other socioeconomic context (Louhichi et al. 2019). Accordingly, this model offers a suitable basis for analysing household behaviour, especially in the absence or imperfection of markets, and is often used in the empirical literature of developing countries (Barrett 2008 ;Woldeyohanes et al. 2017).

In this study, the non-separable theoretical model is used drawing on the work of Fischer and Qaim (2012) and Wardhana et al. (2020). These studies focus on the determinants and impact of smallholder participation in collective action initiatives. They consider that smallholder farmers make decisions with scarce resources under the pressure of information gaps and market failures. According to these studies, participation in collective action initiatives help households to achieve economies of scale and thereby counteract some of the challenges, especially those related to transaction costs and market power. However, participation in such group schemes involves costs as households have to allocate their scarce resources (Fischer and Qaim 2012). Based on this, they assume that different farmers perceive the costs and benefits of engaging in commercialization differently, and hence the main decision is made at the household level. This is formally represented in a random utility framework. Accordingly, a representative dairy household is expected to participate in commercialization to maximize its underlying utility. This means that the dairy household participates in commercialization if the expected net benefit from participation is greater than non-participation, as shown in the following model:

$$Com_i^* = \boldsymbol{\theta Z_i} + \mu_i \text{ , with } C_i = \begin{cases} 1 \; if \; Com_i^* > 0, \\ 0 \; otherwise \end{cases} \quad (1)$$

Com_i^* is a latent variable indicating the utility difference between participating and not participating in dairy commercialization; Com_i is an observable binary variable that takes value 1 if dairy farmer participates in dairy commercialization and 0 otherwise; $\mathbf{Z_i}$ is vector of exogenous variables , $\boldsymbol{\theta}$ is a vector of parameter estimates, and μ is stochastic error term which represents the unobservable part of smallholder dairy farmer's utility function. Based on this, the probability that a smallholder dairy farmer participates in commercialization is derived and estimated as follow:

$$P_r(Com_i = 1) = P_r(Com_i^* > 0) = P_r(\mu_i > -\boldsymbol{\theta Z_i}) = 1 - F(-\boldsymbol{\theta Z_i}) \quad (2)$$

In consonance with Ma and Abdulai (2016), this study links the commercialization decision to the resulting outcomes by further assuming that a rational dairy smallholder aims to maximize net benefit from participating in commercialization (Y), as shown below:

$$Y_{max} = PQ(\mathbf{S}, \mathbf{Z}) - \boldsymbol{SW} \quad (3)$$

Where, P is price of dairy product; Q is quantity supply to the market; **W** is a vector of production inputs (e.g., land); **S** is vector of input prices; and **Z** is a vector of explanatory variables. The net returns can be specified as a linear function of the choice of participation in commercialization, resource endowment and other relevant household and farm-level characteristics:

$$Yi = \boldsymbol{Mi}\,\partial + Comi\,\gamma + \varepsilon i \quad (4)$$

Where Y_i represents commercialization rate; $\mathbf{M_i}$ is a vector of household and farm level independent variables; Com$i$ is a dummy variable for commercialization choice; ð and γ are the parameter estimates and ε_i is the error term.

In this study, commercialization rate is expressed as a percentage of total harvested milk sold. This is used as proxy variables to measure smallholder commercialization. The use of values, instead of quantities, is to make the most out of available data. Commercialization is regarded as an avenue to generate more farm income due to its comparative advantages over subsistence production, it is also observed that a move from subsistence to commercial dairy production may expose dairy farmers to higher market prices in cases where rural markets are well-integrated (Jaleta et al, 2009). In this way, farmers can increase their profit. The profit equation is specified as:

$$LnProf_i = \boldsymbol{M_i}\,\partial + Y_i + \varepsilon_i \quad (5)$$

Where $LnProf_i$ is the log of the profit variable, Y_i represents commercialization rate; Mi is a vector of household and farm level independent variables. Equation (5) is expanded as:

$$LnProfit = \beta_0 + \beta_1 Training + \beta_2 Growgrass + \beta_4 Growforage + \beta_5 Silage + \beta_6 enoughforage + \beta_7 Herdsize + \beta_8 AvgmilkprodLCows + \beta_9 lnfeedcost + \beta_{10} Calvesconmilk + \beta_{11} Milkprimaryinc + \beta_{12} Familyemp + \beta_{13} Paidemp + \beta_{14} COMRATe + \beta_{15} constant + \varepsilon \quad (6)$$

The definition of the variables and the summary statistics are provided in Table 1.

Table 1 Summary of the statistics with the number, of observations, mean values, standard deviation, minimum values, and maximum values.

Variable	Description	N	Mean	Std. Dev.	min	max
Milk price	The milk price in KES	453	45	0.00	45	45
Grow grass	1 if the farmer grows grass, 0 otherwise	453	0.96	0.20	0	1
Grow forage	1 if the farmer grows forage or maize, 0 otherwise	453	0.20	0.39	0	1
Grow Silage	1 if the farmer grows silage, 0 otherwise	453	0.10	0.29	0	1
Silage	How much silage the farmer makes in Kg	451	619.29	3689.31	0	60000
Enough forage	1 if there is enough forage, 0 otherwise	453	0.69	0.46	0	1
Herd size	Number of cows	453	9.42	12.57	1	142
Dry cows	Number of dry cows	453	0.92	1.43	0	9
Heifers	Number of heifers	453	2.35	5.15	0	88
Milk cows	Number of milking cows	453	5.44	6.57	1	41
Total produce milk	Total production of milk in liters per day	453	66.44	94.99	3	700
Average milk yield per cow	Average milk production per cow in liters per day	453	11.39	3.91	3	25
Total milk sold	Total amounts of milk sold per day	453	60.28	88.15	2	650
Milk income per day	Total milk income per day (KES)	453	2730.87	3976.00	90	29250
Feed cost per day	Feed cost per day (KES)	453	1559.42	2345.76	50	17208
Feed cost per liter milk	Feed cost per liter milk (KES)	453	23.21	7.34	8.371	60
Gross profit	Milk income – feed cost per day (KES)	453	1171.46	2047.44	-2350	16092
Paid employees	Number of paid employees	453	0.79	1.12	0	8
Woman Youth employees	Number of woman or youths employees	453	1.12	0.85	0	7
Training	1 if the farmers have received training, 0 otherwise	453	0.96	0.20	0	1
Commercialization rate	Commercialization rate (%)	453	87.57	15.20	22.222	100
Average 1st calving	Average age for first calving	453	28.08	2.91	14	38
Milk is the primary income	1 if milk income is the main income source, 0 otherwise	453	0.48	0.50	0	1
Family employees	Number of unpaid employees	453	1.32	0.65	0	4
Average 1st breed	Average age for first breeding	453	18.51	2.93	12	28

Table 1 continuous

Variable	Description	N	Mean	Std. Dev.	min	max
Other production costs	Other production costs per month (KES)	453	11490.73	21550.33	100	215000
Profit per month	Profit per month	453	24141.02	52512.02	-171479.17	422718.75
Calves consuming milk	Number of calves consuming milk	453	0.71	1.41	0	16
Liter of milk calves consumes	Amount of milk consumed by the calves	453	2.93	7.02	0	96
Calving intervals	Calving intervals	453	14.58	2.06	1	24
Calving intervals	Calving intervals	453	14.58	2.06	1	24

4. Data

The study used cross-sectional data gathered from 453 different farms in Kenya. The data was collected with the help of extension officers directly from the farmers in an interview on the farm. All except thirty-six farmers were interviewed in July of 2022, and the others in September of 2022. The data comes from a development project between Tetra Pak and a dairy processor in Kenya. As seen in Table 1, the data focused on only dairy farming, where the set consists of data on what the farmers grow and if that is sufficient for the number of animals they have, the composition and size of the herd, milk production data, financial production data, employee composition and training data, reproduction and how farmers allocate their milk between calves, consumption, and sales. The whole dataset does not consider other forms of business the farmer might do, which would impact the overall profit which in turn would show a skewed situation of the farmer's income. This is especially true when we consider that 51.88% of the farmers do not have milk as their primary income. The dataset was used because it had a respectable number of respondents to make a statistical evaluation, which is hard to find within the topic of research, and the dataset also consisted of a wide selection of different data collected which made it possible to use the most efficient data.

Table 2 shows the correlations between the different variables. For the correlations with herd size – more milking cows resulting in a bigger herd are reasonable, a bigger herd eats more and therefore the feed cost per day is increasing as well as other production costs, a bigger herd would result in more calves with are consuming milk, with more cows the workload increases with results in more paid employees.

Table 2 Correlations

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
(1) Growing grass	1.000															
(2) Growing Forage	-0.279	1.000														
(3) Silage	-0.127	0.462	1.000													
(4) Enough forage	-0.040	-0.004	-0.025	1.000												
(5) Herd size	0.028	0.238	0.266	-0.112	1.000											
(6) Milk cows	0.031	0.201	0.217	-0.133	0.904	1.000										
(7) Average milk yield per cow	0.029	0.180	0.119	-0.060	0.237	0.175	1.000									
(8) Feed cost per day	0.033	0.211	0.187	-0.134	0.902	0.895	0.321	1.000								
(9) Other production costs	-0.003	0.139	0.194	-0.085	0.736	0.674	0.236	0.657	1.000							
(10) Profit	0.034	0.187	0.205	-0.063	0.525	0.678	0.304	0.485	0.290	1.000						
(11) Calves consuming milk	-0.009	0.292	0.302	-0.006	0.799	0.636	0.243	0.683	0.552	0.283	1.000					
(12) Milk is the primary income	0.015	0.092	0.065	0.032	-0.015	0.027	0.073	0.009	0.007	0.046	0.052	1.000				
(13) Family employees	-0.162	0.148	-0.008	0.045	-0.058	-0.085	0.023	-0.039	-0.003	-0.121	0.076	0.093	1.000			
(14) Paid employees	0.063	0.195	0.215	-0.121	0.790	0.793	0.226	0.804	0.707	0.440	0.546	-0.031	-0.144	1.000		
(15) Training	-0.041	0.040	0.027	0.009	-0.086	-0.081	-0.069	-0.061	-0.141	-0.095	-0.009	0.151	-0.022	-0.119	1.000	
(16) Commercialization rate	0.068	0.076	0.009	-0.109	0.109	0.150	0.089	0.133	0.103	0.189	-0.045	0.004	-0.113	0.107	-0.071	1.000

5. Results

Table 3 is showing the summaries of the different binary variables with is used in the regression. The table is showing whether the farmers have gone through training, have milk as their main income source, and if they are having enough forage, if they are growing grass, forage, and making silage. As shown in Table 3, majority of the farmers have received some form of training. About 52% of the farmers do not have milk production as their primary source of income.

Table 3 Summaries of the binary variables and their percentages as well as the cumulative percentages.

Training	Frequency	Percent
0	18	3.97
1	435	96.03
Total	453	100.0
Milk as primary income		
0	235	51.88
1	218	48.12
Total	453	100.0
Enough forage		
0	142	31.35
1	311	68.65
Total	453	100.0
Grow grass		
0	18	3.97
1	435	96.03
Total	453	100.0
Grow forage		
0	368	81.24
1	85	18.76
Total	453	100.0
Silage		
0	410	90.51
1	43	9.49

The results of Table 4 show the mean difference in commercialization rate for dairy farmers who received training and those who did not receive training. The mean difference is insignificant. However, the results indicate that most of the farmers who did not receive training are commercializing their dairy products. The high proportion of dairy farmers without training is probably due to the small sample observation for this category.

Table 4 Two-sample t-test with equal variances commercialization rate by training

Commercialization rate by Training		Mean
0	18	92.89
1	435	87.35
Difference		5.53 (p-value =0.13)

The result of Table 5 is showing that a framer who has received training has a profit of 25634.88 KES less than a farmer that has not gone to training. The training included best practices in crop production, animal management, and milking. Again, this may be due to the small sample observed for those without training.

Table 5 Two-sample t-test with equal variances Profit by training

Profit by Training		Mean
0	18	48757.30
1	435	23122.42
Difference		25634.88 (p-value=0.04)

Table 6 shows factors affecting commercialization rate. The results show that training negatively affects commercialization rate. This may be due to the type of training received by farmers. For instance, some of the food and nutritional security training programs encourage smallholder households to consume more fresh milk from their farms and hence reduce how much is sent to the market. The herd sizes significance would be explained by having a certain amount that the family consumes them self which means that this part would be a lower share of the total production with a bigger herd. The number of calves that are consuming milk would also affect this by consuming milk that could be sold instead. The number of family employees' effect on the commercialization rate would also be explained by having their own employees probably a bigger family than those who did not have them. The number of paid employees would also be explained by either of them being paid partly in milk or by them not putting in the same amount of effort in taking care of the animals and therefore losing out on some production

Table 6 Factors affecting commercialization rate.

Commercialization rate	Coefficient	Standard Error	t-value	p-value	[95% Conf Interval]		Significance
Training	-4.017	1.327	-3.03	0.003	-6.625	-1.409	***
Growing Grass	5.985	4.118	1.45	0.147	-2.109	14.078	
Growing forage	5.582	4.482	1.25	0.214	-3.227	14.391	
Making silage	-1.613	3.18	-0.51	0.612	-7.863	4.637	
Enough forage	-2.015	1.425	-1.41	0.158	-4.816	0.787	
Herd size	0.224	0.124	1.81	0.071	-0.019	0.467	*
Milk cows	0.291	0.195	1.50	0.135	-0.091	0.674	
Average milk yield per cow	0.235	0.193	1.21	0.225	-0.145	0.615	
lnfeedcost	0.001	0.000	1.39	0.165	0.000	0.001	
Other production costs	0.000	0.000	1.59	0.112	0.000	0.000	
Calves consuming milk	-3.647	0.807	-4.52	0.000	-5.232	-2.061	***
Family employees	-2.187	1.239	-1.77	0.078	-4.621	0.247	*
Paid employees	-1.995	1.060	-1.88	0.006	-4.078	0.088	*
Milk is the primary income	0.501	1.483	0.34	0.736	-2.414	3.415	
Constant	85.103	5.392	15.78	0.000	74.506	95.70	***

Mean dependent var	87.571	SD dependent var	15.200
R-squared	0.101	Number of observations	453
F-test	10.484	Prob > F	0.000

**** p<.01, ** p<.05, * p<.1*

Table 7 presents the logarithmic regression of profit explained by the different variables, the significant variables are: If the farmer is making silage, the herd size, the amount of milking cows, the average milk production per day, and cow, the logarithmic feed cost per day if milk is the primary income source, the communization rate, and the constant.

The regression results further show that a bigger herd, and more employees both family and paid is decreasing the profit, while making silage, more milking cows, higher average production, having milk as your primary income source, higher commercialization rate, and feed cost would increase the profit. The increased feed cost is an indication that the farmer invests more in animal feed and hence, can feed the dairy cows with high quality feed, which can lead to higher milk output. The higher milk output offsets the feed cost. This would result in higher profits.

Table 7 Factors affecting profits including commercialization rate

lnprofit	Coefficient	Standard Error	t-value	p-value	[95% Conference interval]		Significance
Training	-0.338	0.274	-1.23	0.218	-0.877	0.200	
Growing Grass	0.240	0.269	0.89	0.373	-0.290	0.770	
Growing forage	0.042	0.154	0.27	0.785	-0.261	0.345	
Making silage	0.347	0.198	1.76	0.080	-0. 042	0.736	*
Enough forage	-0.015	0.111	-0.14	0.890	-0.234	0.203	
Herd size	-0.025	0.013	-1.87	0.063	-0.051	0.001	*
Milk cows	0.146	0.023	6.46	0.000	0.102	0.191	***
Average milk yield per cow	0.098	0.015	6.48	0.000	0.068	0.127	***
lnfeedcost	0.264	0.094	2.81	0.005	0.080	0.449	***
Calves consuming milk	-0.042	0.068	-0.61	0.541	-0.176	0.093	
Family employees	-0.007	0.083	-0.08	0.935	-0.170	0.157	
Paid employees	-0.108	0.080	-1.35	0.178	-0.264	0.049	
Milk is the primary income	0.243	0.103	2.37	0.018	0.041	0.445	**
Commercialization rate	0.014	0.004	3.96	0.000	0.007	0.021	***
Constant	4.669	0.715	6.53	0.000	3.264	6.075	***

Mean dependent var	9.323	SD dependent var	1.468
R-squared	0.551	Number of observations	408
F-test	34.429	Prob > F	0.000

*** p<.01, ** p<.05, * p<.1

Table 8 is showing the pairwise correlation between profit and commercialization rate and it is showing that the correlation is significant and positive.

Table 8 Pairwise correlation

Variables	1	2
(1) Profit	1.00	
(2) Commercialization rate	0.19*	1.00
*** p<0.01, ** p<0.05, * p<0.1		

6. Discussion

A very limiting factor for paper is that the variables are correlated but cannot be proven any causality. The significant results regarding if milk production was the main income source are like Rademaker et al. (2016) which could be an effect of the off-farm job opportunities. However, this is not possible to make sure because there is no data on either the geographic position of the farm or the alternative job opportunities for the farmers. As also proven by Rademaker et al. (2016), the variable of making silage is significant to the profit, this is also in consonance with Bonilla et al. (2018) who also concluded that with better management practices the milk production goes up, and with better fodder practices this result in more milk sold which are in the same results as my study Mawa et al. (2014).

According to Table 5, t-test of profit by training, the farmers who had received training had less profit than those who have not, this could be explained mostly by the small number of farmers who have not received training (Table 3), which only 4 % did not receive training. On a similar note, the t-test on how the commercialization rate changes dependent on the training also shows that those who received training had a lower commercialization rate which could be explained by the same limitation in the data. This is not in line with other literature but could be an effect of how and when the training is done, but this test does not show significance on any level. In addition, the relationship found in this study may be due to the type of training received by farmers. For instance, some of the food and nutritional security training programs encourage smallholder households to consume more fresh milk from their farms and hence reduce the commercialization rate.

If we consider having enough silage as a form of intensification, then this study could not confirm what van der Lee et al. (2020) concluded in their study. In comparing our results with (Otieno 2020) and look at the use of family employees as a proxy to determine household size then both studies would show that this would decrease the commercialization rate significantly which also could be found in Randela et al. (2008). When comparing our results with (Apind 2015) then we did not see the same effects from other income sources as they did, however, when looking at profit the study shows that off-farm income would increase the profits significantly.

As the results are only for one period and the production changes depending on the season according to FAO (2014) we cannot show if this is affected by the seasonality. The data does not include the distance to the market nor the off-farm job opportunities. The effects that van der Lee et al. (2020) mentioned on the distance to the end market could not be considered done to a lack of geographical data on the farms. Similarly, what Rademaker et al. (2016) mentioned regarding milk quality and seasonality due to a lack of fodder conservation skills could not be considered due to the study not having any data on milk quality and only one period.

7. Conclusion

As proven in the study shows that commercialization rate, making silage, the amount of milking cows, feed cost and having milk as the main income source impacts the profit smallholder dairy farmers on a significant level. To make fundamental research on a broader scale possible there should be structural and continuous data gathering to make useful and research-backed policies in the future.

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