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Original Research Article

The Levels of Dairy Production among Adopters and Non-Adopters of Climate Smart Agricultural Technologies, in Aldai Sub-County, Nandi County of Kenya

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Abstract: This paper aims to evaluate the levels of dairy production (in terms of average monthly milk levels) of adopters and non-adopters of climate smart agricultural technologies in Aldai sub-county, Nandi County of Kenya. We identify three important facts. First, there seems to be a positive growth in milk production amongst EADD project farmers. This increase can be attributed to differences in animal husbandry practices promoted by EADD project. These animal husbandry practices include training in animal health, fodder conservation, feed formulation, water storage and conservation and growing of drought resistant crops. A second important result is the slight reduction in milk production between 2011 and 2012 seasons which we suspect might be attributed to the effect of drought which impacted feed production the whole country. A final fact is that both adopters and non-adopters witnessed an increase in milk production levels, we show that non-adopters had about 25 percent rice in milk production compared to adopters who observed about 23 percent rise in milk production levels. We also undertook a marketing margin analysis using administrative data obtained from a local farmer organization. Here, our results indicate that total milk supplied to a local cooperative society was steady over time. The supply was highest in 2013. On average, monthly value of milk supplied was Kenya Shillings (KES) 5,293 in 2011- two years after the launch of EADD project. The amount of milk supplied increased by about 4.2 percent between 2011 and 2012 period. The small increase in the value of milk can be attributed to drought which negatively impacted feeds production in Nandi County. However, we observe a higher increase in revenue between 2012 and 2013 of about KES 639.51 (or 11.60 percent). In terms of milk production, we estimate that an average dairy farmer in Nandi County supply about 182.50 litres of milk to the cooperative society in 2011. This level of milk supply increased to 190.17 litres in 2012 and to a further 212.23 litres per month in 2013. Based on these levels of supply, we can conclude that the EADD project helped farmers increase their milk production levels. Moreover, the high milk production per farmer, we observe, can be attributed to being a member of a local dairy cooperative society which provided additional services like credit to its members.

Keywords: Dairy Production, Adopters, Non-Adopters.

INTRODUCTION

Livestock production is on the rise globally and this is attributed to high demand for livestock products. Much of this rise in production levels (about 70 percent) is contributed by small scale farmers residing in rural areas of developing countries and the rest by emerging large-scale farmers with improved technology (FAO, 2020). Dairy industry is dominated by small-holder farmers who owns between one to five cows (USAID, 2008). However, farmers experience numerous challenges in meeting this rising demand for animal products. The amount of milk produced differs by genotype, across countries and by production systems. In the livestock sector, dairy production is the

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most developed, and it is mainly practiced in highlands and Coastal lowlands of Kenya (MOLD, 2006). The sub-sector contributes about 6percentage of Gross Domestic Product (GDP), employs about 50percentage of the agricultural labour force and is the main agricultural enterprise for over 10 million Kenyans living in the arid and semi-arid lands (ASALs). The ASALs which are dominantly inhabited by pastoralists, hosts about 70percentage of the national livestock herd with an estimated value of Kenya Shillings (KES) 70 billion accounting approximately 40percentage of the Agricultural GDP.

The livestock population growth in the country is driven by the rapidly increasing demand for livestock products due to increased population growth, urbanization and increasing incomes. The overall livestock population trends (largely based on estimates) across all species have to improve their dairy farming practices and farm enterprise management. The Kenyan dairy sector is transitioning from subsistence to greater commercialization, from low investment into capital-intensive and skilled enterprises, and from fragmentation to consolidation towards a sophisticated supply chain involving many actors and offering a wide range of milk and dairy products (Rademaker *et al.*, 2016). However, much like the agricultural sector in general, dairy is dominated by an older generation of farmers, with limited youth involvement. This poses a potential demographic crisis. This is especially critical considering the high levels of unemployment in Kenya and the new avenues for employment and business that the dairy sector offers (Rademaker *et al*., 2016).

In Sub-Saharan Africa, Kenya has the highest annual per capita consumption of 121 litres per person surpassing the recommended 92 litres per person due to population growth, urbanization, rising incomes, and changing lifestyles believed to be the main drivers of this trend (Macmillan, 2020). The consumption of milk within the urban areas is higher compared to rural areas owing to higher incomes (Rademaker *et al.,* 2016). The ministry of agriculture livestock and fisheries report indicates that because of increased awareness and safety for the processed milk and milk products total milk consumption by Kenyans is growing at 4 percentages per year consistent with the population growth rate (MoALF, 2019).

In Kenya, there are 17,467,774 million dairy cattle, of which 19 and 81 percent are exotic and indigenous breeds respectively (KNBS, 20018). According to Bebe *et al*., (2002), eighty percent of these cattle are owned by smallholder farmers. These farmers mainly reside in the highlands and coastal lowlands characterized by favourable agro-ecologies. In Kenya, dairy production system can be classified into either: extensive, semi-intensive or intensive. Out of the three common production systems, intensive system is preferred in highlands where landholdings are small-i.e., below 5 hactares. The extensive system involves grazing animals in open field while intensive system involves rearing of animals in enclosed zero grazing units while semi-intensive is mixture of both. There are different varieties of dairy cattle kept in Kenya. The most common varieties kept in Kenya are Friesian and Ayrshire. Dairy animals survive well in warm and humid climate with temperature ranging between 4 and 24^0C. Temperatures above 24^0C occasioned mainly by climate variability have negative impacts on dairy production. This is due to resultant lesser grazing time and feed resource constraints, which worsen with effects of drought.

The project selected Kaptumo ward in Nandi County as project location [1]. The project recruited community extension service provider to mobilize farmers and register animals. In collaboration with ICRAF, the project established demonstration sites for fodder production. Amongst selected fodder crops included Napier grass, Rhodes grass, Lucerne, Desmodium, Calliandra (Calliandracalothyrsus) and Sesbania (Sesbaniasesban). In addition, EADD engaged in creating awareness of the need to improve dairy productivity by organizing farmers into dairy groups, provision of extension advice, and strengthening of linkages between dairy value chain actors.

METHODOLOGY

Under this objective, we obtained monthly milk production (in litres) data from local dairy cooperative society for each 350 smallholder dairy farmers. We merged this administrative data with our crossectional dataset. We summed monthly milk production levels to form annual values to allow for comparison with previous studies. We present our result in form of descriptive statistics, consisting of line graphs, percentages and mean values of variables included in the analysis. We present our result in two parts. First, for all households combined to get a general feel of each of the 350 households net profit levels. We then disaggregate our results by adoption intensity of CSA technologies.

Our second outcome variable is average monthly net pay received by smallholder dairy farmers-net profit of using co-operative society as a marketing channel. A marketing margin or price spread is an equilibrium entity that is a function of the difference between equilibrium retail and farm prices. It provides an indication of the performance of an industry or market structure and efficiency levels.

[1]Other counties where EADD project was implemented included Bomet, Kericho, Keiyo, Marakwet, Nakuru, Uasin Gishu, West Pokot, Nyandarua and Nyeri (Zagst, 2011)

In doing so, we apply market margin analysis techniques in calculating net profit of milk production. This is presented below.

$$Net\_Profit_i = Total\ revenue_i - Total\ marketing\ costs_i$$

Where, total revenue is the amount of milk collected by the cooperative society (in litres) for one month and multiplied by unit price of milk per litre. On average, milk is sold at KES 29 per litre to major processors like Kenya Cooperative Creameries Limited and Brookside Dairies limited. For total marketing costs, we included expenses that are charged for marketing through cooperative societies. However, our net profit only covers expenses as provided to us by local cooperative society like veterinary costs (acaricides, artificial insemination), salt, produce cess, transport costs, company fees. Under marketing costs, farmers are charged Kenya Dairy Board produce cess of KES 0.2 per litre of milk sold. Also, farmers are charged transport costs if they do not have their own transport system. Third, farmers are also charged for the animal health practices that they purchased on credit basis. These practices include purchase of acaricides, artificial insemination, and salt among other costs items (See Table 3 for details).

RESULTS AND DISCUSSION

Analysis of milk production levels in Aldai sub-county, Kenya

In the first part of our analysis, we present results from milk production trends amongst smallholder farmers under EADD project. We first present general production trends without disaggregating them by adoption status (Figure 1). In the second part, we disaggregated our annual milk production trends into quarterly values. This is critical in understanding which months require more attention and fodder. In the third part, we subdivided milk production levels between adopters and non-adopters. In the final part of our analysis, we use administrative data in calculating marketing margin accrued from each 350 farmers interviewed in the study area. This administrative is rich and contains all milk supplied by each farmer and all variable costs incurred by each farmer.

Milk production levels

Two facts are observed (Figure 1): First, there seem to be positive growth in milk production in Aldai Sub-county of Nandi County amongst EADD project farmers. This increase can be attributed to introduction of good quality dairy breeds by farmers and adoption of different animal husbandry practices promoted by the project. These practices include training in animal health, fodder conservation, feed formulation, water storage and growing of drought resistant crops. For instance, the project promoted artificial insemination to help improve the quality of existing local dairy breeds in the study area. These initiatives might have helped farmers receive more returns. This rise in milk production is consistent with what we observed in the returns accruing to farmers (See Table 20). A second important result is the slight reduction in milk production in the year 2012 season. This might be attributed to drought which impacted on feed production in the whole country. During this time, farmers went fully on utilization of commercial feeds to bridge the gap in fodder. However, due to the high costs of feeds compared to other variable costs only farmers who can access credit are able to afford such costs (See Table 20). However, there was an upward rise in milk production after small weather shock experience in 2011 season.

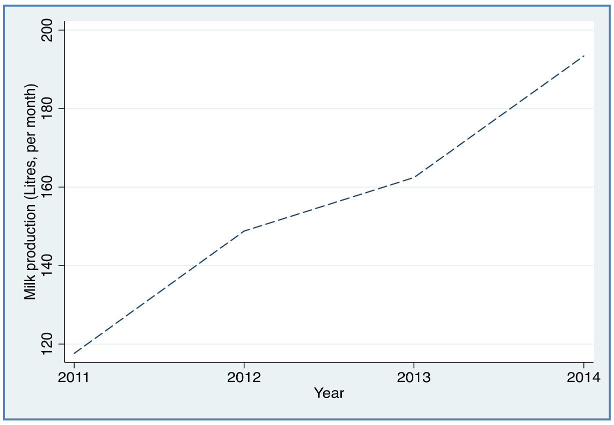

Fig-1: General milk production trends in Aldai sub-county from 2011 to 2014

Annual milk production levels were further disaggregated into quarters (Table 7). A quarter in our study started in the month of January and ended April of that year i.e., it takes approximately 4 months. It's important to note that we did not include 2014 production levels because we only had data for three months (April, September and December). Consistent with what we expected, milk production was lowest in the first quarter of each year. During the first quarter, there are no rains, and this implies lack of enough feeds necessary for milk production (Table 2).

Milk production was high in the fourth quarter of the year- i.e., from October, November and December of each year. This is the period when rain is scarce, and farmers struggle to feed their animals. In other instances, animals are emaciated, and milk production should be low. However, we believe that this high milk production during this quarter can be due to farmers having fodder that were grown during long rainy season. These fodders are free of many diseases which usually infect livestock during dry season like ticks. A second possible explanation is that, during this season, farmers resort to commercial feeds to supplement available fodder. It seems commercial feeds have high nutrients and this help increase production during this lean milk season.

Table-2: Average monthly milk production (in litres), by quarters

	Quarter 1	Quarter 2	Quarter 3	Quarter 4
2013	139.50	165.70	162.3	183.50
2012	126.03	152.15	156.79	162.09
2011	87.63	121.15	107.88	152.43

Milk production levels by adoption status

Farmers were asked their level of uptake of CSA technologies using a four-point Likert scale. The CSA technologies that we analysed in this section include animal health practices; zero grazing units, water storage and conservation, feed formulation, fodder conservation and planting of drought resistant varieties. a summary statistic of the socio-economic characteristics of CSA technology adopters and non-adopters are presented in Table 2 below.

Table-2: Descriptive statistics of adopters and non-adopters

	Adopters (N=284)				Non-adopters (N=66)			
Variables	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
Household size	1.489	0.522	1.000	3.000	1.500	0.533	1.000	3.000
Dairy farming system	0.577	0.495	0.000	1.000	0.545	0.502	0.000	1.000
Marital status	0.880	0.325	0.000	1.000	0.848	0.361	0.000	1.000
Age of farmer	2.870	0.798	1.000	4.000	2.576	0.912	1.000	4.000
Access to extension	0.606	0.490	0.000	1.000	0.242	0.432	0.000	1.000
Access to credit	0.264	0.442	0.000	1.000	0.470	0.503	0.000	1.000
Association	0.275	0.447	0.000	1.000	0.364	0.485	0.000	1.000
Distance to the farm	0.951	0.217	0.000	1.000	0.788	0.412	0.000	1.000
Education level	2.704	0.561	1.000	4.000	2.848	0.685	1.000	4.000
Level of awareness	0.183	0.387	0.000	1.000	0.121	0.329	0.000	1.000

Notes: S.D. is standard deviation; categorical variables like household size was coded as 1=0-5; 2=6-10; 3=11-15; age as 1=15-29; 2=30-39; 3=40-49; 4=greater than 50and level of education of a farmer es 1=no education; 2=primary; 3=secondary; 4=post-secondary; Dairy farming system 1= either zero grazing unit or semi-intensive and 0 otherwise; all other variables are captured as dummies

Our results show that both adopters and non-adopters had similar household sizes of 6-10 members. This can partly be explained by the fact that most of these households reside in one sub-county and are members of a local organization. As Manski have argued, people belonging to one association or group tend to behave in a similar manner due to endogenous, exogenous and correlated effects (Manski, 1993). Moreover, we find that most adopters and non-adopters tend to prefer zero grazing system of livestock farming. This suggests that farmers in the study area learn from each other and adopt what the role model farmer in the area does. In addition, adopter and non-adopter farmers are aged between 40-49 years, are married and have at least an ordinary level of education- i.e., about 12 years in school.

Non-adopters of CSA technologies had higher access to credit compared to adopters. Formal credit institutions in Kenya requires collateral to issue loans, it can be argued that non-adopters have more assets compared to adopters of CSA technologies enhancing their collateral power to access loans. Most smallholder farmers who are adopters are resource poor, and mainly depend on extension services. This is possible because these farmers are old and might have knowledge lapse. In this situation, access to extension services acts as a training avenue for adopters of CSA technologies. Mainly, adopters of CSA technologies tend to live far away from the farm as opposed to wealthy non-adopters who live in their farms. Because of their wealth status and higher access to credit by most non-adopter farmers, they have the potential of buying large parcels from which they can live and keep animals.

Finally, more non-adopters are likely to be members of a local association than adopters. This is possible because associations are member based and each member must ensure payment of annual fees. Non-adopters seem not to be able to pay their membership to association in time. At the same time, adopters are more aware of climate variability adaptation strategies than non-adopters. This is because adopters have close contact with extension agents than non-adopters, hence the former gets trained on how climate change adaptation strategies.

Number of Climate Smart Agricultural technologies adopted by farmers

In table 3, we summarize the total number of technologies adopted by dairy farmers in the study area, Kenya following two simple steps. First, we recoded the level of CSAT uptake (as captured by the four-point Likert scale) as either adopters or non-adopters. We assumed that farmers who reported high or medium level of uptake of each technology have adopted that technology and zero otherwise. A summary of technologies adopted are provided in the Table 3. Our results indicate that most farmers (44 percent) adopted about four CSA technologies.

Table-3: Number of technologies adopted by farmers

Number of technologies adopted by farmers	Frequency	Percent
0	11	3.14
1	24	6.89
2	31	8.86
3	71	20.29
4	155	44.29
5	58	16.57
Total	350	100

Secondly, we show (in Table 3) that about 83 percent of farmers had adopted at least 3 technologies. This is important because such high uptakes of improved technologies are expected to increase milk yield. To ease analysis and interpretation, we further classified farmers into the number of technologies they adopted into two major groupings: either as adopters or non-adopters. In doing so, we merged 66 households – i.e., those who reported to have adopted either zero, one or two as adopters while the rest of the farmers were the adopters, i.e., those who reported to have adopted either 3, 4 or 5 CSA technologies. A summary of the adoption status of CSA technologies are shown in Table 4. In general, we find out that 81 percent of dairy farmers in the study area had high levels of adoption of CSA technologies.

Table-4: Milk production levels by adoption status

Adoption status of CSA technologies	Frequency	Percent
Adopters	284	81.14
Non-adopters	66	18.86
Total	350	100

In Table 4, we analyzed the levels of milk production by adoption status of each respondent. Our results are consistent with traditional wisdom that farmers who have adopted CSA technologies are expected to receive more milk. We find that adopters of CSA technologies achieved higher milk output compared to non-adopters of CSA technologies. Adopters increased their milk production by about 22 percent within a period of two year, i.e., from 2011 to 2013. We followed the same procedure and showed that non-adopters also increased their milk production by about 25 percent, a difference of about of 3 percent higher as shown in Table 5 below, which can be attributable to social learning.

Table-5: Average annual milk production levels in litres per month, by adoption status

Year	Adopters	Non-adopters
2011	153.20	142.65
2012	145.83	141.74
2013	186.42	178.29
N	284	66

Market margin analysis

Market analysis refers to the total income from dairy production less variable cost. Market margins serve two purposes. First, it offers guidance to potential investors in dairy enterprises as it provides guidance on the viability of a dairy enterprise. Secondly, undertaking market analysis enables smallholder farmers to evaluate the performance (in terms of its profitability) of their enterprises.

To undertake a market margin analysis, we limited our analysis to milk supplied to local dairy cooperative society for which we obtained secondary data of every farmer in our dataset, which was collected for three consecutive years i.e., 2011, 2012 and 2013. The selection of this data period was guided by two facts; first, the cooperative society allowed access for the data only for these periods for fear that we might use this information to advice tax agents. Secondly, during 2011-2013 period, EADD project was active in the area and so its effects could be estimated with ease. Table 7, present these results for all 350 smallholder dairy farmers from the study area.

Table-7: Market margin analysis (average per month, in Kenya shillings (KES)) for smallholder farmers

	2011	2012	2013
Total revenue			
Milk sales	5,292.5	5,515.03	6,154.54
Variable costs			
Company fees	725.83	531.67	647.10
Cess	30.24	29.01	36.98
Transport	146.86	116.64	168.85
Loan advance	230.86	1,465.15	800.00
Artificial insemination	521.18	145.01	508.66
Feeds	659.57	1,885.11	1,169.61
Salt	100.64	190.76	270.58
Acaricides	222.58	326.84	161.26
Deworming drugs	355.64	253.01	101.64
Total variable costs	2,993.4	4,943.20	3,864.68
Net profit (KES per month)	2,299.10	571.83	2,289.86
Summaries			
Net profit/total variable cost	0.76	0.12	0.58
Net profit/total revenue	2.30	9.64	2.69
Net profit/Feed cost	3.49	0.30	1.96
Net profit/Company fees	3.17	1.08	3.54
Net profit/Cess	76.0.3	19.71	61.92

It is important to note that revenue from milk sales cover only milk supplied to the cooperative society and all variable costs are for those farmers who accessed these products from the cooperative society. It’s possible that a farmer could access variable cost products in local market. And for those farmers, we report zero values. Results indicate that total milk supplied to cooperative society was steady over time. The highest production was witnessed in 2013 while the lowest was in 2011. On overage, the monthly value of milk supplied was Kenya Shillings (KES) 5,293 in 2011- two years after the launch of EADD project (Table 20). The amount of milk supplied increased by about 4.2 percent between 2011 and 2012 period. The small increase in the value of milk can be attributed to drought which negatively impacted feeds production. However, a higher increase in revenue between 2012 and 2013 of about KES 639.51 (or 11.60 percent) was recorded (Table 7).

In terms of milk production, an average dairy farmer in Aldai sub-county supplies about 182.50 litres of milk to the cooperative society in 2011. This level of milk supply increased to 190.17 litres in 2012 and 212.23 litres per month in 2013 (Table 7). Based on these levels of supply, we can conclude that the EADD project helped farmers in increasing their milk production levels. Moreover, the high milk production per farmer recorded can be attributed to being membership of successful Kaptumo dairy cooperative society.

We also collected detailed information on the costs incurred by farmers when supplying milk to the cooperative society. These costs can be classified into those that are mandatory (like Kenya Dairy Board cess and cooperative fees) and those that are variable like animal health related products, transport charges and loan advance. The largest shares of variable costs are those related to procuring animal feeds. These costs were high in 2012 by KES 1885.11 per month compared to 2011 (i.e., 659.57). An increase of about185.81 percentage in the costs of feeds was recorded. This can partly be attributed to dry conditions witnessed between September-December 2011. During such dry periods, demand for feeds is high and this pushes up the local prices for these important inputs. This is evidenced by the rise in loan advance obtained by smallholder farmers between 2011 and 2012 periods, of about KES 1,234.15.

A reduction in the cost of deworming was observed, signifying the fact that during dry season, worms are few. This is because animals are mainly indoors and feed on commercial feeds. However, we observed an increase in volume of milk supplied compared to 2011. This can be explained by the fact that industrially sourced feeds have better nutrition and thus causes milk production to rise. Another important finding relates to the contribution of Kenya Dairy board cess charged of KES 0.2 per litre of milk supplied to the cooperative society (Table 20). This tax is low compared to other costs and it reduces the profitability of smallholder dairy farmers. A reduction in the cost of AI services was also observed. First, farmers might have received some price reduction in the form of subsidies from EADD project for AI service done and secondly, during drought, the demands for AI services are low and these force service providers to reduce the price of this important service.

Net profit margin to total variable costs was also analyzed. Our results show that this was highest (at about 0.8) in the year 2011 (Table 7). This ratio reduced to 0.1 and 0.6 between 2012 and 2013 periods. The high ratio shows that a shilling invested in variable costs gives higher returns from dairy enterprises, an indication that that dairy production is a profitable enterprise in study area. However, in 2012, low returns from investing in dairy production was observed, which can be attributed to the effect of climate which affected Kenya causing massive drought. This impacted the returns from dairy investment. We also analysed the ratio between net profits and costs of feeds- an item that contributes the highest percentage of variable. Here, return to every shilling invested was considerably high in dairy production except in the year 2012. The net profit rate (i.e., net profit/total revenue) was high on average. High return in 2012 of 9.64 and the lowest in 2011 at 2.30 were recorded (Table 7). These high returns provide suggestive evidence that the high revenues in dairy production cover all variable costs and still gives a farmer some returns. There is therefore financial advantage in smallholder dairy production.

Finally, we can report that Aldai sub-county dairy farmers are vertically integrated into cooperative society system. The core function of Kaptumo cooperative society includes collection of milk (through contracted agents) and marketing of milk. They also provide additional services at cost, which include loan advance, input supply at discounted prices compared to local market prices and on credit basis. Overally, we can conclude that dairy production system was economically a viable venture in Aldai sub-county, Kenya. This means that return to dairy enterprise was able to cover all variable costs and a farmer obtain positive return to capital investment, management and risks associated with the enterprise.

Market margin analysis, by gender classification

In Table 8 below, monthly net profit results were disaggregated (presented in Table 8) by gender of the respondent – either male or otherwise. Our result shows that net profits tend to be higher for male respondents compared to female counterparts. The explanations for this observation are: first, dairy cows are mostly considered male animals as opposed to female animals like goats and sheep. Therefore, it is male who are responsible for management practices. Secondly, male respondents' own assets like land which allow them easier access to credit from financial institutions. This means that they are able to acquire all resources needed for effective management of dairy animals.

Table-8: Market margin analysis (average per month, in Kenya shillings (KES)) for smallholder farmers, by gender of the respondent

	2011		**2012**		**2013**	
Total revenue	Male	Female	Male	Female	Male	Female
Milk sales	5,451.62	4,905.63	5,647.71	5,192.45	6,528.12	5,246.56
Variable costs						
Company fees	747.65	672.77	556.08	472.32	686.07	552.37
Cess	31.15	28.03	30.24	26.03	39.20	31.56
Transport	137.69	169.21	115.38	119.71	171.34	162.80
Loan advance	281.05	108.82	1421.72	1,570.76	917.54	514.22
Artificial insemination	456.09	679.42	123.86	196.46	547.77	413.58
Feeds	702.75	554.57	1,724.27	2,276.19	1,191.81	1,115.63
Salt	92.04	121.54	186.68	198.32	261.39	292.95
Acaricides	233.28	196.57	305.14	379.62	161.10	161.69
Deworming drugs	234.68	297.59	234.68	297.60	96.20	114.84
Total variable costs	2,916.38	2,828.53	4,698.05	5,537.00	4,072.42	3,359.64
Net profit (Net loss)	2,535.24	2,077.10	949.66	(344.55)	2,455.70	1,886.92
Summaries						
Net profit/total variable cost	0.869	0.734	0.202	(0.062)	0.603	0.562
Net profit/total revenue	0.465	0.423	0.168	(0.066)	0.376	0.360
Net profit/Feed cost	3.608	3.745	0.551	(0.151)	2.060	1.691
Net profit/Company fees	3.391	3.087	1.708	(0.729)	3.580	1.606
Net profit/Cess	81.388	74.103	31.404	(13.237)	62.645	59.788

Although female respondents reported receiving positive net profit during this period, we observe a loss of income of about KES 345 in 2012, (Table 8). It's important to note that during preceding year, there were low rains in Aldai sub-county and Kenya in general. And given the fact that most farmers were still grazing their livestock in open spaces, there are chances that they experienced shortage in quality feeds necessary for milk production. However, in general, we show that dairy production is a profitable enterprise, and any aspiring investor should consider such an investment in their portfolio.

Factors affecting milk production levels in Aldai sub-county, Kenya

In general, we analyze how adoption of CSA technologies impact milk production levels of smallholder farmers in Aldai sub-county, Kenya. In the first part of our result, we provide a brief overview of the main explanatory variables used in the analysis. Other socio-economic variables are discussed in Table 8 and therefore not presented here for brevity. In the second part of our analysis, we provide regression results obtained through ordinary least squares regression.

Descriptive statistics

In general, most farmers reported medium uptake of animal health practices like artificial insemination, deworming and spraying acaricides (Table 9). This is consistent with what we expect given that most dairy farmers were not well educated and are of old age. This observation might be attributed to the fact that these practices require technical knowledge which most farmers might be missing in Aldai sub-county, Kenya. A high cost incurred in acquisition of the services and general availability in the area may also be the cause. Most practices like artificial insemination are not costly for smallholder farmers and are not easily found in rural areas. In most instances where they are available, they are of poor quality. So, farmers are susceptible in using them as a way of improving their livestock herds.

On average, a high uptake of fodder conservation like Desmodium, Napier grass, lucerne, Calliandra among others was noted. The uptake level of fodder. The mean level of uptake of fodder conservation was about 4 and a standard deviation of 0.837 (Table 9). This can be explained by the fact that most farmers in the study area are members of a local farmers' association, which allows them to share information about fodder conservation. This information is shared in local language and therefore easily understood by farmers. Secondly, most farmers usually experience low milk output during dry seasons which forces them to purchase expensive commercial feeds. Therefore, farmers are interested on how to reduce expenditure associated with commercial feed purchase. This might have encouraged them to uptake fodder conservation technologies.

Farmers reported low levels of uptake on feed formulation. The mean level of uptake was 3 (+ 1.071) (Table 9), with the highest variation amongst all the CSA technologies adopted by farmers, an indication of the different answers provided by farmers. The high variation can be attributed to the fact that farmers in Aldai sub-county have only basic education which makes understanding feed formulation very difficult. It's almost impossible to maintain good health in dairy animals without proper balancing of the nutrients both quality and quantity wise.

On water storage and conservation, farmers reported medium uptake levels of 3 (+0.714) (Table 9). This can be explained by the fact that dairy farmers in the study area do not experience water stress, coupled with availability of equipment and materials needed for water storage and conservation which are cheap and are locally available and generally, low technical knowledge required to implement the technology contributed to these results.

On training on zero grazing units, farmers reported a mean uptake level of 2.8 (0.785) (Table 9). This high level of uptake might be as result of smaller land sizes and the type of land tenure that most farmers hold. In fact, most farmers have their own land and the inherited one from their ancestors. This type of land tenure system enables farmers to establish permanent structures compared to farmers who lease land. From our focused group discussion, farmers expressed their intention and willingness to change from semi-intensive system of dairy production to full intensive system due to their small land sizes. This was facilitated by the knowledge they acquired from participation in EADD project. Also, they were very optimistic that they income will increase as a result of adopting new farming system.

Finally, we showed that dairy farmers showed medium uptake of drought resistant crops. 3 (+ 0.7) (Table 9. The high uptake of drought resistant crops is testament to the high costs of commercial feeds. These drought resistant crops are important during dry seasons. First, they are a major source of animal feeds. Moreover, they help reduce production costs associated with dairy production. Finally, they can act as a source of income to farmers when sold for cash during hardship periods.

Table-9: Descriptive statistics of main explanatory variables

Explanatory variables	N	Mean	S.D.	Minimum	Maximum
Animal health practices	350	3.569	0.908	1.000	4.000
Fodder conservation	350	3.663	0.837	1.000	4.000
Feed formulation	350	2.663	1.071	1.000	4.000
Water storage and conservation	350	2.629	0.714	1.000	4.000
Zero grazing units	350	2.814	0.785	1.000	4.000
Planting drought tolerant crops	350	2.714	0.663	1.000	4.000

Notes: Explanatory variables were coded as; 1= No uptake; 2= low uptake; 3= Medium uptake while 4=High uptake; S.D. represent standard deviation.

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REFERENCES

- Bebe, B.O., Udo, H.M., Rowlands, G.J., & Thorpe, W. (2003). Smallholder dairy systems in the Kenya highlands: breed preferences and breeding practices. *Livestock Production Science*, *82*(2), 117-127.
- FAO. (2020). Milk production trends in Kenya
- Manski, C.F. (1993). Identification of endogenous social effects: the reflection problem. *The Review of Economic Studies*, *60*(3); 531-42
- Ministry of Agriculture, Livestock and Fisheries (MoALF). (2019). National Livestock Policy Draft report. Government of Kenya.
- Rademaker, I.F., Koech, R.K., & Jansen, A., & van der Lee, J. (2016). Smallholder dairy value chain interventions; The Kenya Market-Led Dairy Program (KMDP) status report. Centre for Development Innovation, Wageningen University & Research centre report CDI-16-018, Wageningen.
- Zagst, L. (2011). Socio-ecomomic survey of the East African Dairy development project/Mitigation of climate change in Agriculture program: pilot project in Kaptumo. Nairobi: Kenya FAO.

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