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Assessment of coping and adaptation strategies employed by dairy cattle farmers to counter the effects of rainfall variability in Keumbu division, Kisii County, Kenya

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Abstract
Rainfall variability characterized by intense rainfall, more frequent droughts and unpredictable rainfall has devastating effects on rain-fed agriculture and dairy production in particular. Over the years, dairy cattle farmers in Keumbu Division have experienced fluctuations in milk production. The purpose of this study was to assess the coping and adaptation strategies employed by small-scale dairy farmers to counter the effects of climate change induced rainfall variability in Keumbu Division, Kisii County. The study adopted a descriptive survey research. Data was collected through questionnaires, key informant interviews, Focus Group Discussions (FGDs) and observations checklist. Both simple random and purposive sampling techniques were used to select small scale dairy farmers. The methods of data analysis were both qualitative and quantitative using statistical package for social sciences (SPSS). Qualitative data were analyzed using thematic data analysis taking into account common words, phrases, themes and patterns in order to enhance understanding. The findings indicated that dairy farmers in the area of study practiced both indigenous and modern adaptation strategies. The common indigenous adaptation strategies practiced included: preservation of pastures, deferred grazing, reducing the number of cattle, rain water harvesting and storage for future use, reserved grazing and paddocking where part of the pasture is reserved for lactating cows and rearing different dairy breeds. The modern adaptation strategies included; harvested and stored water in tanks and house roofs to use during dry seasons, made silage and hay by use a variety of crops and stored to use during the dry season, feed preservation during wet season to use when the rains go down, planted forage varieties like napier grass, fodder shrubs and adopted new dairy cattle breeds like the Guernsey which are known to be resistant to hot climates and also crossbred their livestock with drought-tolerant breeds. The study recommends that the Ministry of Agriculture, Livestock and Fisheries should build the capacity of small scale dairy farmers by increasing their awareness of climate change and possible adaptation strategies.

Keywords: Coping and adaptation strategies employed, dairy cattle farmers, rainfall variability

1. Introduction
Kenya is already experiencing a number of climate change induced hazards characterized by irregular and unpredictable rainfall; while droughts have become more frequent during the long rainy season and severe floods during the short rains [1]. As a result, the small-scale dairy farmers in most parts of the country are currently facing high risk of reduced productivity resulting from extreme weather occasioned by climate change and weather variability. This is mainly because of over-reliance on rain fed forage production, seasonal fluctuation in the quantity and quality of feeds and vector-borne disease challenge [2].
The small-scale farmers in Kenya, have always developed and implemented traditional coping and adaptation strategies that have enabled them reduce their vulnerability to past climate variability and change [3]. Despite the country's heavy investments in research, extension and other donor supported dairy development initiatives; dairy productivity still remains low and positively correlated to seasonal weather and climatic patterns [4]. Kenya's yields remain below international standards, compared with average yields between 2,500 and 3,500 liters/cow in South Africa and Argentina, and 9,500 liters/cow in the United States [5].

2. Statement of the problem

Over the years, small-scale dairy farmers in Keumbu Division have experienced decline in milk production due to deaths of dairy cows caused by tick-borne disease outbreaks and feed shortages [6]. A survey conducted by IFAD [7] on the Small-scale Dairy and Commercialization Programme (SDCP) found that there is decline in milk production in Keumbu Division. Various indicators show that the dairy sector's performance is much lower than its potential. Despite a potential of more than15Kg per cow per day, milk yield has declined down to an average of 6 Kg per cow per day since the early 2000 [8]. There are also increased dairy cattle mortality related to vector-borne disease outbreaks and feed shortages [8]. It also found that most prevalent diseases of cattle in Keumbu Division and across other SDCP districts in Kenya were tick-borne diseases. Despite the importance of dairy production for the economy and livelihoods of smallholder farmers, very little information exists on the effect of rainfall variability and adaptation on small-scale dairy production [7]. The purpose of this study therefore was to assess the coping and adaptation strategies employed by small-scale dairy farmers to counter the effects of climate change induced rainfall variability in Keumbu Division, Kisii County.

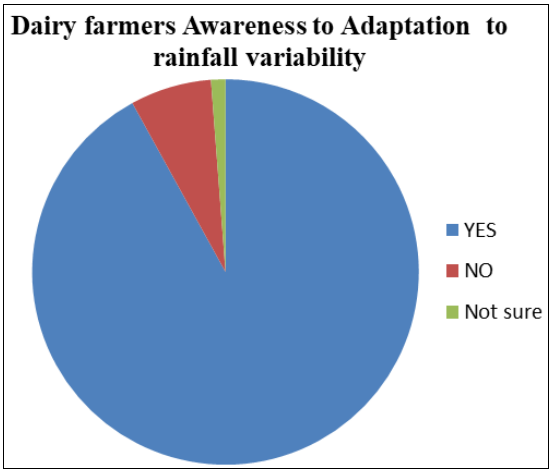
3. Methodology

The study adopted a survey research design, where both quantitative and qualitative research strategies were used. Data was collected through Focus Group Discussions (FGDs), questionnaires, key informant interviews, observations and desk review. Both simple random and purposive sampling techniques were used to sample 323 dairy farmers. It utilized qualitative and time series quantitative data sets for the period 1995-2019. The methods of data analysis were both qualitative and quantitative using statistical package for social sciences (SPSS). Qualitative data were analyzed using thematic data analysis taking into account common words, phrases, themes and patterns in order to enhance understanding.

4. Results and Discussions

4.1 Adoption of Coping and Adaptation Strategies

The purpose of this study was to assess the coping and adaptation strategies employed by small-scale dairy farmers to counter the effects of rainfall variability in Keumbu Division. The results in this section show the proportion of dairy farmers practising each coping strategy. They were divided into indigenous and modern strategies. The researcher sought to establish whether dairy are aware and practising adaptation strategies in Keumbu division. The results as shown in figure 1.



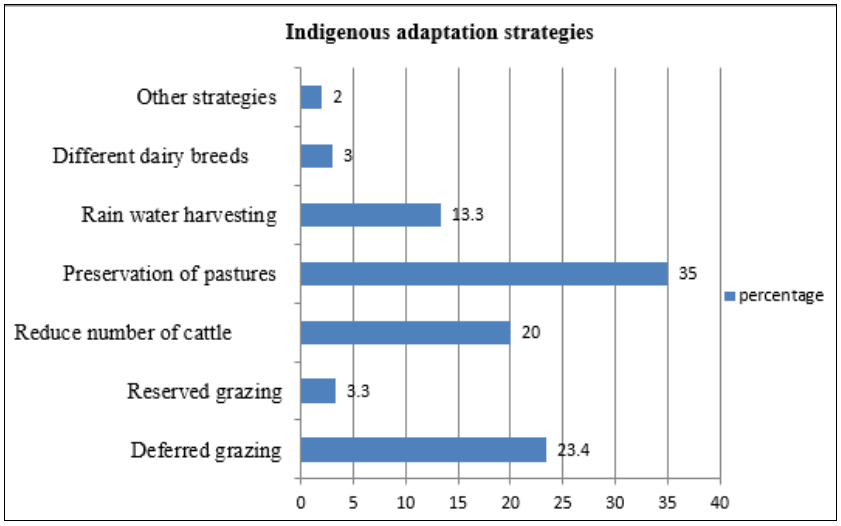
Source: Field data, (2019)

Fig 1: Adaptation to Rainfall Variability among Dairy Farmers

The findings in figure 1 indicates that majority (92%) of the dairy farmers acknowledged efforts towards mitigation to the effects of rainfall variability in the area of study, while 6.8% were not involved in any adaptation strategy and 1.2% were not sure if they practice any adaption strategy to rainfall variability. This revealed considerable emphasis on adaptation to climate change effects in the study area among the majority dairy farmers. This awareness could be attributed to the efforts of extension officers from MOALD and the International Fund for Agricultural Development (IFAD) through the Smallholder Dairy and Commercialization Programme (SDCP). These results concur with a study by [9] who assessed smallholder farmers' perceptions of climate variability and climate change adaptation in Bolero Community, Rumphi district in northern Malawi. The farmers showed concern about climate variability effects and pursuit of adaptation strategies to mitigate against the adverse effects experienced. The high knowledge about rainfall variability and its effect among dairy farmers in the study area, therefore pointed to their serious need for adaptation hence adoption of both indigenous and modern adaptation strategies.

4.2 Indigenous Adaptation strategies

During the study, the dairy farmers were asked to state the indigenous adaptation strategies they had adopted to cope with the effects of rainfall variability in Keumbu Division. Application of indigenous knowledge in the area of study was told of by the Livestock Department personnel and dairy farmers in the division. The results are as indicted in figure 2.



Source: Field Data, (2019)

Fig 2: Indigenous Adaptation strategies to Rainfall Variability by Dairy farmers

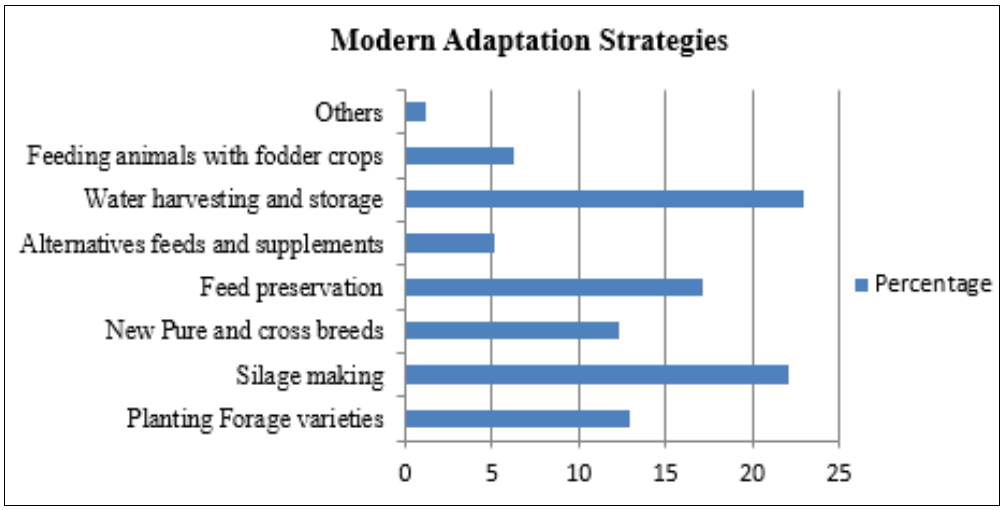
With regard to the indigenous adaptation strategies, most 113(35%) of respondents adapted by preservation of pastures, deferred grazing (23.4%), reduced the number of cattle through selling sold their cattle to mitigate the effects of droughts (20.0%), rain water harvesting and storage for future use (13.3%), reserved grazing and paddocking where part of the pasture is reserved for lactating cows (3.3%), rearing different dairy breeds (3.0%) and other strategies such as milking earlier in the day, feeding animals with shrubs, herbs, weeds, dry maize fodder and banana stems/leaves (2.0%). These findings are in line with [10] who postulates that indigenous people have over time developed traditional knowledge and strategies for adapting to changing habitat and resource conditions due to climate variability.

Efforts by dairy farmers to adapt to rainfall variability were confirmed by the respondents during focus group discussions. The participants observed that the small-scale dairy farmers have employed various measures to cope and adapt to ever changing and unpredictable rainfall. As one elderly respondent in Birongo sub-location put it:-

...I have changed my cattle feeding patterns over time. The free grazing system was common in the past, but now I prefer the mixed feeding system. I allow my cattle to graze when there is grass in the pasture land. In the absence of nutritious grass due to reduced rainfall, they are stall fed on crop by-products, hay from native species and other local grasses available. I usually feed my cattle twice daily in stall feeding. I take care of young calves and lactating females and feed them with better hay and some potatoes. Besides, I feed calves less than a year old with potato leaves, peas, cabbage leaves and maize flour...

4.3 Modern Adaptation strategies

The study sought to establish modern adaptation strategies adopted by the dairy farmers in Keumbu Division in dealing with rainfall variability. The findings are as indicated in figure 3.



Source: Field data, (2019)

Fig 3: Modern Adaptation strategies to Rainfall Variability by Dairy farmers

Majority (23%) of the respondents harvested and stored rain water in tanks and house roofs to use during dry seasons, 21.1% made silage and hay by use of a variety of crops and stored to use during the dry season, 17.1% used feed preservation during wet season to use when the rains go down, 13% of the respondents planted forage varieties like Napier grass, fodder shrubs and 12.3% adopted the use of new dairy cattle breeds like the Guernsey (*Bos taurus*

indicus) which are known to be resistant to hot climates and also crossbred their livestock with drought-tolerant breeds. The findings showed that 6.6% of the respondents were feeding their animals with fodder crops, cabbage leaves, sugarcane, sweet potato, vines and stovers of sorghum and maize after these are harvested and 5.1% providing concentrates (such as dairy meal) as supplements for the natural forage during the dry season. Other feedstuff used was cheaper molasses, salt and drought pellets. The variation in supplements used by smallholder dairy farmers may be explained by household's income from milk sales while those with more than five dairy cows may afford to purchase more supplements during the dry season. The process of adopting these modern practices requires adequate knowledge level among dairy farmers. Proper pasture and fodder management ensures availability of good quality and quantity forage at all times and builds resilience among livestock keepers during dry spells and drought period [11].

Key informant (Veterinarian and livestock production extension officers) findings on the effects of rainfall variability on dairy production and their advisory mitigation measures to the dairy farmers in Keumbu Division, the summary of the results are as shown in table 1.

Table 1: Effects of rainfall variability on dairy production and mitigation measures

Rainfall variability	Effects of dairy cattle production	Advisory Mitigation Measures
Delayed seasonal onset	Reduced growing season, reduced availability of grazing land and fodder/feed shortages	• Supplementation with crops and crop residues • On-farm fodder production, including: ▪ Drought tolerant varieties ▪ Irrigated production ▪ fodder trees • Fodder conservation • Feed and fodder purchase
Frequent and prolonged Droughts	▪ Feed shortage, inadequate water supply ▪ Reduced feed intake. ▪ Longer calving intervals and impacting cow fitness and longevity ▪ Cattle weight loss. ▪ Increase in diseases and deaths ▪ Increased costs of production. ▪ Reduced quantity and quality grazing land/fodder; ▪ Feed and water shortage.	▪ Early land preparation and timely planting of fodder ▪ Supplementary irrigation ▪ Use of mulching to conserve moisture in fodder crops ▪ Drought resistant fodder crops ▪ Dairy cattle insurance ▪ Supplement feeding, ▪ Keeping manageable number of dairy cattle. • Fodder conservation • Feed and fodder purchase
Above normal Rainfall	▪ Increased disease incidence, e.g. foot rot, pneumonia, scouring. ▪ Bloating due to consumption of rush pasture, ▪ Poor quality pasture as a result of nutrient leaching. ▪ Increased worm infestation (round worms, tapeworms and flukes). ▪ Lower milk production due to low quality feed.	▪ Ensure proper and adequate cattle housing ▪ Use additives and feed concentrates ▪ Timely vaccination and de-worming ▪ Make silage and adequate feed storage arrangements ▪ Increase the frequency of spraying, ▪ Make hay before the rains ▪ Rainwater harvesting
Below normal Rainfall	▪ Water scarcity, ▪ Increased pests and diseases, ▪ Reduced animal feed availability and quality ▪ Grazing in fragile areas ▪ Low milk production ▪ Increased dairy cattle mortality	▪ Routine vaccination and de-worming, ▪ Isolate and treat sick animals ▪ Supplement feeding, ▪ Keeping manageable number of dairy cattle. ▪ Regular spraying and vaccination

Source: Field data, (2019)

4.4 Constraints to Adaptation Strategies Employed by Dairy farmers in Keumbu Division

The study sought to establish the constraints that the respondents faced employing effective adaptation strategies to climate change and variability. The results are as shown in table 2.

Table 2: Constraints to Adaptation Strategies Employed by Dairy farmers

Constraints to Adaptation Strategies	Yes		No	
	N	%	N	%
Limited Access to financial resources	302	93.5	21	6.5
Lack of information and awareness	280	86.7	43	13.3
Lack of relevant skills and knowledge	298	92.3	25	7.7
Inadequate access to breeding services	310	96.0	13	4.0
Poor infrastructure	240	74.3	83	25.7
High Cost of Dairy cattle	305	94.4	18	5.6

Source: Field data, (2019)

According to the findings shown in Table 4.10, the dairy farmers in Keumbu Division experienced constraints such as limited access to financial resources and assets (93.5%), lack of information and awareness (86.7%), lack of relevant

skills and knowledge (92.3%), inadequate access to breeding services (96.0%), poor infrastructure (74.3%) and high cost of dairy cattle (94.4%) among other constraints. The results indicated that limited access to financial resources was cited by majority of the respondents as a major constraint facing adoption of adaptation strategies. Majority of the small-scale dairy farmers in area of study are poor and therefore they cannot afford to buy feed supplements, veterinary services, and water tanks for water storage, maintenance costs for water pumps and others.

The high percentages of respondents who reported lack of relevant skills and knowledge (92.3%) and lack of information and awareness (86.7%) can be attributed to limited training of the dairy farmers and poor infrastructure in the area of study. There is only one farmers training facility in the sub county and the road network is generally poor and the division is poorly connected with road transport. This makes it very difficult for extension officers to reach the dairy farmers.

Results from the focus group discussions, also indicated that access to financial resources is critical to water conservation, forage/fodder management, acquisition of feed supplements and adaptation to climate variability in the division. Even with basic knowledge and skill of adaptation strategies, majority of the dairy farmers cannot do much without access to adequate financial resources to implement the adaptation practices. This is clearly demonstrated by the words of one youthful farmer from Ibeno sub-location that;

"Limited access to finances has been a big challenge to us smallholder dairy farmers in Keumbu Division. We know that we are supposed to conserve water and animal fodder during rainy season. We lack finances to buy water pumps and big tanks for storage. Therefore, we just let the excess water and surplus animal forage and fodder crops go to waste during the rainy season. We have basic skills and knowledge on what needs to be done to cope with the seasonal changes but we lack financial resources to do so."

5. Summary and Conclusion

The findings indicated that majority of the dairy farmers acknowledged efforts towards mitigation to the effects of rainfall variability in the area of study. This revealed considerable emphasis on adaptation to rainfall variability effects in the study area among the majority dairy farmers. The dairy farmers in the area of study practiced both indigenous and modern adaptation strategies. The common indigenous adaptation strategies practiced included: preservation of pastures, deferred grazing, reducing the number of cattle, rain water harvesting and storage for future use, reserved grazing and paddocking where part of the pasture is reserved for lactating cows and rearing different dairy breeds. The modern adaptation strategies included; harvested and stored water in tanks and house roofs to use during dry seasons, made silage and hay by use a variety of crops and stored to use during the dry season, feed preservation during wet season to use when the rains go down, planted forage varieties like napier grass, fodder shrubs and adopted new dairy cattle breeds like the Guernsey which are known to be resistant to hot climates and also crossbred their livestock with drought-tolerant breeds. The dairy farmers in Keumbu Division experienced constraints such as limited access to financial resources and assets, lack of information and awareness, lack of relevant skills and knowledge, inadequate access to breeding services, poor infrastructure and high cost of dairy cattle among other constraints.

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