OPEN ACCESS Freely available online

Journal of Climatology & Weather Forecasting

Research Article

Trends in Rainfall Variability and their Effects on Dairy Cattle Production in Keumbu Division, Kisii County, Kenya

William Masaka Ondieki[1*], Warkach Kipkorir Tonui[2]

[1]Department of Geography and Social Development, Jaramogi Oginga Odinga University of Science and Technology, Kenya; [2]Department of Geography and Social Development, Kenya, Jaramogi Oginga Odinga University of Science and Technology, Kenya

ABSTRACT

Over the years, small-scale dairy farmers in Keumbu Division have experienced decline in milk production. The persistent decline in dairy production in the region has let to questions as to what must have contributed to the decline. The study objective was to assess the trends in rainfall variability and their perceived effects on dairy production in Keumbu division, Kisii County. 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 365 small scale 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. The findings indicates that since 1995 rainfall was found to be varied such that during 1995-2019 period, some years recorded high rains whilst others recorded low rains this is a reflection that rain in Keumbu division is highly variable with time. From the annual rainfall averages of Keumbu division, the observed changes of precipitation across the years in the past 23 years might have been as an impact of climate change and variability. These are indicated by rainfall patterns that are no longer predictable, shorter rains, delayed or rainfall coming early, rains that are sometimes heavier than normal and prolonged dry periods. Findings acknowledged the effects of prolonged droughts on dairy production which included: increase in diseases, death of calves and cows due to insufficient feed and water, decrease in milk production levels, poor reproduction and abortion due to poor animal health. The dairy farmers farther indicated that nutritious pasture dried up giving room for the growth of less nutritious pasture. The study recommended for the need for small holder dairy farmers to be empowered to effectively prepare for the effects of rainfall variability through production and conservation of fodder during severe drought and extreme high rainfall.

Keywords: Numerical weather prediction; Ensembled; Bias; RMSE

INTRODUCTION

Over the years, small-scale dairy farmers in Kenya have experienced decline in milk production due to deaths of dairy cows caused by tick-borne disease outbreaks and feed shortages [1]. A survey conducted by IFAD (2010) 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 than 15 Kg per cow per day, milk yield has declined down to an average of 6 Kg per cow per day since the early 2000 (MoLD, 2010). There are also increased dairy cattle mortality related to vector-borne disease outbreaks and feed shortages [1]. 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 [2]. The purpose of this study therefore is to analyse the perceived effects of rainfall variability on small-scale dairy production in Keumbu Division, Kisii County.

STATEMENT OF THE PROBLEM

Despite the efforts by International Fund for Agricultural

Correspondence to: William Masaka Ondieki, Department of Geography and Social Development, Jaramogi Oginga Odinga University of Science and Technology, Kenya, Tel: 0721145930; E-mail: wimasaka@gmail.com.

Received: June 06, 2021; **Accepted:** July 15, 2021; **Published:** July 25, 2021

Citation: Ondieki WM, Tonui WK (2021) Trends in Rainfall Variability and their Effects on Dairy Cattle Production in Keumbu Division, Kisii County, Kenya. J Climatol Weath Forcast. 9:299.

Development (IFAD) and the Ministry of Agriculture through the Smallholder Dairy and Commercialization Programme (SDCP), Kisii County and Keumbu division in particular still experiences persistent decline in milk yield over time more especially during the dry seasons (GoK, 2014). The decline in milk yield in the region has let to questions as to what must have contributed to the decline. Could the decline be as a result of climate change induced rainfall variability? Despite the importance of dairy production, very little information exists on how the variations in dairy production are associated with rainfall over time. This study intends to fill in the gap in the literature by evaluation the perceived effects rainfall variability on small-scale dairy production in Keumbu Division, Kisii County.

MATERIALS AND METHODS

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 365 small scale 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.

RESULTS AND DISCUSIONS

Trend in rainfall variability for Keumbu division, Kisii County

The study sought to establish the trend in rainfall characteristics of Keumbu division for the period 1995 to 2019. The data was collected from the Kenya Meteorological Department (KMD), which included; the total annual rainfall, annual average rainfall, monthly rainfall averages, rainfall variance and seasonal variations. This section also discusses the dairy farmer's perception on rainfall variability in Keumbu Division.

Total annual rainfall trend

Data from the Kenya Meteorological Department (KMD) showed that the amount of rainfall in Keumbu Division, Kisii County has been fluctuating between highs of 2416.4 mm in 2010 being the year with highest recorded annual total rainfall in the last 23 years and lows of 1665 mm in the year 2005. Higher rainfall was also noted in the year 1995 with rainfall total of 2406.8 mm. Comparing both the highest and lowest rainfall annual years, there annual rainfall range was 751.4 mm (2416.4-1665). The findings indicates that since 1995 rainfall was found to be varied such that during 1995-2019 period, some years recorded high rains whilst others recorded low rains this is a reflection that rain in Keumbu Division is highly variable with time (Figure 1).

The shifts in rainfall distribution patterns in the division were confirmed by the respondents during focus group discussions who observed that the rains can no longer be predicted, unlike in the past when there was a clear sequence of seasons. An elderly respondent in Kabosi location observed that "The rainfall pattern has changed, it does not fall as it used to some years five years ago. We used to know the when it will rain, but of late it can rain any time and it is causing confusion to small-holder dairy farmers. Once you plant the rain goes, the seeds and seedlings dry up."

Annual average rainfall trend

The researcher also sought to establish the trend on annual average rainfall for (1995-2019) from analysis (Figure 2).

From the analysis in (Figure 2) indicates that there was a constant rainfall fall as from 1995 to 1998 rainfall annual averages. The trend series shows that 2010 recorded the highest amount of precipitation received in the region with an average of 201.4 mm. The year 1995 had 200.6 mm with 1997 recording the average of 166.0 mm and the year 1998 having the lowest of 149.7 mm annual average rainfall. However there was an increasing rainfall trend across the four years (1999, 2000, 2001, 2003, 2004, 2005, 2006, 2007, 2008, 2010), there was a rainfall decline trend noted between 2013 and 2017. From the annual rainfall averages of Keumbu Division, the observed changes of precipitation across the years in the past 23 years might have been as an impact of climate change and variability.

Monthly rainfall averages

Monthly rainfall data (mm) over the study area was obtained from the Kenya Meteorological Department for the period 1995-2019 (Figure 3).

Analysis of monthly averages indicates that rainfall amounts in Keumbu Division had always peaked from the month of March

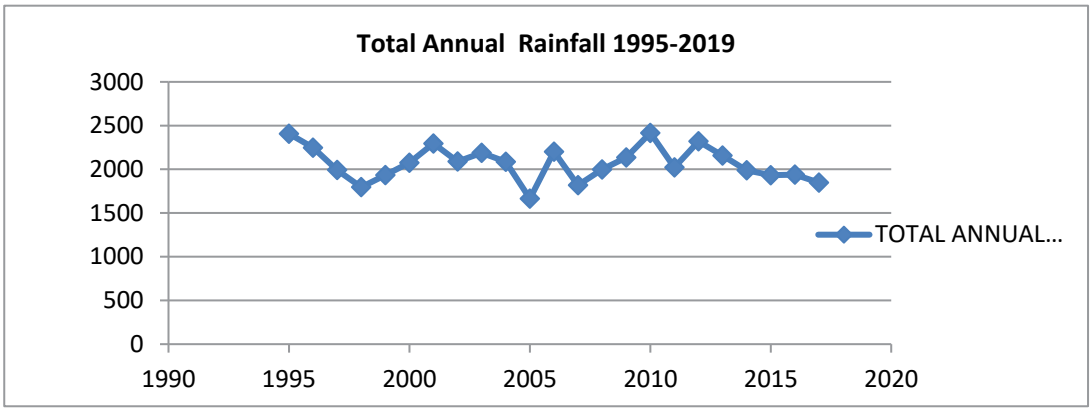

Figure 1: Line graph showing annual rainfall totals for 1995-2019 for Keumbu Division, Kisii County. Source: KMD (2019).

to May (Figure 3). However, over the last 23 years rainfall became bimodal, with another peak in November. Generally, low rainfall amounts were received in the months of February and June over the last 23 years for the period 1995-2017. Rainfall data from KMD for Keumbu Division, Kisii County (1995-2019), which shows that the long term mean monthly rainfall for the area is highest during the months of March, April and May, while the driest months (months of lowest rainfall) are during the months of January-February and June-July (Figure 3).

Results from the key informants and FGDs also acknowledged that is change in rainfall patterns, prolonged dry spells from the usual period of January, February-April, shortening of the long rainfall season from the previous March-July to April-June, change in humidity level and emergence of new pests and diseases for over a period of 3 decades.

Dairy farmer's perception on rainfall variability in Keumbu division

The researcher sought to establish the farmers' perception on rainfall variability in Keumbu Division. One of the questions was whether rainfall amounts had changed, remained the same or increased in the study site for the period 1995-2019. Their responses were as indicated in (Figure 4).

The findings in (Figure 4) indicate that 10% of the farmers agreed that rainfall amount received in Keumbu Division over the last 23 years had increased. 20% of the respondents were of the opinion that there was no change in rainfall amount for the period 1995-2019, while 68.6% of the respondents citing that the amount of rains had decreased. The perception that rainfall had declined was due to drying up of streams and rivers and unpredictability and unreliability of rainfall pattern in Keumbu Division.

The FGDs findings indicated that the local understanding was that climate was changing especially in the form of rainfall amount and patterns. The members' perception of changes in rainfall is accredited to noticeable changes in their environment like reduced rainfall and river water volumes, delayed rainfall and prolonged drought. Majority of the members in the FGDs linked the changes in rainfall patterns to climate change and variability while a small number of them especially those above 70 years age felt the changes rainfall were as result of invoking the ancestors, sin of mankind and an act of God. The findings were in agreement with results of a survey [3], which similarly found out that most of the households had noticed changes in the environment in terms of poor rainfall distribution, increased frequency, intensity and prolonged drought, degraded soils, drying up of wells and rivers, and incidence of diseases and pests.

Changes in rainfall patterns

The respondents were farther asked to state the changes rainfall patterns and events that have taken place in Keumbu Division in the past 23 years (1993-2017) and the results are as shown in (Figure 5).

The results presented in (Figure 5) shows that changes in rainfall patterns in the past twenty three years was mainly noticed in form of prolonged droughts (39.0%), frequent floods (4.0%), shorter than normal (20.0%), longer than normal (5.0%), late onset of rains (8.0%) and change in timing of rains (24.0%). Other significant changes in rainfall patterns that were cited to have occurred in the past ten years include less rain and early onset (1.0%).

These findings were supported by perceptions that emerged during

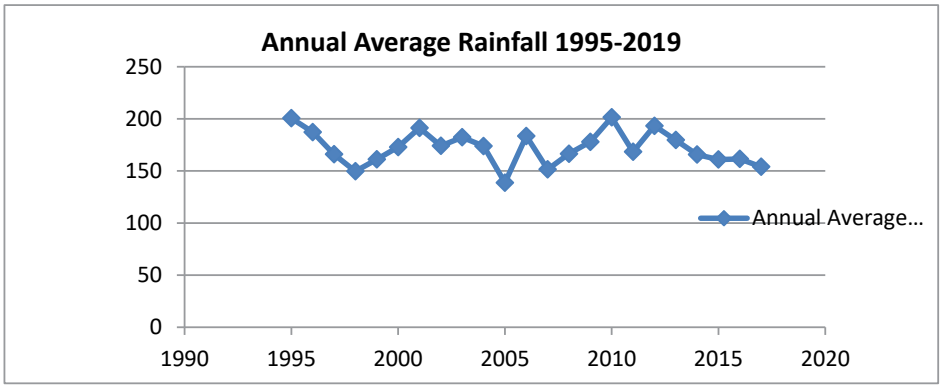

Figure 2: Annual Average rainfall in Keumbu Division, Kisii County (1995-2017). Source: KMD (2019).

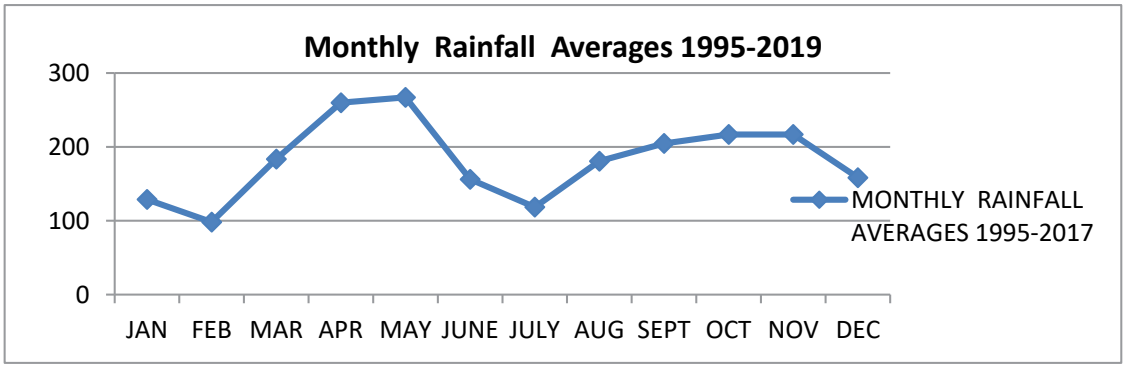

Figure 3: Monthly rainfall for Keumbu Division, Kisii County (1995-2019). Source: KMD (2019).

the interviews when one middle aged respondent said this:

"In the past the rainy season in Keumbu division used to start in the month of March and we could start our farming activities such as planting sweet potatoes, maize and nappier grass, but as you can see we are in the Month of mid-April and we have not seen any sign rainfall, it may not rain any soon, the pattern of rain has changed, it's really unpredictable and therefore with this worrying trend, we may experience drought and famine this year."

This implies that the dairy farming in Keumbu division may be affected with the unpredictable rainfall and therefore dairy farmers may be experiencing decline in milk production.

The findings from key informants also indicated that there are changes in rainfall patterns and amounts in the last 23 years. These are indicated by rainfall patterns that are no longer predictable, shorter rains, delayed or rainfall coming early, rains that are sometimes heavier than normal and prolonged dry periods. The key informants agreed that the change in rainfall patterns is as a result of climate change and variability due to natural processes, eucalyptus trees planted along the river courses, deforestation and high population densities in the area of study. These findings concur with a study which observed that annual rainfall amounts increased between the years 1976-2005 in Laikipia East district, but this did not lead to good agricultural production. This was attributed to the changing rainfall patterns that disrupted farming activities more especially dairy farming. The results of this study are also consistent with findings on farmer's perception of climate change in Sub Saharan Africa that rainfall patterns have changed [4].

Changes in rainfall seasons and dairy production

The study sought to find out if changes in rainfall seasons affect dairy production in Keumbu Division. The results are as indicated in (Figure 6).

The findings in (Figure 6) indicates that 93.2% of the respondents agreed that changes in rainfall seasons affect dairy production in the division, while 5% were of the contrary opinion and only 2.2% were not sure whether changes in seasonality affects dairy production.

The results in (Figure 7) indicates that 68.6% of the respondents indicate that during the dry season there is milk production loss in dairy cows, 24.3% indicated that there is normal milk production while 7.1% indicated that there was increase in milk production during the dry season. Findings from FGDs acknowledged the effects of prolonged droughts on dairy production which included: increase in diseases, death of calves and cows due to insufficient feed and water, decrease in milk production levels, poor reproduction and abortion due to poor animal health. The dairy farmers farther indicated that nutritious pasture dried up giving room for the growth of less nutritious pasture.

On the other hand during the wet season the findings show that dairy farmers experience high milk production as supported by 79.5% of the respondents, while 6.2% indicated that there is normal milk production and 14.3% indicated that there is decline in milk production [5].

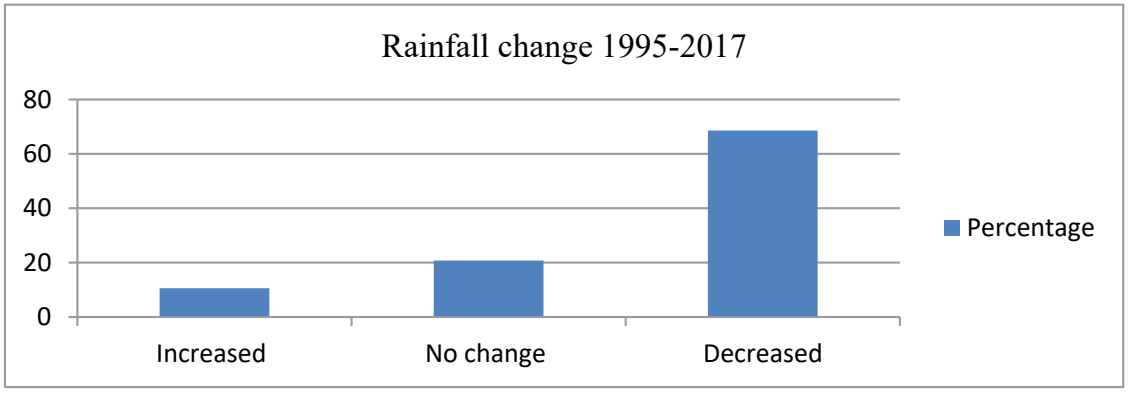

Figure 4: Dairy farmers' perception on rainfall variability in Keumbu Division, Kisii County Source: Author's field survey, 2019.

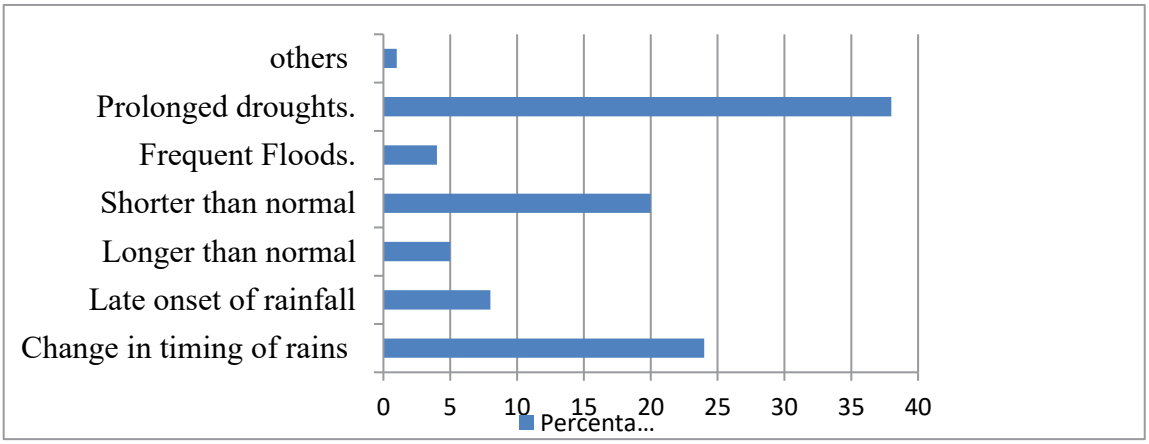

Figure 5: Changes in rainfall patterns in the past twenty three years (1993-2017). Source (Field Data, 2019).

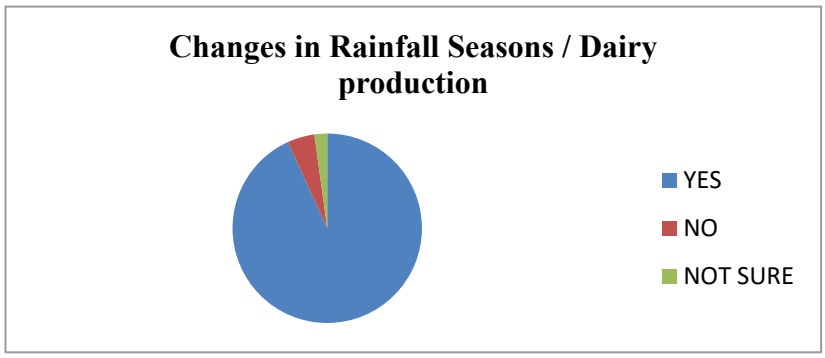

Figure 6: Effects of changes in rainfall seasons on dairy production in Keumbu Division.

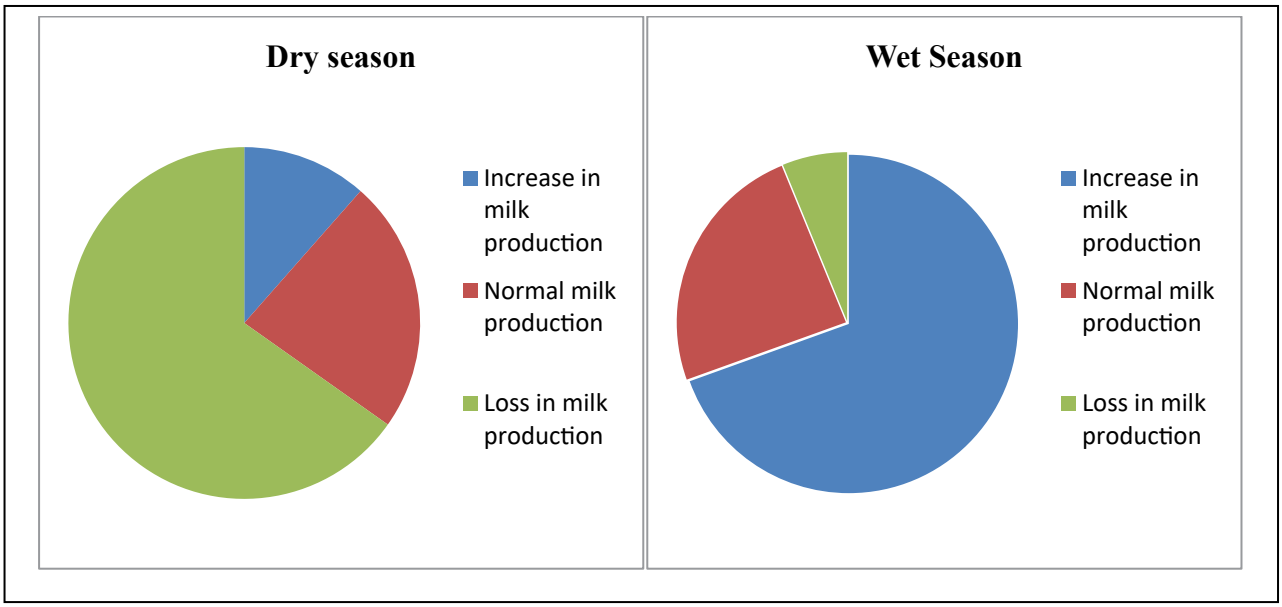

Figure 7: The effects of wet and dry seasonal rainfall changes on milk production.

The researcher farther sought to find out the reason as to why there could be decline in milk production during the dry season. The findings are as indicated in (Figure 8).

The findings in (Figure 8) indicated the negative effects of dry season on milk production were as a result of include low dry matter intake (29.5%), impaired reproduction (16.3%), animal diseases and sickness (12.2%), reduced and poor quality of fodder (26%) and inadequate water availability (16%). All these negative impacts lower milk production. The findings from the key informants' interview and FGDs showed that dry season increased disease and insect infestation of a number of disease vectors and parasites, rinderpest, trypanosomiasis in low land and forest areas during the transhumant, tuberculosis, contagious bovine-pleuropneumonia and haemorrhagic septicaemia. These diseases do not necessarily result in sickness and death of the cattle, but the health state of the cattle equally affects milk production, as the quality and quantity drop due to poor body health [6].

Respondents in Keumbu division were very much aware of the negative effects dry seasons on milk production as indicated by one elderly man from Birongo sub-location.

"I have kept dairy cattle's for the last 15 years, when the rain goes down during the dry season I usually have challenges in feeding the animals because my cows depend a lot on grass and maize fodder. I have not planted sufficient nappier grass because the size of my land is too small. During the dry season grass dries up and my cows change their eating habits, leading to loss in the amount of milk from 8 kg per cow per day to 4 kg per cow per day and sometimes no milk at all reducing the lactation period [7]. However, three to four weeks after the start of the dry season my cows produced normal amount of milk until grass dries up and when I experience shortage water for the animals."

Therefore, rainfall variability has effects on animal health, availability of fodder, water and hence affecting the dairy milk production. The findings suggest that climate change has a take on vector-bone disease transmission affecting animal feeding [8]. On the other hand some researches also had a similar observation from their study on effects of temperature and rainfall variability on livestock production.

On the other hand the findings indicate that wet season has positive impacts of the on dairy animals as shown in (Figure 9).

The findings in (Figure 9) indicate that wet season has positive impacts of the on dairy animals due to increased availability of quality fodder/forage (27%), good animal feeding (26.3%), weight gain (15.3%), general good health (15.1%) and adequate water supply (15%). However, the dairy animals may be subjected to increased incidences of water and vector borne diseases (1.2%)

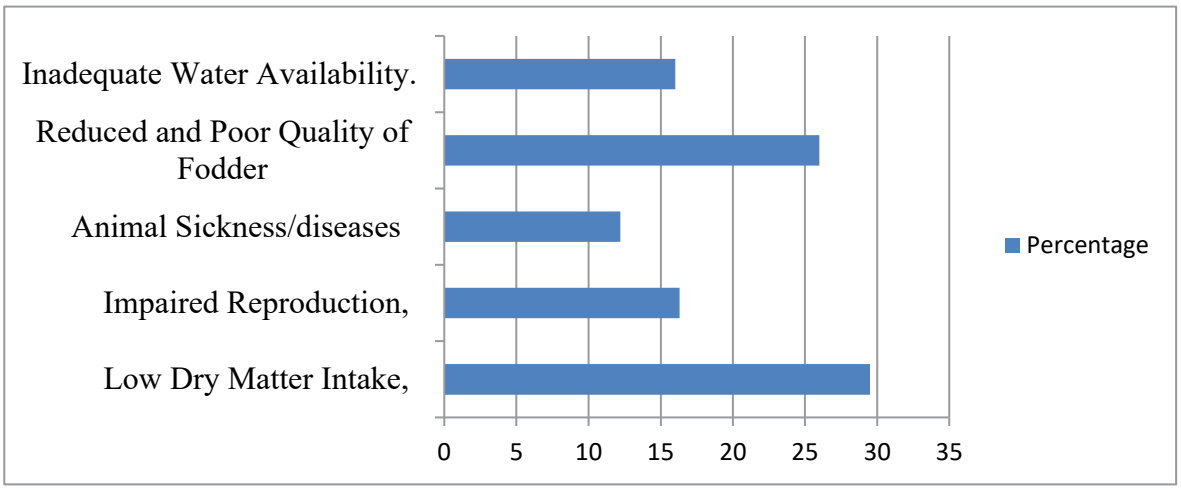

Figure 8: Reason for milk loss during dry season.

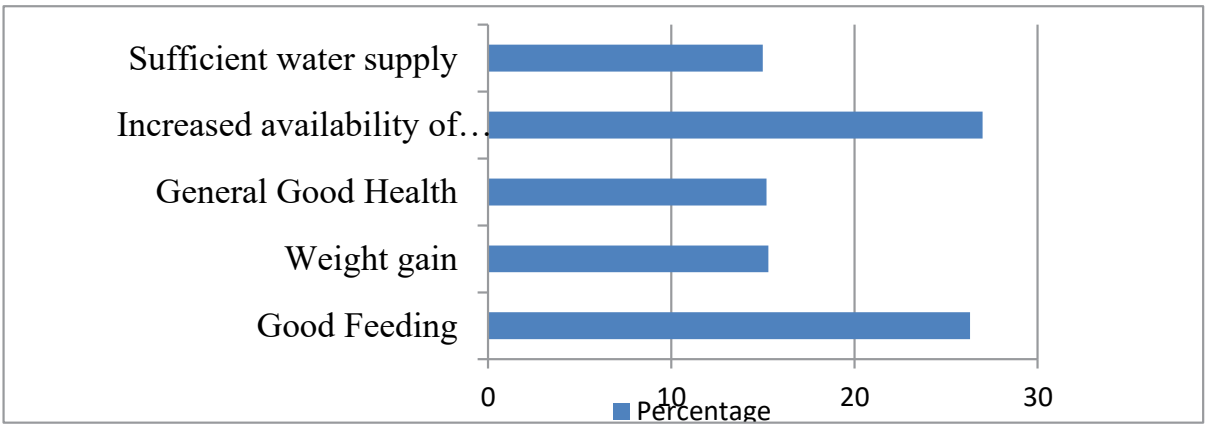

Figure 9: Reason for milk increase during the wet season.

resulting in deaths due to untreated diseases such as endo-parasitic effects caused by round worm and tape worm, ecto-parasitic effects caused by heavy thick infestation and ring worm, food and mouth disease, mastitis, babesiosis and black quarter [9].

Results from the key informants and FGDs reported that excess rainfall amount in the area also affect pasture based grazing systems. Excessive surface run-off and floods along River Kuja and other wetland areas in Keumbu Division caused rotting of natural grass, which led to cattle rejecting the grass, especially in the lowlands [10]. In all sub-locations in the study area dairy farmers reported increased outbreaks of cattle diseases, including tick-borne diseases, pneumonia in calves, and foot rot. When the area experiences heavy rainfall during a wet season cows cannot feed properly on the natural grass. However, these findings on the overall showed low effects of enhanced rainfall that is normally accompanied by flooding in other areas. This is because of the hilly nature of the topography of the study area.

CONCLUSION AND RECOMMENDATIONS

From the annual rainfall averages of keumbu Division, the observed changes of precipitation across the years in the past 23 years might have been as an impact of climate change and variability. Changes of milk production from high to low, was due to dry and adverse weather while high milk production corresponded to high favorable weather conditions. Seasonal changes in rainfall patterns especially the increasing and prolonged droughts on dairy production which included: increase in diseases, death of calves and cows due to insufficient feed and water, decrease in milk production levels, poor reproduction and abortion due to poor animal health. This study recommends for adequate mechanisms to be put in place to minimize losses and damages of the dairy production occasioned by increased frequency of extreme rainfall during the dry and wet seasons. Lastly smallholder dairy farmers should be empowered to adapt and mitigate against the effects of rainfall variability and outbreak of new vector borne diseases occasioned by extreme weather variability.

REFERENCES

1. Government of Kenya (GOK). Ministry of Agriculture Farm Management guidelines for Kisii central district. Nairobi. Government printer. 2013.
2. IFAD, GOK. Small holder dairy commercialization in Kenya program report. IFAD and Ministry of Livestock Development. 2014.
3. ASDSP. Household baseline survey. Nairobi: Agriculture sector development support programme. 2014.
4. Gbetibouo GGA. Understanding farmers' perceptions and adaptations to climate change and variability: The case of the Limpopo Basin. South African Press. 2009.

5. GOK. The Sessional Paper No. 5 on the National Dairy Development Policy. 2013.

6. Government of Kenya (GOK). Kisii central development plan 2009-2013. Nairobi. Government printer. (2010).

7. GoK. National climate change response strategy. Nairobi. Government of Kenya. 2010.

8. Government of Kenya. Agricultural sector dairy commercialization development strategy. Nairobi. Government Printers. 2010.

9. IFAD, GoK. Small holder in Kenya Program Report. IFAD and Ministry of Livestock Development. 2010.

10. Gale P, Adkin A, Drew T, Wooldridge M. Predicting the impact of climate change on livestock disease in Great Britain. Veterinary Record. 2008;4(7):1-6.