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Drought and shifts in agropastoral coping strategies in Uganda's cattle corridor

J. MBAZIIRA[a]*, Y. BAMUTAZE[a], A. EGERU,[b] H. LEIN[c], C. NAKAKAAWA[c], F. MUGAGGA[a] and B. NAKILEZA[a]

[a]Department of Geography, Geo-Informatics and Climatic Sciences, (CAES) Makerere University, Kampala, Uganda

[b]Department of Environmental Management, (CAES), Makerere University, Kampala, Uganda

[c]Department of Geography, Norwegian University of Science and Technology, Norway

***Corresponding Author:** jamesmbaz@gmail.com

ORCID: 000-0001-5482-9795

ABSTRACT

Changing climatic conditions including drought and severe dry spells are major challenges to agropastoral food production. The frequency and intensity of prolonged dry-seasons impact agropastoral livelihoods especially crop production. Households cope with these impacts using purposeful and incidental strategies. However, the associated impacts of droughts in relation to shifts in agropastoral purposeful coping strategies is partially explored. Using cross-sectional data of 426 households, and total mean monthly rainfall of 1991-2020, this study examined how seasonal shifts and deficits in rainfall cause shifts in the short-term purposeful coping strategies among agropastoral communities. Results elicit three key findings: (i) agropastoral areas have high annual mean and seasonal rainfall variations, (ii) there is a very strong relationship between shifts in household coping strategies and annual rainfall deficits, and (iii) shifts in coping strategies demonstrate an inverse relationship with households coping behaviours. Findings from the current study provide a basis for an indepth longitudinal survey to reveal the association between frequency and severity of use of these coping strategies in agropastoral communities. The resulting information could then be used to provide locals with solution of purposeful coping strategies that enhances food security.

Key words: Agropastoral communities, cattle corridor, drought, purposeful coping, severe dry spells, Uganda

RÉSUMÉ

Les conditions climatiques changeantes, notamment la sécheresse et les périodes de sécheresse prolongées, sont des défis majeurs pour la production alimentaire agropastorale. La fréquence et l'intensité des saisons sèches prolongées affectent les moyens de subsistance agropastoraux, en particulier la production agricole. Les ménages font face à ces impacts en utilisant des stratégies délibérées et incidentelles. Cependant, les impacts associés de la sécheresse en relation avec les changements dans les stratégies d'adaptation agropastorale délibérées sont partiellement explorés. En utilisant des données transversales de 426 ménages et une moyenne mensuelle totale des précipitations de 1991 à 2020, cette étude examine comment les changements saisonniers et les déficits de pluie provoquent des changements dans les stratégies d'adaptation délibérées à court terme parmi les communautés agropastorales. Les résultats révèlent trois principales conclusions : (i) les zones agropastorales présentent des variations élevées de la moyenne annuelle et saisonnière des précipitations, (ii) il existe une relation très forte entre les changements

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dans les stratégies d'adaptation des ménages et les déficits annuels de précipitations, et (iii) les changements dans les stratégies d'adaptation montrent une relation inverse avec les comportements d'adaptation des ménages. Les conclusions de la présente étude fournissent une base pour une enquête longitudinale approfondie afin de révéler l'association entre la fréquence et la gravité de l'utilisation de ces stratégies d'adaptation dans les communautés agropastorales. Les informations résultantes pourraient alors être utilisées pour fournir aux habitants des solutions de stratégies d'adaptation délibérées qui améliorent la sécurité alimentaire.

Mots-clés : Communautés agropastorales, corridor bovin, sécheresse, Adaptation délibérée, périodes de sécheresse sévère, Ouganda

INTRODUCTION

Changing climatic conditions in form of more erratic and unreliable rainfall, and increased temperatures, are major challenges to agropastoral food production in Sub-Saharan Africa (USAID, 2017). Erratic and unreliable rainfall manifest as rainfall deficits, resulting into droughts and severe dry spells (Nimusiima *et al*., 2013; Twongyirwe *et al*., 2019b). Prolonged droughts and severe dry spells cause withering of crops (e.g. beans, , maize), water scarcity to produce adequate food and livestock, leading to malnutrition of agropastoralists (IMF, 2022). In addition, communities are pushed beyond the coping range (FAO, 2021), as their current measures are no longer viable (Few *et al*., 2018). In Uganda, agropastoralists have been forced to take on coping and adaptation measures to reduce these impacts (Ssebulime *et al*., 2017; Kiggundu *et al*., 2018). Coping strategies include the actual short term responses in face of drought such as informal risk sharing such as food sharing, informal cash loans, child labour and others (Shuaibu *et al*., 2014). Adaptation are long-term strategies targeting capacity to respond and adjust to drought including technology adoption, insurances and others (Skinner, 2016). However, little is known on how rainfall deficits cause shifts in agropastoral coping strategies. This paper (i) maps out changes in rainfall in agropastoral corridor of Uganda, and (ii) examines how rainfall deficits cause shifts in coping strategies among agropastoral communities.

General knowledge about drought causes and associated impacts show intensity in dry spells in Uganda (Mulinde *et al*., 2016; Egeru, *et al*., 2019). Notable and significant changes in rainfall that have been recorded within the cattle corridor in the 1960s (Nimusiima *et al*., 2013), and other records show changes in rainfall leading to prolonged droughts, for instance, between 1960s and 2015: reduction in total annual rainfall by 15–20 % with a shorter rainy season and increase in average number of extreme hot days by 20-28% (USAID, 2017). More large season-to-season variations in rainfall, with the first dry-season in the central cattle corridor (June to early August) has been shortening while the second dry season (December to February) intensifying (Nimusiima *et al*., 2013). At annual basis, between 2000 and 2021 Karamoja subregion alone experienced seven droughts (OPM, 2019; WBG, 2021).

During the period 2010-2020, Uganda experienced the most devastating droughts in history with massive impacts to over seven million people (IMF, 2022). In Karamoja sub-region more than 7000 cattle died in 2019 and over 2000 cattle died in 2021 in the central cattle corridor due to shortage of water and pasture. Crop growing is increasingly becoming risky with significant reductions in grain yields especially maize (Epule *et al*., 2017; Nimusiima *et al*., 2018). However, strategies including: migratory practices, planting drought resistant

varieties, livestock and crop diversification among others (Nimusiima *et al*., 2018; Atube *et al*., 2021), are known. The extent of shifts in coping strategies among agropastoral communities remain however unassessed. Understanding the shifts lay a foundation to understanding communities' capacity to utilize the available resources to stimulate agricultural production and reduce frequent shocks and stresses from drought.

Theoretical conceptualization/framework. This paper focuses on impact of climatic changes (i.e. deficits in rainfall and seasonal changes) on agropastoral coping strategies (Figure 1). The changes in coping strategies are assessed quantitatively using a hazard adjustment theoretical framework provided by Burton *et al*. (1993). The framework provides three key important elements: hazards, livelihood and adjustments. Drought hazards are anthropogenically induced changes resulting from prolonged deficits in rainfall and hotness (UNESCO, 2018).Within agropastoral areas, the main changes are prolonged deficits and seasonal variations in rainfall which vary from few months to years (IPCC, 2001). The prolonged deficits and seasonal variations are characterised by drought and severe dry spells. Drought is a prolonged period of rainfall deficit, always below the threshold values which can no longer support crop growth (WMO, 2016). Drought is described as a situation of limited rainfall substantially below what has been established as a 'normal' value for the agropastoral areas, leading to adverse effects on human welfare. Droughts occur when rainfall received is below the expected normal or actual amount. While, severe dry spells are defined as the consecutive non-rainy days during the wet season, varying between 7 to 30 days in a season (Banda, 2015; USAID, 2017). In the cattle corridor of Uganda the frequency of droughts and the severe dry spell cause loss of crops, death of livestock, drying up of water sources, among others (Mulinde *et al*., 2016). Livelihood on the other hand, includes the means through which people get food, water and income to earn a living (MAAIF, 2018). In this study agropastoralism is considered as livelihood where people with settled life style grow crops and rear livestock to earn a living (Reid *et al*., 2014). Cropping patterns among the agropastoral communities is predominantly by growing drought resistant crops including the grains, legumes and plantains (e.g. maize, beans, groundnuts, millet, sorghum and others). Variations in amount of rainfall in central and southern parts of the cattle corridor in Uganda allows growth of perennial crops especially bananas and coffee, although these are sensitive to increasing severe dry spells and droughts (Najjuma *et al*., 2021). Leafy vegetables are now part of the agropastoral livelihood, mostly grown in marginal areas (wetlands) and to some extent under small scale irrigation (Monjane, 2016).

In this study, coping strategies are short-term measures taken on by farmers subjected to drought hazards that stretch them beyond present livelihood. Agropastoral communities' coping strategies vary greatly according to the type of drought hazard and cultural setting. Communities use purposeful coping strategies which directly relate with the droughts such as changing to drought resistant crops, sending cattle to other areas, work elsewhere, storing food for the next season, seek income by selling crops, plant cassava, plant additional crops, among others (Mfitumukiza *et al*., 2017; Twongyirwe *et al*., 2019a). Some incidental coping strategies are subsidiary used pray for end of drought, turn to relatives, employ rain makers, government relief, use savings and others (Egeru, 2015 ; Twongyirwe *et al*., 2019). This study uses a theoretical framework to help explain the changes in agropastoral coping strategies in face of drought and severe dry spells. Through this framework, household drought knowledge is used to explain the existing drought effects on cropping livelihoods and purposeful coping strategies undertaken. Drought records for the last thirty years (1991-

2020) were a basis to examine agropastoralists changes in crop yields, crops grown and other short-term coping strategies. Hence, detailed understanding of the key shifts in cropping in relation to drought changes helps to explore further the internal changes in drought resistant crops used and short-term alteration of consumption patterns for the communities before, and during droughts (Fig 1). This conceptual framework examines the main agropastoral purposeful coping strategies for crops amidst drought and severe dry spells in the cattle corridor.

METHODS

Description of the study area and agropastoral practices. The study was confined to the agropastoral districts in Uganda's cattle corridor between Latitude 1^0 30'0" South and 4^0 20' 15" North; and Longitude 30^0 00'0" and 34^0 50' 15" East (Figure 2).The districts represent diverse agro-ecological, production, social and institutional settings and are representatives of agropastoral farming areas in Uganda. Dominant livelihood in these districts is rainfed, with over 90% engaged in subsistence crop (beans, maize, and cassava) and livestock (cattle, goat, sheep and chicken) production. The districts are said to have varying proportions of food poverty, with central being 32% , south 16% and northeast 75% by 2019/2020 (UNHS, 2020).

The study sites included Nakasongola and Nakaseke districts located within central wooded savanna region (Central Buganda). It covers 22,682.6 km^2 of Uganda's total land area (Rugadya, 2006). The rainfall pattern is bi-modal, spread over two growing seasons (March-May and September-November). Average annual rainfall ranges between 750 to 1000 mm, while temperature ranges from 15 to 35.2^0C. The region is drier in June-August and December -February probably owing to the dry North East trade winds blowing over the area (Nimusiima *et al.,* 2018). The topography consists of gently to very gently rolling hills and plains, at an altitude of mostly 1,000 - 1,400 m. Furthermore, the zone is dominated by short savannah grasslands, shrubs and thickets and fairly productive ferrallitic soils (Mpairwe *et al*., 2011). These edaphic and vegetal characteristics support both crops (cassava, beans, millet, maize, coffee and bananas) and livestock farming (cattle, goats, sheep and poultry) practiced by the Baluri, Banyarwanda, and Baganda ethinic groups.

The other study sites, Sembabule and Rakai

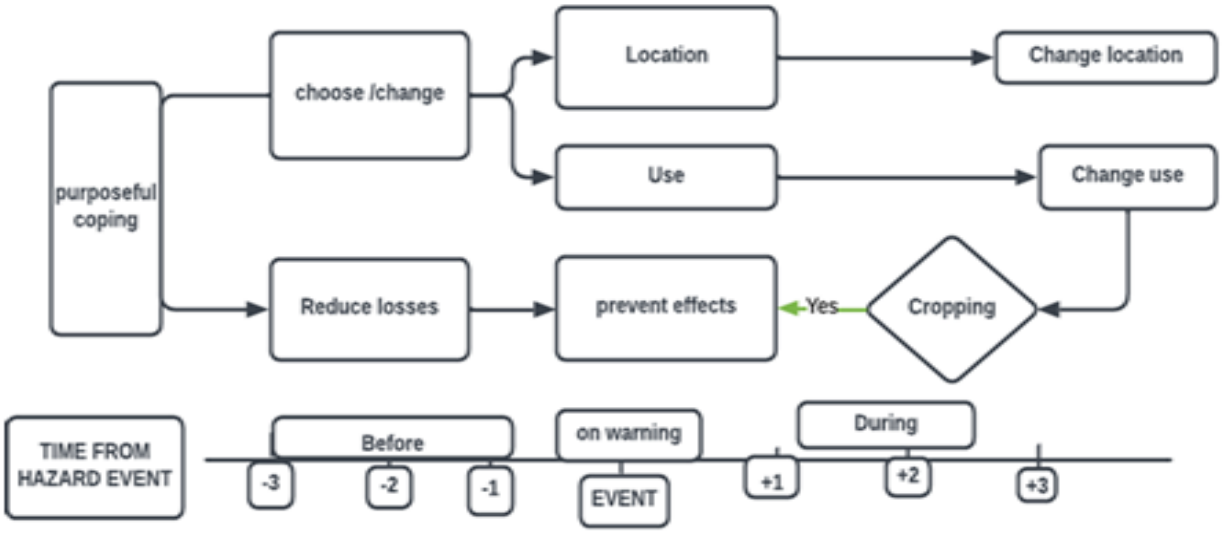

Figure 1. Choice of crop-coping strategies

Source: Adapted and modified from Burton *et al*. (1993). Coping begins with an initial choice of a resource use, livelihood system and location

districts, are located in the south-central region of Uganda (southwestern grass-farmlands). It covers 20,502.4 km^2 of the total land area in Uganda. The rainfall pattern is bimodal, spread over two growing seasons (March-May and September-November). Average annual rainfall ranges between 920 to 1050mm, while temperature ranges from 12.5 to 32.2^{0}C (GoU, 2017). The region experiences severe dry spells in the months of June -August and January – February. Productivity varies from place to place, depending on rainfall, depth and humic topsoil. The soil is generally suitable for grass but marginal for crop production mainly maize, beans, bananas, and cassava. The available grass-lands encourage cattle, goats and sheep rearing practiced by Banyarwanda, Banyankole, and Baganda.

Two other districts were studied, Napak and Nakapiripirit, located within the Northeast savanna grasslands (south and east Karamoja). The region covers 59,515.4 km^2 of Uganda's total land area. The rainfall pattern is unimodal, spread from April–November, with peaks in May - July and minimum in June, the temperature ranges between 15-36.2 ^{0}C (Mubiru, 2010). In this region, agropastoral zone occupy area with annual rainfall of 500-800mm with rains erratically distributed (USAID, 2017). The topography consists of a low plateau and rolling plains, and broadly rolling to flat plains at an altitude of 1000 - 1440m. The vegetation is mainly of grass savannah made up of hyparrhenia, combretum, Brachiaria, acacia trees and thickets. Soils are sandy, ferralitic and loamy with low water holding capacity. Communities depend extensively on beef cattle, goats, sheep, camels, poultry, cassava and sorghum. The main livelihood activity is agropastoralism, practiced by the Dodoth, Jie, Bokora, Matheniko, and Pian living in the area. However, such characteristics makes the zone highly vulnerable to drought, floods and pests and diseases. With Napak having 30% (4474 km^2) and Nakapiripirit with 21% (4182 km^2) of the land areas highly prone to drought hazards (OPM, 2019).

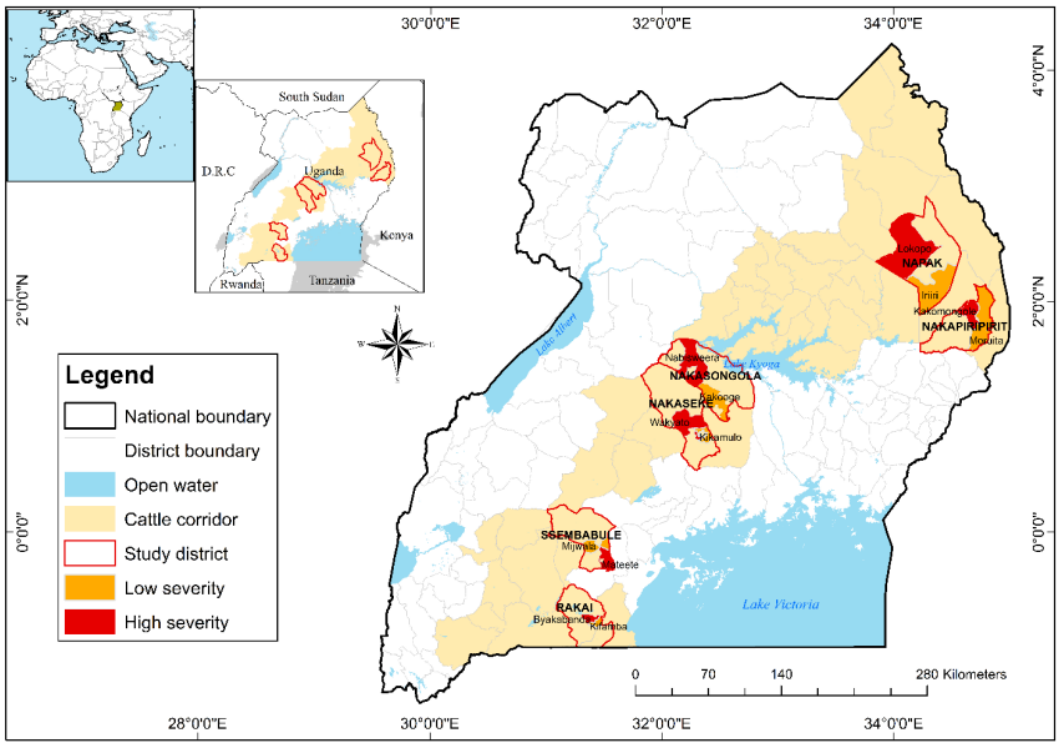

Figure 2. The Uganda cattle corridor and the selected study districts with agropastoral activities and severe droughts: modified from (Mubiru *et al.*, 2017)

Data. Both primary and secondary data were used in this study to understand the nature of changing climatic conditions in the six agropastoral districts.

To address the study objective, primary data set was collected between February 2022 and May 2022 in six agropastoral districts which ar part of the cattle corridor in Uganda. The sample was designed basing on three regions: (i) Northeast; (ii) central and (iii) South. To obtain the representative data set for the regions, data collection followed a two stage sampling strategy. First, stratified sampling to obtain the agropastoral villages and second, random selection of at least 10 households per village. The households were selected basing on their age (>30years), period of stay (>10 years), size of the household (>3 members). The elderly/ sickly /illiterate household heads were represented by either their spouses or an elder son/ daughter. The cross-section data collected essentially provide the baseline against which coping strategies are measured, i.e., the study did not collect data on household adaptation and its interaction with drought.

This survey consisted of two key components: a household survey and village survey (focus group discussions). The asset and innovation variables were collected basing on data from both surveys. However, the village surveys were not detailed enough to match with the household survey, and upon matching the available household and village data sets our total sample filtered includes 426 households for the six districts.

Secondary data was also collected. This consisted of historical data mainly on rainfall from 1991-2020. The total monthly rainfall mean for 1991 to 2020 were retrieved from World Bank data base (pr_climatology_annual-monthly_cru_1991-2020_UGA), for the study areas because of its complete historical weather and climate records. This consisted of mean monthly rainfall and temperature data from which monthly and annual means were calculated and probability of droughts generated.

Statistical Analysis. Data were analysed using excel and STATA, and the differences at $p<.05$ were considered significant. The variations in household coping strategies was checked against season and the number of household coping strategies. The X^2 test was used to check the independence and significance of the distribution of household coping strategies. ANOVA was used to check the significance difference between the household coping strategies means. Graphs, and cross tabulations of variables of specific interest were generated and discussed. Regression analysis was performed the linear trend in seasonality of rainfall. Probability of rainfall variations was determined using coefficient of Variance (CV), which is a statistical measure of the difference between the data points and the mean value of a series. Greater values of CV indicate larger variability and vice versa.

RESULTS

Seasonal Rainfall variations. The total mean monthly and seasonal rainfall (Figure 3) indicates variations for dry season length where the first dry season (June to early August) for the central and south sub-regions is shortening while the second dry season (December to February) is erratic. While in the North East the length of the dry season now stretches from November to March, but still within the wet season during May and June severe dry spells are common. These statistics were also in agreement with people's perceptions who reported that the dry season and its length have been changing making it hard to rely on the wet season. Thus, the altered nature of the

dry spells increases shifts in the length of the planting seasons and the coping strategies. The Central region monthly values show merging two rainy seasons and two prolonged dry spells of June to august and December to February. The end of the first rainfall season is sudden while the second rainy season has notable dry spells for several days. This is because the study area lies in a transition zone of the country between areas with a clear bimodal rainfall in south and areas with a unimodal rainfall in the North. Rainfall seasonal length and onset of rains negatively affects the start of the growing season due to delays and prolonged severe dry spell in during the second rain season. In the South sub-region: Monthly values show two rainfall seasons and two prolonged dry seasons of June to August and December to February. The end of the first rain season and the start of the second rainy season is clear. Thus, longer dry seasons negatively impact the length of the growing season. The Northeast sub-region: Monthly values show unimodal rainfall season from April to October and a long dry season from November to March. The rain season is more variable, with intermittent severe dry spells between June and September. Thus, the start and end of the rainy and dry season have no marked clear differences.

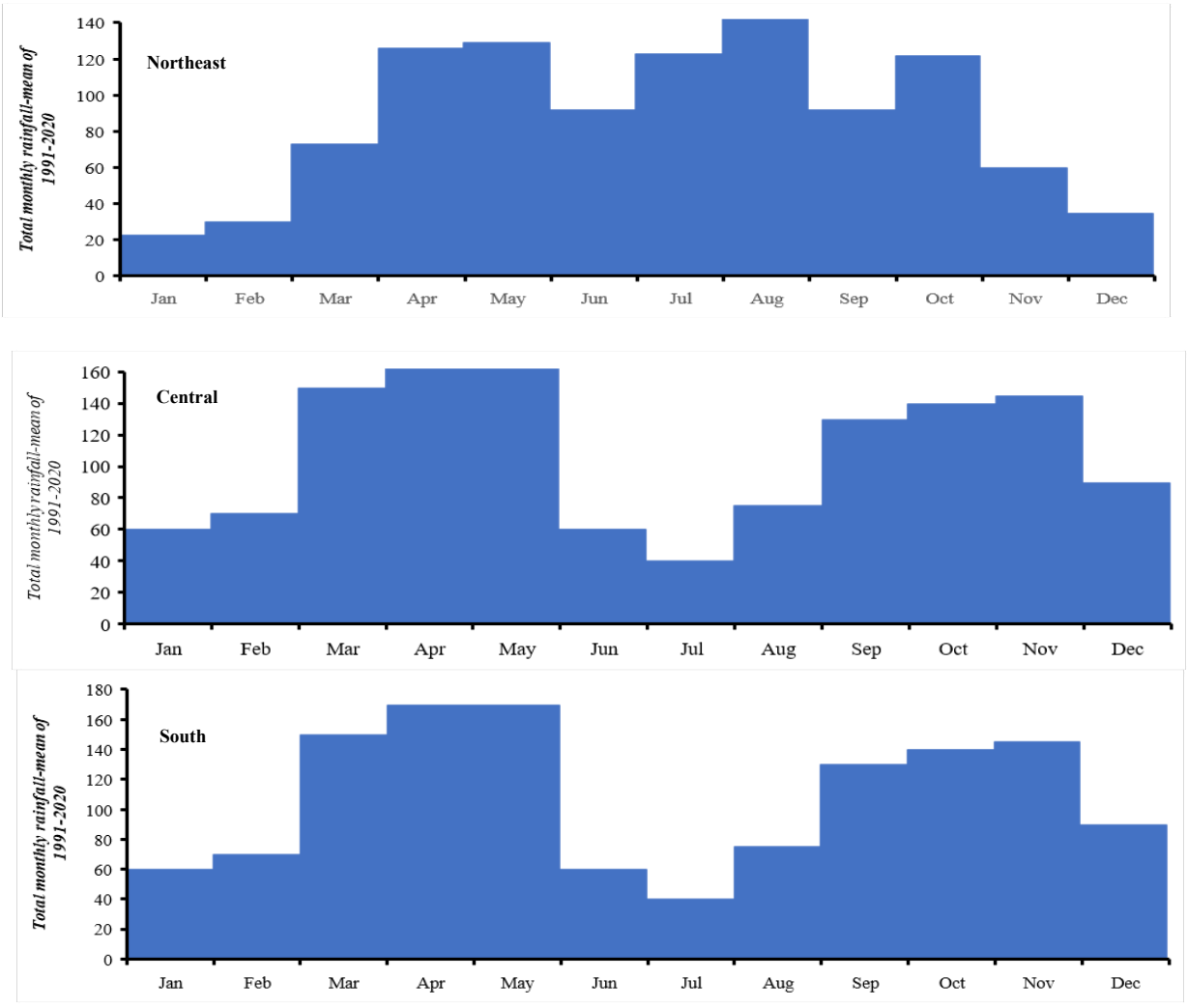

Figure 3. Total Monthly rainfall-mean of 1991-2020
Source: World Bank database 2023

The trend in the number of rainy day (Figure 4), in the last one decade greatly varied according to seasons, on average during the two rain seasons (MAM and SON) for central and south, average number of rainy days were above ten, while in the northeast the rainy days during the rainy season of (April to November), the months of June, August, September and November were below the average 10 rainy days. However, within the central region rainy days increased during the dry season (June, July and August), similarly the south had more rainy day during the dry season of December, January and February. These variations portray the varying seasonal spells existing across the cattle corridor agropastoral areas.

Results in Figure 5 show rainfall variability (the coefficient of variation [CV] of annual rainfall) in the different agropastoral districts. The CV for the agropastoral districts ranges between 38.1% (minimum CV value) and 53.3% (maximum CV value), Results show an inverse CV spatial pattern with respect to those observed for the annual rainfall, with a spatial gradient between the southern and the north eastern areas of the cattle corridor. Thus, the highest variability (CV values up to 53.3%) has been detected in the Northeastern cattle corridor (Napak district), which also shows the lowest values of annual precipitation. Conversely, the Sothern and central parts of the cattle corridor, show higher rainfall, evidenced by relatively lower CV values.

Agropastoral coping strategies. The scatter plot show droughts being associated with severe impacts on food availability and crop yields in the cattle corridor. The length of drought significantly (Fig.5-A) correlated with annual mean rainfall (r^2 =0.88). This coefficient of determination of 0.88 depicts about 88% of the drought length can be explained by the mean annual rainfall. Furthermore, the higher incidence of food shortage with coefficient of determination of 0.77 can be explained by 77% of mean annual rainfall variations (Fig.5-B). Therefore, as observed (Fig.5-C) households use a number of purposeful coping strategies to navigate through the period of food shortage. The strategies when correlated with annual probability of drought show a coefficient of determination of 0.98, implying that shifts in coping strategies among agropastoral communities can be explained by 98% being drought induced.

In addition (Figure 6), agropastoral communities coped with drought by applying purposeful coping strategies. The purposeful coping strategies mainly shifted to during drought were: change in planting dates, use of improved crop varieties, and sale of livestock, petty trade and consuming food banked. Whereas, the proportion of some coping strategies applied depending on degree of susceptibility varied (Table 1), in the central and Southern regions communities shifted to self-employment and watering crops. While in the Northeastern region, drought pushes communities into self-employment, begging and borrowing of food and money to earn a living. Such shifts in coping strategies were instrumental in determining what households do when they do not have enough food and money buy food. Amidst these short-term coping strategies, households employ alteration of consumption patterns through switching from preferred foods to cheaper and less preferred substitutes as well as increasing short-term household food availability.

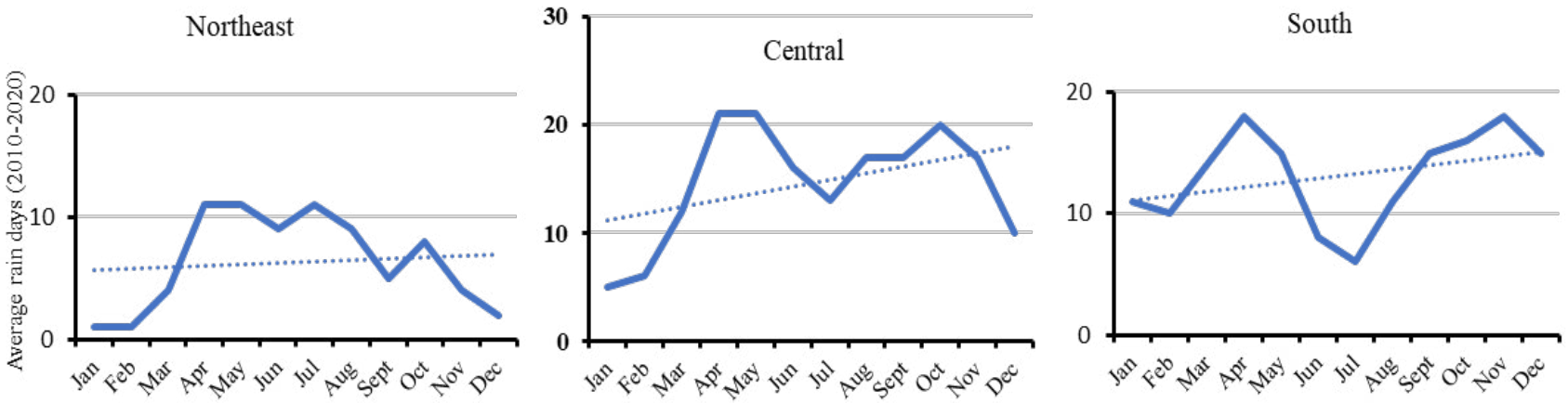

Figure 4. Trends in the number of rainy days from 2010 to 2020 in agropastoral areas. Fig.4-A: Relationship between length of drought and mean annual rainfall; Fig.4-B: Relationship between period of food shortage and annual mean rainfall. Fig.4-C: relationship between annual probability of drought and the coping strategies

Source: World Bank data base 2023

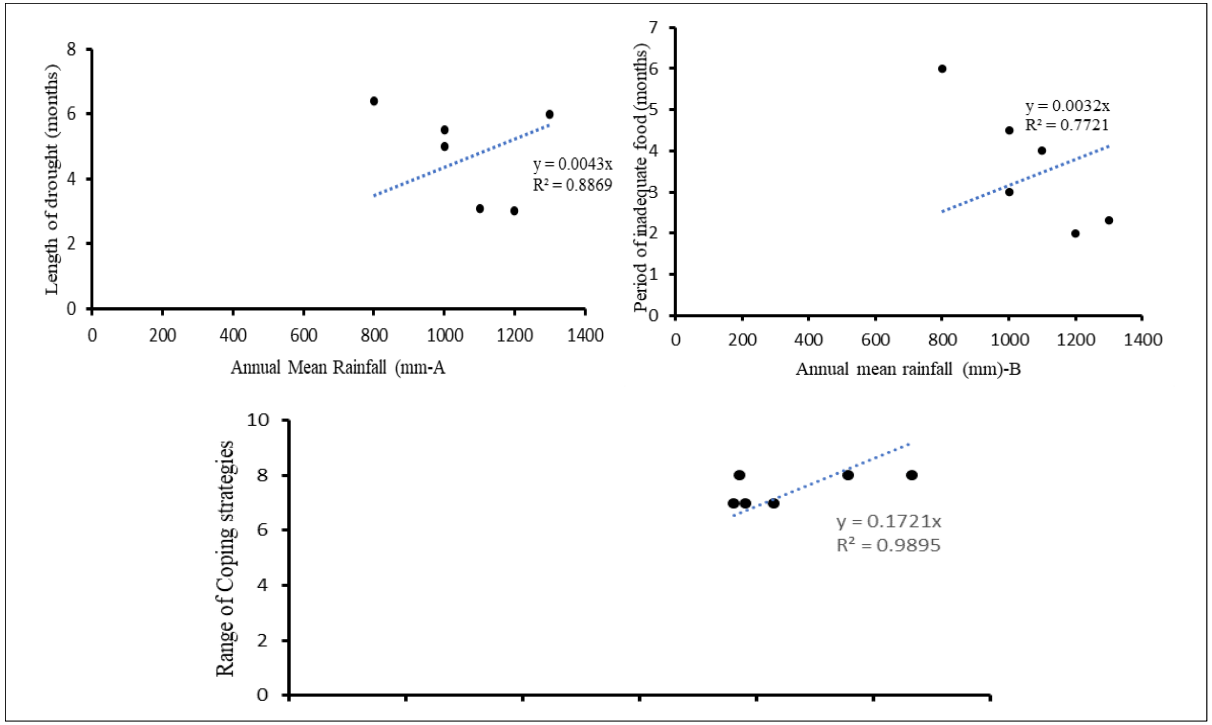

Figure 5. Relationship between drought and coping strategies

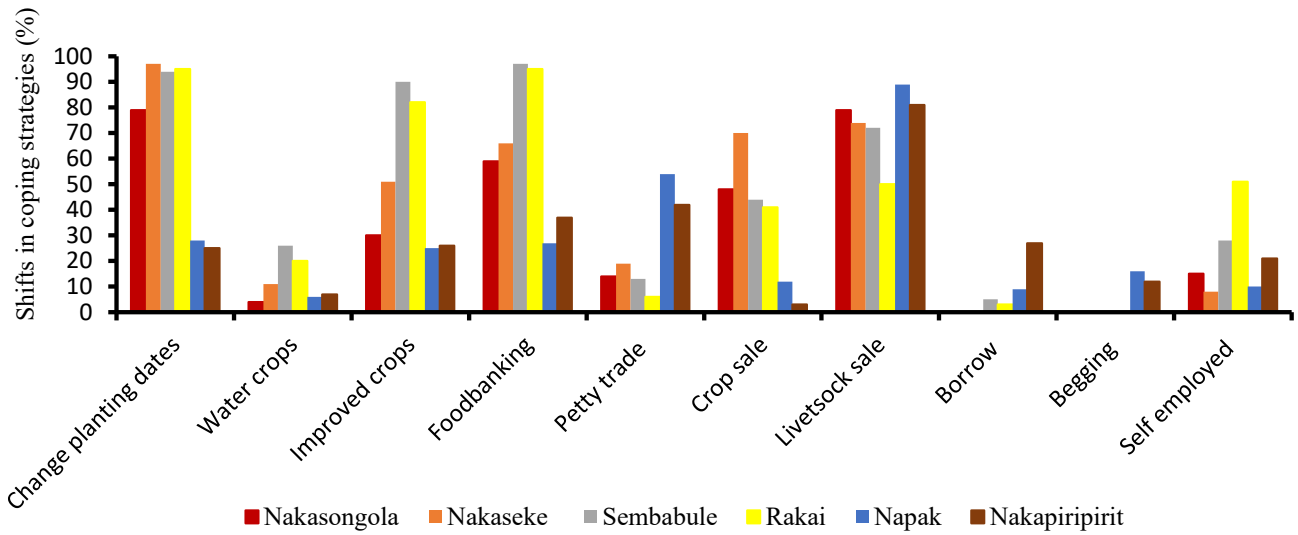

Figure 6. Shifts in coping strategies among agropastoral households
Source: Field survey 2022(n=426)

Table 1. Proportionate change in crop yield and consumption

	%-change in yield	% change in consumption
Matooke	-60	-41
Cassava	-60	-22
Potatoes	-50	-42
Irish	-80	-5
Maize	-81	16
Sorghum	26	-1
Beans	-79	-14
Ground Nuts	-87	-28
Leafy Vegetables	-68	-28

Source: Field survey 2022 (n=426)

Changes in staple food consumption. Among the ten prefered food crops that were consumed during normal and drought can classified into legumes (beans and groundnuts): grains (maize, sorghum, rice); plantain (matooke), tubers (sweet potato, potato, cassave), and leafy vegetables. These crops show substantial variations in consumption as observed when the dry season occurred (Figure 7) Overall, consumption variability can be explained based on classification of the crops consumed for the study sites. Various relations holds for all the crops but exhibits differing changes. specifically the legumes consumption in the normal periods were relatively highy affected during drought as illustated by the average percentage change in consumption. Forintance, groundnut consumption had a substantial decrease of up to 28% and beans of 14%. Plantains which were a stable food crop in the central region decreased subatantially in consumption due drought. Tuber the most affected by drought, e.g. sweet and cassava significantly decreased. Wheras grains had a significant increase in consumtpion during drought periods, e.g. maize consumtpion increased by 16%. And finally vegetables had

a significant decrease in consumption during drought, illustrating the impact of drought in causing water shortage.

DISCUSSION

The study notes that there were evidences of high rainfall variability typical of the cattle corridor, where the coefficient of variations range similar to the ones obtained in past studies performed in Karamoja and central cattle corridor, especially for the maximum values (Nanziri *et al*., 2022). In fact, a high inter-annual variability has been detected in North-eastern cattle corridor, with values higher than 55% (Mubiru, 2010; Egeru *et al*., 2019). Conversely, a belt along Southern Uganda, with moist climate conditions evidenced Coefficient of variance values lower than 10% (Twongyirwe *et al*., 2019a). Differing from past studies analyzing rainfall trend in the cattle corridor, this study also focused on the identification of change within severe dry spells in the seasonal rainfall series, which in the past years has been mainly performed in Northeastern. In particular, this study evidenced similar results with the ones obtained further in central and Northeast in the cattle corridor, where studies have tended to identify changes in seasonal rainfall since 1960s, with numerous peaks of the well-known severe droughts and severe dry spells within a rainy season (Nimusiima *et al*., 2013; Nsubuga *et al*., 2014; Egeru *et al*., 2019). Therefore,

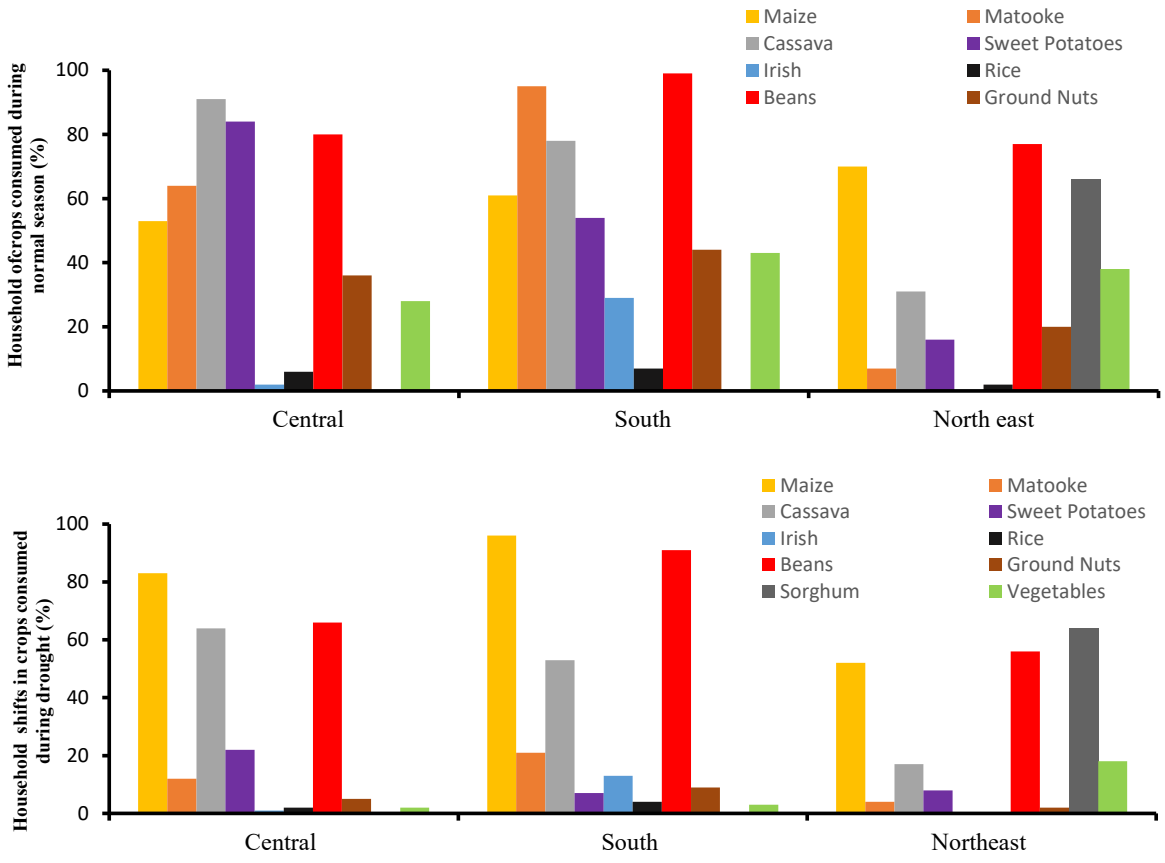

Figure 7. Proportion of household shifts in food consumption strategies during normal and drought season. Source: Field survey 2022(n=426)

recognizable seasons, and unusual events occurring more frequently especially heavy rains occurring in dry seasons and dry spells in rainy seasons. These changes in monthly rainfall and rainy days have significant impact on agropastoral farm-level activities (i.e., pre-production, production, post-harvest and marketing). During these stages more changes are pronounced and these spike numerous and critical changes in the coping strategies.

The seasonal shifts in rainfall and rainfall days directly causes shifts in coping strategies among agropastoral communities is consistent with previous studies (Mayanja *et al*., 2015; Twongyirwe *et al*., 2019b: Nanziri *et al*., 2022). There is a positive relationship between rainfall and landuse in the cattle corridor (Byenkya *et al*., 2014 ; Byakagaba *et al*., 2018; Mbaziira, 2019). The tendency for rainfall to decrease with decrease in productivity is consistent with a study conducted in the central cattle corridor on the Vulnerability of Maize yields in Uganda. The results of this study show that Maize yields in the North (including Northeast) of Uganda are more vulnerable to droughts than in other parts of the country (Epule *et al*., 2017). In agropastoral areas of the cattle corridor, this can be explained by the fact that, the central and southern parts, rainfall is bi-modal (March-May and September –November) and Uni-modal in the Northeast (April-October). (Nimusiima *et al*., 2013; Najjuma *et al*., 2021). The low levels of rainfall continually recorded in Northeast can also be used to explain further the higher level shifts in coping strategies (Muwanika *et al*., 2019; Asiimwe *et al*., 2020).

Purposeful coping strategies households shifts (Figure 8), indicated drought as a known hazard for causing crop failures and forces households to purposively cope by growing drought tolerant crops especially cassava, Maize, Sorghum and green-gram (beans). These crops are dual-purpose, provide grains as food for the people and their residues used as feed for livestock. Traditionally, these crops are contextually affordable and effective because they adapt to water- stressed conditions and also have low feeding habits and nutrient needs. This concurs with the study by Nimusiima *et al*. (2018) which demonstrated that producing diverse range of maize breeds was an important component of food security and adaptive capacity to drought in the central cattle corridor. Thus, increased demand for dual-purpose crops within the cattle corridor, provides practical responses to droughts as it usually increase household income and food security while decreasing drought vulnerability (Zake, 2015; Epule *et al*., 2017). Although, these crops are dual-purpose, few households acknowledge them, because the crops are highly risky and susceptible to recurrent droughts during the growing process (Mfitumukiza *et al*., 2017; Twongyirwe *et al*., 2019a). This is evidenced by communities attesting to specific non-crop growing coping measures like; self-employment and sale of crops especially those treated as cash crops (coffee in central and southern region, sorghum and cassava in the Northeast). Food insecure household largely employ consumption coping strategies: borrowing food or purchase on credit, change of diet (change from preferred to cheaper diet), reduce the number of people in the family and rationalization of food.

Specifically, agropastoral households rely on two purposeful coping strategies: borrowing or begging and change of diet (change from preferred to cheaper or available diet). Borrowing is a prominent feature of households in the Northeast, at the extremes, food insecure households employ begging using women and children in the nearby urban areas, although this may not be a substantial substitute of the situation, but a modest means to curtail death (Maxwell *et al*., 2003). In other findings, borrowing of saving was found common as this concurs with FAO (2016), that within Napak

district, in small scale and loan saving groups members could save over 12 million and this could be good for gap filling e.g. school fees payment and buying food during drought years. While Lybbert *et al*. (2017) noted that over 60% agropastoral households in the cattle corridor cannot borrow due to lack of collateral and financial information. However, in the same study it was noted that the drought of 2015 led to high cost of cereals and this rendered women who brew beer not to afford buy these cereals. Thus, the growing drought effects among the agropastoral communities directly affect the short-term coping strategies applied.

There been continued reduction in consumtpion of legumes during drought among the agropastoral communities, this illustrates how communities in face of adversity resort short term coping strategie. This decrease in legume consumption is in line with the findings by Templer (2019), who attest that during prolonged rainfall deficits, crops wither and this leads to inadeqaute food stocks and a general decrease in seed availability. In addition , productivity of these crops overtime has been hampered by limited adoption of improved varieties leading to low output and poor functionality of seeds amidst droughts (Kakeeto *et al*., 2019; Templer, 2019). Within the cattle corridor, understanding the challenges and opportunities of these crops helps to reduce the vulnerabilities implied by Epule *et al*. (2017). Accoridng to Epule *et al*. (2017), vulnerability of crops like maize to drought in Uganda ideally register losses of 5% annually, which renders the communities to seek for alternative crops whose quality is unrelaible and quantity of output is sub-optimal. Consequently undermining productivity, as weather variations renders major yield losses (GoU, 2008).

The results further illustrate a strong relationship between yield shifts and consumption. Where decrease in average maize yields (81%) did not relate to a reduction in consumption but rather an increase in consumption by 16%. This indicates that during times of drought agropastoral communities mainy consume maize. Thus, maize is either privately solicited or provided through aid. This finding concurs with Caravani, (2019) views that food aid received in the drought year substantially increases the consumption rates of maize.

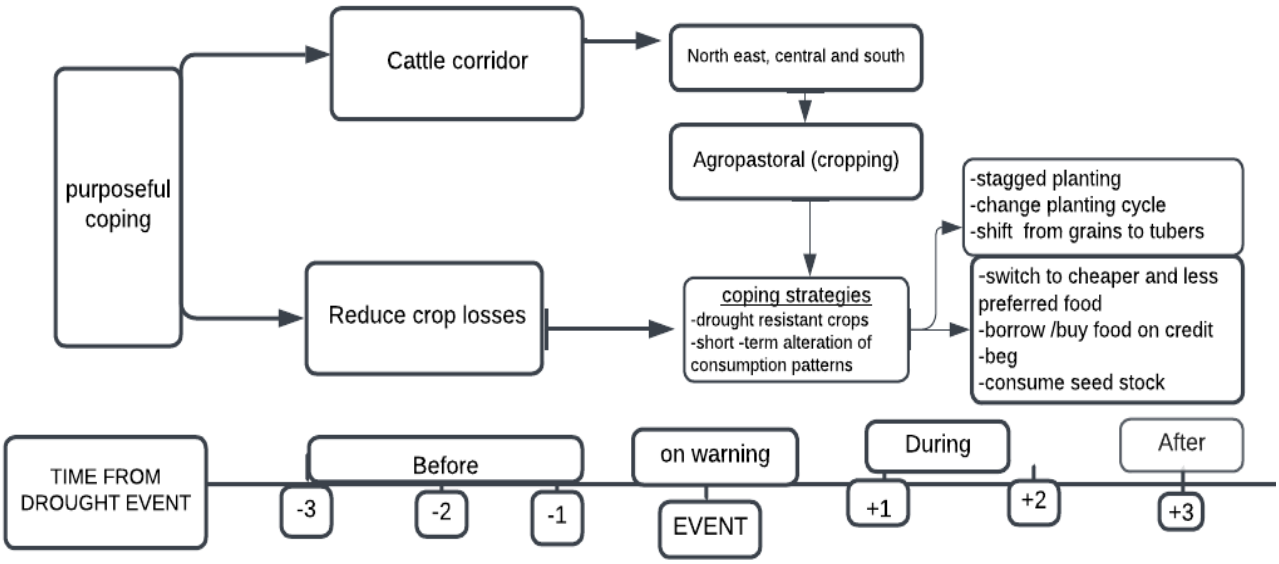

Figure 8. Choice of crop-coping strategies among agropastoral communities

Furthermore, the results show more of the root tubers are consumed during the normal periods and reduces during the drought periods. Whereas the consumption of cereals increase during the drought periods. This illustrates coping mechanisms that agropastoralists engage in times of hardships. This is illustrated by the ease in accessing cereals and grains as compared to tubers (Templer, 2019). This finding is consistent with the discussion that tubers such as cassava and potatoes are scarce during drought season which leads to increase in their prices and consequently a decrease in their consumption (Global Network Against Food Crisis, 2022). Moreover, tubers are known to succumb to warmth in the soils as a result of deficiency in soil moisture during drought (Rufino *et al*., 2013). Vegetables are succulent crops that are highly dependent on water availability. Any shortage of water or drought condition ultimately affect the production of leafy vegetables, For instance, many argue that water scarcity affects loving crops leading to their stunted growth, poor seed germination and withering (Muwanika *et al*., 2019).

There were also noticeable changes in planting cycles in the North east. Reliance on rainfed crops planting cycles shifts as rainfall seasons were interspersed with the dry seasons (USAID, 2017). The cropping cycle agropastoral communities usually defined by the onset rains in April for beans, and sorghum while millet and sweet potatoes are grown in August/ September when soil conditions and rain allows (FAO, 2021).

Thus, the results imply that occurrence of drought essentially leads to consumption changes, confirming the importance of re-assessing the drought impacts on coping strategies as pursued by the study. It is clear that all shifts in coping strategies indicated were outcomes of the drought on agropastoral households such as switching from one crop to another, but the study does not attempt to measure the frequency (how often is the coping strategy is used) and severity of use (what degree of use is suggested?) of these coping strategies. Thus, information on frequency and severity of change in diet and borrowing needs to tested and generate indices for future reference.

CONCLUSION

In this exploratory study, shifts in coping strategies among agropastoral households demonstrated significant variations with annual probability of drought. Mainly, the North-East has a higher coefficient of variance which shows higher impact of drought on the coping strategies, with begging and borrowing of food and money. The study shows direct relationship between shifts in coping strategies and household food crops consumed in all sites. These significant relationships exhibited that calls for urgent attention were: decrease in maize yields does not relate to a reduction in consumption but rather an increase in consumption; and increase in sorghum production in the Northeast which resulted into decrease in consumption. Given this research covers drought and coping strategies, as one of the focus areas of the National Adaptation Plan for Agricultural sector (NAP-agric), findings from the current study provide a basis for an indepth longitudinal survey to reveal the association between frequency and severity of use of these coping strategies in agropastoral communities. The resulting information could then be used to provide locals with solution of purposeful coping strategies that enhances food security.

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STATEMENT OF NO-CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in this paper.

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