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Drought Stress and Adaptation Strategies in Kumi and Amuria Districts of Uganda

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Abstract. This study investigated smallholder farmers' drought adaptation strategies in 246 randomly selected households in Kumi and Amuria districts of Teso sub region of Uganda. Primary and secondary data were collected, the former through individual interviews, focus group discussions and key informant interview and the latter through document review. The results revealed that drought stress was above -4 kilo pascal within the period 2006–2016. The adaptation strategies applied included cultivation of food crops that can be preserved and offering of labour on other people's farms as a survival strategy. Promotion of early warning mechanisms; easy access to farm inputs; group formation and consolidation; and affordable irrigation technology are recommended to enhance farmers' resilience.

Keywords: Climate extremes, drought stress, adaptation, smallholder farmers.

Introduction

Mean global temperatures have increased the risk of climate extremes and Smallholder farmers in developing countries are the most affected (IPCC 2014). This continuous extreme weather conditions such as drought, floods is one of the major environmental factors limiting agricultural productivity (Niles *et al*, 2015). Drought is manifested by increased temperatures, evapotranspiration from plants, reduced water flows, low rainfall and soil moisture (Bachmair et al, 2016). The vulnerability, coping and resilience of farmers to these extreme climatic events in semi-arid farming systems need to be addressed through different adaptation strategies (Kalele *et al*., 2021). Smallholder farmers should be able to identify the changes already taking place in their areas to institute appropriate coping and adaptation strategies (Belay *et al*, 2017).

Several factors determine farmers' adaptive capacity to extreme weather events: household size, wealth, farm size, farming experience, perception of soil fertility, access to credit, extension services and off farm activity (Wannasai *et al*. 2013). For example, the small holder farmers in Zimbabwe, South Africa and Ethiopia, devised climate variability adaptation strategies including agroforestry (Mugi-Ngengaa *et al,* 2021). Another case scenario was registered in Kenya where some communities reduce the size and number of meals to only one per day and walk long distances in search for water (Makoti & Waswa, 2015). This form of adaptation is key in building farmers' resilience against drought (Conrad *et al.* 2014). The recurrent seasonal droughts in an area tend to influence and transform farming practices, farmers' enhanced resilience and adaptability (Abraham *et al.* 2017). Meanwhile increased investment in infrastructure, food security, encouraging group formation, and easing access to financial services promote implementation of adaptation strategies applied by farmers (Kelvin *et al.* 2017).

In Uganda, several parts have been severely affected by drought especially Teso, Karamoja, parts of Busoga, and Northern Uganda regions (Twongyirwe *et al.*, 2019). This has greatly affected agricultural yields, food security, increased prevalence of pests and diseases, led to scarcity of water for human and domestic animal use (Wamboga 2016). An economic assessment on impacts of climate change variability in Uganda indicates that it will contribute to loss in agriculture, water, infrastructure and energy sectors (CDKN 2015). According to Global Facility for Drought Resilience and Relief (2017), drought affected close to 2.4 million people in Uganda between 2004 and 2013, causing loss and damage of properties equivalent to 7.5% of the country's GDP of 2010. This therefore means that local adaptations require external financial assistance given the complexity of some drought adaptation measures that cannot easily be embraced by smallholder farmers (Kalungu *et al.* 2013). Agricultural technology options such as agroforestry, irrigation, intercropping, planting drought resistant crops, early planting, soil and water conservation as well as institutional support are some of the measures that positively impact on the smallholder farmers ((Twongyirwe *et al.*, 2019) Agroforestry is a low cost and viable strategy for reducing farmers' vulnerability to drought, although it's contribution to improved farmers' adaptation to drought needs to be well assessed (Mfitumukiza *et al,* 2017).

The vulnerability of smallholder farmers to current and future droughts will be high if available adaptation strategies are underestimated. This study therefore assessed the role of agroforestry as an adaptation strategy to drought in Kumi and Amuria districts in eastern Uganda. The objective of this study was to determine drought stress of the area between 2006 and 2016, farmers' perception of drought and its effects on livelihoods, adaptation strategies being applied and the role of Agroforestry as an adaptation measure to drought. Therefore, the research questions included; what is the state of drought in Kumi and Amuria district? How do smallholder farmers in the region perceive drought? How does the farmers' social economic status contribute to their resilience to drought? What is the drought coping mechanisms being applied by small holder farmers and the challenges they face in applying these mechanisms, how is Agroforestry important in addressing drought?

Characterization of Smallholder Farming

A small holder farmer is viewed as a person farming a small piece of land (Devotha *et al,* 2019), they total to 570 million (85%) worldwide (Lowder *et al,* 2016). These farmers form the backbone of food production, maintain the genetic diversity of food supply, a good source of nutritional deficiency and mitigate degraded ecosystems (Fanzo, 2017). Such farmers own on average ≤ 2 hectares of land, use family labour, practice mixed cropping and the proceeds are for meeting family needs (Devotha *et al,* 2019). Therefore, any changes in Agricultural productivity can significantly affect livelihoods of smallholder farmers (USAID, 2018) since they solely depend on it and have limited resources, therefore building their capacity to cope up with climate change shocks is key.

In Sub-Sahara Africa (SSA), most of the smallholder farmers depend on rain fed agriculture especially those countries whose economic main stay is agriculture. Therefore, unpredictability of climate and drought is still a challenge to many of the small-scale farmers, restricting their coping options and limiting their development (Gollin, 2014). Uganda in particular relies on rain fed agriculture, with smallholder farmers hardly hit by unpredictable occurrences such as drought, floods living them with less alternatives for livelihoods and increased over dependence on natural resources.

Climate Variability

Climate variability is the variation in the mean state and other statistics of the climate on all temporal and spatial scales beyond individual weather events (Malpeli *et al*, 2020). Extreme events of temperature and precipitation are some of the descriptions of climate variability. Shifts in temperature and precipitation, affects plant phenology, winter severity, drought and wildfire conditions (Malpeli *et al,* 2020). Climate may vary due to natural internal processes in the climate system or anthropogenic causes. Variations can be monthly, seasonal or yearly over a long-term statistic in the same calendar period. Climate variability greatly affects smallholder communities and biological systems who solely depend on them (USAID, 2018)

Projections indicate the globe is to warm 1.0-4.0°C by 2100 if unchecked (IPCC, 2021). This pauses threat to small holder farmers who are solely dependent on rain fed Agriculture.

In fact, long droughts in some parts of Uganda (Teso and Karamoja regions, lower Mt Elgon, some parts of Busoga and Central regions), in 2016, greatly affected crop yield (www.monitor.co.ug, 2016). In Uganda, weather-changing patterns, with more erratic rains is experienced between March to June (Wasswa *et al*, 2013) coinciding with long droughts. This includes increasing trends of hot days, warm nights and warm spells. Climate variability has been associated with El Nino and La nina (ACF, 2015).

Drought Tolerance

In Agriculture, droughts occur for a variety of reasons including low precipitation, the timing of water availability or reduced access to water supplies (Svoboda *et al.*, 2018). Drought can have many devastating effects on communities and the surrounding environment with the poorer communities having limited adaptation alternatives and being mostly affected (Action Aid International, 2014, Gukurume, 2013). Such vulnerable communities resort to exploiting natural resources for survival, including fragile lands, and inevitably become victims of drought effects. High level of chronic poverty contributes to low adaptive capacity to drought and threatens the lives and livelihoods of the poor (Gurume, 2013). A number of factors that determine communities' drought tolerance are well stated (Naumann *et al.*, 2013).

Farmers generally diversify their production systems by employing activities that are less sensitive to drought such as business in general merchandize, transportation which reduce their risk of exposure to drought. Other factors listed by Bekele *et al,* (2014) include: intercropping with different crop species in the same garden, early sowing, combining less productive drought-resistant cultivars with high-yielding but water-sensitive crops.

The ability of farmers to take fast decisions is an adaptive strategy which enables them switch between activities as the situation demands. Integrated strategies are required for drought management including farmer capacity building to enhance their ability to utilize climate information, improving farmer access to credit, use of early warning systems among others will create resilient communities in the face of drought. On the other hand, (Kelvin *et al.* 2017) recommended the need for farmers to focus on building healthy soils in order to cope with drought. In the same vein, (Tirado and Cotter, 2010) also pointed out the importance of planting cover crops, legume intercrops, manure and composts applications that make soil rich in organic matter and enhancing soil structure. In this way, it increases soil water holding capacity and making nutrients more accessible to plants, thereby being tolerant to drought.

Methods

Study Area

Location

The study was conducted in Kumi and Amuria districts in Teso sub region of Uganda (Figure 1).

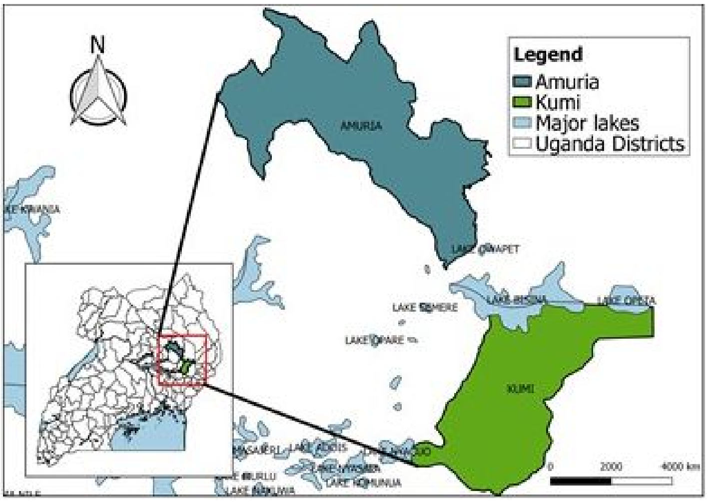

Figure. 1. Map of Uganda showing the location of Amuria and Kumi districts

The districts were selected because they are often greatly affected by drought and floods (UNDP 2014). Data was collected in the following parishes: Obotia and Akide (Ogino Sub County), Agolitom and Agule (Kumi sub county), Acowa and Amero (Acowa sub county) and finally Asamuk and Aparisa (Asamuk sub county) in Amuria district. Kumi is located between $1^{0}27'38.99''$north and longitude $33^{0}56'10.00''$East, at an average elevation of 980m (3,220 feet) with a total area of 1,070-km2at altitude between 1,036 and 1,127 m above sea level in modified Equatorial climatic zone. While Amuria is located at $02^{0}02^{1}$N $33^{0}39^{1}$E with district area of 2,613km^{2} (UNDP, 2014).

Vegetation

Teso sub region is characterized by Savannah grassland with scattered tree cover mainly due to indiscriminate tree cutting. Climate is modified Equatorial type. Rainfall pattern is bi-modal with peaks in April-May and July-August. Annual mean temperature is 24^0C and rainfall is 800-1000m. Of recent, rainfall patterns are erratic and unpredictable. Heavy dependency on fuel wood for domestic use, charcoal for sale and poles for building has resulted in deforestation, affecting weather pattern in the area.

Soils and Topography

More than half of Teso sub region soils are sandy posing a great risk of leaching and erosion especially when poor cultivation of such soils, soil fertility is lost and yet our farmers hardly add nutrients to the soil. The sandy soil's water carrying capacity is low compared to loam clay soils. Generally, Teso sub region is flat with few undulations and isolated inselbergs in Nyero and Makongoro sub-counties. Soils are predominantly shallow grey brown sandy loams over laterite and greyish brown sands and sandy loams whose parent material is lake deposit derived from basement complex granite, gneisses and other materials. These can support Agriculture production of leguminous, cereals and tuber crops. Wetlands/swamps are covered by often-calcareous black and grey clays whose parent material is river alluvium. Some patches of Amuria are covered by other soil types including grey clays with occasional sand (UNDP, 2014).

Climate

Teso region is characterized by bi-modal type of rainfall with peak periods of March-June, and September- November, experiencing pronounced erratic weather conditions with excessive rainfall within a short period leading to water logging and lack of rainfall for a long period (not less than 3 months leading to drought. Thunderstorms accompanied by heavy winds usually occur at the onset of every rainfall season, often resulting in destruction of buildings, trees, vegetation, crops and sometimes life. Occasional hailstorms during rainfall peaks can result in the destruction of crops and even livestock.

Socioeconomic Background

Economically, Teso sub region is predominantly agricultural region of a population more than 90% in subsistence agriculture with little commercial farm production. This implies agriculture is a source of food, income, employment and other social benefits. During late 1980's and early 1990's, the communities suffered loss of livestock by Karimojong cattle rustlers from the neighbouring districts of Kotido and Moroto. Though government-restocking program has been on going, the original level of livestock is not achieved yet. During drought, people go for gathering and hunting wild animals, especially along the border with Karamoja, where there is vast expanse of land while wetlands are for fishing. A small percentage of community members engage in business and formal employment, in the district public service and non-government sector. Business includes trade in farm produce and manufactured goods sold in shops and weekly markets. Those employed have a responsibility of supporting their extended family members by sharing their earnings.

Study Population

The target population was the smallholder farmers in Kumi and Amuria districts. Kumi has a population of 236,694 (National Population and Housing Census 2020) with annual population growth rate of 4.5%. Out of the total population, 112,719 are male and 123,975 females. Majority of the people stay in rural areas with a population of 224,945 while in urban areas they are 11,749. Amuria has a population of 270,601 with 139,068 females and 131,533 males (National Population and Housing Census, 2020).

Data Collection and Analysis

Multistage sampling was employed to select the area of study. Teso region was purposively selected because it is severely and frequently affected by drought and floods (UNDP, 2014). Kumi and Amuria districts were randomly selected while the sub counties were selected with the help of the District Natural Resources and District Forestry Officers who identified the areas that are prone to drought. Households were selected randomly taking into account those who have lived more than ten (10) years in the area, opinion leaders and gender were also considered.

We interviewed 246 household heads using both open-ended and closed questionnaire. The questionnaire was pre tested and computed using Cronbach alpha for reliability and consistency, the alpha value was good (0.71–0.91) (Taber, 2017). The questionnaire had four (4) sections including socio demographic status of household head (respondent), farmers' perception of drought, adaptation mechanisms to drought, application of Agroforestry practices. Questions were asked focusing on small holder farmers' understanding of drought and its effects, coping mechanisms and application of Agroforestry on farm as an adaptation measure to drought. Most respondents were interviewed from their homes and few were in their gardens the interview on average took 20 minutes.

15 Focus group discussions consisting on average of 9 people were considered, these included at least 4 men and 4 women, a representation of youth and elderly was highly considered. A checklist of six (6) questions was used in Focus group discussions and this took on average two (2) hours. Some local leaders participated in FGDs and these included; Local Council III Chairpersons, sub county Production Officers, Parish Chiefs and Local Council II Councillors in parishes, Parish Chairperson Disaster Committee.

Key informant interviews were conducted constituting of 7 people per district with people who were knowledgeable about climate change and drought in particular, these were selected from government, non-government and civil society leaders. The following participated in Key informant interviews: District Forest Officers, District Natural resources officer, District Environment Officer, District Agricultural Officers, sub county Chiefs, field staff from Teso Diary Development Organization (TEDDO) and Heifer International, Operation Wealth Creation Coordinators, field staff from Red Cross-Uganda and Soroti Catholic Diocese Integrated Development Organization (SOCADIDO). Secondary data was collected from Uganda Meteorological Authority on temperature and precipitation to determine drought stress in the study areas over a period of 10 years (2006 to 2016). Drought stress in the area was determined using the Palmer Drought Severity Index (WMO and GWP, 2016) from 2006 – 2016 at different drought levels and other literature from books, journals, working papers were studied.

Responses from questionnaires were categorized in a set of replies of the same theme; these were entered in excel sheet, cleaned and checked to ensure that the data has been recorded and entered properly. For open ended questions, responses were coded under similar answers with coding1for "affirmative response" and 0 for "no answer/response", to speed up data entry into SPSS. Data was later exported to statistical package for social sciences (SPSS version 20) to generate statistical summary of adaptive practices. For close ended questionnaires, a five-point Likert was used to code farmers' responses rating from 1 – 5 (1 for very less and 5 for very high) Data was subjected to ANOVA to show variation in adaptation strategies employed by the small-scale farmers in the study areas. The level of drought stress in the area was determined using Palmer Drought Severity Index (PDSI) (WMO and GWP, 2016).

Results

Socio-Economic Characteristics of the Respondents

Socio-economic status of a community is key for their adaptation to climate change effects. The respondents were 70% male and most (63%) of them had primary and secondary education (21%). Majority (76%) of the respondents were married and the rest were either single, divorced or widowed (Table 1). Their main occupation was farming (87%). The low education and income levels of the communities in Kumi and Amuria districts could have had a negative bearing on the ability to adapt to drought effects.

Table 1. Socio-economic profile of the respondents

Category	Status	N	% Of respondents
Sex of the respondents	Male	172	70
	Female	74	30
	Total	246	100
Level of education reached	None	29	11.8
	Primary level	155	63.0
	O' Level	52	21.2
	A' Level	5	2.0
	Tertiary/University	5	2.0
	Total	246	100
Marital status	Single	30	12
	Married	187	76
	Divorced	12	5
	Widowed	17	7
	Total	246	100
Main occupation	Farming	214	87
	Business	10	4
	Formal employment	10	4
	Self employed	5	2
	Studying	7	3
	Total	246	100

Family Land Use

The mean age of farmers in Kumi and Amuria districts was 41 years with mean size of family members as nine (9), indicating high level of maturity and responsibility because at this age one has both children and grandchildren and other relatives to take care of (Table 2). Mean land size owned is 3.8 acres out of which 3.1 acres were under cultivation and 0.3 under fallow.

Table 2. Household age, size, land use and management (n = 246)

	Minimum	Maximum	Mean± Std
Age	15	89	41.25±15.78
No. of years lived in the area	0.5	87	34.88±18.09
Size of land owned	1	30	3.83±3.87
Size of land under cultivation	1	15	3.12±2.41
Size of land under fallow	1	15	0.36±1.44
Number of family members	1	42	8.88±5.58

Source: primary data.

Drought Stress

Teso sub region experienced extreme drought stress (below -4) in 2006, 2007, 2008, 2009 and 2016 (Figure 2).

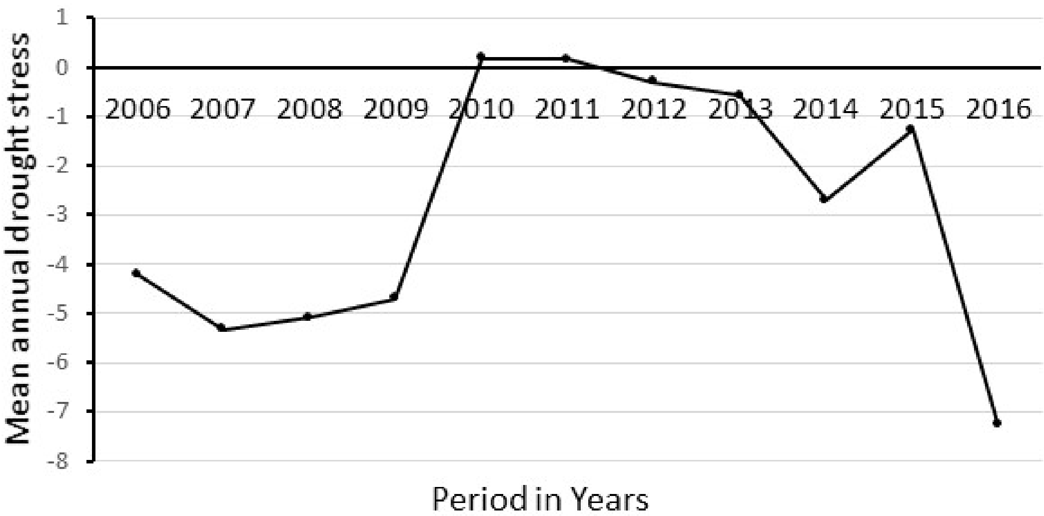

Figure 2. Drought stress over the last ten years (2006 – 2016)

Consequences of Drought in Kumi and Amuria Districts

Respondents pointed out some of the consequences of drought with inadequate food and high food prices, increased pests and diseases, low incomes, inadequate fire wood and increasing distance for water scoring high than the rest (Table 3)

Food inadequacy (85%), reduced income (70%), and increased pests and diseases (54%) ranked highest in the areas. Other consequences included mortality of domestic animals and people and fuel wood scarcity. Drought negatively affects crops by reducing their production due to limited moisture which attracts low harvests to sustain families. Because of drought, farmers have realized the effects on their livelihoods and food security (Shah *et al*, 2017 and Nabikolo, 2014). Drought directly affects crop production in addition to increasing incidences of pests and diseases (Aung Tun *et al,* 2015) and water scarcity which reduce incomes that farmers use to purchase food for the family.

Table 3. Consequences of drought

Responses	Very high	High	Moderate	None
Inadequate food and high food prices	85	8.0	7.0	0
Walk long distance in search for water	41.0	28.0	31.0	0.0
Inadequate fuel wood	28.0	30.0	26.0	14.0
Increased pests and diseases	54.0	23.0	19.0	4.0
Increased malnutrition	23.0	27.0	46.0	4.0
Low incomes	70.0	16.0	14.0	0.0
Death of animals and people	9.0	19.0	57.0	14.0

Drought Adaptation Strategies

Farmers in Teso sub region applied several adaptation measures to cope with drought effects in Kumi and Amuria districts (Table 4). The major strategies were those with proportional percentage 40% and above.

Table 4. Adaptation measures and their level of application

Adaptation	N	Proportion (%)
Reduced meal size/ number	192	78.0
Sale of domestic animals	168	68.3
Offer labour on other peoples' farms	172	69.9
Plant drought resistant crops	104	42.3
Change planting time	142	57.7
Diversify income	18	7.3
Planting of trees	118	47.9
Carry out irrigation	16	6.5
Soil and water conservation	34	13.8
Plant variety of crops	120	48.8
Preserve available food	108	43.9
Group revolving funds	52	21.1
Hunting	1	2.4
Fishing	19	7.7
Home gardens	19	7.7

Adaptation measures included: reduced meal size, offering labour on people's farms, sale of domestic animals, plant drought resistant crops and change of planting time. Growing a variety of crops was another adaptation mechanism applied; the crops included cereals (sorghum, rice, millet, maize), legumes (beans, groundnuts, green grams, peas, soya beans among others), vegetables which include; tomatoes, cabbages, collard greens, tubers include potatoes and cassava. These supplement one another in time of drought; when one variety is affected by drought, others can persist and buffer the food security. Preservation of food was another key adaptation strategy and it involved cereals, potatoes and cassava that were sliced, dried and stored and used during the time of scarcity. Cowpeas leaves were dried, stored and eaten as sauce in time of drought. Farmers also reported theft of food from granaries due to drought induced famine.

Drought tolerant varieties of sorghum, cassava and groundnuts, were grown. Varieties included Serenat 1, serenat 2 for groundnuts, "Epuripuri", "Abiri" for sorghum and

"Ekwangapel", "Emoru" for millet. Government provided the seeds of these- crops as a support measure for farmers' adaptation to drought effects. Farmers also changed planting time to the beginning of rain instead of following the traditional crop-planting calendar. Farmers in focus group discussions affirmed that those who practiced dry planting of cereals got better yields compared to those who waited for adequate rain to plant (Wamboga, 2016).

Agroforestry Techniques

A number of Agroforestry techniques were applied as adaptation measures to drought in Kumi and Amuria districts (Table 5). Majority (40.3%) of the farmers practiced mixed farming by integrating trees, crops and domestic animals on the same piece of land to diversify their drought coping strategies. Some farmers established woodlots and fruit trees (16.7%).

Table 5. Agroforestry techniques applied

Agroforestry technique applied	Proportion (%)
Tree Intercropping with animal rearing	40.3
Woodlot/fruit orchard	16.7
Managing natural regeneration	14.2
Home gardening	13.8
Soil and water conservation	15
Total	100

Agroforestry practice is one of the low-cost adaptation strategies against climate variability such as drought and floods and helps to reduce vulnerability of smallholder farmers (Agroforestry Network brief, 2019, Mfitumukiza *et al*, 2017). Tree growing and farmer managed natural regeneration (sparing of existing and naturally growing trees) was another agroforestry practice practiced by farmers (Odoi *et al.,* 2020). Trees are planted as woodlots, intercropping, fruit orchards, boundary planting and trees for fodder. Trees species included *Pinus carribeae*, *P. oorcapa*, *Eucalyptus grandis*, *E. camaldulensis*, *Albizia chinensis*, *Grevillea robusta*, *Cordia africana*, *Azadirachta indica*, *Croton megalocarpus*, *Calliandra calothyrsus*, grafted mangoes, grafted oranges. Naturally regenerated trees were *Vitellaria paradoxa* (Shea butter), *Tamarindus indica*, *Combretum* spp, *Acacia* spp, *Albizia coriaria* and local landrace mangoes whose populations were reportedly declining due to uncontrolled cutting for charcoal, fuel wood and construction materials. Tree seedlings are supplied by government through Operation wealth Creation program, NGOs such as TEDDO, SOCADIDO, Habitat for Humanity while few farmers bought from roadside nurseries. Agroforestry was practiced by farmers as they testified that farms with trees were losing less moisture during drought season compared to those without. Other uses of trees planted or spared by farmers included fruits/food, firewood, shelter for animals, fodder, herbal medicine, building materials and soils erosion control.

Trees were planted on the land boundaries, mixed with crops, scattered on grazing land and on the compound of homesteads. Woodlots were planted for poles and timber. Long-term trees (tree species with long rotation period) are being planted more compared to the short seasonal trees such as; *Sesbania sesban*, *Tephrozia spp, Callindra spp* and these supplied fuel wood and contributed to soil improvement. Knowledge of the importance of trees on farm is key in harnessing their contribution to adapting to drought. Farmers reported a long-time tradition of keeping valuable fruit trees such as *Vitellaria spp*, *Tamarindus spp* which are valued for their fruits, firewood and charcoal, fruits are eaten and sold for income during drought when crops have failed and the money is used to buy food. Demand for fuel (charcoal, firewood) has also escalated deforestation. Farmers expressed the desire to practice agroforestry despite their worry over the drying of seedlings due to long droughts, limited knowledge on how to raise tree seedlings and the trees that take long to mature.

Discussion

Socioeconomic Status and Drought

A community with an average age of 41 years (Table 1) has more responsible people with children and other relatives to take care of during drought. Young farmers easily adapt to new technologies because they are better exposed through education and innovations compared to the old whose level of adaptation is low towards new technologies and sometimes insist on traditional practices (Sisay *et al* 2019). However, the youths were reported to neglect farm activities but instead move to urban centres looking for jobs such as motorcycle riding and working at construction sites. The impact of drought on families cannot be underestimated, bigger families are not easily sustained due to reduced quantity or quality of food, which leads to starvation and malnutrition (Mequannt *et al* 2020). Ownership of land favours the implementation of certain strategies such as tree planting because the owners have full rights over land while such cannot be done on hired land (Jiri *et al* 2015) therefore, farmers with bigger pieces of land should be encouraged to establish woodlots while intercropping of trees in crops should be recommended for those with small pieces of land. Low levels of education affect uptake of the new adaptation technologies because educated farmers easily access and perceive new ideas and innovations faster than the non- or less-educated who may have some superstitions on the new technologies. (Sisay *et al* 2019, Jiri *et al*, 2015) reported that education positively correlates to the level of knowledge and highly improves farmers' perception to climate change.

Effects of Drought

This study indicates that smallholder farmers were affected by extreme drought stress which is beyond -4 kilo pascal (William and Funk, 2011) this was reported to cause adverse effects leading to declining in agricultural yields, food insecurity and poor livelihoods (Niles *et al*, 2015). Among the key determinants of the choices of adaptation included: household size, farm size and farming experience among others (Nabikolo, 2014). Households with smaller family sizes can easily adapt to drought than larger families, because smaller number of people in a household requires lesser food for survival and can therefore easily manipulate livelihood than the larger households. On the other hand, educated individuals who earn permanent salaries may be affected less since they have regular incomes for alternative sources of survival such as food stores in urban areas, however, these were found to be few in Teso sub region.

Drought Adaptation Strategies

Innovative adaptation strategies are being applied by farmers such as rearing animals, preserving food and timely planting because they are relatively cheaper. Full-time farmers may lack resources off-farm such as other sources of income to enable them purchase improved seeds, irrigation equipment for improved farm yields (Jiri *et al*, 2015). During drought seasons, farmers Sale their animals beginning with the smallest like domestic birds (chicken, ducks, pigeons, turkeys) and eventually sell goats, sheep, pigs and cattle as drought becomes severe. Farmers in Ethiopia and Karamoja have applied the same strategies to adapt to drought (Muthelo, 2019). Bigger animals like cows, goats and sheep are also considered as assets for the family, to buffer against major needs like payment of dowry, payment for serious medical bills while small ones are for emergencies like food. Extreme drought seasons, come with diseases leading to loss of animals. Maintaining one meal per day, offering labour to the well off and over reliance on the natural resources do not contribute to long-term resilience (Mdemu Makarius, 2021) This implies post drought, farmers are left with limited options to help them recover hence the need for intervention from government and other humanitarian organizations in offering a boost in form of soft loans, food and medical aid (Kelvin *et al.* 2017). Most of the existing NGOs in the area operate in designated places but not the entire region and therefore benefit a smaller population.

Role of Agroforestry

On the other hand, agroforestry plays a great role in offering appropriate coping and adaptation strategies to smallholder farmers. Trees protect Agricultural crops with superficial roots which tap water from underground thereby improving the microclimate for other components (crops and animals) with enhanced productivity (Shah Fahad *et al,* 2017). In time of drought, farmers are able to sell fuel wood, fruits which are normally available at a time when food crops are scarce which increases their income to cater for other necessities. Trees on farm also increase and diversify farm productivity through Nitrogen-fixing in the soil, reduced erosion, and provision of construction materials. Culturally, there are valued indigenous tree species by the locals as compared to the introduced species and these promotes conservation. Some of these species include: *Vitalleria paradoxa Tamarindus indica* which can as well promote tree cover restoration (Mfitumukiza *et al*, 2017). Therefore, the contribution of Agroforestry to hamper communities against the effects of drought cannot be under estimated (Amy Quandt, 2021)

However, Agroforestry in the area of study is constrained by the drying of seedlings, limited knowledge in raising seedlings and the patience required for the trees to grow since some take some years to be ready for harvesting. This implies farmers require a deeper understanding of the importance of Agroforestry to increase on uptake of the practice. Even though these adaptations have been reportedly applied in many sub-Sahara countries, farmers ‘commitment is still lacking (Mugi-Ngengaa *et al,* 2021 Abraham Belay *et al.* 2017. There is need to strengthen the local adaptation strategies such as intercropping, adjustments in the planting season, agroforestry, mulching among others because they are generally of low cost to implement. Adaptation to recurrent drought is the way to go to build resilience amongst farmers (Mbow *et al,* 2019).

Limitations to Effective Adaptation

While more effort is needed in promoting universal adaptation strategies like planting drought-resistant varieties, applying irrigation systems, better infrastructures, farmers remain with the challenge of utilizing the local strategies. People who own small pieces of land are limited in planting a variety of crops because of planting space and also, they plant in smaller quantities and in the end save little food to cater for long drought seasons. Limited technical knowledge creates a gap in the knowledge transfer and farmers miss out on the new technologies available, this is a major barrier for sustainable drought management in many Sub Sahara African countries (Bekele *et al.* 2014). Farmers identified diseases such as cassava mosaic, maize wilt as major diseases disturbing their crops while foot and mouth diseases, coccidiosis and pneumonia in animals and birds leading to death and low yields, which demoralizes them (Niangil *et al*. 2014).

Conclusions and Recommendations

The following are the conclusions drawn from this study: 1). Drought incidences in the study area are reoccurring, threatening agricultural productivity and livelihoods. 2). Several adaptation measures are applied by the farmers to mitigate the impacts of drought to boost their resilience, yet some of these measures are short term and cannot build community resilience. 3). Agroforestry plays a major role as a coping mechanism applied by farmers through intercropping trees with crops, rearing animals, establishing fruit orchards and woodlots.

Based on the results of the study, the following are recommended:

1. Small holder farmers should adopt application of multiple adaptation strategies on their farms to enhance their resilience. Application of Agroforestry should be intentional to enable utilization of cheap practices such as farmer managed regeneration, soil and water conservation structures and kitchen gardens
2. Though the government of Uganda has endeavoured to promote some adaptation strategies such as afforestation programs through FIEFOC (Farm income Enhancement and Forestry Conservation), OWC (Operation wealth Creation), animal restocking programs like the Northern Uganda Social Action Fund (NUSAF), most of these programs reach a few farmers and yet many would desire to take part. In depth promotion of these programs should be emphasized.
3. Frequent monitoring and evaluation of government programs is important to ensure all targeted communities are well covered.
4. There is also need to strengthen early warning mechanisms for information forecasting and preparedness, encouraging group formation for easy access of services, subsidizing farm inputs like simple irrigation technologies are some of the key strategies that can be applied to enhance farmers' resilience to drought adaptation.
5. Further research is recommended in understanding the social, economic and environmental costs of Agroforestry in relation to other drought adaptation measures. Deeper study of factors that influence adoption of particular adaptations to drought by small holder farmers is equally important.

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