African Journal of Rural Development, Vol. 1(3): December 2016: pp. 281 - 291 ISSN 2415-2838

Date received: 10 January, 2016 Date accepted: 04 April, 2016

Agro-pastoral choice of coping strategies and response to drought in the semi-arid areas of Uganda

D.A. AKWANGO[1, 2], B.B. OBAA[1], N. TURYAHABWE[1], Y. BAGUMA[2] and A. EGERU[3]
[1]Department of Extension and Innovation Studies, College of Agricultural and Environmental Sciences, Makerere University, P. O. Box 7062 Kampala- Uganda
[2]National Agricultural Research Organization Secretariat, P. O. Box 295, Entebbe-Uganda
[3]Regional Universities Forum for Capacity Building in Agriculture, P. O. Box 16811, Wandegeya, Kampala, Uganda
Corresponding author: dakwango@gmail.com

ABSTRACT
Drought episodes have been on the increase in the semi- arid areas of Uganda with harmful effects like crop failure, and human and livestock mortality, among others. There are barely any studies that have examined why agro- pastoral communities take specific actions in coping with drought. This study examined the factors influencing the choice of coping strategies to drought and the reasons for response and non-response. The study was conducted in the semi-arid Karamoja sub-region of Uganda using a cross-sectional household survey on 305 households. A multinomial logistic model was used to analyze the factors that determine the choice of coping strategy by households against drought events. The results indicate that coping was positively influenced by distance to the nearest water source, access to drought information and training on drought management. Livelihood support, amount of arable land owned and frequency of receiving information from Drought Early Warning Systems (DEWS) had a positive significant effect on response. To enhance response capabilities, there is need to improve livelihoods and frequent dissemination of information on impending drought.

Key words: Drought early warning systems, extreme events, Karamoja sub- region, Uganda

RÉSUMÉ
Les épisodes de sécheresse se sont accrus dans les zones semi-arides de l'Ouganda avec des impacts négatifs tels que la mauvaise récolte et la mortalité humaine et animale, entre autres. Très peu d'études se sont appesanties sur les raisons qui ont motivés les mesures spécifiques prises par les communautés agro- pastorales pour faire face à la sécheresse. Cette étude a examiné les facteurs qui influencent le choix des stratégies d'adaptation à la sécheresse et les raisons de réponse et de non-réponse. L'étude a été menée dans la sous-région semi-aride de Karamoja, en Ouganda utilisant une enquête transversale auprès de 305 ménages. Un modèle logistique multinomial a été utilisé pour analyser les facteurs qui déterminent le choix de la stratégie d'adaptation des ménages face aux événements de sécheresse. Les résultats indiquent que l'adaptation a été positivement influencée par la distance de la source d'eau la plus proche, l'accès à l'information sur la sécheresse et la formation sur la mitigation de la sécheresse. La subvention des moyens de subsistance, la superficie en terres cultivables et la fréquence de réception des informations des systèmes d'alertes précoce de sécheresse (SAPS) ont eu un effet positif et significatif sur la réponse. Pour renforcer les capacités d'intervention, il est nécessaire d'améliorer les moyens de subsistance et la diffusion régulière d'informations sur la sécheresse.

Mots clés: Systèmes d'alerte précoce de sécheresse, événements extrêmes, sous-région du Karamoja, Ouganda

INTRODUCTION

Drought negatively affects agricultural production, water supply and other community livelihoods (Funk *et al.,* 2005; Tadesse *et al*., 2008; Egeru, 2012). Even with the increased efforts to mitigate it, drought effects continue to escalate causing enormous losses around the world. For example, between 1980 and 2003, US$ 144 billion was spent by United States of America on drought in development aid to Africa in 2003 it costed Europe Euro 8.7 billion, while it costed Australia an

estimated AUD$ 3.5 billion in 2006 (Mishra *et al*., 2010). Many Sub-Saharan Africa economies are vulnerable to drought effects due to great economic dependence on rain-fed agriculture and livestock production (Tadesse *et al*., 2008; Bryan *et al.,* 2013; Masinde, 2014). In Africa, depending on intensity and duration, droughts have led to deleterious effects including crop failure, livestock deaths as well as increased pests and disease outbreaks (Whilhite *et al*., 2007; Inter Governmental Panel on Climate Change, 2014). The phenomenon is experienced in the largely semi-arid areas of Uganda consisting of the 'cattle corridor' districts. These districts stretch from South Western to North Eastern Uganda which is dominated by pastoral rangelands with semi-arid characteristics. These districts include among others Mbarara, Isingiro, Nakasongola, Kiboga, Mubende, Sembabule, Soroti, Kaberamaido, Amuria, Katakwi, and Moroto. The future is not any better as climate projections indicate that by the year 2050, most of Uganda will experience a rise in temperature of between 2^0C and 2.5^0C in the warmest months (Bashaasha *et al.,* 2013). The most prominent negative effects of drought in the region have been recurrent food insecurity resulting from crop losses, livestock deaths and scarcity of water for domestic use.

Recently many sub-Saharan African countries have developed drought coping strategies in response to drought effects. Such coping strategies have emphasized scientific understanding of hazards and protection structure (Tadesse *et al.,* 2008; Lautze *et al*., 2011; Hilbruner and Moloney, 2012). Drought being a slow on-set hazard, the Drought Early Warning System (DEWS) has been found to be a critical element in drought mitigation and management (Whilhite, 2000; Tadesse *et al*., 2005; Vincente- Serrano *et al*., 2012). For DEWS to be effective it should be able to prompt early response and early action to minimise the costs associated with drought.This study is based on DEWS that is implemented in the Karamoja sub region of Uganda, the only region in the country with operational DEWS. Owing to the severity and frequency of drought in the region, the Karamoja sub region has had an operational drought early warning system since 2006. The system was designed by Agency for Technical Cooperation and Development (ACTED), with a network of other organizations and the Government of Uganda in response to the consecutive droughts that hit the sub region between 2005 and 2007 (FAO, 2009). The Karamojong are traditionally livestock keepers, being pastoral in nature with very limited understanding and skill in crop cultivation (Birch and Grahn, 2007). However, in the recent past there has been a strong promotion of crop cultivation as an alternative livelihood strategy. This was particularly aimed at promoting and absorbing the pastoral dropouts (Egeru *et al*., 2016). Overall, however, frequent and severe droughts have led to crop failures leading up to >70% yield decline in the region (Mugerwa, 2013). According to Basher (2006) and Wilhite *et al*. (2007), DEWS should provide timely, updated and reliable information for household and community preparedness. The idea is that the early warning system produces an alert on possible risk of drought occurrence in three to six months to enable the community to prepare to cope with drought (International Federation of Red Cross and Red Crescent Societies, 2014). Since the establishment and implementation of the Karamoja DEWS for the last 8 years, there is no empirical evidence on its effectiveness in influencing the communities to respond to drought effects, yet there is a current demand for up scaling DEWS to the rest of the semi-arid areas in Uganda.

To get effective DEWS, it is important to understand why people take action and which actions to cope with drought effects. A better understanding of the factors that influence household decisions on choice of coping strategies and response action will help inform policies to promote successful adaptation in coping with drought effects. The main objective of the study was to identify context specific factors that influence choice of coping strategies and decisions in Karamoja sub region for response and non-response using the following guiding questions: what coping strategies did the households implement?; how different are the DEWS participating households from the non-participating households?; what factors determine the choice of coping strategies; and what factors influence response to DEWS coping strategies?

METHODOLOGY

The study was undertaken in the districts of Kotido and Nakapiripirit, in the Karamoja sub region of Uganda. The two districts were in the first and second phase of DEWS implementation, respectively. Both districts practice crop and livestock production as the main source of livelihoods for inhabitants. The Karamoja sub region experiences frequent and intense drought episodes often resulting into food insecurity in the area. Across the 'cattle corridor' of Uganda, the sub region experiences more prolonged drought events than other regions (Mubiru, 2010). The sub region is located in the north eastern part of Uganda (longitudes 33^0 E-35^0 E and latitude 1^0N- 4 ^{0}N). It comprises of six districts namely: Nakapiripirit, Amudat, Moroto, Kotido, Kaabong and Abim. The sub region is bordered by Kenya to the East and South Sudan to the North. The internal neighboring districts are Katakwi, Kapchorwa, Kumi, Lira, Pader and Sironko. Rainfall in the sub region is highly variable ranging from 400mm to 1000mm in the east and west of the sub region, respectively. The Karamoja sub region is semi-arid and

inhabitants practice rain-fed agricultural production with high chances of crop failure due to drought conditions (Powel, 2010).

Data collection

This study used a cross-sectional household survey research design to collect data from the two districts of Nakapiripirit and Kotido in the Karamoja sub region. Nakapiripirit was selected because it was the pilot district for DEWS. Kotido district was selected because it was among the districts that implemented DEWS in the second phase. In addition the two districts are agro-pastoral in production characteristics. One hundred and seventy three (173) households were purposively sampled based on their active participation in DEWS. A further 132 households that did not participate in the DEWS were used as the control households (Non-DEWS). These households were selected from the hard to reach parishes in the two districts. A semi-structured questionnaire was used and directly administered by the research team in order to gain acceptability by the respondents and obtain relevant data from the largely illiterate and semi illiterate respondents. Data were collected between October and December, 2014. The following information was collected during the study; key coping strategies, household perceptions and attitudes on response, reasons for response and non response, available infrastructure and socio-economic demographics. The Respondents were identified by Parish Chiefs and Local Council Village leaders. Triangulation with three focus group discussions per district was undertaken to enhance data quality.

Data analysis

Coping strategies used in semi-arid rural households for drought mitigation

Data from the cross-sectional household survey were used to generate descriptive and summary statistics to describe coping strategies that agro-pastoralists in the Karamoja sub region use in the event of a drought. The univariate analysis also provided a description of the socio-economic characteristics of the respondents, coping strategies, response or non response, farming changes that occurred, challenges for implementing coping strategies and suggestions to enhance coping strategies to drought. The Statistical Package for Social Scientists (SPSS) V. 18 was used for analysis.

***Factors influencing the Choice of coping strategy used at household level against drought*:**

The Multinomial Logistic (MNL) model was considered appropriate (Geweke *et al*., 1994) to analyze factors that determine the choice of coping strategy used by a household against prolonged drought. The MNL model was chosen because it permits the analysis of variables in which the dependent variable has more than two categories and permits the determination of probabilities for the different choices made (Madalla, 1983; Wooldridge, 2002). Deresa *et al.* (2010) used a similar approach to study factors that affect the choice of coping strategies in Ethiopia. This study also determined what makes them take action or not.

In the specification of the model let *y* denote a random variable that takes on value {*1, 2, 3….j*} for a positive integer. In this study, *y* represents the coping strategies that the household adopts against negative effects during a prolonged drought. The other variables which affect the household choice and serve as conditioning variables are denoted as *x*. These can be household characteristics, institutional factors or environmental measures. The independent variables used in the study are shown in Table 1. The MNL allows us to investigate how changes in *x*, affect the probability of a choice of copping strategy in *y*; that is *P(y=j/x), j – 1, 2, 3….j.* The condition that the probabilities must sum to unity (one) allows the determination of different probabilities once one is known.

If x is a 1xK vector and the first element equal to unity, the MNL model then has response probabilities

$$P(y=jIx) = exp\,(x\beta_j) \Big/ \left[1 + \sum_{h=1}^{J} exp(x\beta h)\,, j = 1 \ldots . J\right] \quad \text{..... Eq. (1)}$$

Where β_j is K x 1, j = 2….J.

In the estimation of the MNL model, coping strategies during a prolonged drought were grouped into six categories or six response probabilities:

1. Took no action (did nothing)
2. Changed cropping system (growing short/early maturing crops, use of improved seeds and watering of vegetables, among others).
3. Adopted long term strategies (such as digging dams, planting trees and establishment of pasture conservation facilities, migrating to the greenbelt, among others).
4. Sought external support like food items, irrigation equipment, and migration, among others.
5. Used food conservation and acquisition strategies (such as adopting food storage technologies and eating wild foods).
6. Income source diversification (including selling of firewood, charcoal, local brew, and sorghum, among others).

The estimation of the multinomial logistic regression for this study was undertaken by normalizing one category, which is normally referred to as the reference state or the base category. In this analysis, the first

Table 1: Explanatory variables used in multinomial logistic regression analysis

Variable	Description
Age of the household head	Number of years
Education of the household head	Number of years in school
Education of the spouse	Number of years in school
Household size	Number of people in the household
Household owns a radio	Dummy, 1 if the household own a radio, and 0 otherwise
Distance to the nearest water source	Distance in Kilometers
Distance to the nearest trading center	Distance in Kilometers
Number of cattle owned	Number of cattle owned
Has traditional ways of predicting drought	Dummy, 1 if there is, 0 otherwise
Used information from DEWS	Dummy, 1 if yes, 0 otherwise
Received training on drought management	Dummy, 1 if yes, 0 otherwise
Seeks help in times of drought	Dummy, 1 if yes, 0 otherwise

category did nothing was the reference state. In modeling the analysis the dependent variable was the coping strategies.

Factors influencing response to DEWS coping strategies

To enable the researchers control for influence of other factors, econometric Probit model was used to separate the major factors influencing household decisions on response based on (Chen *et al*., 2014; Wang *et al*., 2014).

The Probit model (Geweke *et al*., 1994) was used to identify the factors influencing response to drought among the households participating in DEWS in the study area. The Probit often allows for correct binary classification which is generally a consistent estimator of parameters and appears to be suitable to analyze the response decision (Feder *et al*., 1985).This equation models the choice behavior of individual respondents of whether there is response to DEWS or not. The binary decision by an individual can be represented conveniently by a random variable that takes the value one if there is response to DEWS and the value zero if otherwise. This assumes that the decision to respond or not is based on the attributes of the choice, which are specific to the individual decision maker, the individual's socio-economic characteristics (X_i) and unobserved attributes ε (a random disturbance) (Greene, 2002; Bryan *et al*., 2009).

$$Y^*_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2\ \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \varepsilon \quad \text{.....Eq. (2)}$$

Y^*_i which identifies the response variable and explanatory variables as ***X1***, ***X2***, …, X_{11} as described below. Y^*_i is whether the respondent took an action or not responding to DEWS. The binary choice Y^*_i which is equal to 1 if Y^*_i is positive and 0 if Y^*_i is negative. ε is the residual in the specification of the latent variable Y^*_i.

$$Y_i = \begin{cases} 1 \text{ if } y* > 0 \\ 0 \text{ if } y* 0 \end{cases}$$

β_0 = an intercept β_i = coefficients of i^{th} independent variable, X_i = independent variable and 'i' is 1, 2, 3… 11
Y_i = (Y1= Response Y0=non response)

X_1 = Age (number of years), X_2 = Education level of household head (number of years in school), X_3 = Livelihood support (Irrigation structures, Drought tolerant seed, Short maturing seeds, Food storage facilities, Farm equipment and machinery), X_4 = Household size of labor (Persons above 10 years), X_5 = Total number of livestock, X_6 = Frequency of receiving DEWS information (Months), X_7 = Duration under DEWS (Number of years), X_8 = Distance to water source (Km), X_9 = Number of arable land owned (Acres), X_{10} = Distance to local trading center (Km), X_{11} = Training on managing drought (1 = Yes, 0 = No) as shown in Table 2.

RESULTS

Socio-economic and demographic characteristics of households

Table 3 shows the socio-economic and demographic characteristics of the households in the study area. Results show that most of the households who participated in the study were engaged in farming (87%) with 98% of the households being male headed. Only 1.5 % of the households were earning a salaried income. The majority of the household heads were married and we observed that most of the household heads were having more than one wife. Over 94% of households live in mud and grass thatched houses. Only 2.3% of the households had access to education. The results further indicate that there were more households under

Table 2: The following assumptions were made about the determinants of the dependent variable

X_1 Age	-
X_2 Education level of household head (number of years)	+
X_3 Livelihood support	+
X_4 Household size of labor (Persons above 10 years)	+
X_5 Total number of livestock	+
X_6 Frequency of receiving DEWS information (Monthly, Quarterly, Yearly)	+
X_7 Duration under DEWS (Number of years)	+
X_8 Distance to water source (Km)	-
X_9 Number of arable land owned (Acres)	+
X_{10} Distance to local trading center (Km)	-
X_{11} Training on managing drought (1 = Yes, 0 = No)	+

Table 3: Socioeconomic and demographic characteristics of households (percentage)

Household characteristics	Non-DEWS household			DEWS household		
	Pooled (N=132)	Kotido (N=65)	Nakapiripirit (N=67)	Pooled (N=173)	Kotido (N=86)	Nakapiripirit (N=87)
Gender of respondent (% female)	62.9	69.2	56.7	59.5	62	56.8
Gender of Household head (% males)	98.5	96.9	100	94.8	93.5	96.3
Marital status of Household head (%)						
Married	83.3	83.1	83.6	88.4	88	88.9
Divorced	0.8	0	1.5	1.2	1.1	1.2
Widowed	15.2	15.4	14.9	10.4	10.9	9.9
Single	0.8	1.5	0	0	0	0
Occupation of the household head (%)						
Farming	87.9	90.8	85.1	85	89.1	80.2
Salaried income	1.5	1.5	1.5	4.6	5.4	3.7
Self-employment off-farm	1.5	1.5	1.5	1.2	1.1	1.2
Farmer worker	1.5	0	3	2.3	0	4.9
Causal labor	3.8	0	7.5	2.3	3.7	1.1
House keeping	0.8	0	1.5	0.6	0	1.2
Schooling	2.3	4.6	0	2.9	3.3	2.5
Household with children going to school (% Yes)	63.6	67.2	60	79.2	80.2	78.3
Type of household house (%)						
Mud wall, grass thatched	94.7	90.8	98.5	78	65.2	92.6
Brick wall, grass roofed	2.3	3.1	1.5	9.2	16.3	1.2
Mad wall, iron roofed	1.5	3.1	0	6.9	10.9	2.5
Brick wall, iron roof	1.5	1.5	0	5.8	7.6	3.7

DEWS with school going children (79%) compared to the control households with 63%.

The study adopted to use the Kruskal Wallis test so as to determine if there are statistically significant differences between DEWS and Non-DEWs households in terms of choice of coping strategies to prolonged drought. The results in Table 4, shows that most Non-DEWS households adopted income diversification as a major coping strategy and this was significant between the two groups. On the other hand, the DEWS households that sought knowledge and external assistance were significantly more than those in the non DEWS category. Important to note was also the fact that a significant proportion of households from the DEWS category adopted long term measures to managing drought compared to Non-DEWS households.

Table 4: Comparison of choice of coping strategy between DEWS participants and NON DEWS participants

Copping strategy used	Non-DEWS (N=132)%	DEWS (N= 173) %	Sig
Income source diversification	47.7	23.1	0.001*
Changed farming system	8.3	15.6	0.057
Adopted long term approaches	1.5	16.2	0.001*
Sought knowledge and external assistance	11.4	26.0	0.001*
Food conservation and Acquisition strategies	9.8	5.2	0.121
Did nothing	21.2	13.9	0.092

Note: Significant tests are based on Kruskal Wallis test; * level of significance at 1 %

Factors influencing choice of coping strategies to drought

According to the results in Table 5, the decision to change a cropping strategy through adopting early maturing and or drought tolerant crop varieties and germplasm was positively affected by the household having traditional ways of predicting a prolonged drought that included; inclination of the moon, existence of specific fluids in animal intestine, flock of birds and high fruit yield as well as receiving information from the drought early warning systems (DEWS). Information from Drought early warning system includes recommendations on how to cope with drought, storage of food for future, do not sell food, grow vegetables around compound and water, pasture conservation, reduce stock, use water from the dams sparingly, among others.

The results also show that the households that received training on drought management, that used information from DEWS, and owned a large herd of livestock had a greater probability of adopting long term copping strategies in cases of prolonged drought. The long term coping strategies included: planting trees, preparing pastures, digging wells, construction of dams, and migration and settlement to the green belt. Those who are far from the trading center had limited access to the training opportunities.

The probability of seeking knowledge, and external assistance as copping strategies were significantly positively related with having information from DEWS and seeking information from others about drought. Seeking knowledge and external assistance was however negatively associated with distance to the trading center. No household characteristics significantly affected the adoption of food conservation and food acquisition strategies as a choice. This could be explained by the fact that in the last eight or so years, there was low production in the region due to crop failure; hence there was no food to conserve. The decision to diversify income sources was positively affected by a household having traditional mechanisms of predicting drought and having sought external information but was negatively affected by the distance from the water source (Table 5).

Factors influencing response to DEWS coping strategies

The result from the Probit regression analysis show that household size of labor, frequency of receiving DEWS information, and the size of arable land owned significantly influenced the decision to respond to DEWS coping strategies. In addition reports from the focus group discussions indicated that some households did not take any action as they did not have the capacity in terms of resources to prepare to cope with drought. They said, *"Even if we wanted to take action, without resources, it is not possible to take action"*

DISCUSSION

Factors influencing the choice of coping strategies to drought

The findings of the study showed that households adopted several coping strategies based on their ability to implement the strategies. Whilst the DEWS participating households employed knowledge from DEWS supplemented with external assistance and adopted long term coping strategies, the Non-DEWS Households mainly adopted the income source diversification coping strategies that involved selling of livestock, growing and selling vegetables, selling food items, collecting and selling firewood and burning charcoal. The explanation for this is that the majority of the Non-DEWS households still rely on the traditional coping strategies that involved adoption of multiple strategies to cope with drought. Traditionally households in Karamoja sub-region managed to cope with drought by migrating to the green areas with their livestock (Levine 2010), performing rituals to appease 'small gods' for protection against drought, and storing food and firewood for future use, among others (Egeru, 2016). However with the consecutive occurrence of drought almost every year, FAO (2009) highlights that these coping strategies cannot cushion the households from the drought effects. It is very clear from the study that very few Non-DEWS households adopted long term coping strategies (1.5%) such as digging

Table 5: Model results on factors influencing choice pf coping strategies to drought using the multinomial logistic regression model

Explanatory variable	Changed cropping system	Adopted long term strategies	Sought knowledge and external assistance	Adopted food conservation and acquisition strategies	Income source diversification
	Beta (Std. Error), *p<0.1, **p<0.05, ***p<0.01				
Age of the household head	0.01 (0.02)	0.01 (0.02)	0.01 (0.02)	-0.01 (0.02)	0.02 (0.02)
Education of the household head	0.07 (0.06)	-0.10 (0.09)	-0.08 (0.07)	-0.10 (0.11)	0.01 (0.12)
Education of the spouse	0.07(0.12)	-0.11 (0.26)	-0.69 (0.50)	0.14 (0.18)	0.06 (0.11)
Household size	-0.04 (0.06)	-0.071(0.07)	-0.01 (0.05)	-0.01 (0.08)	-0.01 (0.06)
Household owns a radio	0.13 (0.53)	0.57 (0.59)	0.23 (0.49)	0.90 (0.75)	0.29 (0.45)
Distance to the nearest water source	-0.13 (0.18)	0.22 (0.24)	0.14 (0.15)	-0.43 (0.28)	-0.59 (0.18)***
Distance to the nearest trading center	0.06 (0.07)	-0.23 (0.12)*	-0.13 (0.08)*	0.09 (0.08)	0.05 (0.06)
Number of cattle owned	0.03 (0.04)	0.07 (0.04)**	0.02 (0.04)	0.07 (0.04)	0.03 (0.04)
Has traditional ways of predicting drought	0.90 (0.52)*	0.04 (0.54)	0.27 (0.43)	0.39 (0.56)	1.030 (0.39)***
Used information from DEWS	0.94 (0.55)*	2.17 (0.75)***	1.03 (0.49)**	-0.09 (0.63)	-0.38 (0.44)
Received training on drought management	0.44 (0.51)	1.30 (0.63)**	0.36 (0.45)	0.14 (0.59)	-0.31 (0.41)
Seeks help in times of drought	0.39 (0.55)	1.32 (0.87)	1.41 (0.56)***	1.16 (0.73)	0.73 (0.42)*
Intercept	-2.52 (1.17)**	-3.82 (1.57)***	-1.89 (1.06)*	-2.13 (1.38)	-0.21 (0.87)

Source: Authors' calculations using SPSS 18

Table 6: Probit estimation results on determinants of response to DEWS coping strategies

Factor	Probit Regression Parameter		
	Estimate	SE	p-value
Age	-0.001	0.006	0.799
Education level of household head (number of years)	0.014	0.017	0.409
Livelihood support	0.227	0.066	0.001***
Household size of labor (Persons above 10 years	0.002	0.021	0.938
Total number of Cattle	-0.005	0.007	0.434
Frequency of receiving DEWS information(Monthly, Quarterly, Yearly)	0.219	0.101	0.032**
Duration under DEWS (Number of years)	0.082	0.055	0.139
Distance to water source (Km)	-0.039	0.054	0.468
Number of arable land owned (Acres)	0.016	0.006	0.007***
Distance to local trading center (Km)	0.001	0.02	0.944
Training on managing drought (1 = Yes, 0 = No)	0.014	0.156	0.926
Cons	0.127	0.452	0.779

**Significance level ± = 0.05; ***Significance level ± = 0.1, dependent variable: response to DEWS coping strategy (1=yes, 0 = no)

dams, irrigation and planting of trees. These were the lowest adopted coping strategies due to high investments required to establish them (Wang *et al.*, 2015).

Conversely it is evident from the findings that among the DEWS households, the introduction of the drought early warning system provides not only information, but training and livelihood support to the project members. The livelihood support received from DEWS intervention was in the form of watering cans, improved seeds that are drought tolerant and short term maturing; radios to access information from DEWS, and bicycles. These help the DEWS households to focus on specific source of income that they rely on instead of employing tiresome multiple coping strategies of collecting and selling firewood, burning charcoal, among others. The narrowing of focus among DEWS households as a result of information, training and livelihood support given under DEWS project imply that there is growing trust in the reliability of the information, relevance of the training and the livelihood support which helps them to cope better than they used to cope before the introduction of DEWS intervention.

According to the findings, 16% DEWS household adopted long term approaches which included digging of dams, planting trees, and establishment of pasture conservation hay making compared to 1.5% of non-DEWS household participants (Table 4). This variation can be explained by the fact that for a household to implement long term strategies, knowledge and skills need to be acquired through DEWS and other related trainings. The long term strategies are primarily aimed at drought impact mitigation with mechanisms to cope with ongoing drought. The long term strategies gives DEWS households a cutting edge in dealing with adverse effect of drought such as lack of pasture and water for both livestock and human use.

The results further show that the DEWS households mainly (26%) sought knowledge and external assistance such as improved seeds, training on drought management, watering cans, radio, bicycles compared to 11% of non-household DEWS (Table 4). This is due to exposure that the households got as a result of DEWS intervention. At the beginning of the DEWS project, items such as improved seeds, watering cans, radios, and participation in training workshops were provided for by the project. Although most of the items were not functional by the time of data collection, the community had knowledge about the perceived usefulness of the items. The exposure enabled the DEWS households to value knowledge especially the ones related to drought early warning system. This further motivates them to seek more information and opportunities from other organizations and government to enable them cope with drought.

Other long term strategies included migration to the green belt and changing of cropping system which involved growing drought resistant improved seeds and seeking training on water conservation. Egeru (2016) reported adoption of similar coping strategies among the agro-pastoralists in East Africa, although for his study over 50% of the respondents indicated having not taken any action in response to drought compared to 17 % of the respondents in this study. Those who did not take action could be explained by the fact that they lacked ability to respond in terms of resources and knowledge on how to implement some of the coping strategies (Bryan *et al.*, 2013; Egeru, 2016).

Furthermore most of those who do not take action are located in "hard to reach areas" where they lack basic support and training opportunities on drought management. The training opportunities are mainly available to those near trading centers. This is often the case because most of the trainers will select beneficiaries from within the accessible areas due to security reasons.

The study found that having knowledge on drought determined household choice of coping with drought. The explanation for this observation was that those who were able to respond had training on drought management, access to information from DEWS (Makala, 2012; Chen *et al*., 2014) and had large herds of livestock that they sold in order to take action. As such, the choice of coping strategies was determined by households having opportunities to access DEWS information, having trainings, traditional knowledge on how to predict drought, and seeking support. There is a high rate of poverty (80%) in Karamoja sub region (Beg *et al*., 2002; Mugerwa, 2013). The communities in the sub region have to rely on support and information on drought occurrence in order to select coping mechanisms. These include; purchasing early maturing and droughts tolerant seeds; and engaging in watering of vegetables hence the households near to the water sources had an advantage. In addition, the drought early warning system does not only alert the communities of the likely occurrence of drought but also provides some recommendations on what coping strategies need to be implemented in preparation for drought.

Factors influencing response to DEWS coping strategies

The study showed that three explanatory variables: livelihood support, amount of arable land owned (ha) and frequency of receiving information from DEWS had a positive and statistically significant effect on the decision to respond to DEWS coping strategy by the household (Table 6). The households with more land under cultivation, who receive information more regularly and do have livelihood support in terms of social networks, irrigation support, tools and equipments, influences response to coping strategies. The more support the households' gets in terms of improved seeds, watering cans, radio to access information and training, the higher the likelihood of response. The same view was presented by the households during the focus group discussions who lamented that even if they wanted to take action, they did not have the capacity in terms of resources to prepare and cope with drought. That explains the big number of those households who did not take any action. According to Mayhorn *et al*. (2014), sometimes the decision not to take action can be determined by pre-existing beliefs on the likelihood of occurrence of drought 'heuristics'. This is due to the high cost of taking action.

Variables that influence response to DEWS coping strategies so that food security can be attained included frequency and timeliness of DEWS information, livelihood support (Farm equipment, drought tolerant seeds, food storage facilities, and irrigation equipment's, financial and physical supports) and availability of arable land. Regularly receiving information in timely manner triggers the households to respond since they are often reminded about the expected drought effects, which increases the likelihood of taking action. While Deresa *et al*. (2009) found out that access to drought early warning system activate response, this study established that frequency and timeliness is important in prompting households to respond to DEWS. Livelihood support was one of the factors that influenced response to drought early warning systems. This result is consistent with the findings of Chen *et al.* (2014), who found out that livelihood support, post disaster services, technical assistance, financial and physical support significantly contributed to coping strategies in dealing with effects of drought. Hillbruner and Moloney (2012) also pointed out that early livelihoods support in the form of water point rehabilitation, restocking, nutrition support, and cash transfers could prevent the deterioration in food security that was predicted to occur due to crop failure. Frequency of the warning information and social support were significant in influencing response to early warning system. Livelihood support enhances capacity in terms of resources to take action in order to cope with drought. This study further found out that the total number of acres owned by the household significantly influences response action to DEWS. This could be attributed to the fact that owning more land allows for diversification of crops grown and keeping livestock as more households move from being pure pastoralists to agro-pastoralists. According to the finding, there is no evidence that short distance to local trading center positively influences response action as reported by Deresa *et al.* (2009). This is due to the limited available assets and food items for sale in the market by the communities as a result of drought effects. The common item sold in the market was "*ebutia"* (local beer) which takes a lot of their time and reduce the likelihood of taking action.

There was no evidence that education and number of livestock owned by households have a significant influence on response to early warning system as reported by Deressa *et al*. (2009) and Mengistu *et al*. (2015) .This is because of their pastoral nature involving children looking after livestock with their fathers. The explanation for the low level of education is as result

of insecurity caused by cattle rustling and the fact that 80% of the population still live in abject poverty (Mugerwa, 2013). Number of livestock was not a significant factor since they do not believe in selling livestock culturally. Karamojong people normally keep livestock for prestige: the more livestock one has the more power and respect. Since they do not sell livestock as a coping strategy, it has no influence on response to coping strategies. The non significant influence of education could be due to the fact the majority of the households in the study area were illiterate without basic primary education. This is an area for policy intervention.

CONCLUSION AND RECOMMENDATIONS

The majority of the households have devised means on how to cope with effects of the drought which mainly include diversification of income sources, changing cropping systems and looking for external support. The DEWS households mainly employed change of cropping system and sought knowledge and external assistance while the Non-DEWS employed income diversification as a coping strategy. The factors that influence household choice of coping strategies and responses to drought early warning system included frequencies and timeliness of DEWS information, livelihood support and acres of land owned. The choice of coping strategies had to do with households having traditional knowledge on how to predict drought, having opportunities to access information from DEWS, having trainings and seeking support. This study therefore recommends as a key intervention, the need to avail opportunities for training in drought management as an important resource in enhancing coping and managing drought. Additionally socio-economic characteristics of households with livelihood support, households with more arable land and those which receive timely and frequent warning information are more likely to implement drought coping strategies. We recommend that implementers of drought early warning system should not only advance early warning systems, but consider frequent and timely building of the capacity of the households on implementing the available coping strategies and early warning recommendations.

ACKNOWLEDGEMENT

This study was funded by the World Bank through ATAAS project under the National Agricultural Research Organisation (NARO). We thank the households in Kotido and Nakapiripirit that willingly participated in the study.

STATEMENT OF NO CONFLICT OF INTEREST

We the authors hereby declare that there are no competing interests in this publication.

REFERENCES

Bashaasha, B., Thomas, T.S., Waithaka, M. and Kyotalimye, M. 2013. Uganda. Chapter 12. In: Waithaka, M., Nelson, G.C., Thomas, T.S. and Kyotalimye, M. (Eds.). East African agriculture and climate change. A comprehensive analysis. International Food Policy Research Institute, Washington. DC., USA. pp. 347-387.

Basher, R. 2006. Global early warning systems for natural hazards: systematic and people centered: UN-ISDR Platform for Promotion of Early Warning. *Philosophical Transactions of the Royal Society* 364:2167-2182.

Beg, N., Morlot, J.C., Davidson, O., Afrane-Okesse, Y., Tyani, L. and Debton, F. 2002. Linkages between climate change and sustainable development. *Climate Policy* 2:129-144.

Birch, I. and Grahn, R. 2007. Pastoralism: Managing multiple stressors and the threat of climate variability and change. UNDP Human Development Report Office Occasional Paper, UNDP: New York. pp 12 Accessed at http://hdr.undp.org/sites/default/files/birch_isobel_and_grahn_richard.pdf

Bryan, E., Deressa, T.T., Gbelibuo, G.A. and Ringler, C. 2009. Adaptation to climate change in Ethiopia and South Africa: Options and constraints. *Environment Science Policy* 12(4):413-426.

Bryan, E., Ringler, C., Okaba .B., Roncoli, C., Silvertri, S. and Herrero, M. 2013. Adapting agriculture to climate change in Kenya: Household strategies and determinants. *Journal of Environmental Management* 114:26-35.

Chen. H., Wang, J. and Huang, J. 2014. Policy support, social capital and farmers' adaptation to drought in China. *Global Environmental Change* 24:193-202

Deressa, T.T., Hassan, R.M., Ringler, C., Alemu, T. and Yesuf, M. 2009. Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. *Global Environmental Change* 19 (2):248-255.

Egeru, A. 2012. Water productivity in Agriculture: Challenges and opportunities for small holder farmers in the dry lands of Eastern and Southern Africa. Report: University of Nairobi, Kenya 21pp, Accessed at http://www.academia.edu/1612904/Water_Productivity_in_Agriculture_Challenges_and_Opportunities_for_Smallholder_Farmers_in_the_Drylands_of_Eastern_and_Southern_Africa

Egeru, A. 2016. Climate risk management information, sources and responses in a pastoral region in East Africa. *Climate Risk Management* 11:1-14.

Egeru, A., Osaliya, R., Mac Opiyo Laban., Mburu, J., Wasonga, O., Barasa, B., Said, M., Aleper, D. and Mwanyalolo, J.M.. 2014. Assessing spatio-temporal climate variability in semi-arid Karamoja sub-region in North eastern Uganda. *International Journal of Environmental Studies* 7(4):490-509.

Food and Agriculture Organization (FAO). 2009. Karamoja Food security, Assessment Report. Kampala, Uganda.

Feder, G., Just, R.E. and Zilberman. D. 1985. Adoption of agricultural innovation in developing countries; a survey. *Economic Development and Cultural Change* 33:255-298.

Funk, C., Senang Asfaw, J., Verdin, J., Rowland, J., Michealson, J., Eilert, D. and Choulaton, R. 2005. Recent drought tendencies in Ethiopia and Equatorial-subtropical Eastern Africa. Famine Early Warning System Network. Washington DC.USAID accessed at https://rmportal.net/library/content/recent-drought-tendencies-in-ethiopia-and-equatorial-subtropical-eastern-africa/view

Greene, W. 2002. Econometric Analysis, 5th Edition. Prentice Hall upper Saddle River. pp. 665 - 695.

Hillbruner, C. and Moloney, G. 2012. When early warning is not enough-lessons learned from 2011 Somalia Famine. *Global Food Security* 1:20-28.

International Federation of Red Cross and Red Crescent Societies (IFRC), 2014. Early Warning and Early Action Mechanisms for Rapid Decision making: Drought Preparedness and response in the arid and semi-arid lands of Ethiopia, Kenya and Uganda and in the East Africa Region Report. pp. 1-54.

Inter-Governmental Panel on Climate Change (IPCC), 2014. Climate Change 2014: Impacts, adaptation and vulnerability. Summary to Policy makers' .Working Group 11 AR5 Chapter 22, IPCC WG11 AR5 accessed at:http://www.ipcc.ch/pdf/assessment-report/ar5/wg2/ar5_wgII_spm_en.pdf

Lautze, S., Bell, W., Alinovi, L. and Russo, L. 2011. Early warning, late response (again): The 2011 famine in Somalia. *Global Food Security* 1(1):43-49.

Levine, S. 2010. What to do about Karamoja. A food security analysis of Karamoja. FAO/ECHO. Kampala, Uganda.pp58. Available from: http://www.celep.info/wpcontent/ uploads/downloads/2011/07/what-to-do-about-Karamoja.pdf

Maddala, G.S. 1983. Limited Dependent and Qualitative Variables in Economics. New York: Cambridge University Press. pp. 257-291.

Makala, J.N. 2012. Drought preparedness, impact and response: A case of Eastern Cape and Free State provinces of South Africa. Jamba. *Journal of Disaster Risk Studies* 4(1):47-57.

Masinde, M. 2014. An effective drought early warning system for Sub-Saharan Africa: Integrating modern and indigenous approaches. Central University of Technology, Free State, pp. 60-69.

Mayhorn, C.B. and McLaughlin, A.C. 2014. Warning the world of extreme events: A global perspective on risk communication for natural and technological disaster. *Safety Science* (61):43-50.

Mengistu, D. and Haji, M. 2015. Factors affecting the choices of coping strategies for climate extremes: The case of Yabello District, Borana zone, Oromia National Regional State, Ethiopia. *Science Research* 3(4):129-136.

Mishra, A.K. and Singh, V.P. 2010. A review of drought concepts. *Journal of Hydrology* 391: 202-216

Mubiru, D.N.2010. Climate change and adaptation options in Karamoja. A report submitted to FAO/EU. Available from: http://www.disaster riskreduction.net.

Mugerwa, S. 2013. The potential of well-designed Early Warning Systems and Disaster Insurance Schemes in cushioning farmers against drought- induced agricultural losses in the Karamoja sub-region of Uganda. *Scientia Agriculture* 3(1):19-25

Powell, J. 2010. Karamoja: A literature review. Safer World Report. Accessed at http://www.safer world.org.uk/Karamoja%20A%20literature %20review.pdf.

Tadesse, T., Brown, J.F. and Hayes, M.J. 2005. A new approach for predicting drought-related vegetation stress: Integrating satellite, climate and biophysical data over the U.S. Central Plains. ISPRS. *Journal of Photogrammetry and Remote Sensing* 59(4): 244-253.

Tadesse, T., Haile, M., Senay, G., Wardlow, B.D. and Knutson, C.L. 2008. The need for integration of drought monitoring tools for proactive food security management in Sub-Sahara Africa. *Natural Resources Forum* 32: 265-279.

Vincent-Serrano, S.M., Begueria, S., Gimeno, L., Ekludh, L., Giuliani, G., Weston, D., Elkenawy, A., Lopez Moreno, J., Nieto, R., Ayenew, T., Ardo, J. and Pegram, G. 2012. Challenges for drought mitigation in Africa: The potential use of geospatial data and drought information systems. *Applied Geography Journal* 34:471-486.

Wang, J., Yang, Y., Huang, J. and Chen, K. 2015. Information provision, policy support, and farmers' adaptive responses against drought. An empirical study in the North China Plain. *Ecological Modeling* 318:275-282.

Wilhite, D.A. and Svoboda, M. 2000. Drought early warning systems in the context of drought preparedness and mitigation. In: Early warning systems for drought preparedness and drought management. *World Meteorological Organisation*. pp. 1-21.

Wilhite, D.A., Svoboda, M.D. and Hayes, M. J. 2007. Understanding the complex impacts of drought: a key to enhancing drought mitigation and preparedness. *Water Resources Management* 21(5): 763-774.

Wooldridge, J. 2002. Econometric Analysis of Cross section and Panel Data. MIT Press.