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Perceived effects of drought on household food security in South-western Uganda: Coping responses and determinants

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ABSTRACT

Food insecurity is a region–wide problem in Sub-Saharan Africa, exacerbated by severe drought, with devastating impacts at the household level. However, farmers' coping strategies and their determinants remain under–documented. In this study, we: 1) characterise relationships between perceptions of drought and food insecurity and corresponding household coping responses, 2) compare livelihood characteristics of farmers that perceived food insecurity as a problem and those who did not, and 3) investigate how household-level characteristics correspond to household coping strategies. Our study is exploratory in nature: we administered a questionnaire to 140 farmers in Isingiro district in South-west (SW) Uganda whose livelihood is predominantly dependent on crop production. We employ binomial and multinomial logistic regression models to identify the determinants of the respondents' perceptions, how household characteristics correspond to household perceptions of food insecurity, and factors that affect coping responses. Our data show that 68.6% of the respondents perceived food insecurity as a problem in their household. Access to credit for crop cultivation increased the likelihood ($p < 0.05$) that farmers will be more aware and concerned about household food security status. Farmers were more likely to use the credit as a buffer against food insecurity. Whilst drought is widely perceived (by 95.6%: 133) as a problem contributing to food insecurity, the coping responses are wide-ranging. However a considerable 13% (of the total) reported to be "doing nothing" to respond to the drought effects. Notably, farmers that did not perceive food insecurity as a problem have higher ($p = 0.01$) off-farm incomes and larger ($p = 0.00$) farm sizes on average compared to those that did. Significant ($p < 0.05$) determinants of coping strategies include a combination of size of farmland, total income from crops, number of livestock and marital status. Broadly, our study indicates that households believe they are most at–risk of drought–induced food insecurity. Access to credit and alternative means of livelihood may offer resilience building options.

1. Introduction

Food insecurity is a significant challenge in Sub-Saharan Africa contributing to hunger, malnutrition and poverty (Underwood, 2000; Levine, 2010; Wheeler and Braun, 2013; FAO, IFAD, and WFP, 2015; McGuire 2015). The insecurity is mainly due to the prevalence of food production and distribution systems that are vulnerable and sensitive to economic and climate-related shocks (Misselhorn, 2005; Ruwoldt, 2013; IPCC, 2014a). In some other instances, food insecurity is associated with low education levels and low levels of access to information, health or other basic capabilities that constitute people's wellbeing (Burchi and Muro, 2016).

In Uganda, nearly half of households are currently food insecure (we limit this study to food availability and accessibility: for definitions see Maxwell, 1996; Gross et al., 2000; Pinstrup-andersen 2009; Barrett, 2010), predominantly due to a decline in food production and diversity at household level, especially in agriculture–dependent rural areas (Oxfam, 2008; Covarrubias, 2015; Whitney et al., 2018). Consistent

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with many parts of East Africa, food patterns in Uganda (especially in the cattle corridor where this study was carried out) are often characterised by very low amounts of harvest per growing season, small quantities stored by households for consumption, short periods before depletion and a small number of meals taken by several households per day (Ruben and Pender, 2004; Nalule, 2010; Verpoorten et al., 2013; Mbolanyi et al., 2017). Ironically, since agriculture is a main source of income, crop failure leaves the affected people unable to buy sufficient food for themselves (Oxfam, 2008), hence a vicious cycle of food insecurity. As such, incidences of poverty, famine and hunger, are ubiquitous in such areas (FAO, IFAD, and WFP, 2015; Mayanja et al., 2015).

Furthermore, food production in Uganda is sporadic because, as is the case in many countries in Sub-Saharan Africa where agriculture is primarily rain-fed, crop productivity is largely influenced by inter-annual patterns of rainfall amount and distribution (Cooper et al., 2008; Recha et al., 2012). The significance of rainfall is especially marked in most farmlands in Uganda because they are arid or semi-arid and/or subject to climate variability (Thornton et al., 2009; Estes et al., 2014). Erratic and highly variable rainfall affects farming practices, particularly planting (Roudier et al., 2011). With the prevailing magnitude of variability and changes in climatic conditions, the effects are more devastating to agriculture–dependent livelihoods than ever before (Smith et al., 2009; Schlenker and Lobell, 2010), and are projected to worsen (Boko et al., 2007; Mubiru et al., 2012; Cook and Vizy, 2013). The increasing climate variability (manifesting as frequent droughts, floods, and erratic unreliable rainfall) is further likely to exacerbate crop failure culminating in food and nutritional insecurity (IPCC, 2014b; ILRI, 2017).

Drought has been identified as the most challenging climate hazard and food security threat in Uganda (FAO et al., 2015; Berhane et al., 2013) through its negative impacts on agricultural production (Majaliwa et al., 2010; Mbolanyi et al., 2017). Drought results in water stress, crop failure and reduced or no crop yield (van Asten et al., 2011; Elhadi et al., 2015; Sabiiti et al., 2018). With most of the population depending on agriculture for subsistence, the immediate effect of drought is on food availability and accessibility, income, and livelihoods in general (Orindi and Murray, 2005; NAPA, 2007; Stark, 2011; Anwar et al., 2012).

The effects of drought on food availability and accessibility depend on levels of vulnerability and the capacity of the households and communities to respond (Filho and Mannke, 2012). Drought coping strategies are likely to be more limited for resource-constrained people, for example, those whose livelihoods are heavily dependent on natural resources (Fleshman, 2007; Mfitumukiza et al., 2017a, b). Coping response varies depending on the prevailing ecological and socio-economic conditions: these may include local agro-ecology, levels of education, gender, income, availability of support systems and services (Deressa et al., 2008; Mfitumukiza et al., 2017a). These and other capabilities play a key role in determining how individuals and communities are able to cope with the impacts of drought and maintain the functioning of their socio-economic systems (Robeyns, 2005).

Attempts have been made to investigate the general primary effects of climate related hazards (e.g. Babel and Turyatunga, 2014; Adhikari et al., 2015; Lwasa et al., 2018; and Sabiiti et al., 2018). However, there is a very limited number of studies that have focused attention on the direct relationship between drought and food security. Even where attempts have been made, they are too generalised to provide effective location specific drought adaptation response actions for agricultural productivity and food security (e.g. Phalkey et al., 2015; Ampaire et al., 2017; Zizinga et al., 2017; Rahn et al., 2018). Effective planning and decision making for improved food availability and accessibility related to the effects of climate variability and change requires new, location and time–specific information. Moreover, such information is needed for lesson sharing across regional, national and international levels to facilitate learning processes that can lead to global context support and partnerships (STOTT, 2014).

Understanding the relationship between drought and food availability and associated perceptions and responses is critical in managing food insecurity across scale (Knowler and Bradshaw, 2007; Mertz et al., 2009). It is with such information that plausible, context specific adaptation strategies in communities could be identified for the desired social change (Rosegrant and Cline, 2003; Sen, 2004; Robeyns, 2005; Smit and Wandel 2006).

Crop cultivation in our study area is relatively new compared to most parts of Uganda. Producers therefore have had a relatively short amount of time to develop strategies for coping and adapting to drought and associated food insecurity risk (Mbolanyi et al., 2017; Mfitumukiza et al., 2017b). In order to support improvement in farmer management practices, this study identifies factors that influenced farmers' perception of, and response to, drought risk. We address the following questions in particular: i) what household level factors are associated with perceptions of drought as a food security risk? ii) What household level factors are associated with drought coping responses? iii) Are there differences in livelihood characteristics between farmers that perceived food insecurity as a problem (in their households) and those that did not?

2. Methodology

2.1. Description of the study area

The study was conducted in Isingiro District, located in Southwestern (SW) Uganda (Fig. 1). It lies approximately between 00°50′S and 30°50′E. The district has an equatorial type of climate: receives an annual rainfall of 1 200 mm, with average temperatures ranging between 17 °C and 30 °C (Zziwa et al., 2015; Mpairwe et al., 2015). The rains occur during the months of March to May/June, and September to November of each seasonal calendar year. The soils are predominantly yellowish-red loams and sandy loams with occasional soft laterite categorised under Luvisols. The metamorphic rock type composed of argillites (phylites and schists) and arenites with some basal metacalcerous rock dominate the underneath surface (Mugonola et al., 2015).

In terms of vegetation, the study area is predominantly comprised of savannah grasslands, bushlands, wetlands, woodlands and scattered trees (from field observations), and lies at an average altitude of 1800 m.a.s.l. The terrain is mainly characterised by gentle hill slopes with mould tops and low land areas. Other areas are rugged with steep hills exhibiting deep and flat valley bottoms astride the district. Smallholder crop growing and livestock rearing are the major sources of livelihood (Kamukasa and Bintoora, 2014). Other sources of income are formal employment, provision of casual labour and engagement in small–scale businesses.

2.2. Household survey

Our study is exploratory in nature. We administered a questionnaire to 140 farmers who depend mainly on crop cultivation for their livelihood. Isingiro, like other cattle corridor areas, is traditionally known for pastoralism and wildlife (Herlocker, 1999). The area has a long history of animal (wildlife and livestock) production and experience in developing respective adaptation/coping responses (Jameson, 1970). However there is limited published data on coping responses to the inherent climate variability and recurrence of droughts amongst crop farmers. Furthermore, crop cultivation is a relatively recent livelihood typology in this area (Jameson, 1970).

Household surveys were conducted between September and October 2017 in the following parishes: Kaberebere, Endinzi, Birere and Masha (see Fig. 1), where most of the farmers are crop-dependent. The selection of the parishes was based on our extensive knowledge of the study area and sampling of the farmers within parishes was random. We

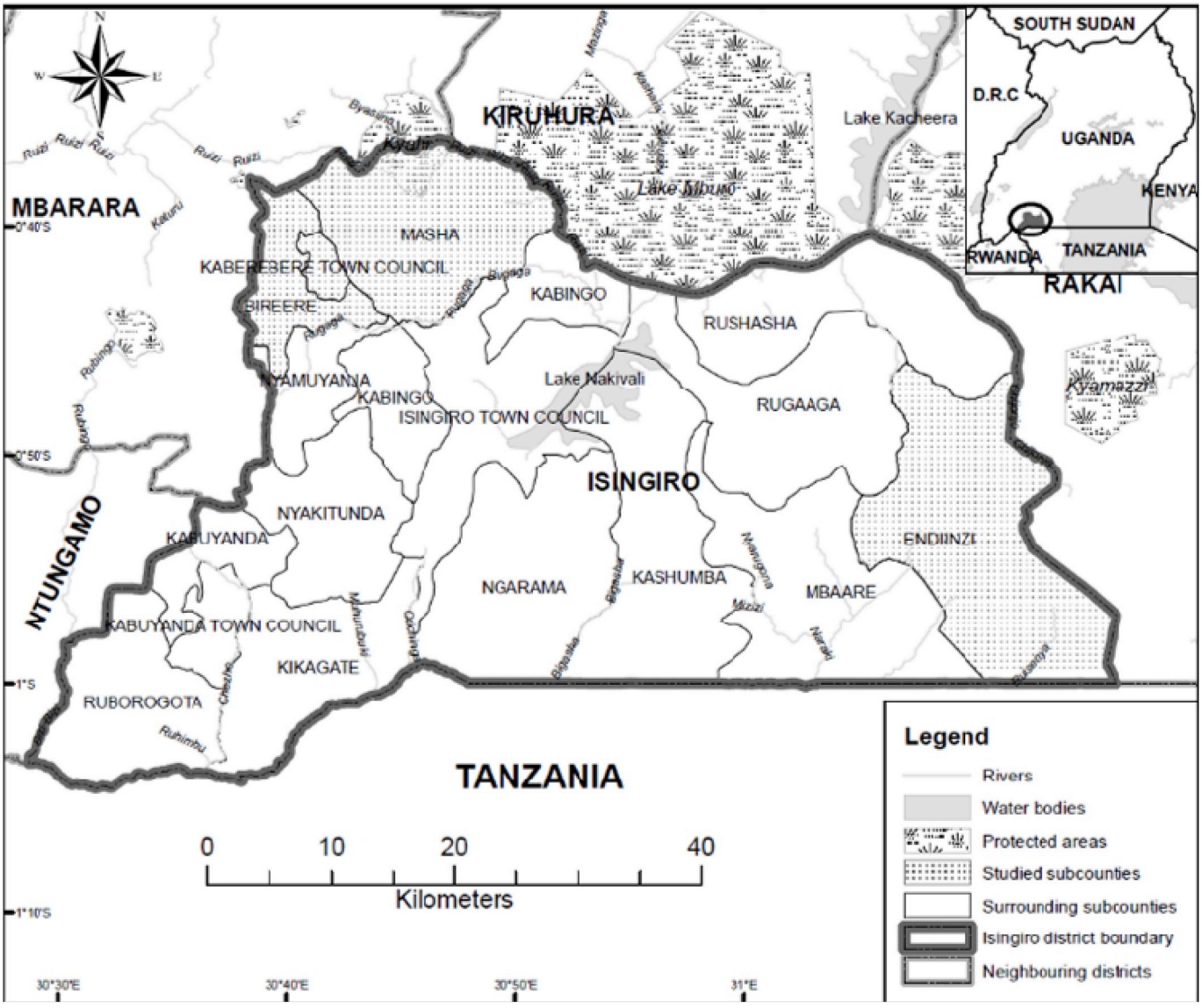

Fig. 1. Map of study area showing areas where sampling was done.

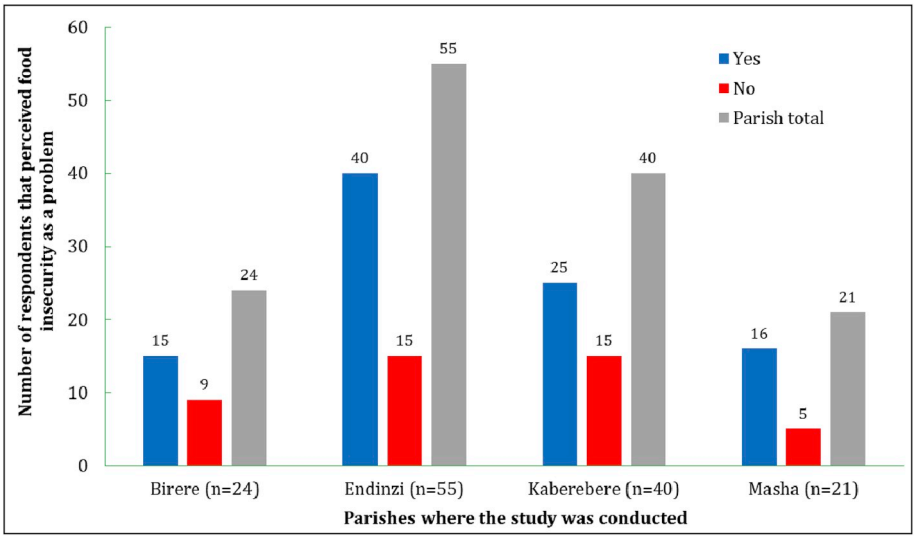

Fig. 2. Parishes where the study was conducted showing farmers that perceived food insecurity as a problem and those that did not.

Table 1
Rationale for selection of variables included in the questionnaire (and the model) to understand perceptions on food (in)security.

Variable	Reason why it could be a predictor of drought-induced food insecurity
Age	Element of farming experience and knowledge that could be developed with advancement in age enables the household to spread the risks of food insecurity through strategies such as diversified production. "*Households headed by older people are thus more likely to be food secure than those with younger heads*" … "*The age of the household head is a proxy for farming experience, on the assumption that the household's knowledge of food security issues will increase as the household head grows older and more experienced*"
Marital Status	Expenditure burden on food related items may compromise food security at household level. "*Marital status was significant at 10% and the coefficient indicated that households headed by unmarried people are more likely to be food secure than those headed by married people*". " …. households with married people as heads may have larger household sizes and thus many mouths to feed".
Off-farm Income	Enables investments, helps to spread risk. "*Households diversify their incomes by working as daily labourers, petty traders, artisans, and by working as daily construction labourers*" … "*It enables farmers to modernize their production by giving them opportunity to reduce the risks of food shortage during periods of unexpected crop failures. Income from these off-farm activities is also invested in agriculture to increase production and food availability at the household level*"
Level of Education	Could indicate level of knowledge to forestall food insecurity. "*It is explained in terms of contribution of education on working efficiency, competency, diversify income, adopting technologies and becoming visionary in creating conducive environment to educate dependants with long term target to ensure better living condition than illiterate ones. Thus, being literate reduces the chance of becoming food insecure in the sample households*"
Size of farm land	"*As the cultivated land size increases, provided other associated production factors remain the same, the possibility that the household gets more output is high as it remains basic resource for food production*"
Rain-fed Agriculture	Variability in rainfall amounts will have a bearing on the extent of vulnerability to low production and productivity of an enterprise dependent on rainfall
Access to credit	There is an implicit linkage between livelihood assets such as financial resources and food security. The financial resources obtained from credit would be necessary to cushion the household against adverse effects of the drought–induced food insecurity. "*This would mean that a household with poor resource endowments would face a higher risk of being food insecure*".
Remittances from family in case of crop failure	Remittances are a source of funds that can be used to enhance adaptive capacity "… *households with access remittance are better in terms of food access than non-remittance households i.e. households with remittance have lower anxiety about not being able to procure sufficient food, higher ability to secure adequate quality food, and lower experience of insufficient quantity of food intake than those without remittance*"
Access to water during drought	The water could be used for irrigation to reduce the risk of crop failure during periods of prolonged drought
Food storage facility	"*By storing and preserving food, households ensure that they secure food without jeopardizing future food consumption*".
Household size	Household size embodies demand on food resources; any additional claim on feeding requirements would translate into a burden in ensuring household is food secure. "*The result indicated that smaller household size tends to be food secure as compared to larger family size. The possible explanation is as family size increases, the amount of food for consumption in one's household increases thereby that additional household member shares the limited food resources*")
Number of meals per day	"The survey results showed that 78.1% of adults and 63.0% of children skipped one or more meals a day due to food shortage"
Crop yield	"The rural households' high dependence on rainfalls in Kambulatsitsi makes them highly vulnerable to climate change. Rainfall changes influence crop yields in the area, thus impacting on availability and stability of food supplies".
Income from crops sales	Avails resources for buying other food stuffs (and household items)
Household expenditure on crops	Could be an indicator of household's ability to copy with food insecurity. "*The study found that around half of the monthly income was spent on purchasing food and, even then, there was a high prevalence of food insecurity. It might be due to the large family-size where the amount spent on food would have been insufficient to meet the food requirements of all the family members*"
Number of livestock	Likely to increase household food sources/diversification. "*Analysis of household food security indicators showed that livestock diversification and increase of per capita livestock holdings were significantly associated with improved household food security. Generally, non-diversified households were significantly more vulnerable to food insecurity with longer periods of food shortage than those households involved in livestock diversification*"

conducted transect drives in the above parishes, and selected every 5th followed by the 10th household in an alternating manner along the transects. This randomisation was done in such a way that we avoided consciously including particular households into our sample, although we acknowledge that this technique could unconsciously result in excluding households that are not easily accessible (we lack evidence though that access to the road may result in different coping strategies). As a result, the sample size varied per parish (Fig. 2); our emphasis was not on establishing livelihood differences across the sampled areas – but rather to obtain an overall picture of climate variability coping and adaptation strategies amongst crop–dependent farmers. In the analysis therefore, we do not seek to illuminate local level disaggregation in the data given the relatively small sample size.

The questionnaire sought for information that was used as proxies for food security (availability and accessibility), including: livelihood characteristics (household demographics, cropping level of education, farm sizes, etc.), number of meals per day, crop yield, expenditure on crop production, access to credit, among others (Table 1). The questionnaire also sought for the farmers' perceptions on drought and food (in)security generally. Of the 140 respondents, 57.9% (81) are female while 42.1% (59) are male, and their average age (n = 140) is 44.5 ± 2.5 (mean ± 95% Confidence Interval: henceforth "CI"). This was considered a reasonable average for providing a history of drought (for the past 15 years) and perceptions on food insecurity.

2.3. Data analysis

We employed three data analysis techniques, one for each research question. For the first research question, we used a binomial logistic regression model (also referred to as the "logit" model) to identify the determinants of the respondents' perceptions of food insecurity (food insecurity is a problem, and food insecurity is not a problem, Bryan et al., 2013):

$$R_i^* = X_i\alpha + \varepsilon_i$$

Where: R_i^* is the latent variable, ε is the error term and X represents the set of household-level explanatory variables that influence farmers perceptions of food insecurity. The binary outcome is equal to one (Pi = 1) if a farmer perceived food insecurity as a problem, and zero (Pi = 0), if otherwise. We run two binomial logistic models separately however: one that looks at perceptions of food insecurity as a threat, and the other that looks at drought as a food security risk.

The second research question has multiple responses: 6 in total. A multinomial logit model is appropriate for analysing the factors that affect coping responses and was therefore employed. This model is useful for analysing multiple responses over a base category (and in this case 'non-response' was used as a base category). The probability that a respondent/household *i* with characteristics X will make choices on coping strategies P_j is specified as (Bryan et al., 2013):

$P_{ij} = X_i\alpha_j + \varepsilon_{ij}, j = 0, 1 \ldots j$

It is worth noting that for a multinomial logit model response choices should be mutually exclusive (i.e. only one major coping strategy is given), and variables were checked to ensure that they are not correlated with each other. With the multinomial logit model, we are interested in households that were coping with drought (in some way or "did nothing") but had perceived drought as a food insecurity risk. We therefore separate households that perceived food security as a threat and those who did not.

We compare livelihood characteristics of the farmers (in the third research question): differences between those that perceived food insecurity as a problem, and those that did not, as well as differences in the characteristics of farmers employing various drought coping strategies. A *t*-test is used to compare means of the former (food insecurity perception), given that the responses are binary: while in the latter, Kruskal-Wallis test (the equivalent of the parametric one-way ANOVA) is employed, especially that the data are non-normally distributed. The discrete variables in both cases are tested for differences using a chi-squared test via a cross-tabulation of discrete variables against food insecurity and coping strategies. The data were analysed using IBM SPSS v. 23.

3. Results

3.1. Perceived effects of drought on household food security and perception determinants

Sixty eight percent of the respondents (n = 140) perceived food insecurity as a problem in their household. Consistent with expectations, farmers who did not perceive food insecurity as a problem had livelihood characteristics that generally suggested that these households had socio-economic advantages over those farmers who did perceive food security as a problem (Table 2). For instance, their land was significantly larger ($p = 0.00$), and earned a higher ($p = 0.01$) monthly off-farm income (Table 2).

The binomial logistic regression of perceptions of food security shows that farmers that have access to credit for crop cultivation are more likely ($p < 0.05$) to perceive food insecurity as a problem compared to those that have no access to credit (Table 3). The other variables used in the model have no significant effect on the outcomes of the food insecurity perception. This is reflected in the fact that the logit model explains 29.4% (Nagelkerke R^2) of the variance in the food insecurity perception albeit statistically significant $X^2 = 12.1$, $p < 0.001$, and correctly classified 76.7% of the cases.

However, an exploration of the data indicates that only 23 (17.0%) respondents had access to agricultural credit. The credit is obtained mostly from BRAC Uganda (a Non-Governmental Organisation: 8 farmers), Centenary Bank (5 farmers), Ankole farmers (4 farmers), and the rest (a much smaller number) from FINCA, Twetungure, and Enkora ensya. These are predominantly formal institutions although some self-help informal associations (e.g. Twetungure, Enkora Ensya) are also mentioned.

We now turn to farmers' perception of drought as a risk factor. Among the subset of households that perceived food insecurity to be a problem (n = 96), 46% and 54% explained food insecurity as the result of drought that caused either total crop failure or reduced yields, respectively. None of the variables used to run the logistic model has a significant effect on respondents' perceptions of drought as a food insecurity risk factor.

3.2. Farmers' strategies for coping with drought

All the farmers (n = 140) perceived drought as a problem for food security in the area. However, 95.6% (133) of the total reported that they had observed changes in drought patterns in the last 15 years. Of these, 127 (96.7%) believed drought had steadily increased in intensity and frequency of occurrence, while a smaller percentage (4.4%) perceived annual drought intensities and frequencies that were both unusually high and unusually low over this timeframe.

The farmers (n = 140) identified the following as strategies they applied to cope with drought and reduce the risk of food insecurity: the majority were storing food and water (food is stored in sacs and granaries – Fig. 3a and b respectively; while water is stored in built underground reservoirs with tarpaulins inside), mulching their gardens (with thick layers of grasses and dry banana leaves and stems – Fig. 3c, although without variation based on severity of drought), small-scale

Table 2
A comparison of characteristics between farmers that perceived food insecurity as a problem and those that did not.

Variables	Food insecurity perceived as a problem (n = 96)	Food insecurity not perceived as a problem (n = 44)	Kruskal-Wallis test, X^2	p
Size of farmland (in acres)	2.4 ± 1.1	4.2 ± 1.7	10.5	**0.00**
Age	44.2 ± 3.2	45.2 ± 4.0	0.3	0.53
Monthly off-farm income (in UGX)	153,406 ± 37,219	289,965 ± 147,406	6.9	**0.01**
No. Members in the household	6 ± 0	6 ± 0	0.5	0.82
Respondent's level of education (grade level)	5.3 ± 0.8	5.5 ± 1.3	0.2	0.64
No. meals per day	1.8 ± 0.1	2.0 ± 0.2	2.3	0.13
Tot. crop yield (in Kg)	210.5 ± 33.9	2 593.7 ± 2 580.3	1.4	0.24
Tot. income from crops in previous season (in UGX)	445,312 ± 92,186	656,447 ± 205,391	3.2	0.07
Tot. expenditure from crops in previous season (in UGX)	141,302 ± 53,850	175,340 ± 88,757	0.2	0.68
Tot. no of livestock	1 ± 1	1 ± 1	0.1	0.82
Categorical variables			**Pearson X^2**	**p**
Sex	M-37; F-59	M-22, F-22	1.6	0.2
Respondent's marital status	Mar-58, Sin-14, Wid-19, Div-5	Mar-35, Sin-2, Wid-5, Div-2	5.6	0.13
Access to credit	Yes-17, No-29	Yes-6, No-37	0.3	0.58
Obtain remittances from family/friends in case of crop failure	Yes-10, No-86	Yes-3, No-40	0.4	0.52
Are remittances enough	Yes-2, No-94	Yes-1, No-43	0.0	0.94
Owns a food storage facility	Yes-52, No-44	Yes-28, No-16	1.1	0.29
Rely on rainfall for agriculture	Yes-92, No-4	Yes-42, No-2	0.0	0.92

In bold are variables whose differences in means (or tallies) is significant across the coping strategies. Missing data from 4 respondents. Abbreviations: M – Male, F – Female; Mar – Married; Sin – Single, Wid – widow[er]; Div – Divorced.

Table 3
Determinants of the perceptions of food insecurity at household level.

Variables	B	S.E	Wald	Exp(B)	p-value
Sex (male)	-.010	.498	.000	.990	.983
Respondent's age	.004	.018	.048	.827	.827
Respondent's marital status			1.263		.738
Respondent's marital status (married)	.291	.915	.101	1.337	.751
Respondent's marital status (single)	−10.561	59.189	.032	0.000	.858
Respondent's marital status (widow [er])	-.505	1.082	.218	.604	.641
Monthly off-farm income (UGX)	.000	.000	2.461	1.000	.117
Respondent's level of education	.020	.061	.107	1.020	.744
Size of farmland	.043	.041	1.065	1.044	.302
Rely on rainfall for agriculture (yes)	-.506	1.096	.213	.603	.645
Access to credit (yes)	−1.536	.745	4.257	.215	**.039**
Get remittances from family/friends in case of crop failure (yes)	-.605	.932	.422	.546	.516
Are remittances enough (yes)	.224	1.875	.014	1.251	.905
Access to water during droughts (yes)	.299	1.369	.048	1.349	.827
Owns a food storage facility (yes)	.346	.481	.517	1.413	.472
No. of members in the household	-.077	.097	.629	.926	.428
No. of meals per day	.756	.505	2.244	2.129	.134
Tot Crop yield in recent season in kg	.000	.001	.075	1.000	.784
Tot income from crops in recent season in UGX	.000	.000	.325	1.000	.569
Tot Expenditure on crops in recent season in UGX	.000	.000	1.472	1.000	.225
Tot no. of livestock	-.056	.060	.881	.946	.348
Constant	−2.011	1.901	1.119	.134	.290

irrigation (hand irrigation – Fig. 3d –mostly used until water becomes very scarce) accounting for 38.2%, 26.5%, 16.9% of the total number of responses, respectively. However, 13.2% reported that they do not do anything to cope with the drought, while 5.1% said that they plant early. We follow up on those that "do not do anything" to cope with drought in the subsequent section.

From the multinomial logistic regression (Table 4), significant ($p < 0.05$) determinants of coping strategies include a combination of

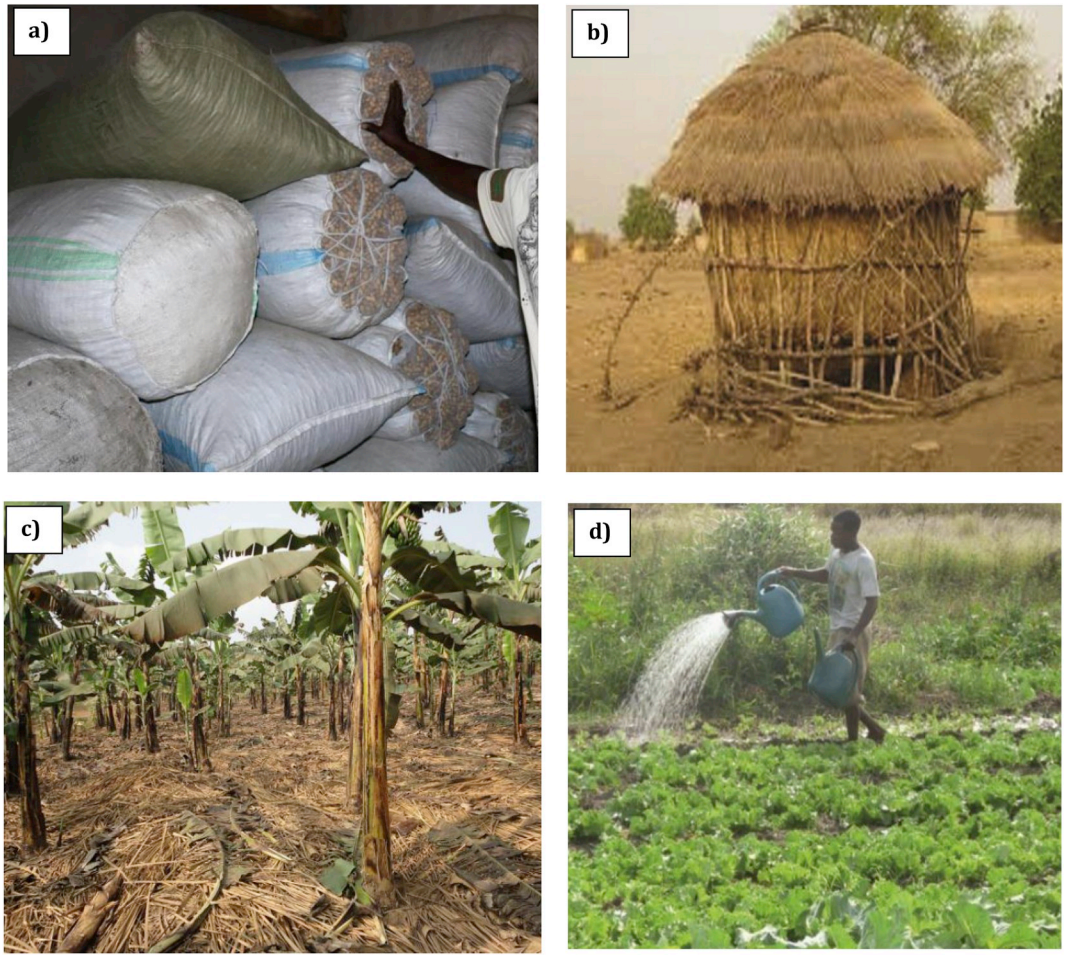

Fig. 3. Farmers' coping strategies with perceived drought–induced food insecurity a) food stored in sacs, b) food storage in granaries, c) mulching with thick layers of grasses and dry banana leaves and stems and d) small-scale hand irrigation scheme.

Table 4
Determinants of coping responses to drought in the sample.

Effect	−2 Log Likelihood	Chi-square	p-vale
Intercept	256.141[a]	.000	.000
Monthly off-farm income	263.274	7.133	.129
Respondent's age	258.996	2.855	.582
Size of farmland	266.726	10.585	**.032**
No. of members in a household	264.177	8.035	.090
No. of meals per day	261.448	5.306	.257
Respondent's level of education	259.697[b]	3.556	.469
Tot. Crop yield in kg	263.604	7.462	.113
Tot. income from crops recent season in UGX	266.072	9.931	**.042**
Tot. expenditure from crops in recent season in UGX	259.210	3.069	.546
Tot. no. livestock	267.928	11.786	**.019**
Sex	261.305[b]	5.164	.271
Respondent's marital status	288.457	32.316	**.001**
Rely on rainfall for agriculture	260.687	4.545	.337
Access to credit	260.821[b]	4.680	.322
Get remittances from family/friends in case crop failure	259.370	3.229	.520
Are remittances enough	260.308	4.167	.384
Access to water during droughts	258.680	2.538	.638
Owns a food storage facility	264.480	8.339	.080

size of farmland, total income from crops, number of livestock and marital status. However, there were no significant differences ($p > 0.05$) in household-level variables across groups of households that used different coping strategies. Farmers own 3.3 ± 0.9 acres of land on average, and this does not differ significantly (Kruskal-Wallis test: $X^2 = 2.2$, $p = 0.3$) across coping strategies. Average total income from crop sales is approximately UGX 511,678 ± 90,394 (at the time of the study I USD = UGX 3 600) from the 'recent' season (season preceding fieldwork: response projections for about half a year) – and this does not differ significantly (Kruskal-Wallis test: $X^2 = 0.9$, $p = 0.6$) across coping strategies. Similarly, the average number of livestock is 1 ± 1 with no significant differences (Kruskal-Wallis test: $X^2 = 2.0$, $p = 0.4$) across the farmers with different coping strategies. There are however significant differences ($X^2 = 23.4$, $p = 0.02$) between marital status and how farmers cope with drought: the majority – married people (66.9%) – store food and water (30), mulch (28) and irrigate (18), compared to their widower/widow, single, and divorced (which comprise 17.6%, 10.3% and 5.1% respectively) counterparts. These are expounded in Table 5.

3.3. A comparison of livelihood characteristics across coping strategies

We find very few differences between farmers that "do nothing" to cope with drought compared to those who are investing in/are expressly coping with drought-related challenges on crop production, and food security in general. The data show that farmers that engage in early planting and mulching have at least 2 meals a day, and on average have more meals a day ($p < 0.05$) than those that use irrigation and those farmers that "do nothing". Farmers who store food and water had the lowest number of meals although the differences across all the response categories are marginal (Table 5).

The number of livestock kept by farmers varied significantly ($p < 0.05$) across coping strategies: farmers that "do nothing" ($n = 18$) and those that use mulching ($n = 36$) as a drought coping strategy own no livestock on average. The farmers that use irrigation, storing food and early planting keep at least one animal.

Respondent's marital status was also significantly different ($p < 0.05$) across coping strategies. The largest percentage (66.9%) of the respondents are married, followed by those that are widowed, then the single and least are the divorced, accounting for 17.6%, 10.3% and 5.1% respectively. Interestingly married people were more likely to store food and water, mulch and practice small-scale irrigation compared to their counterparts (Table 5). There is a sizeable percentage of married respondents (10.6%) who do not do anything to cope with drought however.

Access to credit has partly been presented above: only 17% of the respondents have access to credit. The data show that more farmers that are engaged in storing food and water for their households are accessing credit more than their counterparts that are employing other strategies to cope with drought ($X^2 = 11.2$, $p < 0.05$). Access to credit was particularly rare among farmers who "do nothing" in response to drought. Only 1 farmer (0.74%) out of 18 that "do nothing" in response to drought has access to credit (Table 5).

4. Discussion

4.1. Perceived effects of drought on household food security

Prolonged drought seasons are a trigger for food crises in sub-Saharan Africa as the majority depend on rainfall for crop and livestock production (cf. section 1). Evidence from this study however shows that in the context of drought-induced vulnerability, the households were all exposed to the same hazard but there was variation in perceptions of whether or not food insecurity was a problem. This could be explained in part by differences in their coping and adaptive capacities. The perceived threat of drought in the study area was expected. 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 (Zziwa et al., 2015; Akwango et al., 2016).

Household perceptions indicate differences in vulnerability levels: susceptibility is not always uniform across a given vulnerable population when you take into consideration the effects of a given hazard such as drought. This view is supported by Gaillard (2010) who argues differences in availability and use of resources and assets within an at-risk community, generates differences in the household capacities to minimise (or failure to reduce) their vulnerability to hazards such as drought. These are conditioned by factors that are originating from within that community. Similarly, Shifrew et al. (2014) reiterate this argument that it is the "*capability failure*" accentuated by inability to access markets and "*people's social, economic and political entitlements*" that could be responsible for the differential experience of drought-induced food insecurity (Shiferaw et al., 2014:68). Yikii et al. (2017) corroborate our findings in Isingiro District. They found that drought-induced food insecurity is a critical problem affecting about 6.3% of the households in Uganda. They further confirm that drought has a potential to cause a nutritional gap amongst the smallholder farmers.

In our study, credit seeking behaviour was identified as a more likely determinant of the perceptions of drought effect on food insecurity. Comparison of this finding with those of other studies (Irohibe and Agwu, 2014; Tafesse et al., 2016) confirms that access to credit has a beneficial effect on food security status at household level. Tafesse et al. (2016: 86) show that "*the probability that households are food secure with credit access in the study area was 63.1% [compared to] 41.5% for those who do not have access to credit*". In addition, our study shows that farmers are using a varied set of credit sources to absorb the effects of drought on food security ranging from Commercial banks (e.g. Centenary Bank) to Self-Help Associations/informal community-based banking systems (e.g. Twetungure, and Enkora ensya). One of the issues that emerges is that, the Self-help associations offer a platform for nurturing and institutionalising 'organic' savings and credit mechanisms. These mechanisms can be particularly effective in a farmers' context because they can support farmers' efforts to put in place either *Ex ante* or *Ex post* responses to drought-induced food insecurity (Entz et al., 2016). This corroborates the notion that self-help associations that have a component of credit and saving or revolving fund systems are able to empower farmers and facilitate the upgrade from the status of food insecure to food secure by "*stabilizing incomes, raising incomes*

Table 5
Characteristics of farmers against their main drought coping strategies (mean ± 95% CI).

Variables	Irrigation (n = 23)	Mulching (n = 36)	Storing food and water (n = 52)	Early planting (n = 7)	Does nothing (n = 18)	Kruskal-Wallis test, X^2	p
Size of farmland (in acres)	3.1 ± 1.3	5.62 ± 3.2	2.2 ± 0.7	4.6 ± 4.5	1.4 ± 0.6	6.7	0.15
Age	49.3 ± 6.4	45.9 ± 4.6	43.2 ± 4.3	44 ± 18.1	42.3 ± 6.6	4.0	0.41
Monthly off-farm income (in UGX)	153,487 ± 86,068	278,611 ± 174,044	155,744 ± 52,135	218,517 ± 122,046	194,411 ± 124,801	3.9	0.42
No. Members in the household	6 ± 1	6 ± 1	6 ± 1	6 ± 1	5 ± 2	5.5	0.24
Respondent's level of education (grade level)	4.8 ± 1.5	5.3 ± 1.5	4.7 ± 1.0	7.0 ± 4.6	6.7 ± 2	5.0	0.28
No. meals per day	1.9 ± 0.1	2.03 ± 0.2	1.7 ± 0.2	2.1 ± 0.4	1.9 ± 0.3	9.6	**0.04**
Tot. crop yield (in Kg)	317.8 ± 101.2	177 ± 54.2	2152 ± 2150	201.7 ± 70.6	224.84 ± 123.4	8.2	0.08
Tot. income from crops in previous season (in UGX)	648,043 ± 318,291	448,888 ± 123,297	533,846 ± 145,543	380,000 ± 214,450	515,555 ± 356,093	2.4	0.66
Tot. expenditure from crops in previous season (in UGX)	191,913 ± 137,120	126,666 ± 92,163	177,807 ± 80,285	107,142 ± 100,396	128,333 ± 110,978	1.8	0.76
Tot. no of livestock	2 ± 1	0 ± 0	2 ± 1	3 ± 1	0 ± 0	13.3	**0.01**
Categorical variables						**Pearson X^2**	**p**
Sex	M-10; F-13	M-16, F-20	M-20, F-32	M-3, F-7	M-9, F-9	0.8	0.94
Respondent's marital status	Mar-18, Sin-0, Wid-3, Div-2	Mar-28, Sin-3, Wid-5, Div-0	Mar-30, Sin-7, Wid-12, Div-3	Mar-1, Sin-2, Wid-2, Div-2	Mar-14, Sin-2, Wid-2, Div-0	23.4	**0.02**
Access to credit	Yes-2, No-21	Yes-12, No-24	Yes-6, No-45	Yes-2, No-5	Yes-1, No-17	11.2	**0.02**
Obtain remittances from family/friends in case of crop failure	Yes-1, No-22	Yes-5, No-31	Yes-5, No-46	Yes-0, No-7	Yes-1, No-17	2.7	0.61
Are remittances enough	Yes-0, No-1	Yes-1, No-4	Yes-2, No-3	Yes-0, No-0	Yes-0, No-1	1.8	0.78
Owns a food storage facility	Yes-17, No-6	Yes-19, No-17	Yes-25, No-27	Yes-4, No-3	Yes-12, No-6	5.3	0.26
Rely on rainfall for agriculture	Yes-23, No-0	Yes-35, No-1	Yes-49, No-3	Yes-7, No-0	Yes-16, No-2	3.8	0.44

In bold are variables whose differences in means (or tallies) is significant across the coping strategies. Missing data from 4 respondents. Abbreviations: M – Male, F – Female; Mar – Married; Sin – Single, Wid – widow[er]; Div – Divorced.

and enhancing social justice" (Devereux, 2016:1). Likewise, Shiferaw et al. (2014) identified that access to credit could play a role in incentivising farmers to invest in conservation agriculture as one of the ways of mitigating against the undesirable outcomes of drought. However, offering credit to smallholder holders requires strict monitoring and supervision in order to realise income, food and nutritional security benefits.

4.2. Farmers' main coping responses to drought-induced food insecurity

Our study reveals farmer uptake of both *ex ante* and *ex post* drought coping strategies. Farmer's face significant constraints to adopting these coping strategies. Some of the coping strategies that were identified in our study which can be aligned with the *ex ante* category include early planting, mulching of gardens, as well as storage of food and water in preparation for drought. Our discussions with farmers indicated that this increased chances of food availability throughout the year. On the other hand, the key aspects of *ex post* drought coping strategies that emerge from our findings include access to credit as well as small-scale irrigation. Although our study findings reveal that small-scale irrigation with rudimentary handheld watering cans is one of the coping responses, it is used by very few people and has limited benefits. This finding is corroborated by Makoti (2014) and Tumwesigye et al. (2018), albeit from a different study area. Makoti (2014) found that "*construction of water reservoirs [for water storage] was ranked the least with 25% of the respondents reporting to use it as an ex-ante drought coping strategy at household level*" (Makoti, 2014: 80–81). According to Makoti (2014), income deficiencies within the community explain the tendency for water storage to be the lowest prioritized response strategy. Furthermore, in a detailed examination of the effects of climate variability and its impact on the weather sensitive agriculture-based livelihood system of smallholder farmers in Ethiopia, Tafesse et al. (2016) showed that irrigation water use did not guarantee household food security status. This was attributed to failure to take into account factors such as "*distance to nearest market, road transport, processing industry and information access*" (Tafesse et al., 2016: 86).

Pathmanathan et al. (2017) and Thompson and Meerman (2014) similarly underscore the complex community dynamics that support or hinder adoption of irrigation systems. They argue that establishing water reservoirs for irrigation without paying attention to complementary factors such as "*access to information or finance for modern equipment and practice …. investment in physical infrastructure as well as providing social insurance and social safety nets*" is counter-productive for the drought affected farmers (Baluka et al., 2014; Pathmanathan et al., 2017: 30, 34). Nonetheless, some farmers in Isingiro are investing in water storage facilities because of the devastating drought seasons that have been experienced in the recent past.

4.3. Livelihood characteristics and coping strategies

This study reveals that farmers that did not perceive food insecurity as a problem have more resources than those that did. They own larger sizes of farming land and earn higher monthly off-farm incomes. This finding is unsurprising because farmers who own large (or a number of) pieces of farming land are likely to have larger harvests, and their off farm income is likely to buffer them against food scarcity. These factors are key drivers of investment on land and affect food availability, and access. Similar observations were made by Zziwa et al. (2015) who found that the household within their sample in Isingiro District own on average of 364 acres of land. The large sizes of land are possible under the mailo system [where people typically owned large chunks of land, rooted in the colonial era] (Mpairwe et al., 2015; Yikii et al., 2017). This certainly dwarfs what we recorded amongst crop farmers – perhaps their sample was inflated by cattle keepers that own large sizes of land. However, it is worth noting that the influx of refugees from neighbouring countries such as Rwanda, Burundi among others could also impact the division of land across landholders (Kamukasa and Bintoora, 2014; Ahimbisibwe, 2017; Ilcan et al., 2015).

Household income levels and land area of tenured farmers are key determinants to drought coping strategies and food security. The farmers with higher incomes and more land were more likely to apply drought coping strategies such as planting early and mulching and had at least two meals a day. It is expected that such farmers are likely to be more food secure. Early planting and mulching improve crop productivity and yield owing to early maturing, utilising the first effective rains, and preservation of soil moisture in the farmlands. These facts are corroborated by Kaye and Quemada (2017) who suggest that planting early and mulching are good strategies for increasing food production in drought years.

Although not the main focus of our study, the data show that there are differences in the number of livestock owned by farmers employing different coping strategies. In contrast to farmers that "do nothing" or use mulching as a drought coping strategy who own no livestock, farmers that applied irrigation, stored food and planted early kept at least an animal. This could be due to the fact that we purposively included farmers that had specialised in crop production. Nevertheless, farmers in Isingiro generally own livestock in addition to crop farming (see Zziwa et al., 2015; Turyahabwe et al., 2013). Our study considered the main coping strategy employed by each farmer that predominantly depended on crops for livelihood. Future studies are required to look at combinations of the strategies, with more controls to understand the effectiveness of each.

5. Conclusions

This paper analyses the determinants of perceived food insecurity and drought as a food security risk factor, and coping responses across diverse livelihood characteristics of smallholder crop farmers. While nearly all the farmers perceived changes in drought patterns over the last 15 years, indicating increased intensity and frequency, this did not necessarily translate into perception of drought-induced food insecurity. The perceptions of food insecurity were more likely to be influenced by access to credit from both formal and informal institutions for crop cultivation. Indeed, farmers that did not perceive drought-induced food insecurity as a problem own larger sizes of land, and earn a higher monthly off-farm income than their counterparts. This implies that productive assets (e.g. land) can be easily translated into productive activities for higher income and improved livelihood while off-farm income could provide more choices in terms of food access.

The main coping responses to drought include: storing food in sacs and granaries and water in built underground reservoirs with tarpaulins inside, mulching gardens with grasses and dry banana leaves and stems, and small-scale hand irrigation, albeit with a sizeable number that reported to be "doing nothing" to respond to the effects of drought. The coping responses depend on a combination of factors including: size of farmland, total income from crops, number of livestock and marital status. There were no major differences in livelihood characteristics between farmers that "do nothing" and those that employ various coping strategies except for number of meals taken and livestock owned. Farmers that engage in early planting and mulching have at least two meals a day, and on average have more meals a day compared to those that use irrigation, and a category that "does nothing". Those that reported to be storing food and water had lowest number of meals, farmers that "do nothing" and those that use mulching as a drought coping strategy own no livestock on average and farmers that use irrigation, store food and practice early planting keep at least an animal each on average. The farmers that are engaged in storing food and water for their households are accessing credit more than their counterparts that are employing other strategies to cope with drought.

The implication is that farmers need to adjust their agricultural management practices to ensure that they cope with drought conditions (in Isingiro district). Access to credit and alternative means of

livelihood could provide buffers, to ensure that households remain food secure in spite of the drought. More broadly, while much of the discussion centres around drought when it comes to food insecurity, drought does not automatically lead to food insecurity for everyone, we show that those farmers with high capacity and opportunities to diversify off-farm, do not consider drought-induced vulnerability a significant problem. Policy options for tackling drought-induced food insecurity should take into consideration such heterogeneities, likely to be pervasive in Sub-Saharan Africa.

Conflict of interest

The authors declare that there is no conflict of interest arising from this research or the publication of its findings.

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Appendix A. Supplementary data

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