WIDER Working Paper 2014/107

Adaptation to climate variability and change in Uganda

Are there gender differences across households?

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September 2014

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Abstract: This paper hypothesizes that adaptation to climate change is influenced by the gender of the decision maker of the household. Using a two-wave household panel survey dataset, choice of adaptation strategies employed by female- and male-headed households are examined. A multinomial logit model is used to examine factors determining adaptation choices by gender. Findings reveal that gender of the household head matters in adaptation to climate-induced shocks. Specific differences were found regarding responses during drought, regarding crop pest attacks, and livestock epidemics. Agro-ecological climate zones in which households live play a key role in adaptation options, yet gender matters.

Keywords: adaptation, climate change, covariate shocks, gender, multinomial logit
JEL classification: C35, J16, Q54

Acknowledgements: This paper was written during my PhD internship period at UNU-WIDER. I would like to thank Malokele Nanivazo, Yongfu Huang, Asumani Guloba, and Razack Lokina for their very useful input and comments on the initial drafts of this paper. I am also grateful for comments received from participants during the UNU-WIDER seminar series and the 2012 AERC Biannual Workshop, held at in Arusha, Tanzania.

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This study has been prepared within the UNU-WIDER visiting scholar and PhD internship programmes.

ISSN 1798-7237 ISBN 978-92-9230-828-5 https://doi.org/10.35188/UNU-WIDER/2014/828-5

Typescript prepared by Sophie Richmond for UNU-WIDER.

UNU-WIDER gratefully acknowledges the financial contributions to the research programme from the governments of Denmark, Finland, Sweden, and the United Kingdom.

1 Introduction

Climate change and variability is having long-term effects on rainfall patterns and temperatures especially for tropical countries (IPCC 2007). The adverse effects of climate change are increased frequency, persistence and intensity of droughts and floods that have negative effects on agriculture, food and water availability.[1] Households which are poor and largely dependent on agriculture are most affected. Climate-induced extreme conditions impact men and women differently (see Brody at al. 2008; IPCC 2012). Hence, the adaptation strategies chosen by men and women are also different (see Denton 2002). This recognition has gained prominence through the inclusion of gender in the policy agenda for adaptation to climate change in recent times[2]. All the more as there has been a recognition of the extremely large burden that poor women are facing as they adapt to climate change (see Denton 2002; Masika 2002). Agarwal (1997) argues that land rights are crucial during severe subsistence crises such as during drought and famine. In such instances, poor rural households tend to first dispose of assets such as jewellery, household utensils and small animals, keeping the productive resource such as land, till the last. This has gender implications.

Research on adaptation to climate extremes is on the rise (see Adger et al. 2003; Orindi and Eriksen 2008; Piya et al. 2012). Yet few studies have examined factors influencing choice of adaptation strategies at case (farm) study level (see Below et al. 2010; Deressa et al. 2008; Gbetibouo 2009) and country levels (see Hisali et al. 2011). Further, the gender focus of these studies is inadequate. For example, existing studies on gender and adaptation to climate change are highly theoretical (see Brody et al. 2008; Denton 2002). An empirical analysis of choice of adaptation strategies with a gender focus at country level is hard to find. Nabikolo et al. (2012) attempt to address this gap in the research but their focus on adaptation is limited.[3]

This paper focuses on Uganda, a typical Sub-Saharan low-income country whose people (70 per cent) depend on agriculture which largely depends on nature. According to the Uganda Meteorological Unit, average days of rain are declining and average temperatures are increasing—implying increased frequency in drought conditions. Thus, this paper provides an assessment of the types and frequency of climate shocks in Uganda. Adaptation strategies for covariate shocks[4] and factors determining various adaptation choices, controlling for gender of the final decision maker in the household, are analysed. A focus on adaptation to covariate shocks while controlling for gender, and other socioeconomic, farm level, institutional, community and climate factors is necessary at the individual level, but not sufficient since adaptation to climate extremes is a household level issue. Consistent with most micro-studies on adaptation, the subjective[5] as

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[1] According to IPCC (2007), temperatures in Africa increased by 1 °C from 1900 to 2000 and are projected to increase by 3 °C by 2050. For further reading see earlier IPCC reports.

[2] IPCC (2007, 2012).

[3] Adaptation has been captured as a binary variable.

[4] These are climate induced shocks that have massive impacts on communities and can trigger one or more shocks (for instance natural disasters). Climate change will exacerbate covariate shocks through increased occurrences of droughts, floods, hailstorms/mudslides, crop pests and disease attacks, and livestock epidemics.

[5] Subjective measures are those usually derived from answers to a shock and coping strategy section incorporated in household survey questionnaires asking respondents whether they experienced different types of shocks over a certain period (e.g. drought, floods, pests, landslides, hailstorms, livestock epidemics).

opposed to the objective[6] measures in categorizing coping strategies to covariate shocks at the household level are used. Further, departing from other analyses on Uganda (for instance Hisali at al. 2011; Nabikolo et al. 2012) that use cross-section data and a case study approach, this paper uses a two-wave panel household survey dataset gathered by the Uganda Bureau of Statistics (UBoS) in 2005/06 and 2009/10. The data comprises of 2,566 original households. The econometric analysis employs a pooled multinomial logit (MNL) model based on the utility maximization principle to ascertain factors that determine adaptation choices for female- and male-headed households. Sampling weights to account for under- and over-sampling in enumeration areas are used throughout the analysis, making survey data nationally representative.

Survey findings indicate that a third of the sample households experience more than one type of shock. In response to shocks, findings reveal that female-headed households consistently reduce consumption and male-headed households resort to use of savings as immediate adaptation strategies during drought. Use of agricultural-related technology is seen among all households, irrespective of the gender of the household head, when faced with crop pests and disease attacks. While female-headed households expand labour supply, male-headed households increase use of savings as choices of adaptation strategies during livestock epidemics. Further, with regard to factors determining adaptation strategies for male- and female-headed households, there are differences in the determinants partly characterized by the level of diversification between the two sorts of households. Generally, agro-ecological climate zones play key roles in various adaptation options in the households.

As Uganda drafts its climate change policy,[7] this paper provides important insights that inform the climate change adaptation debate. The rest of the paper is structured as follows: Section 2 highlights gender dynamics in land holdings and employment in Uganda and section 3 discusses data, shocks and variables used for analysis. Sections 4 and 5 discuss the choice of coping strategies categorized by gender of household head and the empirical model employed for adaptation analysis, respectively. Section 6 presents and discusses empirical results with a disaggregation of factors determining adaptation strategies employed for the four covariate shocks for both male- and female-headed households. Section 7 provides a conclusion and policy recommendations.

2 Understanding gender differences in land holdings and employment

Households are characterised by different (often conflicting) preferences and interests, with differential abilities to pursue and realize them. These arise from gender differences in distribution of work both in and out of the household, hours spent on different types of work, and asset holdings. The degree of heterogeneity in work and asset ownership (see Deere and Doss 2006) leads to heterogeneity in the coping strategies adopted by different households amid climate distress events. These differences are *socially* constructed rather than *biologically* determined.

Uganda has a population of about 33 million with a sex ratio of 48.2 to 51.2 in favour of females. The population aged below 18 years is about 57 per cent of the total population—indicating a high dependency ratio. Nearly 85 per cent of the population resides in rural areas (see UBoS 2010a; 2010c). Women and children contribute over 70 per cent of the labour force in agricultural production. Agriculture activities in Uganda depend on nature (UBoS 2010a). Extreme climate

[6] Objective measures are those derived directly from weather data; these measures are often constructed only at a rather aggregated level.

[7] Uganda has started drafting a climate change policy.

change conditions have a negative impact on agriculture, which in turn has an adverse impact on women and children more than men. As a result, any short-term coping strategies have different impacts on the livelihoods of women and men through food accessibility, consumption patterns, time spent working and who owns the land.[8]

Uganda's formal sector employment is dominated by men (and boys) and informal sector employment is largely women (and girls). Overall, workers in Uganda spend on average 33 hours per week on economic activities and 24 hours on care labour activities (UBoS, 2010a). There is a wide disparity between males and females in terms of time spent on care labour activities, probably because men largely do not engage in care activities.[9] In general, people spent about eight hours per week more on economic activities than on care activities. Climate change increases hours spent on care activities more than hours spent on economic activities (see Denton 2002). In Africa, household work is largely the domain of women. Collection of water and firewood are mainly left to females while the construction of homesteads/houses is a job for males (see Denton 2002). But issues related to maintenance of homesteads are undertaken by both genders, depending on the nature of the work; for instance, fetching new grass to patch leaks is mainly undertaken by men and boys, whereas the use of cow dung to enhance finishing on mud walls with thatched roofs is a task mainly performed by women and girls in Uganda (see Ellis et al. 2006; Muhanguzi et al. 2012).

Land ownership, relations, and management are highly contentious issues with a gender bias in Uganda. The historical legacy stems from colonialism. Colonialists gave individual property rights to land that were previously held by the community or by sovereign trustees. This led to an intricate system of political relationships being legitimized. The newly introduced system of property ownership was either to replace existing indigenous land rights systems or formally confirm pre-existing customary arrangements, as was the case for kingdom areas.[10] The dual property rights system has become quite cumbersome and confusing in the current social, economic, and political circumstances.

The dual system of land administration (the formal/statutory and informal/customary) breeds conflict, confusion, and overlaps in institutional mandates. The female gender is disadvantaged. The constitution and land law do not acknowledge traditions, customs, and practices which discriminate against women in matters of access to land, and use and ownership of it, yet in practice discrimination persists. Culture and customs continue to support transmission of land to men, as women's inheritance rights in land remain tenuous (see Republic of Uganda 2011).

Customary land tenure, which constitutes the largest percentage of various forms of land ownership in Uganda, discriminates against women and does not accord them land rights (see Republic of Uganda 2011). In Uganda, women are generally unable to own or inherit land due to restrictive practices under customary land tenure, or do not have the financial resources to purchase land rights in the market.[11] In general, customary practices in some areas of the country continue to over-ride statutory law regarding the recognition and enforcement of women's land

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[8] Uganda's women till the land they do not own, due to patriarchal institutions and cultural values (Bategeka et al. 2008).

[9] Evidence shows that females spent four hours more on care labour activities compared to males, while males spent about six hours more per week than females on economic activity (UBoS 2010a).

[10] For details, see Uganda Land Act, Cap. 227 and Land Reform Decree, 1975.

[11] See, Uganda Marriage and Divorce Bill, 2010; Succession Act, Cap. 162 and Administration of Muslim Personal Law Bill, 2010.

rights. Attempts to redress this situation[12] have been ineffective due to failure in implementation and enforcement. Gender inequalities in the distribution of assets (land in particular) and opportunities mean their choices are severely constrained in the face of climate change (see Otzelberger 2011). Ssewanyana and Kasirye (2012) find that a greater proportion of households, especially female-headed households, owned small animals or poultry which have less cash value than livestock.

This section has discussed gender inequalities and roles in the context of the land tenure system and how ownership and employment type shape choice of coping strategies undertaken at the household level. Insights provided here show how social norms and laws govern gender interactions in Uganda. These are further highlighted in the empirical findings. The various coping mechanisms by gender of the household head bring out differences in factors determining adaptation options.

3 Data, shocks, and variable description

3.1 Data and source

This paper uses a two-wave data panel survey conducted by UBoS. The survey was based on a two-stage stratified random sampling design. In the first stage, Enumeration Areas (EAs) were selected from Uganda's four geographical regions. In the second stage, ten households were randomly selected from each EA. The first wave was a sample of households that were surveyed in the Uganda National Household Survey, 2005/06 (UNHS III). The second wave was a re-tracking of the re-sampled UNHS III households in 2009/10 forming the Uganda National Panel (UNPS) of 2009/10. Specifically, 3,123 households were re-sampled from 7,421 households covered in the UNHS III for tracking in 2009/10. The re-surveyed households were selected out of the same EAs that were covered in UNHS III.[13] The panel in 2009/10 covered 2,975 households out of the 3,123 that were targeted. The 2,975 households include households that had split-off from the original household sampled. For comparability across panels, 368 split-off households and 41 households with incomplete questionnaires were dropped. Thus, 2,566 original households covered in both periods and who had complete information were retained for this study.

The UNHS III and the UNPS 2009/10 have some similarities and differences. First, both surveys utilized the same sampling frame based on the population and Housing Census of 2002, though they differed in terms of stratification. The UNHS III used 'region' as a stratum divided into rural and urban, whereas the UNPS divided the four traditional regions into sub-regions as strata. Second, in surveys the sampled EAs were visited twice over a period of 12 months to cover the two agricultural cropping seasons. Third, the two surveys also administered similar questionnaires: the household questionnaire, community questionnaire and the agricultural questionnaire. Specifically, they administered similar individual and household particulars. The difference in the shocks and coping strategy section in the questionnaire arises in the format in which the

[12] These included outlawing discriminatory cultures, customs, and practices in land ownership, occupation, and use, and a requirement of spousal consent to transactions involving family land in the 1995 Constitution of Uganda and Land Act. While the Land Act (Cap. 227) caters for a spouse to some extent, it does not tackle the land rights of widows, divorcees, women in co-habitation, and children (Republic of Uganda 2011).

[13]The detailed description of the approach can be found in the UNPS 2009/10, Basic Information Document, UBoS (2010b).

households' shocks questions were framed, that is, UNHS III requires households to recall shocks that occurred five years prior to the survey and the UNPS recall period is 12 months prior to the survey. For simplicity of analysis, we assume that a household has experienced a shock one way or another, irrespective of the recall period. To capture Uganda's climate indicators, sampled households in this study were categorized on the basis of agro-ecological zones. Sampling weights are used throughout the analysis to account for under- and over-sampling in EAs, making the survey data nationally representative.

3.2 Types and length of covariate shocks

The surveys capture information on both covariate and idiosyncratic shocks. However, in this paper, only issues related to covariate shocks are analysed. The most common types of shocks are drought-related (Table 1). Households that experienced droughts increased between the survey periods. For other shocks, households' experience a decline from 2005/06 to 2009/10. The difference in experiences to shocks reported is attributed to the recall period.

Table 1: Number of sampled households that experienced and adapted to shocks

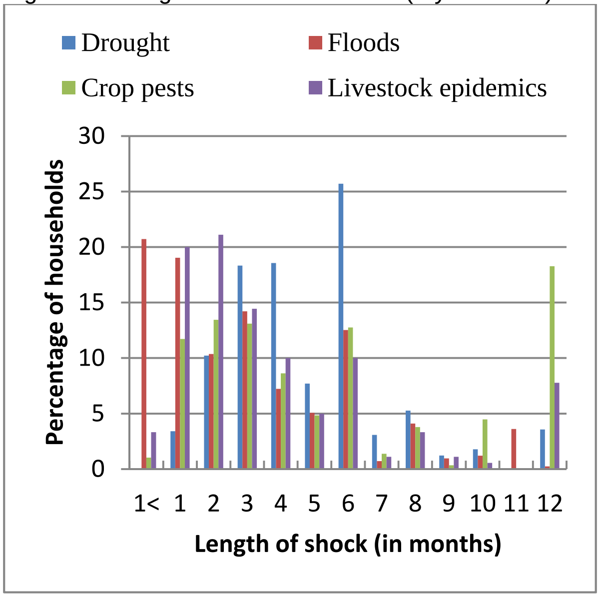
Type of shock	2005/06 No. of households (based on 5-year recall)	2009/10 No. of households (based on 1-year recall)
Drought	1,121	1,235
	(40.69)	(46.09)
Floods	393	51
	(14.66)	(1.98)
Crop pests	274	125
	(10.10)	(4.98)
Livestock epidemics	173	78
	(6.07)	(3.22)
Panel sample	2,566	2,566

Notes: The numbers in parentheses are percentages based on the weighted sample.

Source: Author's own calculations based on panel survey data (UBoS 2006, 2010b).

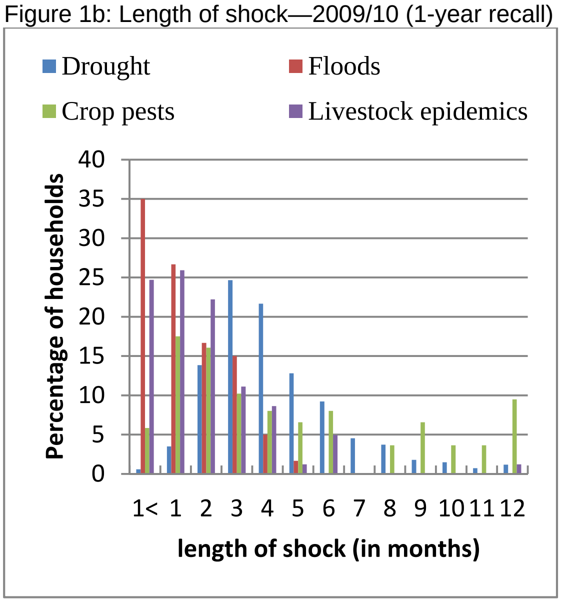
Figures 1a and 1b show the duration of shocks for each year of survey (based on different recall periods).

Figure 1a: Length of shock—2005/06 (5-year recall)



Source: Author's own calculations based on panel survey data (UBoS 2006, 2010b).

Figure 1b: Length of shock—2009/10 (1-year recall)



Source: Author's own calculations based on panel survey data (UBoS 2006, 2010b).

Regardless of the recall period, marginal differences are noted in the length of shocks that the sampled households report between the survey periods. Droughts and crop pests appear to be more persistent throughout the year. The average length of droughts is four months and crop pests five months. Floods and livestock epidemics are also common and persist but severe episodes last only for a short time (Figures 1a and 1b). It is interesting to note that crop pests and livestock epidemics persist more in periods of drought. The persistence of shocks reported is an indication of a changing climate and support evidence on how climate change will manifest itself (see IPCC 2007, 2012).

3.3 Variable description

Dependent variable

Coping strategy: defined as household response to covariate shocks: In response to shocks identified in sub-section 3.2, households have been employing a range of coping strategies.[14] Following empirical literature on adaptation to climate change (see Below et al. 2010; Deressa et al. 2008; Hisali et al. 2011), five coping (unordered) adaptation strategies that are mutually exclusive for a given covariate shock are formulated. These include (i) borrowing—both from formal and informal sources; (ii) labour supply—increasing wage employment, working as self-employed, increasing agriculture labour supply, migration to work elsewhere, and withdrawing children from school and sending them to work; (iii) reducing consumption; (iv) savings—using up assets and past savings, including mortgaging assets, selling assets, and utilizing savings; and (v) technology-based adaptation strategies such as changes in crop choices to avoid bad weather and improving technology.

Control variable

Gender of household head: The head of household in these surveys is defined as 'the one who manages the income earned and expenses incurred by the household, and is considered by other members of the household as the head' (see UBoS 2006, 2010b). The household head could either be male or female, and is not necessarily the oldest person in the household.[15] From Table 2, we observe that the proportion of female- and male-headed households by marital status had increased between the survey periods. There was a decline in households whose were never married for both female- and male-headed households. Polygamous marriages are more common in rural than in urban areas.

Explanatory variables

Maddison (2006) argues that the adaptation to climate extremes at a household and farm level is influenced by household and farm level characteristics, infrastructure, and institutional factors. Therefore, we control for households' characteristics such as age of household head, education of household head, asset holding, household size, area of residence, region, and off-farm employment. Farm characteristics include farm size and land tenure system; institutional factors include access to extension and credit services; and infrastructure includes availability and distance to input and output markets within the Local Council I (LC I) community, and climate factors include agro-ecological climate zone[16] (see Appendix Table A1).

[14] The survey identified mortgaging household assets, selling assets, using past savings, and withdrawing children from school, as some of the adaptation/response mechanisms. Other strategies include sending children to live elsewhere, migration, formal borrowing, informal borrowing, reducing consumption, and reliance on help from relatives, friends, and local governments. More wage employment, changing crop choices to avoid bad weather, improving technology, working as self-employed, and increasing agriculture labour supply were also included.

[15] Many households live with extended families: the old move in with their children or some children move back home after school, become breadwinners and decision makers. For this study, I use the aggregated female- and male-headed households, regardless of their marital status.

[16] Using panel survey data, I categorized Uganda into seven agro ecological climate zones (MAAIF 1996; NEMA 1996; World Bank 1993).

Table 2: Marital status by area of residence and gender of household head (%)

Marital status	Female-headed						Male-headed					
	2005/06			2009/10			2005/06			2009/10		
	Rural	Urban	All	Rural	Urban	All	Rural	Urban	All	Rural	Urban	All
Married monogamously	6.07	6.22	6.11	7.71	3.90	6.91	24.96	27.15	25.44	34.66	33.51	34.46
Married polygamously	5.75	3.27	5.05	7.09	4.47	6.54	7.02	4.90	6.56	10.16	6.68	9.54
Divorced/separated	6.38	8.36	6.93	10.52	12.53	10.95	1.52	1.93	1.61	3.19	3.46	3.24
Widow/widower	9.97	7.33	9.22	15.07	12.45	14.52	1.00	0.69	0.93	1.44	1.42	1.44
Never married	71.84	74.83	72.68	59.6	66.65	61.09	65.50	65.34	65.47	50.55	54.93	51.33

Source: Author's own calculations based on panel survey data (UBoS 2006, 2010b).

4 Gender of household head and choice of coping mechanisms

Variable definition and summary statistics are presented in Appendix Table A2. About 78 per cent of the households reside in rural areas (Table A2). The average age of the household head is 44.4 years. The average farm size is 4 acres where male-headed households (MHHs) have a larger share of their land holdings customary (73.2 per cent) than formal (71 per cent) while the converse holds for female-headed households (FHHs). The average household size is five. Twenty-three per cent of MHHs and 0.8 per cent of FHHs had post-primary education. On average, it is 2 km to the nearest market within the LC1 area. Of the 22 per cent of households who had applied for loans, only 34 per cent of the loans were approved. Four per cent of the households indicated having been visited on average three times by an agricultural extension worker during two cropping seasons.

Table 3 presents cross-tabulations by gender of the household head (decision maker) regardless of their marital status and year of survey. In sum, FHHs increased from 27.2 per cent in 2005/06 to 28.5 per cent in 2009/10. There were more FHHs in rural areas than urban with similar observations for MHHs. Regional variations show that 2005/06 had more FHHs living in the central and northern regions of the country. In 2009/10, FHHs and MHHs in the central region declined, other regions had increases. The trend has been attributed to the northern Uganda Rehabilitation Programme embedded in the Peace Recovery and Development Plan that has resettled over 85 per cent of Internally Displaced Persons.[17]

[17] During the 22 years of conflict, people around and within Northern Uganda fled to neighbouring towns and the city. For further details see Adong (2011) and the UNHS 2009/2010 report (UBoS 2010a).

Table 3: Gender of household head by area of residence and region (%)

	2005/06			2009/10		
	Female-headed	Male-headed	Uganda	Female-headed	Male-headed	Uganda
Area of residence						
Rural	20.5	57.5	78.0	22.9	58.9	81.8
Urban	6.8	15.2	22.0	5.6	12.7	18.2
Region						
Central	11.0	25.5	36.5	9.8	24.0	33.8
Eastern	5.2	15.1	20.3	6.4	16.1	22.5
Northern	5.8	13.0	18.8	6.3	12.1	18.4
Western	5.3	19.1	24.4	5.9	19.4	25.3

Source: Author's calculations based on panel survey data (UBoS 2006, 2010b).

Table 4 presents coping strategies by gender of the household head and covariate shocks identified in the surveys. The choice of adaptation strategies varied between survey periods with a higher variability in MHHs. The analysis reveals that in both survey periods, FHHs consistently scaled back consumption as a coping strategy during drought. Initially, MHHs increasingly relied on savings but reduced food intake in the second round of the survey during drought. Both female- and male-headed households utilized savings and reduced consumption in this order during floods/hailstorms. For both FHHs and MHHs, the use of technology was high in 2005/06 while scaling back consumption was higher in 2009/10 as coping strategies for crop pests and disease attacks. Expanding labour supply is the third most commonly employed choice of adaptation strategy in response to drought, floods, and pest attacks for all households. But during livestock epidemics, MHHs relied mainly on their savings and FHHs supplied more labour. Borrowing was the least applied adaptation strategy, irrespective of gender, where FHHs especially did not access any formal or informal credit institutions during livestock epidemics across the survey periods.

Trends of adaptation choices here are similar to those found in Pakistan by Heltberg and Lund (2009) and in Uganda by Hisali et al. (2011). But what is important here is that households' coping mechanisms are not consistent across survey periods for many of the shocks other than livestock epidemics. Our finding of reducing food intake for households that had a female decision maker during drought is not surprising. Pankhurst and Bevan (2004) and Muhanguzi et al. (2012) find that if there is a shortage of food at home during drought and famine, the woman scales down the number of meals per day, giving priority to her children, while the man can go and eat elsewhere, work locally or migrate. Hisali et al. (2011) argue that the limited use of borrowing as an adaptation choice could partly be due to the stringent repayment conditions coupled with the relatively high interest rates on the Ugandan financial market. But it could also be that the types of coping strategies being undertaken do not require households to necessarily borrow as they rely on 'physical savings' as a buffer to smooth their consumption paths and livelihood amid uncertainty (see Deressa et al. 2008). It can be argued that female-headed homes have limited access to social networks and do not have tangible assets, such as land, to use as collateral when accessing loans (see Agarwal, 1997; Alston 2006; Deere and Doss 2006; Nabikolo et al. 2012). To sum up, many of the coping strategies undertaken are informal, insufficient, and ineffective for covariate shocks whose impacts are severe. They compromise welfare, increase child labour and recovery from shock is slow and often incomplete before another shock occurs.

Table 4: Coping mechanism by gender of the household head and climate extreme (%)

	Drought			Floods			Pests			Livestock epidemic		
2005/06												
Coping strategy	Female	Male	All	Female	Male	All	Female	Male	All	Female	Male	All
Borrowing	0.8	3.0	3.8	2.1	3.9	6.0	0.7	0.4	1.1	0.0	2.2	2.2
Labour supply	7.4	17.3	24.7	5.0	18.5	23.5	5.7	13.7	19.4	11.0	24.7	35.6
Technology	1.2	3.2	4.4	2.7	5.7	8.4	6.8	33.5	40.3	2.6	8.6	11.2
Savings	7.1	31.5	38.6	5.7	32.8	38.5	5.0	16.1	21.0	10.9	37.0	47.8
Reduce consumption	8.6	19.9	28.5	2.9	20.6	23.5	5.6	12.7	18.2	1.2	1.9	3.1
2009/10												
	Female	Male	All	Female	Male	All	Female	Male	All	Female	Male	All
Borrowing	0.7	1.1	1.8	0.0	0.0	0.0	0.0	4.5	4.5	0.0	0.0	0.0
Labour supply	5.0	15.0	20.0	4.1	21.3	25.4	5.0	4.8	9.8	0.0	9.9	9.9
Technology	1.4	3.8	5.2	0.0	5.4	5.4	7.6	13.7	21.2	0.0	6.7	6.7
Savings	7.7	17.7	25.4	3.3	14.8	18.0	2.7	24.2	26.9	8.3	65.7	74.1
Reduce consumption	14.3	33.3	47.5	22.0	29.1	51.1	11.6	25.9	37.6	5.0	4.4	9.4

Source: Author's calculations based on panel survey data (UBoS 2006, 2010b).

5 Empirical approach

This paper uses a pooled MNL model[18] to identify factors influencing choice of adaptation strategies to covariate shocks for male- and female-headed households. The MNL model assumes independence across outcomes and requires that the choice variables be mutually exclusive (see Seo and Mendelsohn 2006). The validity of this assumption is tested using the Hausman–McFadden (1984) test. Here, MNL model specification follows the action theory of adaptation.[19] That is, adaptation takes place when a household is exposed to any form of stimulus (in particular meteorological) indicators associated with climate change. Furthermore, two assumptions are made. First, households seek better adaptation strategies despite employing one already. Second, the household chooses an adaptation strategy based on its current situation. Thus, a household opts for a new coping strategy if the utility of the current coping strategy is lower than the alternative.

Thus, let j be an index of the J possible categories of the polytomous response variable. The MNL model is based on the random utility maximization principle and derived by introducing utilities U_{ij} for each agent i and choice j. It is assumed that the alternative with the greatest utility is chosen. The probability that the choice j is made is the following

[18] See Cameron and Trivedi (2010), Greene (2012) and Wooldridge (2012) for further reading.

[19] For details, see Smit et al. (2000) and Eisenack and Stecker (2011).

$$\theta_{ij} = \Pr(Y_i = j) = \Pr(U_{ij} > U_{ik} \neq k)_i \tag{1}$$

The utility of choice j is modelled as

$$U_{ij} = H_{ij} + \varepsilon_{ij} \quad , \forall j$$

Where $H_{ij} = x\beta_j$ is the linear predictor, ε_i is a random error term and is independent and identically distributed (*iid*), x isa vector of explanatory variables including individual/household and climate characteristics.

In the setting of a standard MNL model the probability of jth alternative may be specified as follows

$$\theta_{ij} = \frac{\exp\left(x_i^{'}\beta_j\right)}{1 + \sum_{j=2}^{J} \exp\left(x_i^{'}\beta_j\right)} \tag{2}$$

Where $j = 1$ is the base category and $\beta = 0$ is an identification condition.

I estimate Equation (2) using a maximum likelihood estimator. The probability of an individual i to choose an alternative is expressed as follows

$$\prod_{j=1}^{J} \left[\frac{\exp\left(x_i^{'}\beta_j\right)}{1 + \sum_{j=2}^{J} \exp\left(x_i^{'}\beta_j\right)} \right]^{y_{ij}} \tag{3}$$

Where y_{ij} is if the probability of individual i choosing j and zero otherwise. Assuming that the observations are independent the likelihood for N observations may be written as

$$\prod_{i=1}^{N} \prod_{j=1}^{J} \left[\frac{\exp\left(x_i^{'}\beta_j\right)}{1 + \sum_{j=2}^{J} \exp\left(x_i^{'}\beta_j\right)} \right]^{y_{ij}} \tag{4}$$

Taking the logarithm of equation (4) results in the following log-likelihood function

$$\ln L(\beta) = \sum_{i=1}^{N} \sum_{j=1}^{J} y_{ij} \ln \frac{\exp\left(x_i^{'}\beta_j\right)}{1 + \sum_{j=2}^{J} \exp\left(x_i^{'}\beta_j\right)} \tag{5}$$

In estimating Equation (5), the problem of omitted variables arises due the omission of some individual characteristics, which can cause observations within individuals to be correlated over time. The omitted variables can bias results of the empirical analysis if not properly solved, implying that the usual standard errors may be incorrect. Therefore, the Huber-White estimator is used to correct for individual heterogeneity in standard errors with additional corrections for the effects of clustered data at the household level.

6 Empirical results and discussion

Tables 5 to 8 present the results of the pooled MNL model based on the gender of the household head and the four covariate shocks, that is, drought, floods, crop pest attacks, and livestock epidemics. Each model constructed is based on different factors that determine the choice of coping strategies for a covariate shock for male- and female-headed households.[20] The corresponding relative risk ratios[21]are discussed. In addition, annexed are the Hausman–McFadden tests for IIA (Appendix Tables A.3–A.6) and the predictive probabilities (Appendix Figures A.1–A.8) for each model estimated.

Factors determining choice of coping strategies during drought occurrences

The Hausman test validates the IIA assumption (Appendix Table A3). Factors that influence the choice of coping strategies in response to drought for FHHs and MHHs are presented in Table 5. These include:

Age of household head: In FHHs, age of household head reduces the relative risk of expanding labour supply as opposed to reducing consumption by 0.979 times as a coping strategy in response to drought. This reflects the relative vulnerability FHHs face in accessing their social networks.

Size of the household in FHHs reduces the relative risk of increasing labour supply relative to reducing consumption by 0.91 times while increasing the relative risk of utilizing savings relative to reducing consumption during drought. Access to credit in FHHs reduces the odds of utilizing savings as opposed to reducing consumption during drought.

Extension services: Here, FHHs are less likely to borrow relative to reducing consumption and are more likely to employ use of technology by 4.19 times than reduce consumption while MHHs are more likely to increase use of savings as opposed to reducing consumption by 2.39 times.

Land tenure system: In Uganda, customary land holding for women is less secure compared to formal land holding due to the social and cultural construction of gender roles in land ownership. Results show that, with a less secure land tenure system arrangement, the odds of utilizing of savings relative to reducing consumption are reduced by 0.499 times. But again, FHHs are more likely to supply more labour than reduce consumption in drought conditions. In MHHs, the tenure system is associated with an increase in the chances of adapting to drought through increased borrowing, expanding labour supply, and use of savings by 2.66 times, 2.45 times, and 2.72 times, respectively relative to scaling back consumption.

Regional setting: Relative to the central region, for MHHs in the western region, the odds of increasing labour supply, use of technology and savings relative to reducing consumption reduces

[20] Empirical analysis included variables, identified as much as possible subject to data limitations, on their ability to achieve convergence and foster good predictions.

[21]The marginal effects are available upon request.

by 0.21 times, 0.28 times, and 0.45 times, respectively during drought. MHHs in the eastern region are less likely to utilize savings relative to reducing consumption and also more likely to use technology (by 2.87 times) than reduce consumption. On the other hand, FHHs in the eastern region are less likely to use technology relative to reducing consumption. Here, it can be argued that the endowment effect is stronger in households in the central region as a result of the region being in proximity to Kampala, the capital city.

Off-farm employment of head: Access to job opportunities off the farm increases the relative risk of adapting to drought through expansion of labour supply by 2.13 times as opposed to reducing consumption in MHHs. This supports the positive effect that increased access to employment opportunities (formal or otherwise) has on credit-worthiness, hence increasing chances of increasing labour supply as individuals' social networks widen (see Below et al. 2010; Gbetibouo 2009).

Distance to market: This is used to proxy for the availability and ease in access to input and output markets. For FHHs, this increases the relative risk of borrowing by 1.26 times and labour supply by 1.17 times relative to reducing consumption. On the other hand, for MHHs during drought, distance to markets increases the odds of borrowing by 1.11 times and utilizing savings by 1.08 times relative to reducing consumption during drought.

Agro-ecological climate zone: FHHs in the West Nile zone are more likely to increase labour supply (by 11.15 times) and use savings (by 3.63 times) relative to reducing consumption, and those in the pastoral system are more likely to also increase labour supply. FHHs in montane zone are more likely to use savings as opposed to reducing consumption. Furthermore, FHHs in the banana/millet/cotton zone are less likely to borrow and use technology relative to reducing consumption and those located in the Teso system are also less likely to borrow but more likely to increase labour supply as opposed to reducing consumption in drought conditions. MHHs in the West Nile, banana/millet/cotton and northern systems are less likely to borrow while those in pastoral systems are likely to increase borrowing relative to reducing consumption during drought. In addition, MHHs in the West Nile and northern zones are less likely to use savings relative to reducing consumption, and those in the northern zone are also less likely to increase labour supply as opposed to reducing consumption.

Predictive probabilities confirm findings from the descriptive analysis indicating reducing consumption, savings and labour supply as the most common adaptation strategies for FHHs and MHHs amid droughts (Appendix Figures A.1 and A.2).

Table 5: Pooled MNL estimates for factors determining coping strategies against drought

Variable	FHHs				MHHs			
	Borrowing	Labour supply	Technology	Savings	Borrowing	Labour supply	Technology	Savings
Age head	0.958	0.979*	0.995	0.997	1.017	0.993	0.987	0.997
	(0.029)	(0.012)	(0.016)	(0.010)	(0.012)	(0.006)	(0.011)	(0.006)
HH size	0.943	0.905**	1.169	1.16**	1.001	0.944	1.083	0.983
	(0.107)	(0.044)	(0.125)	(0.071)	(0.081)	(0.04)	(0.065)	(0.028)
Credit	2.277	1.749	0.517	0.39**	1.379	0.932	0.911	1.278
	(2.648)	(0.808)	(0.484)	(0.165)	(0.872)	(0.222)	(0.341)	(0.279)
Region								
Eastern	2.710	0.651	0.00***	1.236	0.391	0.563	2.867*	0.29**
	(3.620)	(0.514)	0.000	(0.850)	(0.407)	(0.262)	(1.682)	(0.124)

Western					1.234	0.21***	0.282*	0.449*
					(1.020)	(0.089)	(0.187)	(0.203)
Tenure	0.445	2.729**	0.716	0.499*	2.662*	2.450**	0.668	2.72***
	(0.381)	(1.528)	(0.510)	(0.192)	(1.470)	(0.829)	(0.358)	(0.799)
Off-farm head					1.806	2.13***	0.753	1.071
					(0.889)	(0.485)	(0.298)	(0.208)
Dist. input mkt	1.259*	1.169**	0.954	1.035	1.106*	1.049	0.995	1.08**
	(0.170)	(0.073)	(0.065)	(0.059	(0.059)	(0.041)	(0.062)	(0.038)
Extension	0.00***	4.112	4.191*	1.303	3.410	0.432	0.307	2.39**
	0.000	(4.460)	(3.490)	(0.890)	(2.582)	(0.233)	(0.320)	(0.937)
Agro-ecologies								
West Nile	2.453	11.2***	0.678	3.63**	0.00***	1.699	0.842	0.33**
	(2.703)	(5.190)	(0.798)	(2.291)	0.000	(0.697)	(0.538)	(0.146)
Pastoral	1.096	2.192*	0.629	1.014	3.436*	1.707	0.00***	0.797
	(1.312)	(1.032)	(0.686)	(0.681)	(2.586)	(0.944)	0.000	(0.417)
Montane	0.256	0.549	2.177	2.087*	2.289	0.788	0.483	1.006
	(0.247)	(0.375)	(1.553)	(0.899)	(1.393)	(0.327)	(0.254)	(0.393)
Banana/millet/ cotton	0.00***	2.241	0.00***	2.451	0.00***	0.596	0.474	1.172
	0.000	(2.469)	0.000	(2.709)	0.000	(0.351)	(0.310)	(0.517)
Northern					0.083*	0.23***	0.808	0.04***
					(0.109)	(0.092)	(0.410)	(0.017)
Teso	0.00***	17.6***	1.091	3.712				
	0.000	(16.444)	(1.202)	(3.680)				
Diagnostics								
Un-weighted sample	346				1,094			
Weighted sample	431,772				1,338,245			
Pseudo R^2	0.1640				0.1354			
Log pseudo likelihood	-457255.97				-1512397.80			
Base outcome	Reduced consumption				Reduced consumption			

Notes: Controlled for are strata-specific fixed effects and control years. In the parentheses are robust standard errors clustered at household level for all estimates to allow non-independence in errors at the household level, where ***p<0.001, **p<0.05, *p<0.1.

Author's calculations based on panel survey data (UBoS 2006, 2010b).

Factors determining choice of coping strategies during floods

Predictors of different adaptation strategies to floods for FHHs and MHHs are presented in Table 6 (the Hausman test validates the IIA assumptions: Appendix Table A4) and these include the following.

First, for FHHs, age of household head leads to the odds of expanding labour supply as opposed to reducing consumption increase by 1.068 times. Second, a breakdown of regions indicates that the relative risk of increasing labour supply and using savings relative to reducing consumption reduces by 0.047 times and 0.18 times, respectively for FHHs located in the eastern part of Uganda. MHHs in the eastern region are less likely to resort to technology use (0.197 times) and reducing consumption (0.26 times) relative to relying on savings. Similarly, MHHs located in the western region are less likely to expand labour supply and reduce consumption relative to savings when floods occur. Third, with regard to off-farm employment for the household head, this indicates that the odds of expanding labour supply relative to saving increases by 2.378 times in MHHs.

Heltberg and Lund (2009) asserts that employment opportunities help widen safety nets available to households, thus enabling them to maintain their consumption when calamities arise.

Fourth, distance and accessibility to markets for MHHs reduce the relative odds of minimizing consumption and increasing labour supply as opposed to savings by 0.92 times and 0.93 times, respectively. FHHs on the other hand are more likely to expand labour supply relative to reducing consumption in response to floods. According to Below et al. (2010) and Hisali et al. (2011), ease in accessing markets within and outside sub-counties helps to smooth consumption paths as households easily sell assets (such as crop yields).

Lastly, the odds of increasing savings as opposed to reducing consumption are low for FHHs in the banana/millet/cotton agro-ecological zone amid floods and, similarly, the odds of reducing consumption relative to using savings are higher in MHHs (6.97 times). In banana/coffee systems, the relative risk of supplying more labour relative to reducing consumption is low for FHHs and the likelihood that MHHs in the same zone will expand labour supply relative to the use of savings is low. Furthermore, the relative risk of increasing technology use relative to savings in MHHs located in the Teso agro-ecology zone becomes higher by 26.278 times. FHHs in the montane zone are less likely to expand labour supply relative to reducing consumption and MHHs are more likely to reduce consumption relative to savings. Simply put, both FHHs and MHHs in montane areas reduce consumption as a coping strategy during floods.

In line with the descriptive statistics, the predictive probability for FHHs' coping strategies against floods shows no discernible pattern in use of reducing consumption, labour supply and savings (Figure A.3). And predictions indicate persistence in use of labour supply and savings as coping mechanisms in the event of floods occurring for MHHs (Figure A.4).

According to meteorological data, areas most hit by floods/hailstorms in Uganda are located in parts of the northern, western and eastern regions. Differences in factors determining coping strategies in agro-ecological zones and regions noted here support meteorological information. Areas in the northern, Teso and some parts of montane agro-ecologies receive emergency food aid (which is untimely and unsustainable) during floods (see Republic of Uganda 2010).

Table 6: Pooled MNL estimates for factors determining coping strategies against floods

Variable	FHHs		MHHs		
	Labour supply	Savings	Labour supply	Technology	Reduced consumption
Age head	1.068*	0.969	0.991	1.018	0.998
	(0.043)	(0.029)	(0.015)	(0.020)	(0.012)
Urban	1.096	0.665	1.171	2.552	0.466
	(0.216)	(0.964)	(0.889)	(2.936)	(0.365)
Region					
Eastern	0.047**	0.180*	0.606	0.197*	0.260**
	(0.056)	(0.175)	(0.901)	(0.175)	(0.166)
Western			0.049*	0.167	0.153**
			(0.077)	(0.227)	(0.115)
Off-farm head	1.387	0.944	2.378**	0.470	0.946
	(1.457)	(1.102	(1.021)	(0.370)	(0.358)

Dist. input mkt	1.617**	1.283	0.926*	1.042	0.916**
	(0.329)	(0.223)	(0.042)	(0.079)	(0.035)
Agro-ecologies					
Banana/millet/cotton	3.955	0.000***	1.527	8.425	6.975*
	(5.966)	0.000	(2.627)	(11.706)	(7.392)
Banana/coffee	0.000***	1.192	0.175*	1.572	3.195
	0.000	(1.612)	(0.206)	(1.732)	(2.881)
Northern	3.661	1.050	0.948	2.258	2.174
	(6.046)	(2.719)	0.746)	(2.676)	(1.783)
Teso			2.544	26.278**	1.595
			(4.114)	(35.051)	(2.165)
Pastoral			0.921	1.287	3.439
			(1.196)	(1.937)	(3.669)
Montane	0.009*	0.819	2.333	0.350	6.012*
	(0.023)	(0.972)	(3.961)	(0.674)	(6.432)
Diagnostics					
Un-weighted sample	54		274		
Weighted sample	51,324		223,039		
Pseudo R^2	0.4063		0.1473		
Log pseudo likelihood	-33074.16		-239891.76		
Base outcome	Reduced consumption		Savings		

Notes: Controlled for are strata-specific fixed effects and control years. In the parentheses are robust standard errors clustered at household level for all estimates to allow non-independence at the household level, where ***p<0.005, **p<0.05, *p<0.1.

Author's calculations based on panel survey data (UBoS 2006, 2010b).

Factors determining coping strategies for crop pests

Results for FHHs and MHHs presented in Table 7 and the Hausman test supports the null of IIA since probability value (p>chi2) is 1.00 (Appendix Table A5). Thus, the variables that determine the choice of adaptation strategies to crop pests are as follows.

For FHHs, age of the household head reduces the odds of increasing supply of labour and use of savings, as opposed to use of technology, and for MHHs, the relative risk of increasing labour supply, use of savings and cutting back consumption relative to use of technology increases by 1.031 times, 1.029 times, and 1.048 times, respectively. Household size can be either a curse or a blessing, depending on the quality of the labour force of household members either in ability to access better paying jobs, age, education, and health. Findings indicate that the odds of expanding labour supply are lower by 0.754 times in FHHs relative to use of technology.

Table 7: Pooled MNL estimates for factors determining coping strategies against crop pests

Variable	FHHs			MHHs		
	Labour supply	Savings	Reduced consumption	Labour supply	Saving s	Reduced consumption
Age head	0.940*	0.959*	1.002	1.031*	1.029**	1.048**
	(0.029)	(0.02)	(0.028)	(0.018)	(0.012)	(0.018)
HH size	1.211	1.048	0.773	0.754**	0.848	0.959
	(0.288)	(0.14)	(0.187)	(0.074)	(0.096)	(0.071)
Credit				3.177	4.894	1.333

				(4.181)	(6.606)	(1.278)
Urban	1.025	7.692*	0.914	3.177	7.73***	14.370***
	(1.204)	(9.59)	(2.161)	(2.401)	(5.056)	(10.377)
Input mkt LC1	11.118	0.893	23.448**	1.393	1.328	8.065**
	(18.770)	(0.78)	(24.670)	(1.485)	(1.087)	(6.905)
Dist. input mkt	1.395*	0.907	1.371**			
	(0.265)	(0.15)	(0.191)			
Agro-ecologies						
Teso	0.384	0.199	0.000***	1.238	0.268	0.555
	(0.723)	(0.37)	0.000	(0.913)	(0.261)	(0.610)
Northern	0.842	1.685	0.184	1.686	1.153	0.881
	(0.969)	(2.62)	(0.229)	(0.996)	(0.733)	(0.635)
West Nile				0.854	0.00***	0.490
				(0.765)	0.000	(0.654)
Banana/millet/ cotton	1.26***	0.341	13.035	0.633	0.489	0.183
	(2.040)	(0.47)	(32.418)	(0.493)	(0.371)	(0.223)
Banana/coffee	0.060*	6.038	1.849	0.130**	0.457	0.256**
	(0.098)	(7.08)	(1.725)	(0.096)	(0.267)	(0.157)
Diagnostics						
Un-weighted sample	68			211		
Weighted sample	71,183			196,786		
Pseudo R^2	0.2756			0.1590		
Log pseudo likelihood	-69970.09			-220849.44		
Base outcome	Technology			Technology		

Notes: Controlled for are strata-specific fixed effects and control years. In the parentheses are robust standard errors clustered at household level for all estimates to allow non-independence in errors at the household level, where ***p<0.005, **p<0.05, *p<0.1.

Author's calculations based on panel survey data (UBoS 2006, 2010b).

Relative to households in urban areas, being in the rural areas increases the relative risk of relying on savings (e.g. last season's harvests) more than use of technology for FHHs (by 7.69 times) and MHHs (by 7.73 times). In addition, MHHs in rural areas are more likely to further scale back consumption needs by 14.37 times relative to use of technology during pest attacks. Availability and distance to market show that for FHHs and MHHs, availability of a market within the LC I area increases the relative risk of reducing consumption relative to adoption of technology by 23.448 times and 8.065 times, respectively. While, actual distance to the available market implies that FHHs are more likely to expand labour supply (1.39 times) and further cut on consumption needs by 1.371 times relative to use of technology. As discussed in Deressa et al. (2008), reduction in consumption for many households in relation to markets is due to the sale of the buffer stock in nearby markets for income to purchase other household needs.

And last, with regard to agro-ecological zones, FHHs in the Teso system are less likely to reduce consumption and MHHs in the West Nile system are also less likely to increase use of savings relative to technology use. But FHHs in the banana/millet/cotton systems will likely expand labour supply by 1.26 times while those in the banana/coffee systems are likely to reduce labour supply relative to use of technology during pests and disease outbreaks. Furthermore, the odds of MHHs in the banana/coffee region expanding labour supply and reducing consumption relative to use of technology become even lower.

Predictions show a mixed pattern in use of coping strategies in FHHs, such as reducing consumption, increasing labour supply and using savings when crop pests and disease are present (Figure A.5). While predictions show use of technology and reducing consumption (in this order) as the most commonly used forms of coping mechanisms undertaken by MHHs during crop pest and disease outbreaks (Figure A.6).

Factors determining coping strategies during livestock epidemics

Table 8 presents results of factors that ascertain the choice of adaptation strategies to livestock epidemics for FHHs[22] and MHHs, and the Hausman tests indicate a fulfilment of the IIA assumptions (Appendix Table A6).

During livestock epidemics, for FHHs, age of household head increases the relative risk of reducing food intake as opposed to use of savings by 1.19 times. The size of the household lowers the likelihood of expanding labour supply relative to savings for FHHs and MHHs. Customary land tenure system reduces the odds of increasing use of technology and labour supply relative to use of savings in MHHs. Regional variations show an increase in the relative risk of MHHs in the eastern region increasing use of technology relative to savings by 19.88 times. Relative to the central region, MHHs and FHHs in the Northern region are more likely to increase labour supply relative to savings. In addition, FHHs in the North are less likely to scale back consumption relative to savings and MHHs in the western region are less likely to increase labour supply relative to use of savings.[23] Furthermore, the odds of FHHs located in the pastoral and Teso agro-ecologies reducing consumption relative to savings are low. The same holds for MHHs in montane and pastoral systems in expanding labour supply relative to use of savings.

As shown in Appendix Figure A.7, predictions for FHH coping strategies influenced by livestock epidemics indicate no discernible pattern in use of labour supply, savings, and reducing consumption, as shown by the descriptive statistics. Predictions confirm the descriptive analysis that MHHs resort to use of savings in the event that livestock epidemics occur (Appendix Figure A.8).

Table 8: Pooled MNL estimates for factors determining coping strategies against livestock epidemics

Coping Livestock epidemics	FHHs		MHHs	
	Labour supply	Reduced consumption	Labour supply	Technology
Age head	1.050	1.188*	0.999	0.978
	(0.049)	(0.106)	(0.024)	(0.024)
HH size	0.710*	0.797	0.671**	0.922
	(0.115)	(0.279)	(0.111)	(0.176)
Urban	1.547	106.867	2.346	0.347
	(1.881)	(295.027)	(2.255)	(0.732)
Region				
Eastern			0.807	19.879**
			(0.794)	(28.801)
Northern	25.709*	0.000***	3.072	8.799

[22] Borrowing as an adaption option was automatically dropped from the estimation. Recall from the descriptive statistics, FHHs did not borrow when livestock epidemics occurred.

[23] The western cattle corridor has the largest farms of beef cattle in Uganda followed by the east (see MAAIF 2009).

	(42.199)	(0.000)	(3.506)	(18.745)
Western			5.668	0.000***
			(10.967)	(0.000)
Tenure			0.246*	0.011**
			(0.198)	(0.021)
Dist. input mkt			1.151	1.143
			(0.128)	(0.125)
Agro-ecologies				
Montane			0.028	0.000***
			(0.073)	(0.000)
Teso	8.925	0.000***	1.905	4.719
	(13.901)	(0.000)	(2.287)	(6.237)
Pastoral	0.751	0.000***	0.098**	0.000
	(1.035)	(0.000)	(0.109)	(0.000)
Diagnostics				
Un-weighted sample	29		83	
Weighted sample	25,936		89,438	
Pseudo R^2	0.4729		0.1748	
Log pseudo likelihood	-13669.44		-65203.63	
Base outcome	Use savings		Use savings	

Notes: Controlled for are strata-specific fixed effects and control years. In the parenthesis are robust standard errors clustered at household level for all estimates to allow non-independence in errors at the household level, where ***p<0.005, **p<0.05, *p<0.1.

Author's calculations based on panel survey data (UBoS 2006, 2010b).

The diversity in livestock ownership in MHHs and FHHs are in tandem with the choices of adaptation strategies to livestock epidemics exacerbated by climate change. MHHs are more likely to own large livestock farms and FHHs have small-scale livestock rearing projects. Seo and Mendelsohn (2006) assert that small livestock and large livestock farms respond to climate differently with large farms being more responsive to climate shocks. The strategy for livestock epidemics is selling livestock at low prices, increasing savings for MHHs. Asset ownership such as livestock and land in FHHs is limited (see Agarwal, 1997; Deere and Doss 2006; Ssewanyana and Kasirye 2012) such that climate shocks drive them to expand labour and also sell their small assets. Simply put, households that are more diverse and have livestock (like MHHs in the western region) appear to have a consistent income (savings) in times of epidemics, smoothing income from year to year.

7 Conclusion and policy implications

This paper examines the importance of adaptation strategies in development. A two-wave panel dataset of 2,566 original households from the UBoS is used. The paper looks at different coping strategies in response to shocks from a gender perspective. Specifically, the choice of adaptation strategies to covariate shocks disaggregated by the gender of household head is analysed. An MNL model is applied on pooled data to understand the factors that determine the choice of adaptation strategies. One-third of the sampled households experience more than one type of shock. The findings show that choices of adaptation strategies to covariate shocks are similar in both FHHs and MHHs but factors influencing the responses are not gender neutral. Lambrou and Nelson (2010) argue that, when emergencies erupt in areas without prior development activities, men and women's capacities and coping strategies to address climate change are often complementary.

Coping strategies for covariate shocks reported by households are 'last-resort' or 'impromptu' responses, largely behavioural, hence informal in nature and ad hoc. Specifically, survey findings show that FHHs reduce consumption while MHHs utilize savings and reduce consumption during droughts. Faced with livestock epidemics, MHHs use savings and FHHs provide more labour as coping strategies. Use of agricultural-related technology and increased labour supply was higher during crop pests and disease outbreaks, regardless of gender of the household head.

Furthermore, variables such as age of the household head, distance to markets, land tenure system, area of residence, region, off-farm employment, and agro-ecological zones are key factors influencing choice of adaptation strategies for FHHs and MHHs but the direction of causality differs in some cases. For instance, agro-ecological zones play a key role in adaptation strategies adopted by FHHs and MHHs, reflecting the relative importance not only of indigenous knowledge and externalities in climate change adaptation but also ingrained social and cultural norms across groups. MHHs, who had some employment off the farm during drought, are better off (do not reduce consumption). For FHHs, land tenure system (customary) is negatively associated with adaptation during drought; but it is vice versa for MHHs. In some instances, such as during livestock epidemics, results show a negative effect of land tenure system with adaptation strategies for MHHs.

Such findings suggest that greater effort is needed to increase the resilience of households to cope with climate change through the accumulation of assets, the creation of off-farm jobs, and the enforcement of the land rights law. Policy should specify adaptation options that reduce the vulnerability of women and men in times of crisis. As advocated for by Heltberg and Lund (2009), public action is needed to ensure that households can meet their consumption needs. This may take the form of timely food aid, food subsidies, or other programmes that offer safety nets to households more vulnerable to climate shocks. Households should be encouraged to increase food stocks, for example, through drying fruit and vegetables in times of bumper harvests to be used during poor production years, and improving food storage facilities such as granaries. Governments need to invest in irrigation schemes to harvest excess rain water during floods and to act as reservoirs during drought. The rates of population growth and persistent shocks, especially drought, have led to a reduction in the availability of arable land. Agricultural land is now more being used for growing trees instead of food crops. Women are more affected by this change of land use than men due to their primary concern of food security and household consumption patterns. Enforcing the National Land Policy should favour women, especially poor women, and men feeling secure in agriculture. This will reduce household vulnerability in food availability and security when climate change induced shocks occur.

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Appendix

Table A1: Uganda's agro-ecological zones

Farming system	Districts
Banana/coffee system	Bundibugyo, parts of Hoima, Kabarole, Mbarara, Bushenyi, Mubende, Luweero, Mukono, Masaka, Iganga, Jinja, Kalangala, Mpigi, Rakai, Kayunga, Wakiso, Lyandonde, Mitiyana, Nakaseke, Bugiri, Mayuge, Masindi, Kyenjojo, Kibaale, Namutumba, Buliisa, and Kampala
Banana/millet/cotton system	Kamuli, Pallisa, Tororo, parts of Masindi, Busia, Hoima, Nakasongola, Budaka, Kaliro, and Luweero
Montane	Kabale, Kisoro, parts of Rukungiri, Kasese, Kabarole, Bundibugyo, Mbarara, Mbale, Kanungu, Bushenyi, Kamwenge, Sironko, Buduuda, Bukwo, Manafwa, Ibanda, Isingiro, Kiruhura, and Kapchorwa
Teso system	Soroti, Kumi, Amuria, Bukedea, and Kaberamaido
Northern system	Gulu, Lira, Apac , Oyam, Amolatar, Dokolo, Amuru, and Kitgum
Pastoral system	Kotido, Moroto, parts of Mbarara, Ntungamo and Masaka, Ntungamo, Masaka, Nakapiripirit, Ssembabule, Kaabong, and Rakai
West Nile system	Moyo, Arua, Adjumani, Yumbe, Nyadri, and Nebbi

Source: Generated from panel survey dataset (UBoS 2006, 2010b).

Table A2: Variable description and descriptive statistics

Variable name	Variable label	Obs.	Mean	Std Dev.	Min.	Max.
Sex head	Gender of household head, 1 if male	5173	0.7189	0.4496	0	1
Sex spouse	Gender of household spouse, 1 if male	3480	0.0543	0.2267	0	1
Age head	Age of household head	5169	44.3819	15.1208	13	100
Age spouse	Age of spouse	3423	35.8596	12.1304	15	98
Male HH head education	Primary	3599	0.7697	0.4211	0	1
	Secondary	3599	0.1987	0.3991	0	1
	Tertiary	3599	0.0317	0.1752	0	1
Female HH head education	Primary	3482	0.9156	0.2781	0	1
	Secondary	3482	0.0796	0.2706	0	1
	Tertiary	3482	0.0049	0.0697	0	1
Region	Central	5173	0.3027	0.4595	0	1
	East	5173	0.2314	0.4218	0	1
	North	5173	0.2414	0.4280	0	1
	West	5173	0.2244	0.4172	0	1
Off farm head	Off-farm employment for HH head	5146	0.2627	0.4402	0	1
Off farm spouse	Off-farm employment for spouse	4680	0.1169	0.3213	0	1
Credit	Applied for a loan in the last 12 months, 1 if yes	5165	0.2170	0.4123	0	1
Loan status	1 if loan was fully approved	2190	0.3379	0.4731	0	1
Urban	1 if urban	5173	0.2281	0.4197	0	1
HH size	Household size	5170	5.5851	2.9343	1	29
Cope drought	Coping strategy for drought	2026	3.7671	1.2501	1	5
Cope floods	Coping strategy for floods/hailstorms	366	3.4836	1.2599	1	5
Cope pests	Coping strategy for crop pests	300	3.4333	1.0876	1	5
Cope lepidemic	Coping strategy for livestock epidemics	140	3.2643	0.9936	1	5
Banana/coffee	Agro-ecological climate zone	5172	0.3877	0.4873	0	1
Banana/millet/cotton	Agro-ecological climate zone	5172	0.0889	0.2847	0	1
Montane	Agro-ecological climate zone	5172	0.2109	0.4080	0	1
Teso	Agro-ecological climate zone	5172	0.0443	0.2057	0	1
Northern	Agro-ecological climate zone	5172	0.1164	0.3207	0	1
Pastoral	Agro-ecological climate zone	5172	0.0588	0.2352	0	1
WestNile	Agro-ecological climate zone	5172	0.0930	0.2905	0	1
Farm size	Parcel size in acres	3711	3.9116	17.2480	0	600
Tenures	Tenure system, 1 if formal	3677	0.6239	0.4845	0	1
Extension	If ever visited by an extension worker, 1 if yes	3346	0.0451	0.2076	0	1
Textension	No. of times the extension worker has visited	374	3.7807	4.9997	1	48
Inputmktlcl	Availability of input market in LC1, 0 if no	4752	0.4112	0.4921	0	1
Distinmkt	Distance to input market	4663	2.1995	3.8279	0	32

Notes: For coping strategies; we categorized borrowing (1), labour supply (2), technology (3), savings (4), and reducing consumption (5).

Source: Author's calculations based on panel survey data (UBoS 2006, 2010b).

Table A3: Hausman–McFadden IIA test—Drought coping strategies

FHH					MHH				
Omitted	chi2	df	P>chi2	evidence	Omitted	chi2	df	P>chi2	evidence
Borrowing	0	3	1	for Ho	Borrowing	0	1	1	for Ho
Labour supply	0	6	1	for Ho	Labour supply	0	3	1	for Ho
Technology	0	3	1	for Ho	Technology	0	2	1	for Ho
Savings	0	6	1	for Ho	Savings	0	3	1	for Ho
Reduce cons.	45.049	33	0.079	for Ho	Reduce cons.	0	3	1	for Ho

Source: Author's calculations based on panel survey data (UBoS 2006, 2010b).

Table A4: Hausman-McFadden IIA test—Floods coping strategies

FHH					MHH				
Omitted	chi2	df	P>chi2	evidence	Omitted	chi2	df	P>chi2	evidence
Labour supply	0	3	1	for Ho	Labour supply	-0.475	24	1	for Ho
Technology				for Ho	Technology	-0.219	26	1	for Ho
Savings	0	4	1	for Ho	Savings	27.667	26	0.375	for Ho
Reduce cons.	0	4	1	for Ho	Reduce cons.	0.258	26	1	for Ho

Source: Author's calculations based on panel survey data (UBoS 2006, 2010b).

Table A5: Hausman-McFadden IIA test—Crop pests and diseases coping strategies

FHH					MHH				
Omitted	chi2	df	P>chi2	evidence	Omitted	chi2	df	P>chi2	evidence
Labour supply	0	1	1	for Ho	Labour supply	0	1	1	for Ho
Technology	0	3	1	for Ho	Technology	-85.277	21	1	for Ho
Savings	0	2	1	for Ho	Savings	0.733	22	1	for Ho
Reduce cons.	-0.001	2	1	for Ho	Reduce cons.	0	1	1	for Ho

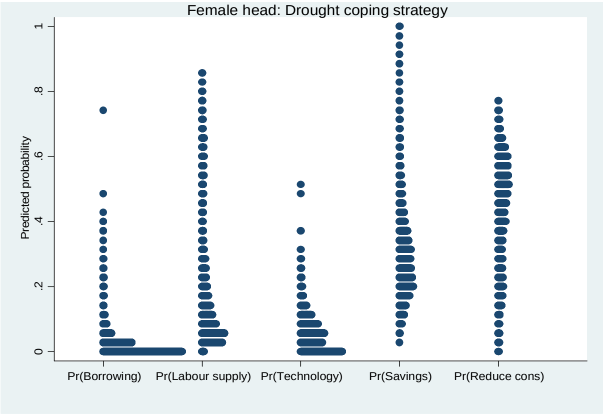
Source: Author's calculations based on panel survey data (UBoS 2006, 2010b).

Table A6: Hausman-McFadden IIA test—Livestock epidemics coping strategies

FHH					MHH				
Omitted	chi2	df	P>chi2	evidence	Omitted	chi2	df	P>chi2	evidence
Labour supply	0	3	1	for Ho	Labour supply	0	3	1	for Ho
Savings	0	6	1	for Ho	Technology	-1.301	13	1	for Ho
Reduce cons.	-0.336	7	1	for Ho	Savings	0	2	1	for Ho

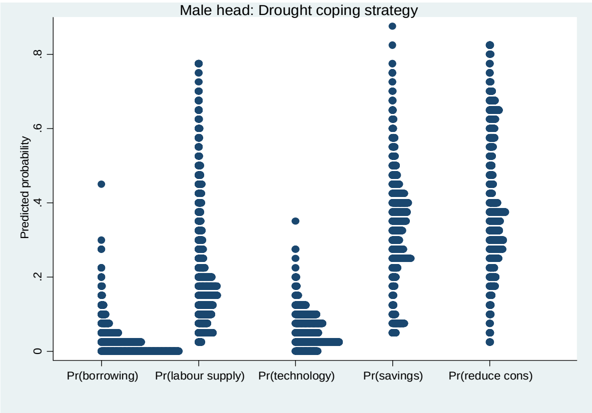
Source: Author's calculations based on panel survey data (UBoS 2006, 2010b).

Figure A.1: Predictive probability for FHHs for coping strategies—Drought



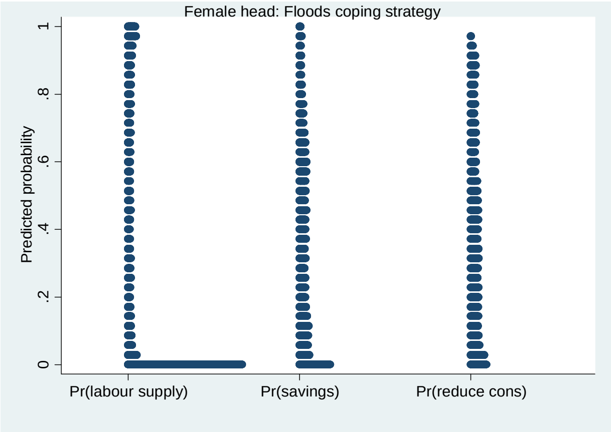
Source: Author's calculations based on panel survey data (UBoS 2006, 2010b).

Figure A.2: Predictive probability for MHHs coping strategies—Drought



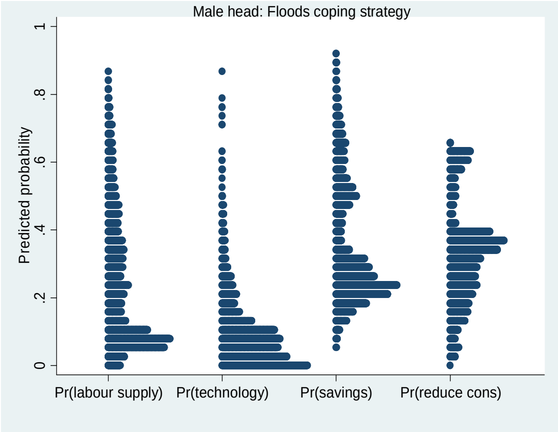
Source: Author's calculations based on panel survey data (UBoS 2006, 2010b).

Figure A.3: Predictive probability of FHHs for coping strategies—Floods



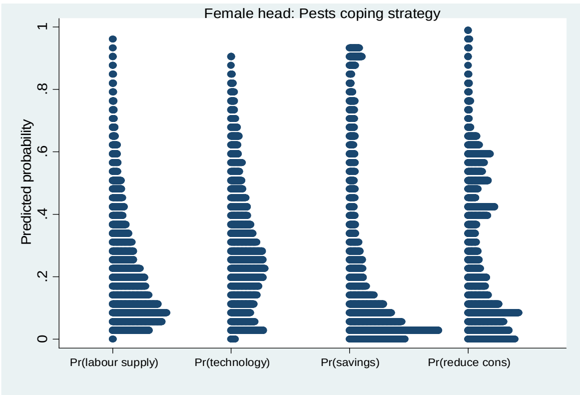
Source: Author's calculations based on panel survey data (UBoS 2006, 2010b).

Figure A.4: Predictive probability for MHHs coping strategies—Floods



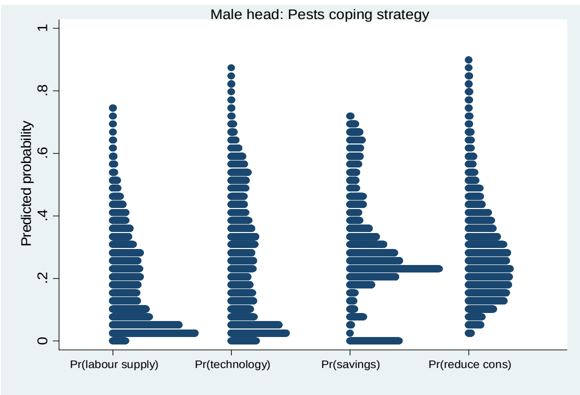
Source: Author's calculations based on panel survey data (UBoS 2006, 2010b).

Figure A.5: Predictive probability for FHHs for coping strategies—Crop pests



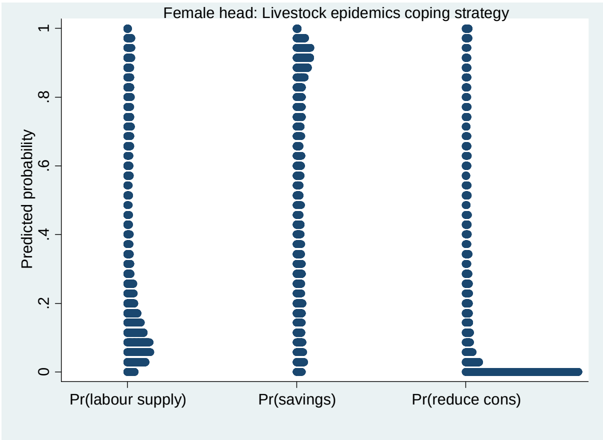
Source: Author's calculations based on panel survey data (UBoS 2006, 2010b).

Figure A.6: Predictive probability for MHHs coping strategies—Crop pests and diseases



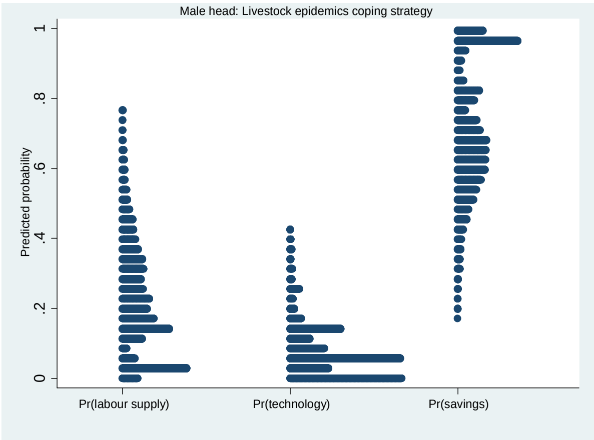
Source: Author's calculations based on panel survey data (UBoS 2006, 2010b).

Figure A.7: Predictive probability for FHHs coping strategies—Livestock epidemics



Source: Author’s calculations based on panel survey data (UBoS 2006, 2010b).

Figure A.8: Predictive probability of MHH coping strategies—Livestock epidemics



Source: Author’s calculations based on panel survey data (UBoS 2006, 2010b).