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Research Application Summary

Assessment of Adaptation Strategies to Climate Change and Variability of Smallholder Dry Bean Farmers in Hoima District, Uganda

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Abstract

The adverse effects of climate change and variability have affected crop production through the increasing erratic rainfall, drought, floods, pests, and diseases that have significantly reduced crop yields in many places including Uganda. The present study assessed the adaptation strategies and perceptions of smallholder dry bean farmers in Hoima district in Western Uganda to climate change and variability. A total of 90 households from three sub-counties of Buhimba, Kiziranfumbi, and Kyangwali were randomly selected and interviewed. The farmers' perceived climate change as increasing temperature and decreasing rainfall which was in agreement with the scientific trends for the historical rainfall and temperature data in Hoima district. The findings further indicated that 63% and 56% of the respondants used several adaptation strategies to respond to temperature and rainfall changes respectively. The smallholder farmers changed planting dates frequently and employed early planting, spraying, crop diversification, and improved crop varieties in response to the impacts of climate change and climate variability in the zone. The findings further showed that 94.4% of the respondents had not heard about agricultural insurance. The low awareness about agricultural insurance adaptation strategy amongst the smallholder farmers requires critical attention by Government and private sector involved in delivering insurance products to farmers. Results from the logistic regression model revealed that access to inputs, sources of off-farm income, land ownership, and access to credit significantly and positively influences farmers' decisions to adopt various adaptation strategies to minimise the impacts of climate change and climate variability. It was recommended that these factors limiting adaptation need to be addressed, and adaptation strategies enhanced to increase resilience and reduce vulnerability amongst the smallholder farmers in Hoima district.

Keywords: Adoption strategies, climate change and variability, crop insurance, resilience, Uganda, vulnerability.

Résumé

Les effets néfastes du changement et de la variabilité climatiques ont affecté la production agricole par l'augmentation des précipitations irrégulières, la sécheresse, les inondations, les ravageurs et les maladies qui ont considérablement réduit le rendement des cultures dans de nombreux endroits, y compris en Ouganda. La présente étude a évalué les stratégies d'adaptation et les perceptions des petits producteurs de haricots secs du district de Hoima, dans l'ouest de l'Ouganda, face au changement et à la variabilité climatiques. Au total, 90 ménages de trois sous-comtés (Buhimba, Kiziranfumbi et Kyangwali) ont été sélectionnés au hasard et interrogés. Les agriculteurs ont perçu le changement climatique comme une augmentation de la température et une diminution des précipitations, ce qui est en accord avec les tendances scientifiques des données historiques sur les précipitations et les températures dans le district de Hoima. Les résultats indiquent également que 63% et 56% des

personnes interrogées ont utilisé plusieurs stratégies d'adaptation pour répondre aux changements de température et de précipitations respectivement. Les petits exploitants modifient fréquemment les dates de plantation et ont recours à la plantation précoce, à la pulvérisation, à la diversification des cultures et à des variétés de cultures améliorées en réponse aux impacts du changement et de la variabilité climatiques dans la zone. Les résultats ont également montré que 94,4% des personnes interrogées n'avaient pas entendu parler de l'assurance agricole. La faible connaissance de l'assurance agricole comme stratégie d'adaptation parmi les petits exploitants nécessite une attention particulière de la part du gouvernement et du secteur privé impliqués dans la fourniture de produits d'assurance aux agriculteurs. Les résultats du modèle de régression logistique ont révélé que l'accès aux intrants, les sources de revenus non agricoles, la propriété foncière et l'accès au crédit influencent de manière significative et positive la décision des agriculteurs d'adopter diverses stratégies d'adaptation pour minimiser les impacts du changement et de la variabilité climatiques. Il est recommandé de s'attaquer à ces facteurs limitant l'adaptation et d'améliorer les stratégies d'adaptation afin d'accroître la résilience et de réduire la vulnérabilité des petits exploitants agricoles du district de Hoima.

Mots clés : Stratégies d'adoption, changement et variabilité climatiques, assurance récolte, résilience, Ouganda, vulnérabilité.

Introduction

There is increasing evidence that climate change and climate variability (CCV) altered patterns of rainfall andd increased temperatures, incidences of extreme climatic conditions such as strong winds, floods and drought are projected to increase agricultural production risks and decrease crop yields in several countries (Bagamba *et al*., 2012). The smallholder farming households are likely to be disproportionately affected by the negative impacts of these climate changes intensifying the risk they face (Shikuku *et al*., 2017). African countries are the most affected by these changing weather conditions because of heavy dependency on agricultural production which is naturally sensitive to weather conditions coupled with limited equipment and skills for disaster management, weak institutional capacity and limited financial resources (Bagamba *et al*., 2012; Bennett *et al*., 2015). Therefore, as climate variability and change continue taking place and the effects spreading and becoming extreme in many regions across the world, a focus on adaptation is essential (IPCC, 2007).

Uganda, like in many other countries in Africa, highly depends on smallholder farmers for agricultural production. Moreover, the country in recent decades has experiencing frequent episodes of both deficient and excessive rainfall and seasonal increase in mean temperature (Bennett *et al*., 2015; Shikuku *et al*., 2017). The dependency of smallholder farmers in Uganda on rain-fed farming makes them vulnerable mostly to late rainfall on-sets and drought (Nicolas *et al*., 2012). As a response to CCV impacts, adaptation has received increasing consideration by many governments including in Uganda (Dolan *et al*., 2001). Agricultural adaptation strategies like soil conservation practices, changing planting dates, use of improved seed/ crop varieties, irrigation and planting of trees are the common adaptation options used in Sub-Saharan Africa (SSA) (Komba and Muchapondw, 2015).Thus, considering the smallholder farmers in view of their significant vulnerabilities, they have a very important role to offer in efforts towards developing effective adaptation strategies. However, the specific adaptation strategies relevant for smallholder farmers in Uganda are still not clearly known and this calls for documentation of possible options to enhance adaptation and resilience of the farmers to the increasing CCV impacts (Bagamba *et al*., 2012).

Common beans are the main source of protein and vital subsistence crop for smallholder farmers in Uganda (SPIA, 2014).The short maturity period of beans, ease of production and storage makes them easily converted to cash crop by smallholder farmers. However, dry bean productivity is declining and

undermining food security in Uganda (Zizinga *et al*., 2015). For example, the average bean yield in recent years has been documented as 0.6 to 0.8 mt ha^{-1} from 1.5 to 2.0 mt ha^{-1} potential yield which can be harvested with good crop management and improved varieties (Sibiko *et al*., 2013).The decline in dry bean productivity in recent years has been accelerated by frequent episodes of both deficient and excessive rainfall and the seasonal increase in mean temperature (Shikuku *et al*., 2017).

Implementation of farming practices like land, water, soil and crop management technologies remains very low in SSA (Shikuku *et al*., 2017). Weather risk is persistent in agriculture and can trap farming households in poverty. IFAD (2011) stated that the risk of weather shocks limits the farmers' willingness to invest in adaptation strategies that would otherwise improve their agricultural productivity and economic circumstances. The native fragility of smallholder farmers' income makes them less able to influence their environment to adapt to climate stresses, whether predictable or not (DFID, 1999).Thus, increasing access to appropriate financial services including insurance amongst smallholder farmers is one way of reducing vulnerability and enhancing adaptation to weather shocks (Hepworth *et al*., 2008). Hoima district in mid-western Uganda was identified by national partners as a predominantly bean growing area that is facing climate related stresses of increased temperature, shifting seasons and highly erratic rainfall (Gloria *et al*., 2016).Though extensive studies on smallholder adaptation strategies have been carried out at a regional and global scale, specific studies in Uganda are lacking. Hence, a focussed study on smallholder dry bean farmers in Hoima district was conducted to assess adaptation strategies currently used to adapt to CCV.

Methods

Study area. The study was undertaken in Hoima district (Figure 1) in mid-western Uganda. Hoima district is situated between Longitude 31° 05' 00" E and Latitude 1° 25' 00" N in Mid-Western Uganda, 230 km North-west of the capital city (Kampala) of Uganda. The district covers an area of 3671 km^2 (UBOS, 2014). Hoima district enjoys a tropical climate and is located at an altitude of 1160m above sea level with an average total annual rainfall range of 750-1500mm (UNMA, 2015). Hoima district is divided into two counties that include Bugahya and Buhaguzi counties (sub-districts). Kibaale district

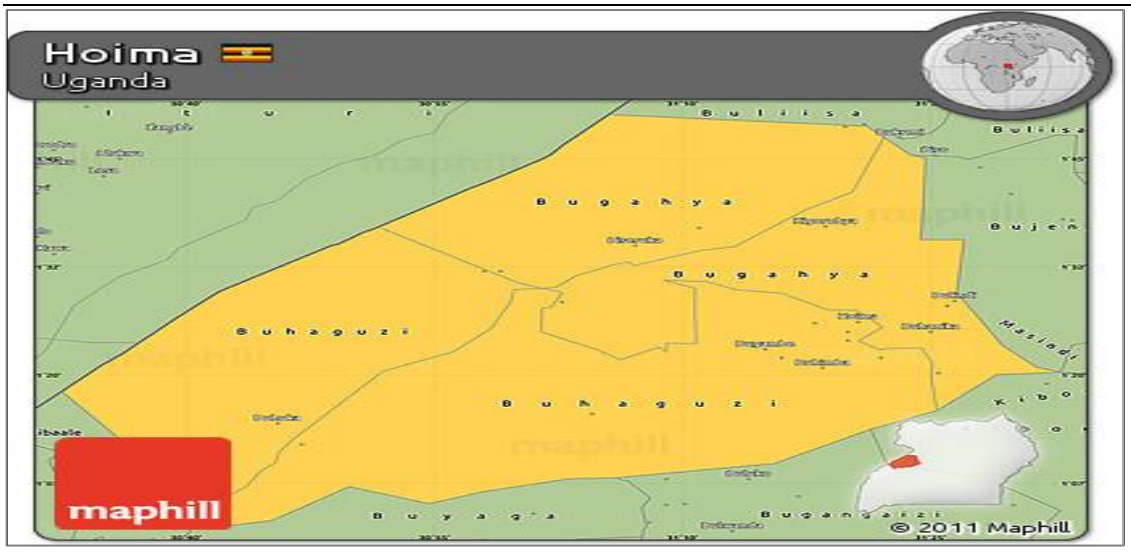


Figure 1. Map showing the location of Hoima district where the survey was conducted

Hoima is one of the 112 district of Uganda and is ranked as the 8th most inhabited district in the country with a population of 573, 903 people in 2014, comprising of 286,705 males (49.96%) and 287,198 females (50.04%) (UBOS, 2014).The rural population in Hoima district is made up of 81.4% of the population (UBOS, 2014). The area has an average household size of 4.5 members with people's life expectancy at birth estimated at 54 years, far lower than 80 years for people in the United Kingdom (UBOS, 2014). For many years people in Hoima district have remained with high poverty levels where 25.3% of people are poor, higher than the national average of 24.5% (UBOS, 2010). Hoima district is predominately agricultural with an emphasis on crop production employing more than 70% of the population (Mubiru and Kristjanson, 2012). The farming system consists majorly of annual cropping. The agricultural production practiced by the smallholder farmers in the area is characterised by low input use, use of low yielding crop/animal breads and reliance on rain-fed agriculture. These practices have led to the loss of soil fertility and biodiversity, which will negatively affect the environment (Zizinga *et al*., 2015).

Research design

The study was conducted using mixed methods but predominately qualitative. A field survey using semi-structured questionnaires was administered to 90 randomly selected smallholder households during the 2016/2017 production year in Hoima district. Field interviews and on-farm field observations were conducted to collect data. The primary reason for carrying out field observation was to check for the accuracy of the information to be obtained from the interview survey method. Most prominently, during face to face interviews, the respondents were asked questions with respect to their perceptions of CCV over the previous10 years. If the respondents had witnessed changes they were later asked to state the farming practices they used or had adopted to respond to the perceived CCV.

Unit of analysis and sampling procedure. The unit of analysis in this study was the rural smallholder legume farmer households who operated as the final decision-making unit in livelihood and farming developments in Hoima district. The average number of households in Hoima district was 125,907 households (UBOS, 2014). Buhimba sub-county had an estimated 8,729 households, Kiziranfumbi sub-county an estimated 7,563 households, and Kyangwali Sub-county had approximately 20,911 households, making 37,203 households in total for the three sub-counties where the study was conducted.

Using the formula proposed by Yamane (1967), the sample size was derived as follows:

$$n = \frac{N}{1+N\,(\propto)2}$$

Where:

n = Sample size

N= Total number of households in the study area,

α = Marginal error set at 5%

With the above formula, the estimated sample size for the study was 396 households. However, given the limitation of resources available, the study could only allow 90 households to be included in the study. The study therfore targeted 90 randomly selected households comprising of an average of 30 households from each of the three sub-counties as identified by district production officers as major legume growing sub-counties (sub-district). Eight parishes in the three sub-counties were randomly selected and included Nsozi, Muhwiju, Musaijamukuru East, Kinogozi, Munteme, Kisaru, Bulimya and Kimbugu. By using simple random selection, 18 villages from eight parishes were chosen for randomly selecting smallholder households for the study. These villages were Nsozi, Kyamugasa, Muhwiju, Musaijamukuru East, Kinogozi west, Mpigiza, Kisenyi, Kiswaza, Kyocholeka, Kikuuba, Kiryamagojo, Kabeerya, Nkwanzi, Bulimya, Kyabasara, Kisozi, Muziranduru and Kigaya.

A proportionate sampling was used to randomly choose 30 households from each of the three sub-counties (Buhimba, Kiziranfumbi, and Kyangwali) to ensure that the common adaptation strategies spread out in the region were represented given the importance of adaptation and to ensure that both female and male headed households were well represented.

Data collection techniques. Interviews using a semi-structured questionnaire were conducted by enumerators under supervision to the randomly selected respondents to capture relevant data required for this study. To ensure questions were understood by the respondents, local language (Runyoro) was used during interviews and questionnaire pre-testing was conducted on five households to ensure questions were being asked correctly by the enumerators. The questionnaire was designed to includ both open and close-ended questions.

Data analysis and interpretation. Survey data collected from smallholder farmer households was analysed using the Statistical Package for Social Sciences (SPSS version 24). Rainfall and temperature data were analysed using the Microsoft Office Excel computer programme. All the 90 household survey questionnaires that were collected were used in the analysis. Data interpretation was based on field observations and interviews on smallholder farmers' adaptation strategies against climate change impacts (Table 1).

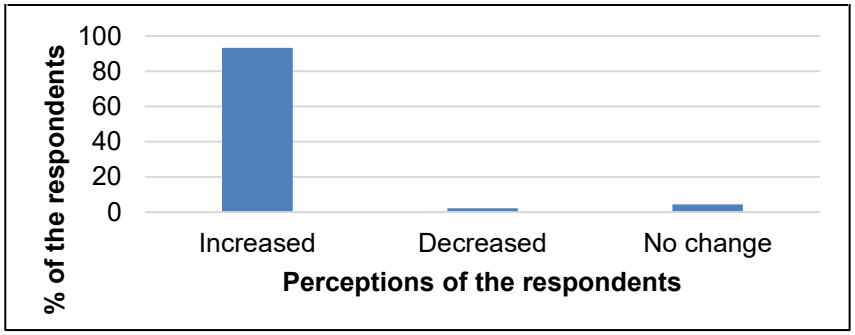
Table 1. Summary of analysis by specific objectives

Objective	Specific analysis
1. Perceptions of farmers to temperature and rainfall changes	Descriptive statistics including percentages are used to measure the farmers' perception to temperature and rainfall changes. Farmers' perceptions of rainfall and temperature changes are compared to meteorological temperature data obtained from BuZARDI. Rainfall and temperature trend analysis over the previous 13 years period analysed using Microsoft Excel.
2. Assessment of smallholder farmers' adaptation strategies	Percentages used to assess the distribution of adaptation strategies to CCV in the study area. Spearman correlation analysis used to test the relationship between access to credit, age, gender, access to forecast, rearing of animals to farmers' adaptation strategies.
3. Perception of smallholder farmers to agricultural insurance	Descriptive statistics, as well as percentages and means were used to measure farmers' perceptions of agricultural insurance.
4. Determining factors influencing farmers' decisions to adapt to CCV	The binary logistic regression analysis was conducted to investigate the factors influencing farmers' decisions to adapt to CCV in Hoima district.

Source: Author's field survey (2017)

Results

Farmers' perceptions to long-term changes in temperature. An impressive 95.5% of the respondents indicated that temperature changes had occured over the previous 10 years. The majority (93.3%) perceived increasing temperature, 4.5% of the respondent perceived more or less the same temperature, and only 2.2% of the respondents perceived a decrease in temperature over the past 10 years in Hoima district (Figure 2). The findings of this study were consistent with previous studies conducted in Uganda and in other countries. For example, Kisauzi (2014) in attempting to understand the farmers' perceptions and knowledge to climate change in Soroti district in eastern Uganda, found out that 97% of both males and females perceived temperature increases. This was in accordance with the average annual temperature meteorological data in Soroti district which showed that temperature increased by 0.6^0C over the previous 30 years. Komba and Muchapondw (2015) also reported that 98.9% of the smallholder farmers in Tanzania perceived increase in temperature.



Source: Author's field survey (2017).

Figure 2. Farmers' perceptions on long term temperature changes

Farmers' perceptions to rainfall changes. The study found out that 94.4% of the respondents recognised rainfall changes over the past decade in Hoima district. The majority (92.3%) of the respondents perceived rainfall decrease, 2.2% of the respondents perceived an increase in rainfall amount, 2.2% of the respondents reported no change in the amount of rain over the past10 years, while 3.3% of the respondents said they did not notice any change in rainfal pattern (Figure 3). The respondents attributed the decrease in rainfall amounts in the area to high deforestation rate being caused by high demand for agricultural land and wood fuel. The high percentage of farmers reporting decreases in rainfall amount was not surprising as other studies had earlier indicated similar findings. For example, Mubiru (2010) revealed that most of the farmers in Karamoja district in northern Uganda, perceived also a decrease in rainfall.

Farm-level impacts of climate change and climate variability. The findings indicated that out of the 90 sampled smallholder farmers, the majority (35.60%) considered pest and disease outbreaks as the main impact of CCV, followed by erratic rainfall (33.90%), drought (28.80%), hailstones (0.9%), and increased weed infestation (0.8%). The farmers reported that there were high pest and disease outbreaks in the area that affected dry bean production leading to high crop failure. The inadequate control measures used by the smallholder farmers to control the pests and diseases made them incur heavy yield losses to pests and diseases. The farmers reported the lack of inputs like pesticides and equipment; more especially lack of spray pumps, as a major barriers to effective control of pest and disease outbreaks.

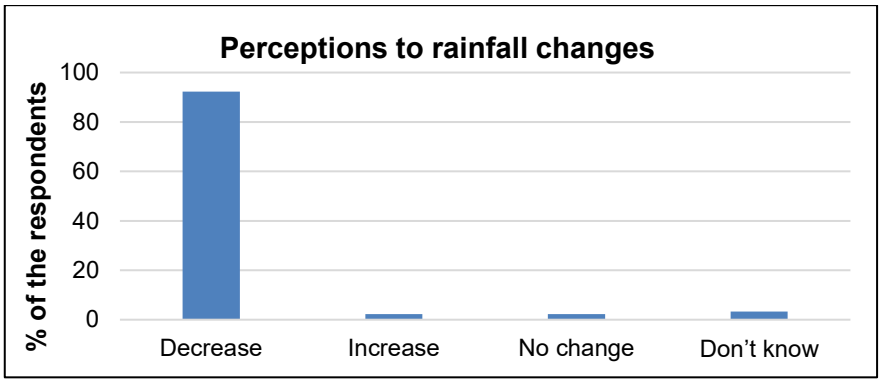


Figure 3. Farmers' perceptions of long-term rainfall changes

Rainfall variability in forms of early end and delayed start of the rainy season caused the second most reported impact on legume production in Hoima district. The respondents indicated that there was always high crop failure when beans were affected by the mid-season drought at flowering stage. Similar observations by Sulewski (2014) noted that agriculture was a risky business where the surveyed farmers indicated drought as the major source of risk on their farms. Weeds were not as much of a problem as they could be controlled. Also hailstones were re not common in the area, but cause significant damage if they occurred.

Adaptation response to the increasing temperature and changing rainfall patterns. The results showed that 70% of the respondents adopted various adaptation strategies to overcome the increasing temperatures. This indicated that most of the farmers in Hoima district employed adaptation tactics to respond to the increasing temperature. Similar results were reported by other studies in and outside Uganda showing high farmer response to increasing temperature. For example, Mubiru and Kristjanson (2012) indicated that in Hoima District, and in Central Uganda, over 65% of the households were making changes in their agricultural practices and were quite adaptive to their changing circumstances over the last 10 years. Nabikolo *et al*. (2012), in their research carried out in Eastern Uganda reported that 72% of male-headed household and 59% of female-headed households were adapting to CCV. Deressa *et al*. (2010) also stated that the majority (58%) of the farmers in the Ethiopia Nile basin were adapting to climate changes. This clearly suggests that many rural farmers are putting in place farming practices and innovations to adapt to perceived temperature increase.

With regards to the decreasing rainfall, the results indicated that 62.2% of the respondents in Hoima district were adopting numerous adaptation strategies to respond to the decreasing rainfall. This suggests that most of the respondents were employing more adaptation strategies in response to the perceived temperature increase than the perceived rainfall decrease. Nevertheless, the majority (62.2%) of the respondents were responding to the changing rainfall pattern. The findings are in agreement with Mutunga *et al*. (2017) who observed that the majority of the farmers (88% and 76% in Mikuyuni and Kaveta villages, respectively) used several adaptation measures in response to the decreasing and unpredictable rainfall pattern.

Farmers adaptation strategies to perceived temperature increase and the changing rainfall patterns. The results indicate that the important adaptation strategies adopted by smallholder legume farmers to respond to the increasing temperature included early planting (46.1%), spraying (16.9%), crop diversification (10.1%), crop rotation (4.5%), fertilizer application (4.5%), planting near swamps (3.4%), minimum tillage (3.4%), interval planting (3.4%), use of improved seed (4.2%), irrigation (1.1%), planting trees (1.1%), and timely weeding (1.3%), as shown in Table 2. In an effort to respond to the decreasing rainfall, the majority of the respondents (56.2%) changed planting dates to adapt to the perceived rainfall changes, followed by spraying (9.6%), crop diversification (9.6%), improved

seed (6.8%), phased planting (4.5%), crop rotation (4.1%), minimum tillage (3.6%), timely weeding (1.4), planting near swamps (1.4%), irrigation (1.4%), and sole cropping (1.4%), as indicated in Table 2.

The popular adaptation strategies adopted by the smallholder farmers in Hoima district includeed changing planting dates, early planting, spraying, crop diversification, and use of improved seed (Table 2). The findings showed that the adaptation strategies to perceived rainfall and temperature changes were almost similar. The study further revealed that most of the adaptation options employed by the farmers were not specific to a given type of climatic hazard.

Table 2. Adaptation strategies to increase in temperature and rainfall changes

Adaptation strategies	Increasing temperature % (n=63)	Rainfall changes % (n= 56)
Early planting	46.1	-
Changing planting dates	-	56.2
Interval planting	3.4	4.5
Minimum tillage	3.4	3.6
Use of improved seed	4.2	6.8
Crop rotation	4.5	4.1
Planting near swamps	3.4	1.4
Irrigation	1.1	1.4
Spraying	16.9	9.6
Fertilization	4.5	-
Timely weeding	1.3	1.4
Planting trees	1.1	-
Crop diversification	10.1	9.6
Sole cropping	-	1.4
Total	100%	100%

Source: Author's field survey (2017).

The results of the study are consistent with that of Kisauzi (2014) who reported that the majority (64%) of the households in Soroti district, Uganda, adapted to climate change impacts by using timely planting, improved varieties, crop diversification, intercropping, low/upland cultivation, and tree planting as major strategies for adaptation. Bryan *et al*. (2009) indicated that South African and Ethiopian smallholder farmers were adapting to CCV by adopting diverse crop varieties or different crops, planting of trees, changing of the planting dates, irrigation, and soil conservation.

Effectiveness of the farmers adaptation strategies. The effectiveness of the adaptation strategies in this study refers to the ability of the adaptation strategies to successfully ensure food security and reduce loss of revenue as a result of the increase in the magnitude and frequency of drought and rainfall variability. Farmers ranked the adaptation strategies where the adaptation strategies that were desirable at eliminating the risk received a higher rank than ineffective adaptation strategies. The adaptation strategies that were ranked highly by the farmers included timely planting, improved varieties, growing crops near swamps, spraying, phased planting, changing of planting dates, enterprise mix, tree planting, and use of fertilizers (Table 3).

Hepworth *et al*. (2008) questioned the resilience and sustainability of the available adaptation strategies in a study to appraise climate change response in Uganda. However, based on the smallholder farmers' experience, circumstances and needs, they have identified sustainable adaptation strategies based on their desires and capacities to make change. Many organisations have promoted various adaptation strategies like organic farming practices, but they are adopted only during the project period. After the termination of the project, farmers return to their local practices. Therefore, it is very important for different actors to develop and implement effective adaptation strategies desired by the smallholder farmers in a given locality.

Although growing crops near the swamps was ranked as a highly effective strategy by the smallholder farmers, it is not sustainable as such practices of shifting to lowland areas negatively affects the environment and goes against environmental protection laws in Uganda. The environmental law in Uganda prohibits farmers or individuals from cultivating or constructing in lowland areas according to Act, Cap, 153 of the Environmental Law which seeks to manage natural resources, sustain biosphere and protect human health (NEMA, UNEP & Greenwatch, 2004). Furthermore, the majority of the people cannot access the lowland areas to adapt to climate change using the practice, thus planting near swamps or in lowland areas as an adaptation strategy should not be promoted amongst farmers.

Table 3. Ranking of effectiveness of the adaptation strategies by smallholder farmers

Adaptation strategies	Level of effectiveness (score*)	Major reason for the score
Timely planting	***	Risk reduction
Spraying	**	Lack spray pumps and chemicals
Improved seed / varieties	***	Risk reduction
Growing crops near swamps	***	Risk reduction
Diversification	***	Spreads the risk
phased planting	**	Risk reduction
Planting trees	**	Reduces crop destruction by the wind
Fertilizer use	***	Increase crop yield
Irrigation	*	Lack of irrigation equipment

*** Highly effective ** moderate effective * effective
Source: Author's field survey (2017).

As shown in Table 3, planting trees is not widely practiced as the farmers have small landholding mostly used for crop cultivation to feed their households and provide a source of livelihood. The farmers' quest for land can be addressed by the practice of inter-planting agricultural staple foods with trees. Thus, smallholder farmers need to be educated about modified taungya systems which offer diverse benefits for both adaptation to climate change and forestry. Smallholder farmers ranked irrigation as a fairly effective adaptation strategy, but they lacked irrigation equipment. However, various studies have shown that irrigation is very effective for overcoming drought impacts on crop production (Nzuma, 2010; Devarajan, 2011; Komba and Muchapondw, 2015; Taheripour *et al*., 2015). Therefore, there is a need to train the farmers in micro-irrigation techniques and to mobilise farmers into groups to enable them acquire irrigation equipment.

Hepworth *et al*. (2008) questioned the resilience and sustainability of the available adaptation strategies in a study to appraise climate change response in Uganda. However, based on the smallholder farmers' experience, circumstances and needs, the farmers identify sustainable adaptation strategies based on their desires and capabilities. Although growing crops near the swamps was ranked as a highly effective strategy by the smallholder farmers, it is not sustainable as such practices of shifting to lowland areas negatively affects the environment and goes against environmental protection laws in Uganda. Furthermore, the majority of the people cannot access the lowland areas to adapt to climate change. Therefore planting near swamps or in lowland areas as an adaptation strategy should not be promoted amongst farmers.

Flexibility of the adaptation strategies. The flexibility of an adaptation strategy is the ability of the adaptation strategy to function under various climate change events (Dolan *et al*., 2001). Adaptation strategies that are flexible are more cost effective to the farmers.

The current study revealed that crop diversification, timely planting, use of improved seed, and use of fertilizers were the most flexible adaptation strategies used by the farmers in Hoima district (Table 4). The majority (72%) of the smallholder farmers used flexible adaptation strategies because they were in response to the predicted or prevailing effects of CCV in the region. The results of this study are consistent with Kisauzi (2014), who indicated that 83% of farmers in Soroti district in Uganda used flexible adaptation strategies (timely planting, improved varieties and diversification) to respond to drought, floods and strong winds/storms.

Some adaptation strategies such as spraying were specific to controlling pests, while other adaptation strategies such as timely weeding, sole cropping, phased planting, planting of trees, irrigation, up/lowland shifting cultivation and crop rotation were used to respond to at least two climate effects. Therefore, in order to increase resilience of smallholder farmers, developing countries should use the most effective adaptation strategies capable of responding to a range of environmental stresses (UNFCCC, 2007).

Table 4. Use of adaptation strategies over various climate change conditions (n=59)

Adaptation strategies	Drought (%)	Pests and diseases (%)	Erratic rainfall (%)
Crop diversification	28.3	23.0	14.2
Timely planting	27	7.1	12.2
Minimum tillage	3.4	-	2.1
Use of improved seed	12.2	16.8	12.0
Crop rotation	1.0	6.1	-
Up / lowland shifting	3.4	-	2.3
Irrigation	7.0	-	17.0
Spraying	-	25.2	-
Use of fertilizers	4.5	10.8	2.0
Interval planting	5.1	-	1.2
Planting trees	1.1	-	29.0
Timely weeding	-	9.6	6
Sole cropping	-	1.4	1.0
Total	100%	100%	100%

Source: Author's field survey (2017).

Farmers' awareness of agricultural insurance. A large number (94.44%) of the respondents had not heard about agricultural insurance. Only 5.56% of the respondents knew about agricultural insurance. The high percentage of farmers with poor awareness of agricultural insurance is not surprising a study conducted in the Imo State, Nigeria by Chikaire *et al*. (2016) reported that 87.3% of the respondents were not aware of agricultural insurance. Other similar findings were obtained by Pandaraiah and Sashidar (2015), while working with farmers in Kurama Pally Village of Nalgonda district, Telangana State in India, where findings revealed that 80% of the smallholder farmers had no information on agricultural insurance. The poor awareness amongst the smallholder farmers about agricultural insurance in Hoima district can be attributed to low education status and lack of publicity of agricultural insurance amongst the rural farmers. Although a few (5.56%) of the farmers were aware of agricultural insurance, none of them had ever purchased the agricultural insurance policy.

Farmers' perceptions of agricultural insurance. Given the poor awareness of the farmers to agricultural insurance, there is a limitation in knowing the right perceptions of the farmers since none of them had not used agricultural insurance. Only a few (5.6%) of the respondents were aware of agricultural insurance. Thus, obtaining a clear perceptions from the smallholder farmers in rural communities such as Hoima district remains a challenge and requires further research when farmers are sensitised towards and engaged in agricultural insurance. Despite the very poor awareness of the farmers about agriculture insurance, the majority (83.3%) of the respondents indicated that they were willing to use agricultural insurance on availability in Hoima district. Only 8.9% and 7.8% were not ready to use and did not know whether they would use agricultural insurance, respectively. This means that most of the farmers in Hoima region were willing to use agricultural insurance as a strategy against the impacts of CCV. There appeared a high need for agricultural insurance and possibly due to high crop failures in the region.

Conclusions

This study describes diverse adaptation strategies implemented by the smallholder legume farmers to overcome the negative impacts of climate change and climate variability in Hoima district, Uganda. The smallholder farmers perceived that climate in Hoima district was changing from time to time, increasing the risk in their rain-fed agricultural system. Their perception of decreasing rainfall and increasing trend of temperature in the area was supported by the meteorological records from the district.

It is apparent from the study that smallholder farmers' livelihoods were being affected by the high outbreak of pests and diseases, frequent drought and erratic rainfall. The most popular adaptation strategies adopted by the smallholder farmers in Hoima district comprised changing of planting dates, timely planting, timely weeding, spraying to control pests and diseases, use of improved seed, and use of fertilizers.

The study found out that the majority (94.4%) of the smallholder farmers had not heard about agricultural insurance. Given the high level of vulnerability to climate changes especially drought, experienced amongst the farmers in Hoima district, the majority 83.3% of the farmers expressed willingness to use agricultural insurance strategies upon its availability in Hoima district. Moreover, the findings from the logistic regression model revealed that access to credit, sources of off-farm income, access to inputs, and land ownership positively influences farmers' decisions to adapt to climate change and climate variability. Thus, the farmers would likely adopt agricultural insurance.

Recommendations

The study recommends that interventions aimed at climate change adaptation should capitalise on the high farmers' perception and awareness levels about climate change that were observed to stimulate adaptation strategies. The study also recommends that adaptation policies should build on existing adaptation strategies and focus on addressing the factors that limit farmer's adaptation to climate change and variability. Policy makers should create a conducive environment to encourage climate change adaptation by increasing farmers' access to inputs, access to credit, improved markets and ensure security of land ownership amongst the smallholder farmers.

Adaptation campaigns involved in promoting climate change adaptation should harmonise the local perceptions and knowledge with scientific thinking through the dissemination of climate information for timely adaptation amongst smallholder farmers. This can be done through providing information to local radio stations, since the majority of the farmers reported to be mostly acquiring information from radio. Providing climate information to inform timely planting, encouraging adoption of improved/ drought tolerant varieties and promoting soil conservation practices like the use of fertilizers might be successful in the short term at increasing resilience of the farming systems. Sustainable strategies including encouraging group formation and easing access to credit are also required to encourage smallholder farmers to adapt to climate change and climate variability.

The study also recommends that agricultural insurance campaigns and training should be carried out by concerned actors to enhance awareness and its adoption amongst smallholder farmers to mitigate agricultural risks. Easy credit availability is necessary for encouraging adoption and promotion of agricultural insurance amongst smallholder farmers. Moreover, insurance companies offering agricultural insurance should develop insurance policies that are affordable by the smallholder farmers and, where possible, the government should subsidise agricultural insurance for smallholder farmers since they are key in building food security in the country.

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