Research Application Summary

The impact of climate change and variability on agricultural production: Adaptation strategies in Teso sub-region of eastern Uganda

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Abstract

Climate change is emerging as the most important environmental problem facing modern society. Africa in particular is highly vulnerable to climate change and variability due to heavy reliance on rainfed agriculture by the majority of its population. Past experience in Uganda shows climate change related disasters with more devastating effects on the agricultural sector, physical infrastructure and the health sector. This study analyses factors that influence farmer's choice of climate change adaptation strategies and impacts on agricultural production in the savanna grassland agro-ecological zone of Teso sub-region of Uganda. Both Poisson and negative binomial technology adoption models were used to determine factors that influence farmers' choices of climate adaptation strategies. Ricardian analysis was done to understand climate change impacts on agriculture using climate and production data for 1980-2010. Results from this study indicate that increase in rainfall/precipitation, age of the farmer, access to credit, irrigation, access to asset, climate extension services and climate information significantly influenced number of climate adaptation strategies used by farmers in Teso. Increase in rainfall due to climate change and variability led to loss in cereal (millet) output by 2.8%. It is evident from this study that climate change and variability has had significant impact on agricultural production in Teso/Uganda, hence the need to promote adaptation strategies. The policies that promote climate change adaptation should aim at creating credit institutions to support farmers, developing irrigation infrastructure and provision of both climate and agricultural information on better technologies for farmers in Teso and Uganda as a whole.

Key words: Agro-ecological zone, climate adaptation strategies, Climate change and climate variability, negative binomial, poisson, rainfed agriculture, ricardian, Savanna grassland, Teso, Uganda

Résumé

Le changement climatique est en train de devenir le plus important problème environnemental auquel fait face la société moderne. En particulier, l'Afrique est très vulnérable à la variabilité et aux changements climatiques dûs à la forte dépendance sur l'agriculture en temps de pluie par la majorité de sa population. En Ouganda, l'expérience du passé montre le changement climatique lié aux catastrophes accompagnées d'effets plus dévastateurs sur le secteur agricole, les infrastructures physiques et le secteur de la santé. Cette étude analyse les facteurs qui influencent le choix par les agriculteurs des stratégies d'adaptation aux changements climatiques et les impacts sur la production agricole dans la zone agro-écologique de savane herbeuse de la sous-région de Teso en Ouganda. Ensemble le modèle d'adoption des technologies binomial négatif et celui de Poisson ont été utilisés pour déterminer les facteurs qui influencent les choix par les agriculteurs de stratégies d'adaptation au climat. L'analyse ricardienne a été faite pour comprendre les impacts du changement climatique sur l'agriculture en utilisant les données climatiques et celles de production pour la période 1980-2010. Les résultats de cette étude indiquent que l'augmentation de la pluviométrie / précipitation, l'âge de l'agriculteur, l'accès au crédit, l'irrigation, l'accès aux biens, les services d'extension climatique et l'information climatique ont influencé significativement le nombre de stratégies d'adaptation au climat utilisées par les agriculteurs de Teso. L'augmentation des précipitations due aux changements du climat et à sa variabilité a conduit à la perte de la production céréalière (mil) de 2,8%. Il ressort de cette étude que le changement et la variabilité climatiques ont eu un impact significatif sur la production agricole à Teso, en Ouganda, d'où la nécessité de promouvoir les stratégies d'adaptation. Les politiques qui favorisent l'adaptation aux changements climatiques devraient viser à créer des établissements de crédit pour soutenir les agriculteurs, développant les infrastructures d'irrigation et la fourniture de l'information climatique et agricole sur les meilleures technologies pour les agriculteurs de Teso et de l'Ouganda dans son ensemble.

Mots clés: Zone agro-écologique, stratégies d'adaptation au climat, changement climatique et variabilité climatique, binomial négatif, Poisson, agriculture pluviale, ricardien, savane herbeuse, Teso, Ouganda

Background

Climate change is emerging as the most important environmental problem facing modern society. Many reports (IPCC, 2008 & 2007; Christensen *et al.*, 2007) predict that climate change over the next century will affect rainfall patterns, river flows and sea levels all over the world. Uganda where agricultural sector contributes 73% (employment); 21.5% (GDP) in 2008 (UBOS 2009), is extremely vulnerable to rainfall variability and weather extremes. Climate models for Uganda (IPCC, 2001) point to an increase in temperature in the range of 0.7^0C to 1.5^0C by 2020 and predict likely increase in the variability of rainfall (and other extreme weather events). In contrast, 70% of the disasters are climate change related and in agricultural sector, noticeable changes are; increasing pest and disease incidences, change in rainfall patterns, increase in temperature, and expansion of drought prone areas (cattle corridor). Teso sub-region of eastern Uganda was hard hit by ElNino of 1997-98 and since 2001 the area has experienced extreme weather patterns (extended dry spells in years 2002, 2004, 2006, and 2009 and floods in 2007 (GoU, 2010) leading to persistent food insecurity.

In Teso sub-region of eastern Uganda, the Government of Uganda and other development partners have undertaken a number of interventions in the agricultural sector that should have enabled farmers to build resilience to climate change and variability. Some of the interventions included; Soil and water conservation, agro-forestry (Banadda, 2010), breeding and promotion of drought tolerant crops (sorghum, millet, groundnuts), small scale irrigation, promoting early maturing high yielding crop varieties , tree planting, etc. But the extent of how farmers translate interventions to build resilience to climate change and variability is not clear as it is common to get reports of persistent food shortage. This study sought to answer the following key research questions; Are farmers in Teso sub-region of eastern Uganda adapting to climate change and variability?; What could be the factors influencing farmers choice of climate adaptation strategies in the area?; Does adaptation strategy selected by a farmer reduce impact of climate change and variability on losses in crops and animal production?; Are there any impacts on crop yields/animal output?

In addition, the study determined whether adoption of climate adaptation strategies reduced impacts at farm level. Detailed empirical analysis of climate change and variability impacts on agricultural production, as well as determine farmers' choice

of climate change adaptation strategies in Teso sub-region of eastern Uganda is important. This had to be done because Government of Uganda demands that the design of climate adaptation strategies for agriculture should be based information about climate change and variability at geographical levels that match agricultural districts, different crops, livestock and agro-forestry as well as agro-ecological zones (MAAIF, 2009).

Literature Summary

Africa in particular is highly vulnerable to climate change and climate variability due to the fact that the majority of its population depends on subsistence rainfed agriculture (Boko *et al.*, 2007). For example, Kurukulasuriya *et al*. (2006) indicate loss of revenue from agriculture dry land crop (1.9%) and livestock (5.4%) with increase in temperature; Kurukulasuriya and Mendelsohn (2008) also indicate 1.3% decline in net farm revenue with increase in temperature.

Study Description

This study analyses the impact of climate change and variability on agricultural production in Teso sub region of Uganda. Primary data collected from a survey of 440 farm households was used to run Poisson and negative binomial technology adoption models to determine factors that influence farmers' choices of climate adaptation strategies. Subsequently the Ricardian analysis using secondary panel data regression was applied to district specific fixed effects to control for unobserved location specific effects on yields of major crops in Teso sub-region of eastern Uganda.

Research Application

Based on the results from a household survey of 440 farmers in Teso sub-region, the number of climate change adaptation strategies selected by the farmers in Teso sub-region included; No adaptation option selected by 2 % of the farmers, Early maturing and drought tolerant crops was used by 99% of the farmers, Mixed crop/livestock farming used by 60% of the farmers, Intercropping was used by 4.9% of farmers, Adjusting planting and harvesting dates was used by 50.5% of farmers, Crop diversification was mentioned by 91.3% of farmers, Soil and water conservation (89.3%), Agroforestry (6.8%) and Irrigation (1%) of the farmers. Other studies in Africa (Hassan and Nhemachena, 2008; Kurukulasuriya and Mendelsohn, 2008; Deressa *et al*., 2009) have also indicated similar approaches being applied by farmers to adapt to climate change.

The Incident Rate Ratios (IRRs) from the Negative Binomial are presented in Table 1. Results show that increase in amounts of rainfall during the second planting season led to increased

Table 1. Negative binomial results on factor influencing choice of climate change adaptation strategies in Teso sub-region of Uganda.

Number of climate change adaptation strategies selected by the farmer	IRR	Z	(95% Confidence Interval)	
First season rains (Fr1)	1.0001	0.77	0.9998	1.0005
Second season rains (Fr2)	1.0003*	1.69	0.9999	1.0007
First season temperatures (Ft1)	0.9934	-0.12	0.891	1.1075
Second season temperatures (Ft2)	0.9707	-0.3	0.8001	1.1777
Adult household labour	0.9545***	-3.52	0.93	0.9795
Access to credit (1=Yes, 0=No)	1.1929*	1.77	0.9818	1.4494
Member of SACCO (1=Yes, 0=No)	0.9792	-0.28	0.845	1.1349
Number of extension visits during the previous season	1.0104	0.53	0.9727	1.0496
Number of floods occurring during the last 10 years	1.0393	1.02	0.9651	1.1192
Number of droughts occurring during the last 10 years	0.8999**	-2.01	0.8117	0.9976
Remittances received from abroad (1=Yes, 0=No)	0.9868	-0.25	0.888	1.0966
Asset ownership (Number of Animals)	1.0217***	4.14	1.0114	1.0322
Distance to the nearest input/output market	1	0	0.9756	1.025
Distance to the nearest motorable access road	0.9594	-1.18	0.8954	1.028
Agro-ecological zone (1=Bimodal rainfall, 0=Unimodal rainfall)	0.9441	-0.46	0.7398	1.2049
Access to irrigation (1=Yes, 0=No)	1.7951***	4.23	1.369	2.3539
Number of acres owned by farmer	1.0024	0.64	0.995	1.0098
Farmer planted trees (1=Yes, 0=No)	1.0438	0.55	0.8956	1.2165
Farmers year of education spent at school	0.9943	-0.77	0.98	1.0089
Sex of the household head (1=Male, 0=Female)	1.0492	0.72	0.9214	1.1948
Age of the farmer in years	1.0060*	1.66	0.9989	1.0132
Farmers farming experience in years	0.9419***	-12.1	0.9328	0.9511

number of climate adaptation options used by a farmer by 0.03% and age in years increased options farmer selected by 1% both of which are significant at 10%. Similarly, choice of irrigation as a climate adaptation option by farmers in Teso led to increase in number climate adaptation options by 79%, asset ownership also increased number of adaptation counts by 2% and access to credit led to 19% increase in number of adaptation options, all of which are highly significant at 1% and 10% levels respectively. These results are similar to those by Deressa *et al*. (2009) who indicated that access to credit, access to extension services, age of the farmer and irrigation enhanced adaptation to climate change. Therefore, policies aiming at promoting climate adaptation should aim at creating credit institutions to support farmers, developing irrigation infrastructure and provision of both climate and agricultural information on better technologies for farmers in Teso and Uganda as a whole.

Increase in family labour, frequency of droughts and farming experience significantly reduced the number of climate adaptation strategies applied by a given farmer in the region.

This result implies that farmers tend to divert excess labour to off farm activities hence reducing labour available for climate adaptation strategies adoption. Farmers with more experience in farming are more risk averse, hence they tend to use fewer climate adaptation options, a result similar to that reported by Hisali *et al.* (2011) indicating that the elderly tend to be more affected by climate change yet have low ability to adapt. This will call for establishment of policies that help such households' smooth out consumption, like social protection policies.

Preliminary results from the Ricardian analysis indicate that increase in first season rainfall reduced millet (cereal) output by 2.8% and while in the second rainy season, it led to increase in millet output by 39% and the result was highly significant ($p<0.001$). An increase in temperature also shows a positive effect on millet output. These results confirm the predictions that global warming leads to increase in precipitation which in turn will lead to increase in cereal output/yields in the shorter run (Deressa and Hassan, 2009). Their study also however indicates that increasing rainfall amounts annually marginally reduced crop output. The results vary from season to season and crop to crop. The impacts of climate change on agriculture in Teso / Uganda are thus significant. Actions that make agriculture sectors more resilient to climate change should be taken in advance, such as promoting climate adaptation strategies that have a proof to work under farmers conditions.

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