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Research Application Summary

Perception on climate change and climate smart agricultural technologies among small holder mixed farmers in East Africa

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Abstract

Climate change is one of the major challenges facing small-scale farmers in East Africa. A study was conducted in Central and Eastern Uganda representing the humid and sub-humid regions in East Africa respectively with the objective of identifying the implemented and missing adaptation strategies among small-holder mixed crop-livestock farmers in Uganda. Non-self-administered questionnaires were used to collect data from 80 farmers (implementers and non-implementers of planned adaptation strategies). A large number of farmers in Masaka (86.7%) observed change in climate in terms of decreased rainfall while most farmers in Ngora (66.7%) reported increased rainfall amounts over the past 30 years considered in the study. The major climate smart agricultural technologies identified in the two districts were: soil rainfall fertility management (75%), water harvesting and small scale irrigation (64.5%), soil and water conservation (65%) and use of drought tolerant forages (100%) and these practices are also implemented in Kenya and Tanzania. Change of planting dates, crop diversification, large scale pasture conservation, use of green houses for vegetable production, access to credit for adoption of adaptation measures, use of early warning systems, implementation of climate change awareness, and introduction of agroforestry systems were the missing strategies in the study areas. Therefore it is recommended that governments and organizations aiming at implementing adaptation strategies among smallholder mixed crop-livestock farmers should consider these factors prior to their execution of the projects.

Key words: Climate change, climate smart agricultural adaptation practices, smallholder mixed farming, Uganda

Résumé

Le changement climatique est l'un des défis majeurs auxquels sont confrontés les petits agriculteurs en Afrique de l'Est. La présente étude a été menée au centre et à l'est de l'Ouganda, régions humides et subhumides d'Afrique Orientale, dans le but d'identifier les stratégies d'adaptation courantes et absentes chez les petits agriculteurs en Ouganda. Des questionnaires ont été utilisés pour collecter des données auprès de 80 agriculteurs (exécutant ou pas les stratégies d'adaptation planifiées). Un grand nombre d'agriculteurs à Masaka (86,7%) ont observé un changement dans le climat en termes de réduction des précipitations tandis que la plupart des agriculteurs de Ngora (66,7%) ont signalé une augmentation des précipitations au cours des 30 dernières années considérées dans l'étude. Les technologies agricoles intelligentes majeures pour faire face au climat identifiées dans les deux districts étaient: la gestion de la pluie et de la fertilité des sols (75%), la collecte d'eau et irrigation à petite échelle (64,5%), la conservation des sols et des eaux (65%) et l'utilisation de fourrages qui supportent la sécheresse ; et ces pratiques sont également en cours au Kenya et en Tanzanie. Le changement des dates de semis, la diversification des cultures, la conservation des pâturages à grande échelle, l'utilisation de serres pour la production maraîchère, l'accès au crédit pour l'adoption de mesures d'adaptation, l'utilisation de systèmes d'alerte précoce, la sensibilisation aux changements climatiques et l'introduction des systèmes agroforestiers étaient tous des stratégies absentes dans les zones d'étude. Par conséquent, il est recommandé que les gouvernements et les organisations visant à mettre en œuvre des stratégies d'adaptation à être utilisées par les petits agriculteurs système agro-pastoral, considèrent ces facteurs avant d'exécuter les projets.

Mots-clés: Changement climatique, pratiques d'adaptation agricole intelligentes face au climat, agriculture mixte paysanne, Ouganda

Background

It is well established that over the last 1000 years, the global climate has been warming at an alarming rate causing changes in the regional and local weather conditions at the global scale (IPCC, 2001). Numerous climate change models have predicted increased precipitation in East Africa in the past, however, the latest studies suggest that there will be decreased precipitation due to local circulation effects (Funk *et al.,* 2008).

In Uganda, agriculture has been noted to be the major sector affected by climate change and these effects have been observed through decreased agricultural production, increased food-insecurity and poverty among households (Ocaya, 2007). This sector plays a key role in providing economic and social development in the country as over 80% of the rural resource poor smallholder farmers depend on it as a main source of livelihood (UBOS, 2009). Agriculture also contributes up to nearly 20% of the country's Gross Domestic Product (GDP) and accounts for 48% of Uganda's exports (UBOS, 2009).

Because of the climate change impacts on the agricultural sector, different farmer communities have implemented various adaptation measures in an effort to adapt to these impacts more so with the help of agricultural organizations. For instance, the National Livestock Resources Research Institute (NaLIRRI) has assisted smallholder mixed crop-livestock farmers of Masaka and Ngora districts implement some measures such as, collecting water from house roof tops and storing in underground water tanks, and planting of drought tolerant forages that are fed to animals during the dry season, among others. The organization has implemented these strategies because despite the changing climate and its effects, farmers continue to produce food crops and rear animals to survive yet they have limited adaptation measures.

Nonetheless the farming communities vary across several scales regarding the ability to cope as well as the adaptation measures implemented and this discrepancy may be at the individual, farm and plot levels to country levels. Thus these varying scales should be considered when analyzing the capability of a system to adapt as well as the suitable adaptation responses (Vincent, 2007). In this regard, various studies have been carried out with the aim of identifying adaptation measures being implemented by farming communities in response to climate change. An example of such a study is the climate change vulnerability and adaptation preparedness in Uganda (Nick, 2010). Unfortunately most of these studies rarely examine what adaptation measures are missing in these areas yet they could be relevant in assisting the farming communities increase their resilience to climate change impacts. Therefore this study was designed to identify the climate smart agricultural adaptation strategies that are missing in the study areas but implemented in other East African countries that have the same climatic conditions as those in the study areas.The specific objectives of the study were to: (a) identify and validate farmer's perception on climate change using the regions' climatic data; and (b) identify adaptation strategies that have been implemented by the farming communities.

Materials and Methods

Study areas. The study was carried out in Masaka and Ngora districts located in Central and Eastern Uganda, respectively. Masaka district is representative of the banana/coffee system sub-humid agro-ecological zone and is located about 37 km away from the equator. It occupies an area of 1,295.6 km with a total population of 251,600 (UBOS, 2008). Masaka lies between 00 15' and 00 43' South of the equator and between 310 and 320 East longitude, having an average altitude of 1,150m above sea level. The annual average rainfall averages 800-1,000 mm received in two bi-modal rainfall seasons which are March – May and September - November. Mean temperature ranges between 16^0C and 30^0C, while mean relative humidity is 62.1%. The district is typically dependent on crop-livestock systems, with vegetable production as a key income earner. Banana and coffee are the main cash crops, sweetpotatoes and cassava, and beans are common root and legume crops, while cattle and goats are the main livestock reared. The vegetation is mainly forest-savanna mosaic with pastures suitable for intensive livestock production.

Ngora district on the other hand is representative of the Teso semi-arid agro-ecological zone and is located in Eastern Uganda. The district lies at an altitude of between 1,036 and 1,127 meters above sea level with an estimated population of 356,500 (UBOS, 2008). Average rainfall ranges between 1000 mm and 1500 mm coming in two seasons: March–May and September–November. Mixed agriculture is practiced with cultivation by oxen as the main agricultural technology employed. Livestock is kept extensively in areas that are tsetse-fly free. The main crops grown include; finger millet, groundnuts, sorghum, rice, cowpea, and soybeans, which are predominantly intercropped. The vegetation in Ngora district is characterized by wooded savannah, short-grass savannah, forests and short grassland.

Data collection, sample size and population and sampling techniques. The study comprised of a sample size of 40 respondents from each district. This population included smallholder mixed crop-livestock farmers applying planned climate change adaptation measures and those adapting autonomously who were considered non adopters of adaptation measures. The study sites were purposely selected based on the implementation of the climate smart agricultural adaptation regional project "Harnessing crop-livestock integration to enhance food security and livelihoods resilience to effects of climate variability and climate change in Eastern and Central Africa" implemented by the National Livestock Resources Research Institute (NaLIRRI) and funded by Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA).

Purposive non-random sampling technique was used to select two villages within each district based on the criteria of implementation of planned adaptation strategies. Twenty farmer households per village were then randomly selected using the systematic sampling technique. Ten project beneficiaries were selected to represent adopters of adaptation measures while ten non-project beneficiaries were selected to represent non-adopters.

Data sources and analysis packages. Climatic data for the study sites were collected from the National Metrological Station in Kampala, National Semi-Arid Resources Research Institute in Soroti and Kamenyamigo District Agricultural Training and Information Centre (DATIC) in Masaka district. Climate data for Soroti district (Approximately 60 km for Ngora) was taken to represent climate data in Ngora due to lack of data for Ngora district. The years selected for analysis were based on the availability of data from the stations as well as the farmers' long term climate change perception. The data were analyzed using INSTAT software and Ms. EXCEL.

Semi-structured interviews were conducted in each study site using non self-administered questionnaires (open and close ended) to establish farmers' perception on climate change, identify the adaptation strategies being implemented by the house holds as well as the psychological factors that enhance adoption of these strategies. In addition, Focus group discussions were held with key project stakeholders to generate extra information and validate information gathered in the questionnaires.

Subsquently, analogue tool was used to find out which regions around East Africa currently have the same climatic conditions similar to those in Ngora and Masaka. A literature review was done to find out which adaptation strategies are employed in these regions but missing in the study areas.

Results and Discussions

Perceptions of the farmers on change in weather patterns over the past 30 years. Field responses showed that 86.7% of the farmers in Masaka observed a change in climate in terms of decreased rainfall and increased temperature while the other 13.3% reported otherwise. On the other hand, 66.7% of the respondents in Ngora reported a change in climate in terms of increased rainfall amounts received while the 33.3% reported a decrease in the amount of rainfall received (Figure 1).

In terms of seasonal variability, two rainfall seasons were considered for both study areas, that is; March-May and September-November. In both study areas, farmers reported a late start of the rainfall in both seasons in the present as compared to over 30 years before. In this regard, 74.6% of the farmers reported a late start in the first rainfall season and about 53.8% reported an early end of this season (Figure 2). On the contrary, about 60% of the respondents identified the second rainfall season to be starting and ending later than expected.

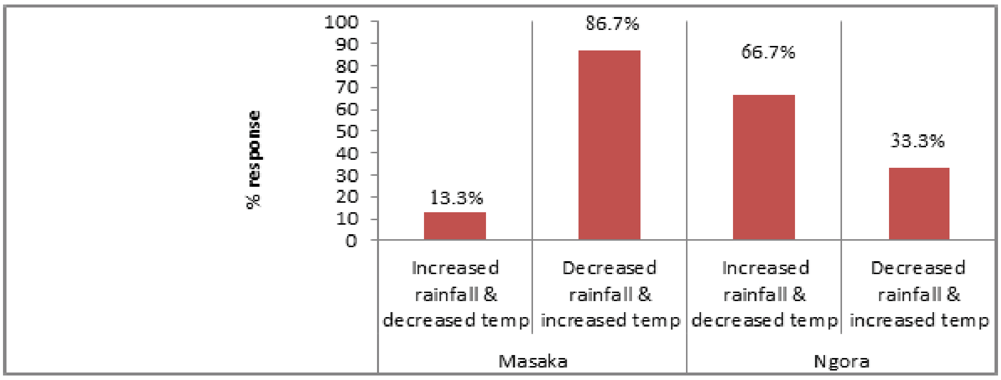

Figure 1. Farmers' perception on climate change in two diverse areas of Uganda

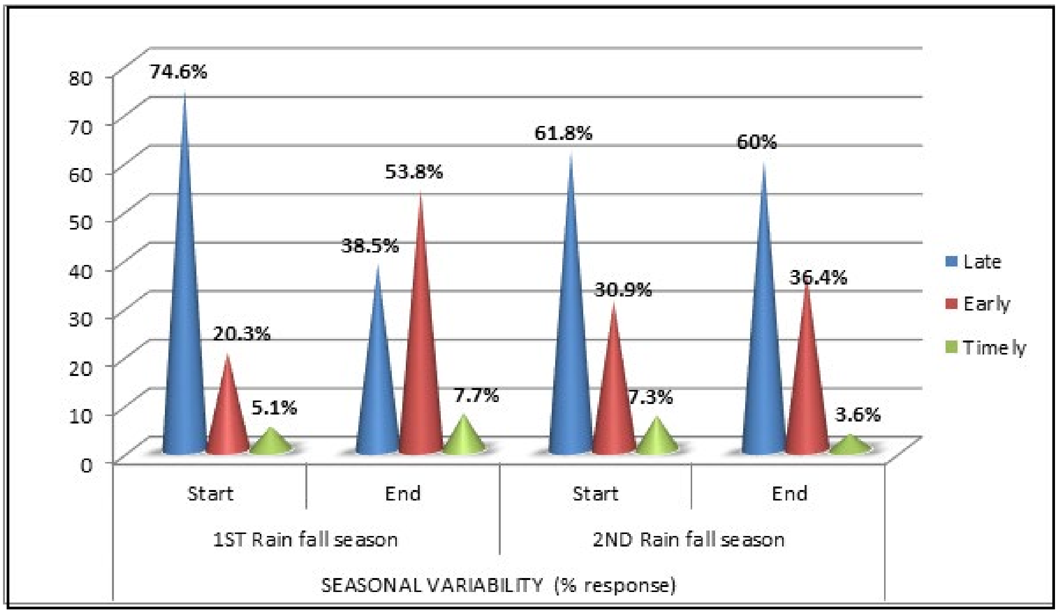

Figure 2. Perceptions of farmers on rainfall seasonal variability

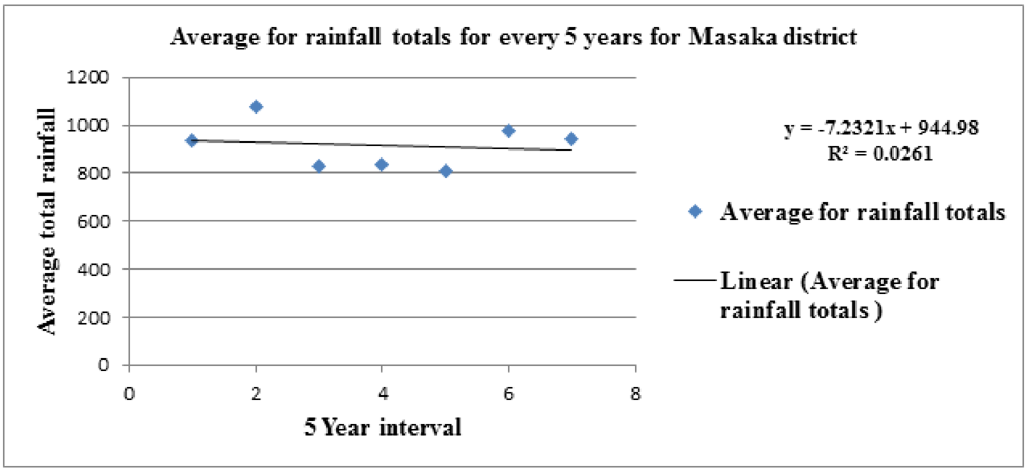

Figure 3. Regression analysis results for annual rainfall totals for Masaka district

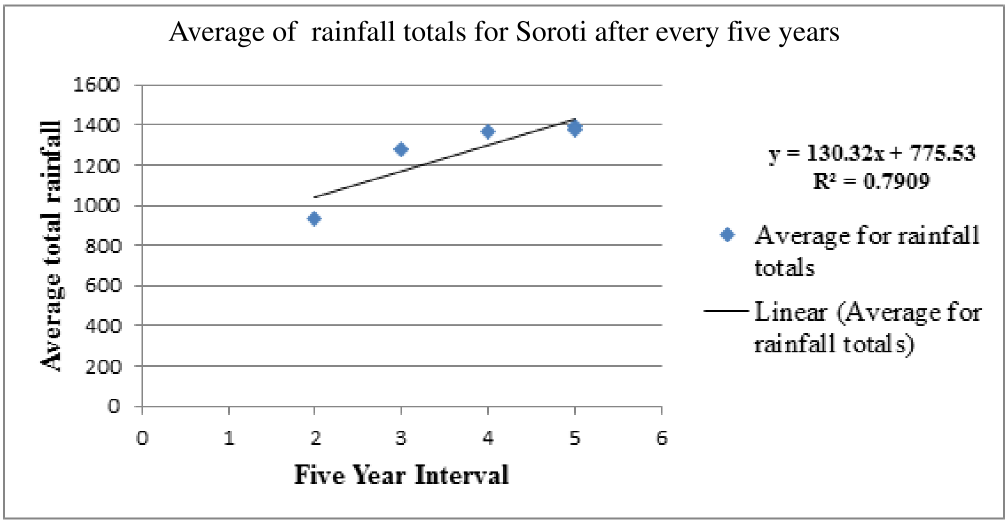

Figure 4. Regression analysis results for annual rainfall totals for Soroti district

To further justify the significance in the change in rainfall over the given years, a regression analysis was done for both Masaka and Soroti. Averages for the annual rainfall totals were computed for every five years after which a regression analysis test was done to compare the means. The regression results (Fig. 3) for Masaka shows $R^2 = 0.026$, indicating that rainfall was fairly increasing but this was not statistically significant at ($P = 0.73$).

For Ngora, regression results (Fig. 4) showed that at $R^2 = 0.7909$ implying that the rainfall was relatively declining and this was also statistically significant ($P = 0.043$). These results justify the farmers' perception that there had been climate change using the rainfall parameter.

Adaptation strategies identified in the study areas. Strategies implemented in the region were identified in response to the given weather extreme to which the farmers were responding to (Figure 6) and these included:

1. Soil fertility management. This was used to improve the fertility of the soil so as to enhance growth of crops especially during the dry season. The major raw materials used to maintain soil fertility included animal manure, composite manure locally known as "nakavundira", ash from charcoal, kitchen waste, animal waste, as well as dry and wet grass.

2. Soil and water conservation. Some of the conservation techniques employed by the farmers included mulching, intercropping, crop rotation, and digging trenches around the farm. This conservation technique is often done to avoid some of the challenges faced during extreme weather conditions such as soil erosion.

3. Water harvesting and drip irrigation technique. This technology involved harvesting water from the house roof tops using pipes and storing in an underground tank which on average held 10,000-30,000 litres. This water was sufficient to cater for a family of four household members, keeping one cow and providing drip irrigation for 0.01 ha of vegetable crop for 3-4 months during the dry season.

4. Planting of drought tolerant forages. This was practical to ensure availability of high quality feeds for dairy cattle particularly during the dry seasons when there was shortage of fodder. There were pastures grown by the farmers which were considered resistant to drought. The most common drought tolerant forage identified was Napier grass fodder. Other types of forages grown included pasture grasses such as *Bracharia-mulato*

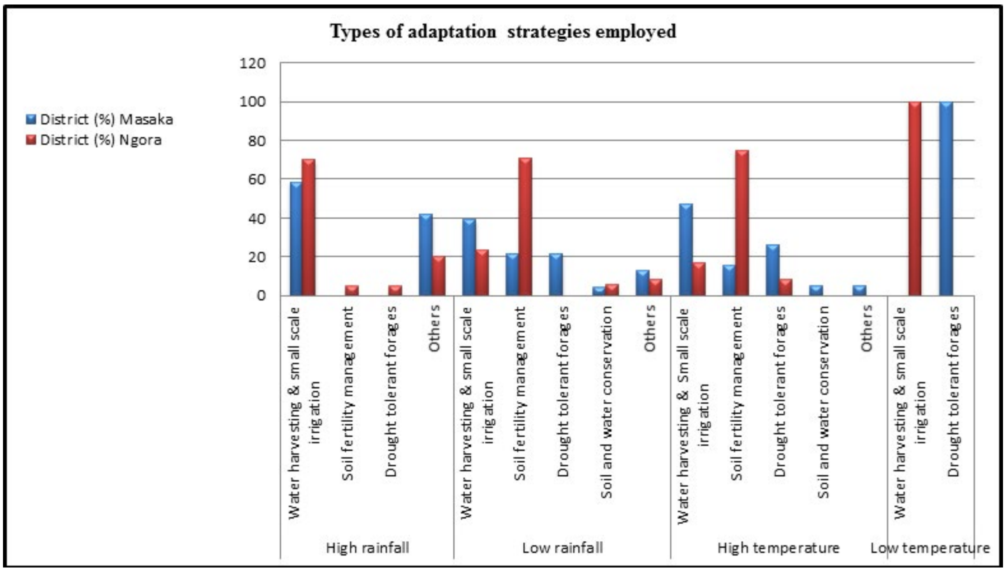

Figure 5. Implemented climate change adaptation strategies in Masaka and Ngora districts of Uganda

Table 1. Summary of identified missing climate change adaptation strategies in Ngora and Masaka districts

Country	Adaptation strategies implemented
Ethiopia	• Large scale pasture conservation • Use of early warning systems • Implementation of awareness-creation programs regarding the effects of greenhouse gas emissions, the natural environment and climate change • Introduction of agro forestry systems to plant multi-use trees which can be used to produce animal feed, conserve soil, and produce fruits for human consumption
Kenya	• Use of green houses for vegetable growing • Access to credit by smallholder famers for adoption of adaptation technologies

Sources: {Ngigi, 2009; Makau, 2010; Nabikolo, 2012}

and *Panicum maximum*; leguminous forages such as *Lablab, Stylo, Desmodium, Centro, Calliandra* and *Grilicida* especially in Masaka.

The above mentioned strategies were also implemented by smallholder mixed farmers in Kenya and Tanzania. Other non-direct adaptation measures identified included; labour saving technologies such as use of fixed knife grass chopping machines and water treadle pumps, planting trees, fetching water from spring wells, buying water during the dry season, and looking for pastures from far places during periods of scarcity among others.

Missing climate change adaptation strategies. Analogue tool was used to find out which regions around Africa had the same climatic conditions as those in Ngora and Masaka. Ethiopia and Kenya were observed as the regions that had a high co-relation. A literature review was done to find out which adaptation strategies were practiced in these regions but missing in the study areas and yet relevant in enhancing the farmers' resilience to climate change as summarized in Table 2.

Conclusions and policy implications

The findings of the study indicated that farmers' observations on climate change were consistent with results obtained from the meteorological climatic data and that farmers had adapted to this change in climate by using a number of adaptation strategies. However, there were climate change adoption strategies employed in Ethiopia and Keniya which were not practiced in the two study areas of Uganda. Implementers of climate change adaptation projects should therefore encourage or support smallholder farmers to take on the identified missing adaptation strategies where applicable so as to improve on their resilience to climate change. Analogue tool can also be used to identify other practices in other regions in and outside Uganda that have similar climatic conditions and identify their climate change adaptation strategies missing in the areas of interest, and then implement them where necessary and applicable.

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