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Farmers' risk perceptions and adaptation to climate change in Lichinga and Sussundenga, Mozambique

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In Africa, climate change exerts significant pressure on the agricultural sector. Current changes in climate for most parts of Mozambique have resulted in increased frequency of droughts, dry spells and uncertain rainfall. This has resulted in loss of food production and smallholder farmers are most vulnerable to these climatic disasters as they affect the food security status of the household. Despite an increased number of country level case studies, knowledge gaps continue to exist at the level of impact analysis. In addition, while adaptation and coping strategies with climate change and variability have become key themes in current global climate discussions and policy initiatives, literature on adaptation in Mozambique appears to be limited. The objective of this study was to assess the perception of smallholder farmers to climate change and adaptation strategies in Lichinga and Sussundenga districts of Mozambique. Using data obtained from a survey carried out in Lichinga and Sussundenga districts in Mozambique descriptive statistics analysis was undertaken using SPSS software to characterize the households, in terms of perceptions and coping strategies of the household to climate change. The farmers from both districts sited rainfall variability and higher temperatures to have severely affected maize production. Due to the late onset of rains, in Lichinga the planting period has changed from November (47.5%) to December (70%) while in Sussundenga the planting period has changed from September/October (40%) to November (62.5%). The rain seasons have become shorter and dry seasons are longer. Some farmers have switched from growing maize to growing drought tolerant crops, such as cassava, sweet potato and cultivation of horticultural crops in wetlands as strategies to cope with the climate change.

Key words: Climate variability, farmer's perceptions, adaptation strategies.

INTRODUCTION

Climate variability and droughts are already important stress factors in Africa, where rural households have adapted to such factors for decades (Mortimore and Adams, 2001). Historical data shows that the continent is already undergoing climate change. The continent is becoming warmer and drier. Rainfall is becoming less predictable. In Mali, Lacy et al. (2006) revealed a tendency for a shortening of the rainy season to induce farmers to shift some of their sorghum production to a variety with a shorter cycle than the traditional one. In a

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study from Burkina Faso, Nielsen and Reenberg (2010) found rainfed cereal production to be declining due to a change in climate and a shift towards a higher level of dependence on migration, livestock, small scale commerce and gardens. In the Sub-Saharan El Niño rains cause floods and destruction, while in the recent years droughts have also had catastrophic impacts (Nielsen and Reenberg, 2010). Recent events, such as the poor rains in Southern Africa 2001 and 2003, demonstrate that communities may already be suffering the consequences of less predictable weather patterns (Wiggins, 2005).

As the poorest country in Southern Africa, a region that is projected to become substantially hotter and drier, Mozambique is likely to feel the impacts of climate change more than most (Ehrhart and Twena, 2006). The most striking impacts of climate change over south-eastern Africa are expected to be an increase in the frequency and severity of extreme events such as droughts, floods, and cyclones Ribeiro and Chaúque (2010).

Climate variability directly affects agricultural production since agriculture is inherently sensitive to climatic conditions and is one of the most vulnerable sectors to the risks and impacts of global climate change. Climate change will affect food security by reducing livelihood productivity and opportunities. The impacts will be mostly negative in Mozambique (Ehrhart and Twena, 2006). Research by the Government of Mozambique suggests that mean air temperatures will raise by at least 1.8 to 3.2°C nationwide by 2075 (MICOA, 2007). Precipitation is predicted to fall by 2 to 9%, which will take greatest effect between November and May. As this coincides with the growing season, it will have an especially pronounced impact on crop yields (Ehrhart and Twena, 2006). Harvest failure and incidents of food insecurity in Africa have become regular events occurring at least once or twice every decade (Eriksen, 2005).

Most countries in Sub-Saharan Africa (SSA) rely heavily on agriculture for employment and food security for their economies. The sector also has large numbers of smallholder farmers, most of who produce under unfavourable conditions characterized by low and erratic rainfall and poor soils (Mutsvangwa, 2011).

Most households succeed in protecting their short term consumption from the full effects of income shocks, but in the long term these shocks have consequences for low income households, which are forced to reduce their investment in children's health and schooling, or sell productive assets in order to maintain consumption (Trærup, 2010). Over time, rural households develop a range of coping strategies as a buffer against uncertainties in their rural production induced by annual variations in rainfall combined with socio-economic drivers of change (Cooper et al., 2008). Coping strategies may be preventive strategies such as altering planting dates, introducing other crops and making investments of water equipment, or may be in-season adjustments in the form of management responses (Trærup, 2010). Farmers can adapt to climate change by modifying the set of crops planted and their agronomic practices (Blanc, 2011). The latter most often include consumption smoothing, the sale of assets such as livestock, remittances from family members outside the household and income from casual employment (Niimi et al., 2009; Kinsey et al., 1998).

While extensive research on the impacts of climate change has tended to focus on impacts on country level, less effort has been directed at household level in developing countries, and little has been done on the farmer risk perception and adaptation. There is thus need to investigate the farmer risk perception and adaptation to climate change on agriculture in Mozambique, at the household level, considering that agriculture remains the backbone of the country's economy. This study seeks to contribute to the body of research on climate change by investigating the vulnerability of smallholder farmers in Mozambique.

METHODOLOGY

Study sites

The study was conducted at Lichinga and Sussundenga Research Stations in Mozambique. Mozambique´s economy is essentially agricultural; its agriculture is predominantly subsistence, characterized by low levels of production and productivity. In 2009, it contributed 24% of GDP (INE). In addition, the sector employs 90% of the country's female labour force and 70% of the male labour force. This means that 80% of the active population is employed in the agriculture sector.

Lichinga Research Station is located in Lichinga district to the west of the Niassa province and lies 12° 30′ to 13° 27′ S; 34°50' to 35°30' E. The site receives unimodal rainfall between November and April ranging from 900 to 2000 mm per annum. The temperature ranges from 16.1°C to 32.9°C with an annual average of 22.9°C (MAE, 2005a). The agricultural production is predominantly rain fed (MAE, 2005a). The soils are ferralsols according to FAO (2006) soil classification system. The soils are red in colour with compacted structure (Geurts and Tembe, 1997). The soil fertility is poor with CEC of 27.80 cmol kg^{-1}, low base saturation ranging from 1.75 to 9.63 cmol kg^{-1} and soil organic matter of 6.78%. These soils are deficient in nitrogen (0.69%) but have high level of phosphorus (1750 ppm).

Sussundenga Agrarian Research Station is located in Manica province, Central Mozambique and lies 19° 20′ S; 33° 14′ E, with an altitude of 620 m. The area has a unimodal rainfall occurring between November and April with average annual rainfall of 1,155 mm (MAE, 2005b). The average minimum temperature is 9.5°C in the month of July and average maximum is 29.1ºC in the month of January (Famba, 2011), giving an annual average of 23.0°C (MAE, 2005b). The agricultural production is predominantly rain fed (MAE, 2005b). The soils consist of ferralsols, lixisols and acrisols (FAO, 2006). The soil fertility is poor with CEC of 25.80 cmol kg^{-1}, low base saturation ranging from 0.18 to 0.88 cmol kg^{-1} and soil organic matter content of 7.70%. These soils are deficient in nitrogen (0.78%) but have high phosphorus (1875 ppm) content.

Data collection procedures

A survey was conducted in Lichinga and Sussundenga districts of Mozambique and two villages were randomly sampled from each of

Table 1. Farmers' awareness of climate change over the last 10 years.

District	Rainfall		Temperature	Unusual weather conditions experienced		Noted changes	
	Changed (%)	Unchanged (%)	Changed (Hot) (%)	Drought (%)	Heavy rains (%)	Longer rain periods (%)	Shorter rain periods (%)
Lichinga	87.5	12.5	100	0	40	42.5	57.5
Sussundenga	90	10	100	45	0	0	100

N = 40 each district.

the selected Districts. The study sites are located within 20 km radius of Lichinga and Sussundenga research stations. The objective of the survey was to evaluate the farmers' risk perception and adaptation to climate change. The survey was carried out at Lichinga District from 16 to 17 February and at Sussundenga from 20 to 21 February, 2012 using questionnaire with open-ended and closed questions. The survey included face-to-face interviews of 80 farmers. Forty (40) farmers were selected in each district of which 20 came from one village. Selection of respondents was based on farmer's willingness to participate in the research. During the data collection process, the participants were told the objective of the study as well as its confidentiality. Interviews were done at farmers' homesteads. Respondents were household heads and in their absence, any member of the household was interviewed. In each district, a lead farmer was identified, contacted and met to make arrangements to meet other farmers and an interpreter was used where necessary.

The first phase of the survey was to collect data to assess the factors influencing farmers' decisions making on fertilizer use. Besides general household information, the questionnaire contained modules on agricultural productivity, types of organic and inorganic fertilizer use. Data on cropping systems, land use and maize production was also collected.

The second phase of the survey was to collect data to evaluate the farmers' risk perception and adaptation to climate change. In order to understand how farmers perceive climate risk events data on weather/climate change, weather event severity, weather event effects, indicators of change in crops operation and coping strategies was collected.

The data were analysed using the Statistical Package for Social Sciences (SPSS) version 16 (SPSS 16.0 for Windows, Release 16.0.0.2007. Chicago: SPSS Inc). Descriptive statistics, means, frequencies, percentages and cross tabulations were used to present the outcome of the research.

RESULTS AND DISCUSSION

Perception about climate change

Results in Table 1 show that 87.5% of respondents in Lichinga and 90% in Sussundenga were aware of climate variability and change. Farmers reported to have noticed significant changes in rainfall and temperature over the past ten years. The higher likelihood of insights on climate change with increasing age of the head of the household is associated with experience which lets farmers observe changes over time and compare such changes with current climatic conditions. Maddison (2006) reported farmer perception of climate change through noticing an increase in temperature and a decrease in precipitation. Similar results have been reported by Nhemachena and Hassan (2007) and Mubaya et al. (2008) who reported that majority of farmers across Southern Africa perceive warming and drying of climate and low unpredictable rainfall as indicators of climate change. Studies by McSweeney et al. (2012), Queface and Tadross (2009) and INGC (2009) indicated that in Mozambique the mean annual temperature have increased by 0.6°C and the mean annual rainfall decreased at an average rate of 2.5 mm per month between 1960 and 2006.

The results also showed that 40% of respondents in Lichinga have noticed heavy rains while 45% of respondents in Sussundenga have noticed drought in the last 10 years. 57.5 and 100% of respondents in Lichinga and Sussundenga respectively, believe that there is shift in the beginning of the rain season in both short and long rain seasons. Rains that would normally start in October and stretch up to April are now starting late in November and in most cases ending in February as indicated in Table 2. These results are supported by Usman and Reason (2004), who reported that in different parts of Southern Africa countries a significant increase in the number of heavy rainfall events have been observed and that MICOA (2007) and INGCC (2009), noted that farmers in the Central zone of Mozambique (Sussundenga) are the most likely to experience increased risk of droughts. A study by Ribeiro and Chaúque (2010) in Mozambique, revealed that farmers faced prolonged drought over the last few years causing a decrease in agricultural productivity.

The findings of this study showed that 40% of small holder farmers in the past ten years used to plant in November and but presently over 63% of farmers plant in November. This increase may be explained by the shift in the start of the rain season from October to November. These results are in agreement with those of Mary and Majule (2009) and Mortimore and Adams (2001) who found that the onset of rainfall has shifted from October to November.

Adaptation to climate change

Results in Table 3 show that coping strategies to climate

Table 2. Changes in planting dates in the last 10 years in percentage.

District	Farm operations dates changed (%)		Planting date for maize 10 years ago (%)				Planting date for maize now (%)			
	Yes	No	September	October	November	December	September	October	November	December
Lichinga	90	10	0	22.5	47.5	30	0	7.5	22.5	70
Sussundenga	75	25	5	30	40	25	2.5	12.5	62.5	22.5

N = 40 each district.

Table 3. Mitigation strategies to climate change effects.

District	Mitigation strategies (%)			Mitigations crops (%)		
	Change crop variety	Kitchen garden	Off farm job	Cassava and sweet potato	Cabbage, Onion and Tomatoes	Adopting improved maize variety
Lichinga	15	75	10	47.5	2.5	10
Sussundenga	35	32.5	32.5	65	5	17.5

N = 40 each district.

change employed by most households include change of crop variety, kitchen gardening and seeking for off farm job. With increased frequency of droughts the results showed that changing crops varieties was a strategy in which 15 and 35% of respondents in Lichinga and Sussundenga were using by growing drought tolerant crops. These results are similar to those of Mutsvangwa (2009), who indicated planting drought tolerant crops as the most common adaptive strategy among Gweru and Lupane districts in Zimbabwe. In Lichinga 47.5 and 65% in Sussundenga of the respondents were planting cassava and sweet potato. However in Lichinga 90% of respondents and 82.5% in Sussundenga reported not to be using drought tolerant maize variety. This result are similar to those of Cavane (2011), who reported that improved maize varieties, whose traits have been selected for drought tolerant, were not yet widely adopted. International Fertilizer Development Center (2012) reported that in Mozambique only five percent of smallholders use improved seed varieties. The results confirms with those reported in Zambia by Mubaya et al. (2008) that farmers do crop diversification to cope with low rainfall.

The results also indicated that 75% farmers in Lichinga and 32.5% of respondents in Sussundenga are engaged in kitchen gardening. Kitchen gardening is also intensified in both districts and this could be due to the fact that farmers take advantage of the fact that wetlands remain charged for a long time after the rains and they therefore grow crops throughout the year. This finding are consistent with studies by (Mubaya et al., 2008), which indicate kitchen gardening is a strategy adopted in Zambia and Mozambique to cope with climate change. The study indicated that farmers in Lichinga (10%) and Sussundenga (32.5%) in times of low rainfall concentrated more on off farm activities. Ziervogel and Taylor (2008) and Maddison (2007) indicated that due to low rainfall, farmers have moved towards non farming activities. The workers mentioned that off farm activities were considered to contribute significantly to the income of rural households.

The results also indicated that 47.5% farmers in Lichinga and 65% of respondents in Sussundenga are cultivating cassava and sweet potato as mitigation crop to cope with climate change effects. The study also showed the use of horticultural crops such as cabbage, onions and tomatoes as mitigations crops. Studies by Aggarwal et al. (2004); Easterling et al. (2007) and Maddison (2007), suggested that changes in temperature and precipitation call for changes in crop varieties more adapted to mitigate the effects of climate. Study done in Ghana by Acquah (2011), showed that farmers were using different crop varieties as major methods to cope with climate change. The respondents in Lichinga (10%) and Sussundenga (17.5%) reported not using improved variety such as resistant to drought due to high cost of seeds purchase. Enete and Achike (2008) and Cavane (2011) indicated that undercapitalized farmers fail to adopt the required level of agricultural technologies that will ensure profitable return.

CONCLUSION AND RECOMMENDATION

This study established that rainfall and temperature in study area has been decreasing and increasing, respectively, thus negatively affecting the production and management of crops. Different forms of changes on rainfall have been identified including shrinking of rain seasons due to late onset of rainfall period shifting from October to November or even December. A combination of strategies to adapt; such as proper timing of agricultural operations, crop diversification, use of different crop and diversifying from farm to non–farm activities were applied.

Consequently the following recommendations have been proposed on the basis of the study:

i) Farmers should be encouraged and enabled to use crop diversification as adaptation coping strategy to guard against crop failure in times of adverse climatic conditions.
ii) All effective adaptation options that farmers have applied in the study area should be widely disseminated to others farmers.

Conflict of Interest

The authors have not declared any conflict of interest.

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