Adapting to climate change through land and water management in Eastern Africa

Results of pilot projects in Ethiopia, Kenya and Tanzania

Tanzania

Strengthening the capacity for climate change adaptation through sustainable land and water management in Kiroka village, Morogoro, Tanzania

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Introduction

Over the last four decades, Tanzania has been hit by a series of severe droughts and flood events (Kandji *et al.*, 2006; Tumbo *et al.*, 2011). These are undeniably part of the impacts of increasing weather variability and climate change, which are already affecting ecosystems, biodiversity and people all over the world. The observed increase in variability in most countries and especially Tanzania has increased the uncertainty in seasonal rainfall prediction. Increasing weather variability and climate change are therefore increasing the need for actions to overcome the challenges and provide accurate and reliable weather and climate predictions that will enable the agricultural sector not only ensure food security of the majority of the population but also help them get out of poverty, which is in line with Tanzania's Vision 2025 and Kilimo Kwanza Policy (URT, 2010).

Agriculture is the leading sector in Tanzanian economy in terms of its contribution to real gross domestic product (GDP) (URT, 2001). The livelihoods of the majority of the population (about 80%) are heavily dependent on the agricultural sector (URT, 2001). Agriculture in Tanzania is mostly rainfed and thus the success of activities in the sector remains highly sensitive to weather, especially rainfall. Many places in Tanzania receive less rainfall than the crop water requirements (only about half of the country receives over 750 mm of rainfall per annum with 80% probability). Climate change adaptations in river basin systems rely to a great extent on encouraging upstream and downstream farmers to be partners in river basin management. Knowledge and practice to improve upstream and downstream management is available and needs to be implemented systematically. It is

therefore important to strengthen the capacity for farmers at the catchment (upstream) and irrigation scheme (downstream) for climate change adaptation through enhancing land and water management, increasing agricultural productivity and encouraging farmers to diversify their livelihoods. It is on this basis that the project 'Strengthening the Capacity for Climate Change Adaptation through Sustainable Land and Water Management in Kiroka Village, Morogoro' (see location map, Part 1 Figure 1) was initiated.

There is a considerable potential for both rainfed and irrigated agriculture in Kiroka village and the surrounding areas. In the lowlands, the soils have good water holding capacity and remain moist for a long period during the dry season. There is also abundant water supply, good road access, markets (Morogoro and Dar es Salaam) are close and there is high market demand. Despite this, potential, land degradation (soil erosion, loss of soil fertility and bush fires) is widespread in the highlands. One of the main reasons is poor land husbandry exacerbated by increasing weather variability and climate change. Furthermore, during the dry season, there is water shortage due to poor management of water sources. However, during the rainy season, flooding is experienced in the lowlands, causing damage to property and crops.

Appropriate, effective and informed decision making are required to allow people to organize their activities (both short- and long-term) for effective climate change adaptation.

Objective

The overall objective of the project is to: 'Reduce the impact of climate change and variability on smallholder farmers through sustainable land and water management and thereby contribute to improved agricultural productivity, livelihood and ecosystem resilience in Kiroka village, Morogoro'.

In order to appreciate the level of stakeholders understanding on issues of climate change, a baseline study was carried out with the following specific objectives:

- To understand the community awareness and perception on climate change.
- To assess the climate related risks and hazards facing the communities in the study area.
- To analyse gross margins for food and livestock and the major challenges facing the production.

- To assess soil conservation measures practiced by the communities in the study area.
- To identify adaptation options practiced by farmers in the study area in response to the changes in climate.

Methodology

Study Area

The study was conducted in Kiroka village in Morogoro District in September, 2012. Specifically the survey was carried-out in six hamlets in Kiroka (Mahembe, Mwaya, Kimangakenge, Temekelo, Msamvu and Kingobwe). Kiroka village lies between 6° 25'S and 6° 30'S and 37° 30'E and 37° 35'E, at an altitude of 887 masl along the lower reaches of Mahembe Mwaya and Kiroka River valleys in Morogoro District (see Figure 1). Access to the project area is 35 km from Morogoro town, along the murram road. The area experiences a humid climate, receiving an average of 1,100 mm of rainfall per annum (May-Oct 650 mm/Feb-March 450 mm) (URT, 2001).

Data Collection and Analysis

Data collection involved structured interviews using a questionnaire, checklist, key informant interviews and focus group discussions. Data collected during the questionnaire survey was analyzed and synthesized using the SPSS, then results calculated. Information collected from the key informants and focused group discussions was grouped together and synthesized according to the checklist questions, then the information summarized for easier interpretation.

Results and Discussion

General Information

A total of 112 respondents were interviewed using a structured questionnaire. Respondents were asked whether they were indigenous in Kiroka village. Results show that majority of the respondents were from Mahembe, while only few were from Kimangakenge. The results showed that 72 (64%) of respondents were native and born in Kiroka village, while 40 (36%) had migrated to Kiroka village. Some of the reasons that led to their migration and resided in Kiroka villages included marriage (27%), accompanied parents (24%), farming (24%) and employment transfer (7%).

The interviews were conducted with 73 (65%) male respondents and 39 (35%) female. The majority of the respondents 88 (79%) had received primary education, while 15 (13%) did not attend any formal education. However, only one person had received a certificate level of education. Results show that majority of the respondents 89 (80%) were married, 14 (13 %) were widows/widowers while only 9 (8%) respondents were single. Household member adults ranging between the ages of 35-60 years were a dominant group with an average age of 42 years, thus the majority of Kiroka farmers were within the working age group.

The main source of income was generated from crop sales (107 (96%) of respondents) while 5 (5%) of respondents said they generated their incomes from off-farm activities. Some of the off-farm activities were teaching, selling timber and charcoal, petty business and retailing. Respondents were asked to list their main occupations, and results show that majority of the respondents 108 (96%) were farmers, and only 3 were businessmen while only 1 respondent was a government official.

Community Awareness and Perception on Climate Change

Generally, results indicated that the majority of the respondents (107 (95.5%)) were aware of the changes in climate. However, 2 respondents reported to be unaware while 3 claimed not to know anything about climate or any changes related to it. While 94 respondents (84%) reported to have observed the changes themselves, radio was the most used media (9%) to find weather and climate information. Other weather- and climate-related information sources widely used by farmers were village meetings (3%), newspapers (2%), and researchers (2%). The least used sources of weather and climate information were television, NGO's, Tanzania Meteorological Agency and input suppliers. There is room to improve sources such as NGOs and input suppliers in weather and climate information dissemination. The majority of respondents (82 (73%)) were fairly well informed on weather variability and climate change, while only 21 respondents (19%) claimed to be very well informed on increasing weather variability and climate change. However, 9 respondents (8%) had not received any information on increasing weather variability and climate change.

Notably, results show a remarkable observation that almost 76 respondents (68%) reported to have heard of or experienced the changes in climate only recently, compared to 36 (32%) who reported having heard or experienced the changes in weather and climate five to nine years ago. A possible reason for this observation could be that the majority of the interviewed respondents were not elderly, who particularly track the changes in their local area's climate.

In general, climate change was perceived to be a bad thing as reported by 109 respondents (97%). Reasons behind these observations could be due to the fact that they have seen climate change cause unpredictable and unreliable rainfall, resulting in droughts and sometimes floods, which in turn have led to crop failure, poor yield, loss of income, hunger, damage to property and life. Respondents also recalled and said that twenty years ago in their village, when rains were reliable, they used to grow all sorts of cultivars of fruits and crops with no crop diseases. However, 3 of the 112 respondents perceived climate change to be a good thing. For instance, farmers with access to irrigated agriculture may not feel seasonal drought to be a bad thing contrary to the experience of farmers without access to irrigation (perhaps due to location). Moreover, the perceived severity of the negative impacts caused by climate change underlies the knowledge on awareness and understanding of the term climate change and its related risks, as well as the ability of farmers to cope with the hazard(s) he/she is exposed to.

Climate Related Risks and Hazards in the Community

Occurrence and severity of climate extremes

According to respondents' opinions, the nine major weather / climate extremes / impacts presented in Table 1 are occurring more frequently over the past 6 years in the study area. Drought appears to have occurred most frequently (85%) compared to other climate extremes, followed by crop insect pests (85%). Extreme cold was the least reported to have occurred in the study area (31% of respondents).

Perceptions of climate change as risk

The majority of the respondents (102 - 88%) reported drought as a major risk. This is supported by the fact that drought has seemed to have occurred most frequently compared to the other weather extremes. Moreover, crop insects and pests have also been observed to be among the main risks in the community. This is evidently supported by 95 respondents (85%) who reported to have been highly affected (i.e. crop yields reduced due to insect and pest outbreaks). Surprisingly, high temperatures were not mentioned as a problem by many respondents (only 35 - 31%), despite the fact that drought prevails in the project area.

Severity and concern of climate extremes

The perceived severity of weather extremes and changing climate underlie the ability of a farmer to cope with a hazard he or she is exposed to. Therefore, the

Table 1: Occurrence of extreme climatic events in Kiroka village

Climate extreme	Reported Occurrence of the extremes	
	Frequency	%
Drought	99	88
Floods/excessive rain	94	84
Stormy rainfall	62	55
High temperature	45	40
Extreme cold	35	31
Crop insect pests	95	85
Livestock insect pests	66	59
Human disease epidemics	69	62
Other diseases epidemics	39	35

pattern of the perceived severity of extremes can change, with an increase in the ability of a farmer to cope with such climate hazards. Adaptation to risks is next to perception and attitude processes - after the farmer has experienced or anticipated the threshold of risk damage and become determined to react. However, due to the dynamism of risks and contexts, such adaptive strategies are not always understood, because they never remain static over time and space for the same individual or among individuals. In this study, the results show that drought and crop insects and pests were cited to be the most severe by farmers. It was also reported that the severity of the seasonal drought had an effect on food production in the area, due to the fact that drought leads to decreased yields of crops as compared to previous non-drought years.

For any farmer who is deprived of the means to manage a certain climate hazard is likely to feel concerned about the hazard. Results in Table 2 indicate that many respondents were concerned about weather and related extremes compared with those who were not. About a quarter of all respondents were extremely concerned about seasonal drought, also crop and livestock insect pests. Seasonal drought is an extreme concern for both farmers and livestock keepers, since drought decimates crop and livestock production.

Overall, 92 respondents (82%) reported being affected by the impacts of climate change. It was apparent that the most prominent negative impacts of climate change were unreliable rainfall (unclear onset and ending of rains), reduced crop yields (food shortage), reduced income, destruction of crops due to floods, pests and diseases and sometimes death.

Table 2: Concern of climate and weather extremes to farmers

Climate extreme	How concerned (%)		
	Unconcerned	Concerned	Extremely concerned
Drought	39	48	13
Floods	5	41	54
Stormy rainfall	41	54	5
High temperature	59	39	2
Extreme cold	35	65	0
Crop insect pests	7	47	46
Livestock insect pests	12	68	21
Human disease epidemics	37	61	3
Other diseases epidemics	34	66	0

Food and Livestock Gross Margins and the Challenges facing Production

Gross margins for crops and livestock production

Gross margin (GM) is a technique that is used to establish economic profitability. GM is defined as the difference between gross income accrued and variable costs incurred. The analysis is therefore a simplified tool, but in many cases it is a sufficiently powerful tool for economic analysis (Makeham *et al.*, 1986). The GM enables one to directly compare the relative profitability of similar enterprises and consequently provide a starting point to decide or alter a farm's overall enterprise mix. It is important to compare GMs of different participants in the same line of investment, in order to know who are able to pursue their economic activities sustainably. Therefore, the GMs for both crop and livestock production are presented in Table 3. The results show the GMs for farmers and livestock keepers were 10,929 Tshs/kg (21%) and 37,235 Tsh/kg (27.6%) respectively. The GM for farmers was the lower (21%) compared to that of livestock keepers. This could be due to the fact that majority of farmers sold their produce at lower prices and they faced a number of environmental and production challenges, the most critical being high production costs as compared to the livestock keepers. In addition, crop production as a sector is seen to be the most vulnerable sector in the context of changing climate compared to livestock production. This shows that farmers are still not benefiting from crop production, due to the lower returns.

Table 3: Gross margins for crops and livestock production

Sector	Description	Sales/Costs (Tshs)	Percent (%)
Crop production	Average revenue (Tshs)	51,249	
	Less		
	Average costs (Tshs)	40,320	
	AGM	**10,929**	**21%**
Livestock production	Average revenue (Tshs)	134,897	
	Less		
	Average costs (Tshs)	97,662	
	AGM	**37,235**	**27.6%**

Note: AGM=Average Gross Margin and is given in Tshs/kg

Constraints to crop and livestock production

The constraints facing crop and livestock production in the target villages are shown in Table 4. Higher costs during production activities and insufficient modern agronomic practices were widely reported as constraints limiting crop production while floods, unavailability of inorganic fertilizer and improved seeds were the least reported constraints. Inadequate extension services were also mentioned as constraints to crop production, as well as prolonged drought (unreliable rainfall). Livestock activities seem to be highly constrained due to lack of availability of pasture, livestock diseases and unavailability of veterinary drugs.

Assets and Energy Security

Assets

Assets ownership is summarized in Table 5. As presented, the majority of respondents (107 - 96%) owned hand hoes. A radio was also owned by the majority (84 - 75%), an indication that it is the most used media to access all sorts of information, including on issues concerning climate change. Assets ownership could be one of the indicators of levels of vulnerabilities and adaptive capacities to the impacts of climate change. Results also indicate that 39 (35%) of the respondents had consolidated mud walls with iron sheet roofing while 73 (65%) said their houses were made up of simple mud walls with thatched roofing (Table 6).

Energy security

Tanzania has a good range of energy sources including solar, wind, biogas, coal reserves, natural gas, hydropower, biofuel, wood fuel and geothermal power.

Table 4: Constraints to crop and livestock production in a changing climate

Sector constraints	Frequency	Percentage (%)
Crop production		
Floods	4	5.2
Insufficient modern agronomic skills	64	83.1
Unavailability of inorganic fertilizer	6	7.8
Unavailability of improved seeds	6	7.8
Inadequate extension services	52	67.5
Crops pests and diseases	40	52
Prolonged drought/unreliable rainfall	29	37.6
High production costs	73	94.8
Livestock production		
Unavailability of pasture	56	72.7
Livestock diseases	51	66.2
Inadequate extension services	29	37.7
Unavailability of veterinary drugs	40	52
Wild animals and theft	6	7.8

Note: The basic question was whether a certain constraint was a serious constraint to production

Table 5: Assets Ownership

Assets	Ownership	
	Frequency	Percentage (%)
Car	1	0.9
Motorcycle	5	4.5
Bicycle	31	27.7
Television	4	3.6
Satellite dish	0	0
Radio	84	75
Mobile	84	75
Plough	4	3.6
Tractor	0	0
Hand hoe	107	95.5
Axes	92	82.1

Table 6: House structure

House structure	Frequency	Percentage (%)
Brick walls tiled with iron sheet roofing	0	0
Consolidated mud walls with iron sheet roofing	39	34.8
Simple mud walls with thatched roofing	73	65.2
Total	**112**	**100**

Respondents were asked to rank the main energy sources widely used in their villages and the results show that, of all sources, wood fuel was the most commonly exploited (91%), followed by kerosene (62%) and charcoal (58%). This could be explained by the fact that firewood is considered both cheap and accessible to the poor in the majority of both rural and urban areas. However, this practice has negative impacts on the environment, as it accelerates deforestation and drying out of streams. Due to the reported recent increase in frequency and duration of droughts, water flows in most of the rivers in the area of Kiroka such as Mahembe, Mwaya, and Ndege have progressively been declining in recent years as reported by many respondents.

Weather extremes such as drought are most frequently considered to have occurred in the study area mainly as a result of prolonged deforestation practiced by the community members for the purpose of getting firewood.

Soil Conservation Practices, Water Sources and Woodlots Ownership

Soil Conservation Practices

The survey results showed that 89% of farmers in Kiroka village reported that there was a great demand for conserving soil and water in their village, while only 11% disagreed. Farmers suggested practices such as afforestation, provision of training on environmental conservation, avoiding bush fires, avoiding farming along water courses should be done in order to conserve soils. Moreover, they said that laws ensuring environmental conservation should be strictly enforced and penalties should be given to people who break them.

A number of factors that contributed to soil degradation were mentioned by land users, including bad agronomic practices, deforestation and removal of vegetation cover. The majority (55%) of the interviewed farmers reported to have faced

soil degradation in their villages while the remaining 50 (45%) said they did not face soil degradation. Some farmers used contour ridges as a strategy to minimize soil erosion, in order to encourage better root penetration and enhance moisture conservation. The most common factors that caused soil degradation in the study area were the removal of soil nutrients mainly through harvests and burning of crop residues (poor agronomic practices). Cultivating on very steep slopes without any conservation measure could be another factor (Figure 1).

Figure 1: Cultivation on steep slopes around Kiroka village without conservation measures

Photo: © Henry Mahoo

Linked to climate change, drought might have also contributed to low soil productivity as it tends to reduce water in the soil, consequently affecting nutrient mineralization and their availability to crops. On the other hand, increasing temperature might also contribute to rapid decomposition of organic matter and thus accelerate nutrient loss through production of carbon dioxide (CO_2) (Mkeni, 1992).

In response to these situations, farmers were asked to explain the measures they were using to reduce degradation of soils in their areas. As shown in Table 7, about half of the respondents said they did not practice any measures to solve the problem. This response brings an alarming signal to the environmentalists and soil and water experts, as it indicates many of Kiroka farmers take no action to curb soil degradation. However, 65 respondents (58%) reported that all measures that are undertaken do not reduce the risks associated with soil degradation.

Water sources

Water has become increasingly scarce locally due to the demands placed upon it. The opportunity cost of Tanzania's raw water is increasing, especially in many of the areas considered to have irrigation development potential. The use of water for productive purposes which include irrigation is seen as an essential requirement for poverty alleviation and food security. According to the survey results , 95 (82%) of the respondents reported that they have water sources in their areas. Some of the main water sources found in the study area as mentioned by farmers were Mahembe River (34%), Kiroka River (15%), Temekelo River (13%), Mwaya River (12%),

Table 7: House structure

Soil conservation measures	Frequency	Percentage (%)
Afforestation	39	35
Contour farming	4	4
Conserve water sources	1	1
Mulching	2	2
Planting vegetation cover	3	3
Use of traditional terraces	4	4
Do not practice any measure	59	53
Total	**112**	**100**

Bamba River (11%), Ndege River (9%), Kimangakenge River (5%) and Kisogoso River (2%). Respondents were asked to report the benefits they have received from the mentioned water sources and majority (46 (37%)) reported using it for domestic purposes. However, 22 (18%) of respondents use the water for irrigation purposes and 17 (14%) use it for both irrigation and domestic purposes. However, 36 (31%) respondents reported not to have benefited from the use of the mentioned water sources, probably because their farms were not located near the water sources. Despite the availability of water sources, irrigation was observed not to be widely practiced, maybe due to poor water distribution and availability in some areas. The existing irrigation scheme is still under rehabilitation and unless this is completed, some areas will continue to suffer from water shortage

Woodlots ownership

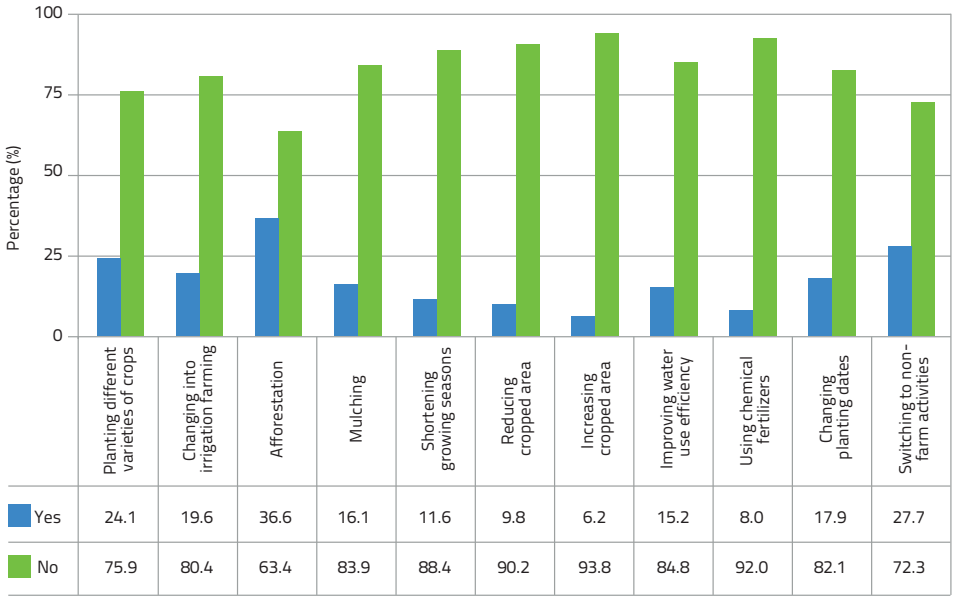
Many researchers have demonstrated that emission of greenhouse gases (GHGs) such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), chloro-and-fluoro-carbons and a number of other gases resulting from human activities are responsible for the recent changes in the global climate system (IPCC, 2007). Therefore, there is a need to use cleaner technologies that do not emit a lot of GHGs or provide sinks for the emitted GHGs. In the forestry sector strategies include planting of trees species in woodlots, forestry plantations, on farm boundary planting and other agroforestry systems. Woodlot ownership plays a significant role in the establishment of forests. Raising the number of people who own woodlots is likely to increase the chance of reducing deforestation in a particular area. In Kiroka village, however, the results show that the majority of the respondents do not own woodlots (53%).

Climate Change and Adaptation Options

Strategies for adapting to the fluctuations in climate

The results of the baseline survey indicated that 103 (92%) of respondents reported that climate change has negative impacts in their village, while only 9 (8%) reported this was not a concern. Respondents were asked whether they have made any adjustments in response to the impacts they have faced. To avoid or at least reduce the negative effects and exploit possible positive effects, several agronomic adaptation strategies for agriculture have been suggested. However, the majority of the respondents (53%) have not made any adjustments to reduce the impacts of increasing weather variability and climate change. Results indicate that about 47% of respondents had adopted some strategies and ways to minimize the impacts from increasing weather variability and changes in climate. Saka (2008) noted that adaptation measures to climate change among communities have been considered with two broad activities in mind: i) measures that reduce vulnerability and ii) measures that increase resilience through the utilization of the available common assets. Figure 2 gives a summary of the strategies used by the respondents in response to the impacts associated with climate change and variability in the study area.

Figure 2: Strategies adopted by farmers to respond to climate change and variability



	Planting different varieties of crops	Changing into irrigation farming	Afforestation	Mulching	Shortening growing seasons	Reducing cropped area	Increasing cropped area	Improving water use efficiency	Using chemical fertilizers	Changing planting dates	Switching to non-farm activities
Yes	24.1	19.6	36.6	16.1	11.6	9.8	6.2	15.2	8.0	17.9	27.7
No	75.9	80.4	63.4	83.9	88.4	90.2	93.8	84.8	92.0	82.1	72.3

The findings are in line with a study by Mahoo *et al.*, (2007) which indicated that farmers adopted tillage methods, agronomic practices and crop diversification approaches to maximize yields from available water. However, these adaptation strategies need to be undertaken in tandem with government policies and strategies for poverty alleviation and food security.

Adjustments made by Kiroka farmers as a result of changes in rainfall

Rainfall variability due to climate change has proved to be one of the biggest challenges to many farmers in Kiroka. Changes in rainfall patterns are at times leading to increased water levels, but at others decreased levels. For farmers, this leads to increased risk of crop failure due to poor seed germination, washing away of seeds and crops, also stunted growth. Sometimes this requires re-ploughing and replanting, so increasing production costs. For livestock, this leads to decreased pasture productivity, also increased outbreaks of parasites and diseases. Surprisingly, results in Table 8 show that the majority of farmers have not yet adopted any strategy to minimize the negative impacts resulting from changes in rainfall patterns in the study area. However, about 6% of the respondents said they had shifted to production using irrigation instead of relying only on the traditional rain-fed mode of production. The prospects of adaptations due to the variability of rains in the study area are summarized in Table 8.

Adjustments made by Kiroka farmers as a result of changes in temperature

According to IPCC (2007), increasing average temperatures will adversely affect crops, especially in semi-arid regions, where already high temperatures are a limiting factor of production. Increased temperatures also increase evaporation rates from soil and water bodies, as well as evapotranspiration rate. Results in Table 9 indicate that about 90% of the respondents reported not to have adopted any strategy in response to the changes in temperatures, while others have shifted to irrigation production systems due to water scarcity exacerbated by rising temperatures. Some have planted banana trees for the purpose of providing shading in their farms, to reduce heat intensity (Table 9).

Perceived hindrances to adoption of modern techniques

Farmers were asked their perceived barriers to adoption of modern technologies for adapting to climate change. The majority of the respondents (88%) reported the most common challenge facing them was lack of capital (cash) to acquire modern technologies such as irrigation pumps (Figure 3).

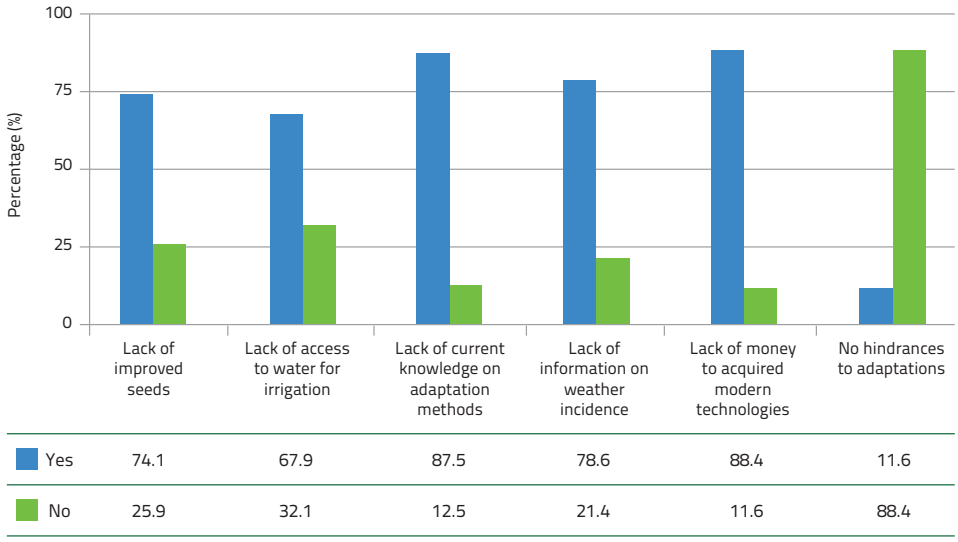
Table 8: Adjustment strategies due to changes in rains

Adjustment strategies	Frequency	Percentage (%)
Shifted to irrigation production system	7	6.3
Construction of dams	16	14.2
Use of the drought resistant banana seeds	2	1.8
Not adopted any strategy	87	77.7
Total	**112**	**100**

Table 9: Adjustment strategies due to changes in temperature

Adjustment strategies	Frequency	Percentage (%)
Shifted to irrigation production system	10	8.9
Plant banana trees on farms for shading	1	14.2
Not adopted any strategy	101	0.9
Total	**112**	**100**

Figure 3: Perceived hindrances to adoption of modern (climate resilient) techniques



	Lack of improved seeds	Lack of access to water for irrigation	Lack of current knowledge on adaptation methods	Lack of information on weather incidence	Lack of money to acquired modern technologies	No hindrances to adaptations
Yes	74.1	67.9	87.5	78.6	88.4	11.6
No	25.9	32.1	12.5	21.4	11.6	88.4

Farmers Association and Institutional Support

Some of the associations, groups and NGOs concerning with food and livestock production as well as environmental conservation in the study area included World Wildlife Fund, Wildlife Conservation Society of Tanzania, Food and Agriculture Organization, Japan International Cooperation Agency, Pennsylvania Department

of Environmental Protection, New Rice for Africa, CARE International and Savings and Credit Cooperative Organizations (SACCOS). There were some other local associations and farmers groups, including: Msamvu Development for People; Umoja wa Wamwagiliaji Kiroka; Mahembe Mazingira Group; Mkombozi SACCOS; Juhudi group; Wangeuye group; and VICOBA. These groups provide services such as education on environmental conservation, training on paddy rice production and on the proper utilization of agricultural inputs such as fertilizers, also savings and loans provision. Farmers were asked if they were members in any association in the study area and the majority of respondents (54%) responded to be actively involved in those organizations.

Conclusions and Recommendations

Conclusions

Like many other parts of Tanzania, Kiroka village is seen to be vulnerable to environmental change, particularly climate change. Such vulnerability is reflected in various impacts of environmental change on, among others, food security, livestock and human health. Agricultural production, which is an essential component of food security, is largely rain-fed in Kiroka village. Droughts have become more frequent, while floods have often destroyed infrastructure, affecting food distribution and access by many communities. Other climate-related risks have also increased, for example outbreaks of pests and diseases such as diarrhea. Increased health risks due to climate change are of particular concern as they affect the population, including reducing the labor force for agricultural production, also other sectors of the economy. Sound adaptation mechanisms are needed to address the consequences of climate change on agricultural production, food insecurity and health, which cause stress factors that affect livelihoods in rural communities such as Kiroka.

Recommendations

It is significant that Kiroka's local government formulates and implements policies that will accelerate environmental conservation in Kiroka village. This also requires scaling-up of budgetary allocations to issues such as construction of improved irrigation schemes and capacity building to Kiroka farmers. Afforestation, mulching when planting different crops, as well as switching from farm to non-farm activities, should be encouraged as strategies to adapt to increasing weather variability and climate change. Constraints on the wide scale adoption of modern technology by households must be identified and dealt appropriately through further research, training and information dissemination.

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Tanzania Paper 1

The system of rice intensification to maximise paddy yields using improved water management, Kiroka village, Morogoro, Tanzania

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Introduction

As described in the baseline study (Tanzania Baseline Paper), Tanzania is highly vulnerable to the impacts of climate change and various parts of the country are already experiencing increasing water scarcity, which is negatively affecting agricultural production especially by small-scale farmers. In addition, water conflicts are occurring very frequently. Examples of conflicts involve upstream versus downstream farmers; livestock keepers versus farmers; also farmers versus farmers in water distribution.

Kiroka village is among the most productive areas for cultivation of rice under irrigation practices in Morogoro Region and has 147 ha of a land which could potentially be used. Following water stress conditions attributed to climate change, the current command area under cultivation is only 80 ha (see Figure 1).

Figure 1: Sketch map of Kiroka irrigation scheme