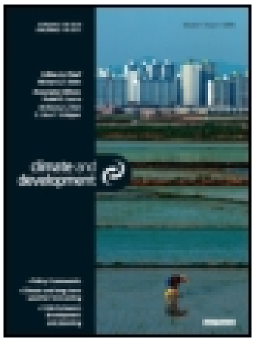

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RESEARCH ARTICLE

Enhancing adaptation to climate variability in the East African highlands: a case for fostering collective action among smallholder farmers in Kenya and Uganda

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There is an increasing recognition of the role of climate change adaptation among smallholder farmers in rain-fed agriculture in Africa. Collective action among smallholder farmers has been suggested as influencing local adaptation processes hence the need to evaluate its impact in different contexts. This paper provides evidence of collective action in enhancing local adaptation to climate variability. It determines the importance of different forms of collective action for enhancing adaptation. Through simple random sampling, a survey of 240 households in Embu County in Kenya and 200 households from Kapchorwa district of Uganda was undertaken. Focus-group discussions involving farmer groups and local government representatives were performed to triangulate information collected through the surveys. The results show a positive relationship between membership in farmer groups and adaptation to climate variability in both sites. Four main components of collective action were identified in Embu and these included the development of internal group capacities, assets mobilization and management, collective marketing, and management of human and natural capital. In Kapchorwa, the development of internal group capacities, risk spreading, and financial resources were significant. We argue that local-level governance and institutional arrangements for collective action are critical for successful adaptation to climate variability.

Keywords: adaptation; climate policy; capacity building; institutions; Africa

Introduction

Climate change and variability is expected to influence agriculture in sub-Saharan Africa (SSA). It has been projected that climate change and variability will reduce agricultural production by 10–20% by 2050 (Nelson et al., 2009). The projected reduction will mainly result from the changing rainfall patterns and the increase in the frequency of extreme weather events. This will also increase the prevalence of crop pests and diseases (Barrios, Ouattara, & Strobl, 2008; Rarieya & Fortun, 2009).The effects of these changes are expected to be particularly severe in SSA, where persistent poverty makes populations more vulnerable than in other parts of the world, and importantly the huge reliance on agriculture in this region. The sector contributes about 40% of gross domestic product of SSA countries and employs 62% of the population (Barrios et al., 2008). Given this vulnerability it is necessary to identify and embrace suitable adaptation mechanisms to climate variability among rural farming communities in SSA.

Adaptation is a social process and there is growing recognition that it is important to build the adaptive capacity of smallholder farmers that will be affected by climate change and variability (Adger, 2003; Wolf, 2011). Consequently, adaptation is a major focus in national policy formulation and among development agencies in SSA. Though initially promoted through a top-down process, emerging evidence suggests that enhancing the adaptive capacity of rural farming communities is better achieved through bottom-up processes building on local knowledge and practices and community ownership of the processes. Unfortunately, there is a disconnect between national- and local-level adaptation initiatives. This disconnect is a result of failure to engage local communities in a participatory manner into planning and developing locally appropriate policy initiatives for climate change adaptation. Most adaptation measures often include investments in infrastructure for physical protection and ‘climate-smart’ farming practices. The proposed interventions and policies are usually general not taking the

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local contexts into consideration (Maina, Newsham, & Okoti, 2013; Prolinnova, 2011). Hence, there is a need to better connect national adaptation strategies to initiatives that mobilize adaptive capacity among rural farming communities. There is a need for a solid evidence of suitable and successful strategies and interventions at the local level and research on collective action in rural communities in differing contexts.

The need to consider local processes in national adaptation planning received has considerable attention in Africa. A study by Smucker et al. (2015) identified local institutional and resource tenure gaps in the climate policy of Tanzania. The study concluded that these gaps would potentially exacerbate inequalities in the planned interventions in the country. In Cameroon, Brown and Sonwa (2015) focused on the interactions and information flow between local and higher level institutions. The study identified the need for the government to build capacity of diverse local institutions and improve the relationships between local- and national-level adaptation planning. Osbahr, Twyman, Neil Adger, and Thomas (2008) identified collective land-use management as one of the local responses to climate risks in Mozambique and recommended specific areas to support social institutions. As these studies show, local adaptation policy needs vary.

Adger, Huq, Brown, Conway, and Hulme (2003) stated that there is a need for research on how collective action is central to adaptive capacity at various scales of decision-making. Therefore, this study has been informed by the need for case-specific research on the role of collective action for adaptive capacity at the local level in rural farming communities. The success of collective action depends on rural institutions. Hence, Agrawal, Perrin, Chhatre, Benson, and Kononen (2013) highlight the need to improve the capacity of these rural institutions in adaptation planning. The implication for this study is to provide opportunities for strengthening rural institutions as avenues for enhancing household adaptation in the study areas. So far there has been little research on the role of collective action in climate change adaptation.

This study focuses on two sites in the highlands of East Africa where communities depend on rain-fed agriculture. These are Embu County in Kenya and Kapchorwa district in Uganda. The main objective of the paper is to explore the organization and functioning of collective action among smallholder farmer groups in enhancing adaptation to climate variability, with a focus on rainfall and temperature variability in Embu and Kapchorwa. The following research questions guided this paper. First, what adaptation strategies to climate variability are the rural farming communities using in the study sites? Second, does membership in rural institutions such as farmer organizations enhance household adaptation to climate variability? And, what forms of collective action contribute to enhancing such adaptation in the study sites?

Conceptual framework

Collective action has been defined in various forms in the context of smallholder farming. However, there is a consensus that it involves several actors and directed towards certain interests or purposes shared between them (Meinzen-Dick, Di Gregorio, & McCarthy, 2004). The actions are in most cases, voluntary, and take various forms such as making collective decisions, setting the rules of conduct and asset management, and implementing decisions that affect communities in their activities. Other forms include contributions in the form of money, labour, or in-kind contributions, and monitoring adherence to the rules. These collective approaches, which may encourage or limit adaptation, require a better understanding (Adger, 2003).

There are a number of considerations that emerge from the literature in the study of collective action. The unit of analysis and indicators of collective action varies depending on the context and research questions (Meinzen-Dick et al., 2004). For instance, McCarthy, Dutilly-Diane, and Drabo (2002) used multiple units of analysis, at the household, group, and community levels. Meinzen-Dick et al. (2004) further noted that collective action is difficult to measure directly and therefore proxy indicators are generally used. The indicators include outcomes associated with collective action and provision of public goods such as soil erosion control and deforestation. Studies by Chakrabarti, Khaling, Bhattacharya, Ranjan Ghosh, and Sarkar (2001) in India and Varughese (1999) in Nepal developed indices for collective action in forest management activities. Communities of practice have also been used to conceptualize collective action (Andersson & Gabrielsson, 2012). Individuals form communities of practice in different sectors to enhance social learning (McDonald, 2015).

Collective action is also demonstrated through organized groups as earlier noted. Therefore, in this study, we have used household membership and participation in groups as an indicator of collective action. Based on the literature, we identified collective action activities that could enhance adaptation to climate variability. These included labour sharing, resource mobilization, managing group assets, market information sourcing, and collective marketing. Additional activities identified included insurance schemes, management rules, skills and knowledge sharing, making decisions, sharing income, and farm equipment (German et al., 2008; Ireland & Thomalla, 2009; Meinzen-Dick et al., 2004). Figure 1 suggests that collective action can address some of the household constraints to adaptation to climate variability. Collective action through organized groups and the integration of other interventions such as improved agricultural practices, and the influence of enabling factors such as policies are likely to enhance household adaptation to climate variability.

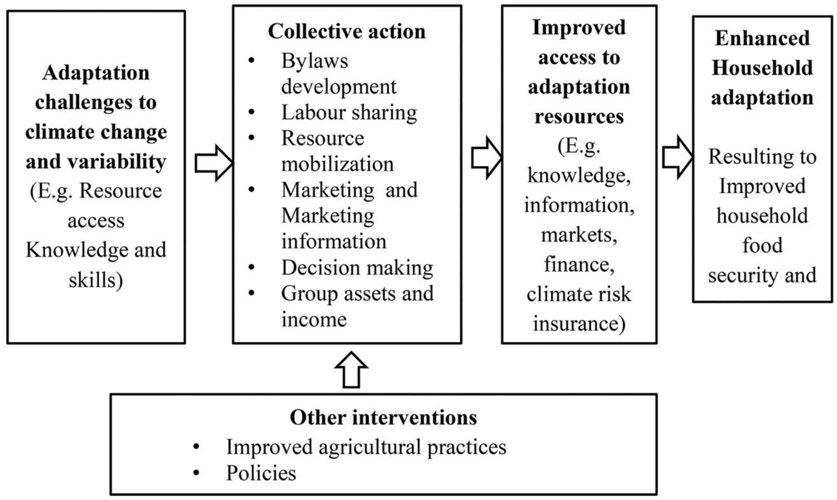

Figure 1. Conceptual framework for collective action and adaptation to climate variability.

Methods

Study area

The study was conducted in two sites in East Africa, Embu County in Kenya and Kapchorwa District in eastern Uganda. The sites were selected based on the following criteria; first, they are part of the East African highlands where rain-fed agriculture is the dominant farming system; second, there were already established community groups with organized collective activities; and third, they have experienced the effects of climate variability. We selected two catchment management areas known as Focal Development Areas (FDAs) in Embu County and three sub-counties in Kapchorwa District. The FDAs in Embu County were initially delineated by the Mount Kenya East Pilot Project (MKEPP) for natural resources management, which was initiated to promote sustainable natural resource management in the Upper Tana region.

Embu County lies on the eastern side of Kenya on the windward slopes of Mount Kenya. The major agro-ecological zones in the county are tropical alpine (TA), Upper Highlands (UH), Lower Highlands (LH), Upper Midland (UM), Lower Midland (LM), and Inland Lowland (IL) (GoK, 2014). The two FDAs, Kiriari and Mutunduri, lie along the Kapingazi River catchment that is part of the Upper Tana River catchment and covers an area of 61.2 km^2. Kiriari is a high altitude area where tea is the dominant crop. Mutunduri is a coffee zone on the lower part of the catchment. Subsistence farming is also practised with farmers growing maize and beans. The catchment's elevation varies from about 1200–2100 metres above sea level. Small land sizes and increasing agricultural intensification are common in the catchment (Balana, Yatich, & Mäkelä, 2011).

Embu County receives a bimodal rainfall pattern. The 'long rains' occur between March and May and 'short rains' between October and December, with a dry period from June to September. The mean annual rainfall in the catchment varies from 1000 mm in the lower part to 2000 mm in the upper part, with a mean annual temperature of 18–22°C (Hoang et al., 2014). The indicators of climate variability in the County include reduced yields, drying up of seasonal rivers, prolonged drought, incidences of diseases such as malaria and receding snow caps on Mount Kenya. Greater variations in rainfall have been predicted in the County with models indicating a rainfall increase from 1630 to 1790 mm in 2050, and an average temperature increase of 2.3°C (CIAT, 2010).

Kapchorwa District is in eastern Uganda on the slopes of Mount Elgon and occupies an area of 1731.7 km^2. The district has three agro-ecological zones. The zones are Mt. Elgon high farmlands, Kapchorwa farm forest, and northeast short grass plains with clay soils. The average altitude in the three zones is 1466, 1455, and 1093 m, respectively. Rainfall varies from less than 1000 mm in the north increasing to 2000 mm towards Mt. Elgon (NEMA, 2004).

The main economic activity in the district is subsistence agriculture. The main crops are maize, millet, potatoes, beans, sunflower, cotton, coffee, and livestock farming. Other than the main environmental challenges facing the district such as loss of land productivity due to soil erosion (NEMA, 2004), unpredictable rainfall patterns and dry spells are also threats to crop production (UNDP, 2013). Soil erosion is largely a result of cultivation on steep slopes and lack of soil conservation measures. Indicators of climate variability include erratic rainfall during the March–June season associated with drought and low agricultural performance, and intense downpours in the September–November season associated with landslides and soil erosion (NEMA, 2010).

Sampling procedure

Purposive and random sampling techniques were used in this study. The first step was purposive selection of two FDAs in Embu and three sub-counties in Kapchorwa District. In Embu County, 3 sub-locations within each FDA were selected through simple random sampling, and 2 villages in each sub-location giving a total of 12 villages. In Kapchorwa, three sub-counties were randomly selected and two villages in each sub-county, hence a total of six villages were selected. Simple random sampling using a table of random numbers was then used to select households from each selected village based on the village household list obtained from the Local Council Chairpersons (LCC) in Kapchorwa and Local Chiefs in Embu. A total of 240 households were selected in Embu and 200 in Kapchorwa.

Data collection and analysis

Primary data were collected from the selected households using a structured questionnaire, focus-group discussions with farmer groups and key informant interview. Information was collected on household socio-economic variables, access to services such as extension, credit, input and output markets, weather information, membership and participation in groups, perception of climate variability, and climate variability adaptation strategies used. Focus-group discussions were held with selected farmer groups to triangulate the results of the household survey. The focus-group discussions provided information on the group activities, climatic risks, experiences, and collective adaptation mechanisms employed by the members. The farmer groups were selected based on their activities such as crop, livestock water users, among other activities, and gender composition to include women only groups and mixed groups. A total of six focus-group discussions were held in each study site.

Group members rated the extent to which participation in different collective activities enabled them to adapt to climate variability on a Likert scale. The indicators used included collective action activities indicated in the conceptual framework in Figure 1. Respondents rated the importance of these collective activities in helping them adapt to climate variability on a 5-point Likert scale rating where 1 = *very little extent* and 5 = *very great extent*. The data were analysed to compare the relationship of group membership in collective action groups and adapting to climate variability. Chi-square (χ^2) test was used to compare adaptation by group membership. Chi-square is used to determine significant relationship between categorical or nominal variable. This study satisfied the assumptions of Chi-square test: random selection of the sample; the independent and dependent variables were categorical; the categories were mutually exclusive; and no more than 20% of the expected count was less than 5. Chi-square test was also applied in studies such as Babu, Gajanan, and Sanyal (2014), Yucens, Kuru, Safak, Karadere, & Turkcapar (2014), and Wollni, Lee, and Thies (2010). Further, the collective action indicators were analysed using principal component analysis (PCA) to identify the main activities that enhanced household's adaptation. The use of PCA was necessary to derive unique indicators from all the indicators used. It has been suggested that collective action indicators are often correlated, hence the advantage of using PCA (Krishna, 2003; Meinzen-Dick et al., 2004).

Results and discussion

Socio-economic characteristics of the respondents

The summary statistics of selected socio-economic characteristics of the respondents in the two study sites are presented in Tables 1 and 2. As indicated in Table 1, the numbers of male and female respondents in both sites were similar. Agriculture was the main source of income for 86% of the total respondents in Embu, and 91% in Kapchorwa. Forty-seven per cent of the sampled households in Kapchorwa, and 68% in Embu were members of at least one group. The most accessed services at both sites were crop and livestock extension, weather, and market information. Crop and livestock insurance were least accessed by the respondents in both sites.

Adaptation strategies to climate variability in Embu and Kapchorwa

Respondents in the two sites had adopted a diverse range of adaptation strategies in their farming practices in response to climate variability. About 67% of the sample respondents in Embu and 84% in Kapchorwa had adapted to either rainfall or temperature variability. Figures 2 and 3 show adaptation strategies used in the two sites. The most common adaptation strategies to rainfall variability in Embu were growing different crop varieties (59%), planting trees (52%), and growing different crops in different seasons (46%). Other strategies include soil and water conservation, varying planting and harvesting dates, and diversification of off-farm and on-farm income-generating activities. The activities included timber production, tree nurseries, honey production and wage labour. Respondents identified the following adaptation strategies in response to temperature variability; the use of chemicals, fertilizers and pesticides (22%), shading and shelter (20%), and increasing irrigation (14%). The most grown crops in Embu included maize (16%), bananas (14%), and coffee (13%), whereas maize (22%), beans (22%), and bananas (17%) were common in Kapchorwa. Different crop varieties were preferred due to quicker harvesting periods which supported food availability for consumption and sale to

Table 1. Household socio-economic characteristics (categorical variables).

Variable description	Units (1 = Yes, 0 = No)	% Respondents	
		Kapchorwa (*N* = 200)	Embu (*N* = 240)
Gender of respondent		Male 48.0 Female 52.0	Male 50.8 Female 49.2
Belong to a group	0/1	46.5	67.5
Experienced adverse conditions	0/1	73.9	61.7
Household assets			
Own livestock	0/1	92.5	93.3
Own land	0/1	98.5	96.7
Have cash savings	0/1	55.5	75.4
Off-farm income	0/1	45.0	56.7
Other on-farm activities	0/1	37.0	56.3
Own transport	0/1	10.0	51.3
Access to services and information			
Access to input/output market	0/1	89.0	84.4
Access to crop/livestock extension	0/1	53.5	62.9
Access to crop/livestock insurance	0/1	1.5	6.3
Access to credit for farming	0/1	22.2	36.3
Access to crop training	0/1	31.0	59.6
Access to livestock training	0/1	28.8	52.1
Access to environmental conservation training	0/1	28.0	42.1
Access to financial management training	0/1	12.0	42.1
Access to agroforestry training	0/1	28.5	27.1
Access to weather information	0/1	56.0	87.1
Access to market information	0/1	65.5	78.1

generate income. Apart from climatic variations, market value was also a factor for shifting to crop varieties such as tissue culture bananas.

The most applied adaptation strategies in Kapchorwa were planting different crops in different seasons (56%), planting trees (49%), and varying planting and harvesting dates (39%). Other strategies were soil and water conservation and planting different crop varieties. Respondents identified the following adaptive strategies in response to perceived temperature variations; growing different crops in different seasons (25%), planting trees (25%), and varying planting and harvesting dates (24%).The least applied strategies in both sites included those that involved shifts in farming activities. These included shifting from crops to livestock and from farming to non-farming activities. Whereas similar strategies were applied in both sites in response to perceived rainfall variation, the percentage of households who used the strategies varied. Most farmers in Kapchorwa were adapting to temperature variations through growing different crops, whereas use of chemicals and fertilizers was mostly applied in response to temperature variations in Embu. The results indicate that in both sites respondents adapted more in response to rainfall variability than temperature variability (Figure 4).

Adaptation strategies across the two study sites are consistent with studies in Kenya and Uganda which show that farmers are taking specific measures in response to climate variability. For instance, a study by Hoang et al. (2014) in Kithunguriri and Muthatari FDAs in Embu showed that farmers adapted by planting drought resistant and early maturing crop varieties, mixed cropping, and planting trees for multiple benefits, such as fodder and shelter for crops. Planting different crop varieties, varying planting dates, and changing crop types are also common adaptation strategy in other parts of Kenya (Bryan et al., 2013; Oloo, 2013). Similar strategies have also been reported in Africa such as Tambo and Abdoulaye (2013), and Maddison (2006). The use of different crop varieties could be as a result of relatively low investment and availability of information on different crop varieties.

Differences in adaptation strategies in other sites could also be explained by a number of factors in the study sites. There is less diversification of crops in Kapchorwa compared to other districts in Uganda. The main crops grown are maize and plantain bananas. Beans and cassava are least grown. There is limited application of external inputs such as fertilizers due to cost, and land sizes are limited (UNDP, 2013). Flash floods and landslides are common in Kapchorwa, and this explains tree planting and application of other soil and water conservation strategies to reduce erosion. In the Embu site, trees buffer the landscape gradients against soil erosion when there is increased rainfall intensity. The watershed management initiatives of local projects such as MKEPP have also enhanced tree planting (Hoang et al., 2014). Agriculture extension services have provided advice to farmers on crop varieties that are suitable in the face of climate variability in the area.

Table 2. Household socio-economic characteristics (continuous variables).

		Kapchorwa			Embu		
	Units	Min	Max	Mean	Min	Max	Mean
Household size	No. of people	2	13	6	1	13	5
Age of respondent	Years	16	95	41	21	99	50
Years lived in the area	Years	1	90	18	1	87	30
Land size	Acres	0.25	20	2.20	0.10	9.00	1.80
Distance to market	Kilometres	1.0	80.0	7.0	1.0	8.0	1.7

Adaptation and membership in collective action groups

The distribution of households in collective action groups is first considered in Table 3. Sixty-seven per cent of sampled respondents in Embu and 47% of respondents in Kapchorwa were members in at least one group. Most group members in Embu were mainly involved in financial activities such as table banking and savings and loan schemes to members such as the 'merry-go-round' system. Conversely, livestock production was the main activity for most group members in Kapchorwa. However, group members were also involved in other activities apart from these main functions. This study considered the relationship between adaptation and membership in collective action groups. In this study, the null hypothesis H_0, is that there is no relationship between group membership and adaptation to climate variability. *P* value results less than or equal to .05 are considered statistically significant and therefore the null hypothesis is rejected. A relationship was found between adaptation to either rainfall or temperature variability and group membership in Embu, χ^2 (1, $N = 240$) = 42.09, $p < .001$), and Kapchorwa, χ^2 (1, $N = 200$) = 4.17, $p = .041$). Table 4 presents chi-square test statistics for tests exploring the relationship between group memberships and the common adaptation strategies in the two sites. The results indicate a relationship between group membership and the most applied strategies in response to rainfall variability in Embu. Group members in Embu were more likely to use different crop varieties, plant trees, vary planting dates, grow different crops in different seasons, and diversify crops ($p < .05$). In Kapchorwa, group members were more likely to plant trees, apply soil and water conservation practices, diversify crops, and use water harvesting technologies ($p < .05$).

The results show an association between membership in farmer groups and adaptation to climate variability which compares with other studies in Kenya. For instance, Oloo (2013) showed that membership in groups had a positive influence on adaptation to climate variability in western Kenya. Bryan et al. (2013) showed that

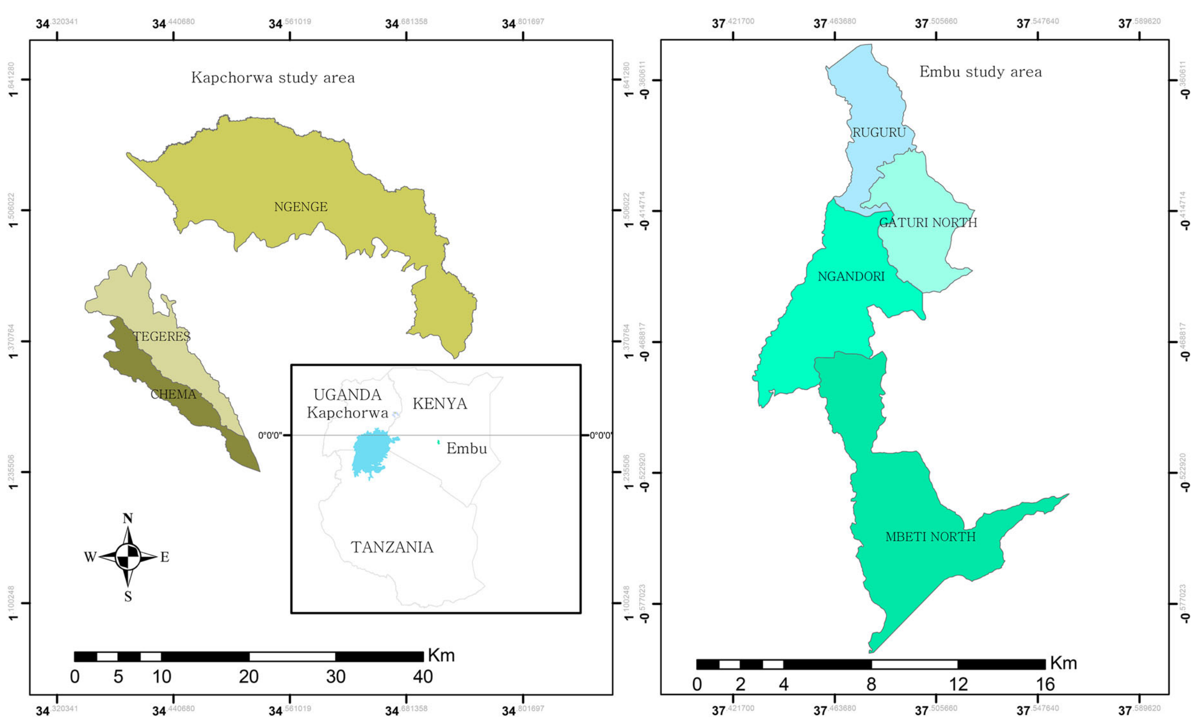

Figure 2. Map showing location of study areas in Kenya and Uganda.

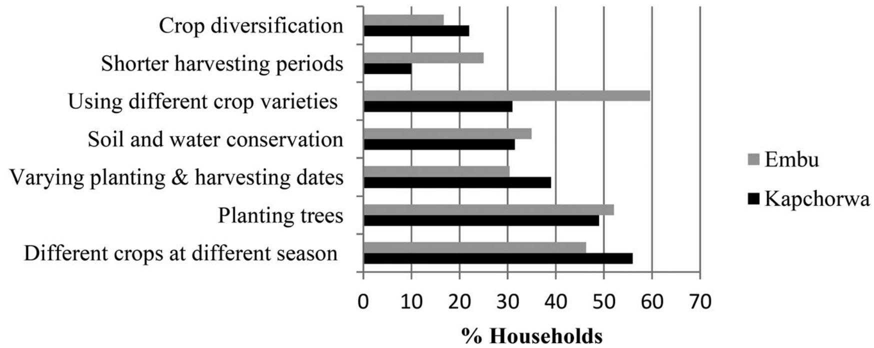

Figure 3. Adaptation strategies to rainfall variability in Embu and Kapchorwa.

membership in community-based associations increased the likelihood of planting trees as an adaptation strategy. Groups often allow for the sharing of information on adaptation strategies, and overcome barriers to adaptation through a collective response. Individuals who were members in groups had an advantage in accessing services such as extension services, market information, finance, credit, and training and knowledge on natural resource management. Access to services and information is important for enhancing adaptive capacity of individuals and groups. As manifestations of collective action, community groups have played a role in providing safety nets for households and providing avenues for addressing common environmental problems (Bisung, Elliott, Schuster-Wallace, Karanja, & Bernard, 2014).

The effect of group membership on uptake and use of technologies for adaptation varies depending on the local context. For instance, studies have shown a positive effect of group membership on adoption and use of improved crop and soil conservation technologies and practices in Uganda (Kassie, Shiferaw, & Muricho, 2011), Nigeria (Kristjanson, Okike, Tarawali, Singh, & Manyong, 2005), and Honduras (Wollni, Lee, & Thies, 2010). In some cases, group membership had no significant effect on the use of technologies. For instance, Shiferaw, Obare, Geoffrey, and Silim (2009) showed that group membership had significant positive effect on uptake of dry land legume crops, but no significant effect on adoption of improved maize varieties. The group members had skills on quality seed production methods for the dryland crops. Similarly, there were variations on the effect of group membership on use of different adaptation strategies in the two sites considered in this study.

Main collective action activities enhancing adaptation

The PCA for collective action activities that were important in enhancing household adaptation revealed four main categories in Embu, and three categories in Kapchorwa. In Embu, the components are broadly classified as development of internal group capacity, asset mobilization, and management, collective marketing, management of human, and natural capital (Table 5). In Kapchorwa, the components are broadly classified into development of internal group capacity, risk spreading processes, and financial resources from the group activities (Table 6).

Skills and knowledge sharing

From the PCA results, an important collective action component in both sites was the group capacity to share knowledge and skills, and make collective decisions on matters affecting individual members. Focus-group discussions indicated that members shared skills and knowledge on crop and livestock production technologies, soil and water conservation, and tree planting. Application of the skills has the potential to enable households to improve farm production through adopting appropriate farm production technologies. Group meetings and linkages with other groups and individuals provided avenues for capacity development, information sharing, and identifying opportunities for external assistance. However, most issues discussed in group meetings in both sites were only limited to the respective group activities. Group linkages formed networks, which were useful for identifying marketing opportunities, as indicated by focus-group discussions. This illustrates the important role of networks in adaptation, which Ensor and Berger (2009) refer to as the ‘glue between many elements of adaptation’ (p. 27). Furthermore, networks also enhance communication channels for new knowledge on environmental changes (Ireland & Thomalla, 2009).

Inclusive decision-making

Important decisions in the groups involved inclusion of group members’ views and opinions. The decisions involved critical aspects required for successful adaptation, such as consensus among group members on access to credit and group resources, support to vulnerable members, risk coping, and resource sharing. Studies have shown that access to assets, information, finance, and

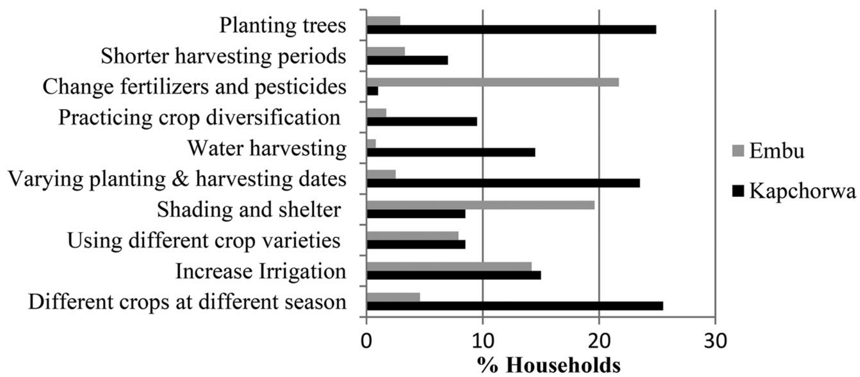

Figure 4. Adaptation strategies to temperature variability in Embu and Kapchorwa.

ability to make decisions between men and women affect positively their capacity to adapt to climate risks (Bernier et al., 2013; FAO, 2011). Hence, the inclusion of all members ensured that vulnerable members gain benefits. An inclusive process enhanced adaptive strategies such as diversification of activities, livestock management, soil and water conservation, and irrigation.

Resource mobilization and management

Mobilization and management of group resources was indicated by respondents as vital for assisting individuals to adapt to climate variability in both sites. Respondents identified both physical and financial assets in the form of merry-go-round systems, table banking, and group loaning schemes. Access to financial capital was necessary during the planting season when farmers often require farm inputs. Focus-group discussions indicated that one of the financial management mechanisms for groups was a vetting process for loan applicants before awarding loans. For instance, the loan applicant had to ensure that the investment undertaken would generate greater economic returns, and it would also be sustained in the face of climatic risks.

Collective management of physical assets such as livestock and irrigation structures was important to enhance access to and sharing services for enhanced agricultural productivity. Though physical assets emerged as important in both sites, institutional arrangements for managing such assets to reduce risks emerged as a key aspect in Kapchorwa. Institutional arrangements such as collective marketing of produce and cushioning members from losses were identified. This corroborates with other studies which have suggested that assets play a necessary role in pro-poor adaptation to climate change (Mude et al., 2007; Prowse & Scott, 2008). Assets offer a safety net especially where external support from governments or private entities is limited (Place et al., 2004). From this study, it is evident that collective management of assets enabled farmers to engage in diverse production activities and access water for irrigation.

Table 3. Distribution of respondents in different group typologies.

	% Respondents	
Group main function	Embu	Kapchorwa
Crop production	13.8	15.0
Livestock production	13.3	17.5
Financial	39.6	13.0
Environmental and resource user	2.9	10.0
Mutual non-financial	1.7	0.0
Social cultural	2.5	0.5
None	32.5	54.0

Resource pooling and marketing

The ability to source market information and pool resources to access markets for inputs and end products was important in the study sites, as identified by respondents. To benefit from economies of scale, group members pooled their resources to enable them to buy inputs such as fertilizers and seeds, which were important during the planting season. Therefore, farmers who could not afford the cost of inputs benefited from this collective arrangement. The arrangement enabled farmers to have access to fertilizers for application on their farms, receive seeds to enable crop diversification, cultivate different crop varieties, and plant crops during the optimal planting period in preparing for the rains. Studies have shown that acting collectively through farmer groups reduces transaction costs and enables farmers to have access to market information, access to new technologies and compete more effectively with other large-scale farmers (Markelova, Meinzen-Dick, Hellin, & Dohrn, 2009; Rodima-Taylor, 2012; Rurinda, 2014). Though this is the case, Shiferaw, Hellin, and Muricho (2011) argue that for local markets, collective action is not necessary because individual farmers can sell locally. However, there are constrains which can limit access to local markets ,such as poor storage, long distance

Table 4. Relationship between group membership and use of common adaptation strategies.

	Embu		Kapchorwa	
Adaptation strategies in response to rainfall variability	Chi-square test statistic	*p* value	Chi-square test statistic	*p* value
Using different crop varieties	29.91	.000**	1.290	.720
Planting trees	18.58	.000**	5.715	.017*
Different crops at different seasons	17.36	.000**	2.859	.091
Soil and water conservation	3.314	.069	17.495	.000*
Vary planting and harvesting dates	5.35	.021*	1.890	.169
Shorten length of growing period	0.025	.874	1.628	.202
Crop diversification	4.923	.027*	8.542	.003*
Water harvesting	0.477	.490	4.055	.044*

*Significant at 5% probability of error.
**Significant at 1% probability of error.

and terrain, poor post-harvesting, and lower prices. Hence, collective action plays a role where there are such constrains.

Social support

Social support if found in varying forms is an important structure influencing factor to buffer farming groups/rural communities from the negative impacts associated with climatic risks and is important for reducing vulnerability within communities. One form of social support identified in the study sites was labour sharing, which was particularly important to resource users and environmental conservation groups in both study sites. During planting and harvesting seasons, more labour is required during a short period of time and is a challenge for many farmers and rural communities. Households who were identified as most vulnerable and those who could not afford the cost of hiring labour were the main beneficiaries of labour provided by other farmers from groups. In addition to labour, studies have shown that sharing equipment also enhance adaptation (Eriksen & Selboe, 2012). However, sharing of equipment was not reported in the study sites.

Enabling factors for collective action

There are key factors which are necessary for collective action to deliver potential benefits. In this study, the existence of group governance structures and bylaws enhanced collective action. Governance structures defined inclusive membership criteria, leadership roles, resources mobilization and management processes, and knowledge sharing mechanisms. Information flow structures such as committees facilitate information and knowledge flow to farmers. Bylaws governed access to and use of forest and water resources to reduce potential conflicts. Furthermore, application of the bylaws enhanced management of irrigation, and soil and water conservation projects for wider community benefits.

Organizational arrangements at local, national, and regional levels are important under current environmental changes and risks. Studies by Ingold, Balsiger, and Hirschi (2010) in the mountainous region of Switzerland, and Schulze and Schmeier (2012) in the river basins of four southern African states (Angola, Botswana, Namibia, and Zimbabwe), show that organizational arrangements that are inclusive, involving local groups

Table 5. Principal components of collective action activities that enhance adaptation in Embu.

	Component			
Collective action activity	Internal group capacity	Group assets	Product marketing	Human and natural capital
Skills and knowledge sharing	0.816[a]			
Collective decision-making on group matters	0.895			
Sharing income from group activities	0.814			
Resource mobilization e.g. finance, credit, assets		0.932		
Managing group assets (finance, property)		0.86		
Market information sourcing			0.851	
Collective marketing of produce			0.812	
Formulating resource management rules				0.79
Labour sharing				0.616

[a]Factor loadings.

Table 6. Principle components of collective action activities that enhance adaptation in Kapchorwa.

Collective action activity	Component		
	Internal group capacity	Risk spreading	Group financial assets
Labour sharing	0.710		
Sharing farm equipment	0.715		
Formulating rules for management of natural resources	0.677		
Skills and knowledge sharing/training received	0.703		
Collective decision-making on group matters	0.693		
Managing group assets (finance, group property)		0.677	
Collective marketing of produce		0.720	
Insurance scheme to cushion members from losses (e.g. crops)		0.570	
Resource mobilization (e.g. finance, credit, assets)			0.766
Sharing income from group activities			0.832

and actors, and adequate communication flows for the formulation and implementation of adaptation interventions are crucial in fostering adaptive capacity. Furthermore, Place et al. (2004) indicate that household resilience is enhanced in the presence of good governance processes in access to natural resources in groups.

Despite its successful outcomes, there are also limitations that undermine the effectiveness of collective action. These include the free rider problem, limited financial resources, and limited scope of issues discussed within the groups. The free rider problems have been found to exist especially in collective management of natural resource (Mushtaq, Dawe, Lin, & Moya, 2007). Free riding can occur when one person contributes less to the public good, but benefits more than the other (Ertan, Page, & Putterman, 2009). The main source of financial capital for activities in the study sites were members' personal contributions, with limited external support, which limited the level of activities and social support to members.

Conclusion and recommendations

Most smallholder farmers in Embu and Kapchorwa have experienced the effects of rainfall and temperature variations. Consequently, the farmers have adapted in response to the variations by using several strategies. Adaptation strategies in response to rainfall variability were similar in the two sites. Households plant different crop varieties, different crops in different seasons, plant trees, use soil and water conservation practices, and vary planting dates. However, planting different types of crops in different seasons was more predominantly applied as a strategy to deal with rainfall variation in Kapchorwa, while in Embu, planting different varieties of crops was a predominant adaptation strategy. The agro-ecological contexts and climatic risks experienced in the two sites informed the use of the strategies.

Smallholder farmer groups create linkages with external institutions and agencies. These linkages enable and enhance application of adaptation practices. Household members in the groups were more likely to adapt to climate variability compared to non-members. In both study sites, group members were more likely to diversify crops and plant trees. In Embu, group members were more likely to plant different crop varieties, plant different crops in different seasons, and vary planting dates, whereas in Kapchorwa group members were more likely to apply soil and water conservation and water harvesting techniques. However, there are limitations to the effectiveness of collective action. These include the free rider problem where some members benefit without contributing their efforts to the group, resource limitations, and limited scope of issues discussed within the groups.

Local-level institutional arrangements for collective action and governance processes are essential and need consideration for successful adaptation to climate risks. Improved governance processes within farmer groups enhance participation and access to resources, skills, practices, and information to farmers. Participation in collective activities in the study sites contributes to reducing vulnerability to climatic risks by creating social safety nets and applying risk reduction mechanisms. Resource pooling mechanisms reduce transaction costs for members in accessing inputs and output markets. These existing institutional arrangements, which are potential mechanisms for scaling up of relevant technologies to mediate climate and other environmental risks among rural farming households in the study area, need to be recognized and success stories identified. Therefore, an important step is to incorporate these local mechanisms in planning, for instance in management of natural resources such as forests, irrigation water and other resources, to enable adaptation.

Capacity development interventions to enhance adaptation in the study sites should not only focus on technological skills, but also on strengthening rural institutions capacity to act collectively. Therefore, development of soft skills within farmer groups is important. Soft skills are required to strengthen governance processes and collective action for the smallholder farmer groups. Additionally, skills to enhance mobilization and management of physical and financial assets are important to ensure access and benefit sharing among households.

Though broad adaptation plans exist at the national level in the two sites, the adaptation strategies employed by farmers, as presented in this study, should be better incorporated into these plans. There is a need to recognize and involve smallholder farmers through their groups in adaptation planning at the local levels. Capacity development to enhance local collective action and governance processes is an important part to include in the national adaptation plans of the two countries, specifically the priority projects under the Uganda National Adaptation Programmes of Action (NAPA) and the national climate change action plan in Kenya. Further research areas in the study sites include the role of social norms (such as beliefs and sanctions) in influencing adaptation decisions, and factors that influence successful collective action.

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