Farmers 'Access to Institutional Support for Climate Change Adaptation in Rural Tanzania

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Abstract
Smallholder farmers in rural areas need access to institutional support for their effective responses to climate change and related challenges. Rural Local Institutions (RLIs) are very close to farmers and thus have the potential to deliver institutional support and enhance smallholder farmers' adaptability to climate change and variability. This article responds to two important questions; one, what institutional support that smallholder farmers perceive as relevant in addressing their adaptation challenges? And, how farmers access that institutional support? To answer these questions, I conducted a study framed within mixed methods design targeting smallholder farmers in 5 villages of Rufiji district in Southern Tanzania. Data collection protocol started with qualitative approaches; Key Informant Interviews (KIIs) and FGDs, to explore the nexus between local understanding of climate change adaptation and institutional roles in adaptation. This informed and was complemented by a quantitative survey of 416 farming households obtained through stratified random sampling. Quantitative data analysis was done with the assistance of the Statistical Package for Social Scientists (SPSS v.16) software. Qualitative analysis followed a content analysis framework using Nvivo 12 software. The study found that smallholder farmers perceive a mismatch between their perceived adaptation needs and available institutional support. Farmers identified access to markets, access to climate information; access to agricultural inputs, skills and technologies, land tenure security and access to credits as critical institutional factors necessary for their effective adaptation to climate change and variability challenges. Also that their access to the available institutions for adaptation support is poor due to social, environmental, political and economic barriers. The paper argues that RLIs require capacity building to enable them to comprehend, design, prioritize, and coordinate farmers' adaptation actions in relation to other development actions.

Keywords: Climate Change and Variability; Farmers access to adaptation support, Rural local institutions, Institutional support, institutional barriers to adaptation

1. Introduction

1.1 Climate Change and Smallholder Farming

Climate change[3] Climate variability, pose serious threats to the sustainability of farming dependent communities in the developing world (Mase *et al*., 2017; Nelson *et al*., 2009; Bates *et al*. 2008; IPCC, 2007: IPCC, 2014). In particular, smallholder farmers in the rural areas of Sub-Saharan Africa are among the extremely vulnerable to climate change and climate variability. The vulnerability is due to the high sensitivity of the crop farming sector to climatic changes. This is coupled with weak institutional capacity to coordinate and support farmers' responses (Juana *et al*., 2013; Mwamfupe, 2014). The effects of climate change and increased variability are increasingly becoming prominent in various parts of the world (IPCC, 2014). These effects are usually manifested through increased droughts, floods, crop diseases and pests, unreliable rainfall and extreme episodes of temperature. These patterns are poised to disrupt crop productivity, agricultural markets, farm-based income and lead to intensified rural poverty (IPCC, 2007; Bates *et al*., 2008; Komba&Muchwaponda, 2012; UNFCCC, 2008; Mustelin *et al*., 2009; Onuoha, 2010; Mwamfupe, 2014).

In the recent two decades, severe floods and droughts episodes have been recurrent in many parts of East Africa (Ogutu *et al*., 2017). These and other effects of increased climate variability are already constraining human development sectors such as water, health, environment, and agriculture in the region. Agriculture is arguably the mainstay of East Africa's economies and mainly practised by smallholder farmers in rural areas. Projections by Tanzania's National Bureau of Statistics (NBS) estimated the country's population to be more than 54million people and by 2018 it was estimated that 70.4% would be based in the rural areas (NBS, 2019). In rural areas of Tanzania, communities engage in small-scale livestock keeping and crop farming as the main source of livelihood (URT, 2013). Increased climate variability in the past three decades has set a constant reminder that smallholder farmers are vulnerable and must be protected against the

[3] is defined by the United Nations Framework Convention on Climate Change (UNFCCC) as "… a change in global patterns in measures of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere, and that is in addition to natural climate variability observed over comparable time periods" (IPCC, 2007*).*

adverse effects of climate change, and variability before the worst is recorded. A call for institutional roles to support smallholder farmers at the local level where adaptation occurs is thus justifiable. Institutional adaptation support is required to provide frameworks within which local and extra-local responses can be structured and implemented.

Adaptation is a legitimate option for rural communities to respond to climate change and climate variability. Studies on communities' vulnerability to climate change and determinants of adaptation strategies are numerous (Lusiru& Mwamfupe, 2017; Nhemachena & Hassan, 2008; Mwamfupe, 2014; Juana *et al*., 2013). These studies have indicated that many people in the rural areas are aware of the changing climate, but not all are able to adapt due to cognitive, normative and institutional barriers (Jones and Boyd, 2011). Most important are institutional barriers that hinder their access to institutional supports such as access to credits, climate information, markets, and extension services. This study appreciates a growing literature focusing on the role of local and rural institutions in supporting rural communities to adapt to climate change and variability (Ananda, 2012; Agrawal, 2008; Dungana *et al*. 2013). However, the literature on institutional adaptation considers what institutions do irrespective of adaptation needs. Such literature is void of the relevancy of rural local institutions in addressing adaptation needs sought by particular categories of vulnerable farmers. Such relevancy should hinge on smallholder farmers' perceptions of institutional support in relation to their priority adaptation needs, and their interpretation of accessibility to institutional support for addressing climate change and variability challenges in their context. This gap of knowledge calls for empirical-based research for which it justifies this study in selected villages of Rufiji District in Southern Tanzania.

1.2 Theoretical Perspectives on Access Institutional Adaptation Support

Smit *et al*. (1999:200) refer adaptation to climate change as *"… adjustments in ecological-social-economic systems in response to actual or expected climatic stimuli, their effects or impacts."* A landscape of adaptation literature suggests the process to depend on an interplay of multiple factors and processes mediated within an institutional context to deliver suitable adaptation actions relevant for a specific system or locality (Carruthers, 2012; Agrawal,

2008; Brown & Sonwa, 2018; Jones & Boyd, 2011: 1262). Agrawal & Perrin (2009) assert that effective adaptation at the local level is a function of responsive and flexible local institutions. Local institutions shape the *process* and *outcomes* of adaptation.

Local institutions refer to formal and informal organizations designed or established by local communities or external organizations that work with local communities in organizing their collective social action towards achieving a specific goal (Uphoff & Buck, 2006; Agrawal, 2008; Agrawal & Perin, 2009). Agrawal (2008) categorizes these institutions into *civic, public* and *private*. In the context of rural areas, these are referred to as *Rural Local Institutions* (RLIs). In examining the role of RLIs in adaptation, Agrawal and colleagues (2009: 08) mention three sets of factors: (i) *nature and goals of institutions* (ii) *patterns through which institutions facilitate various adaptation strategies*, and (iii) *linkages among institutions and rural households*. The contrast between the first and the second set of factors is critical to informing theoretical thinking behind this paper, in particular on how they shape farmers access to institutional support. *Institutional support* is the role that institutions play in creating enabling environment and pathways through which smallholder farmers link their adaptation needs and derive assistance to inform or enhance their adaptability to climate change and variability. Examples of institutional support include access to credits, climate information, and markets (*see* Agrawal, 2008; Agrawal & Perin, 2008; Crane, 2013; Mwamfupe, 2014). RLIs goals need to be linked to farmers' adaptation priorities. This requires an understanding of farmers' evaluation of the efficacy of institutions and ways to address adaptation barriers (Lusiru & Mwamfupe, 2014; Gbetibuo, 2009; Agrawal, 2008; Ananda, 2012; Jones and Boyd, 2011). RLIs are rarely formed to address climate change, but their functions or roles require flexibilities to meet local adaptation needs. In places where RLIs are strong, communities are in a good position to address climate change compared to places where RLIs are weak.

1.3 Reflections on Climate Change Adaptation and Institutional Support in Tanzania

Studies suggest that farming communities in Africa are increasingly becoming aware of climate change in their localities (Nhemachena& Hassan, 2007;

Gbetibouo, 2009; Nyanga *et al*., 2011; Nzeadibe *et al*., 2011; Kebede&Adane, 2011). Also, several scholars have investigated farmers' responses to climate change and determining factors behind specific adaptations (Nhemachena& Hassan, 2007; Deressa *et al*. 2008, Apata *et al*., 2009; Falco *et al*., 2011). The most commonly identified strategies include diversification of rural livelihoods, diversification of crops, and the adoption of drought-tolerant and high yielding varieties. Institutional support in terms of access to insurance, credit, agronomic skills necessary for climate-smart agriculture is reported to be at a low level and sporadic. Some studies have been specific in dimension. For instance, a study by Nabikolo *et al*. (2012) focused on gender and adaptation to climate change. However, few studies have paid particular attention to the farmers' perception of the role of local institutions in relation to localized adaptation (Brown and Sonwa, 2018). How smallholder farmers evaluate local institutions against their adaptation challenges, and their access to institutional support provide policy insights of relevant institutional role in responding to climate change and variability.

Responses to climate change in Tanzania are guided by the Environment Management Act (EMA) of 2004 and the National Climate Change Strategy (NCCS, 2012). The success of the NCCS depends on the institutionalization of climate change into other policy frameworks, especially the National Agriculture Policy of 2013 (URT, 2013). The policy has a set of objectives aimed at transforming commercializing agriculture and rural livelihoods. The policy emphasizes on supporting smallholders in addressing climate-related challenges and reducing widespread rural poverty in tandem with National Development Vision of 2025. The NCCS 2012 understands climate change to be a cross-cutting challenge and therefore sectoral policies on water, land, health, and forests, and together with legal frameworks are critical in addressing climate change.

For decades, crop farming has been the main source of income and food supply for households in Rufiji district. The district has also been experiencing several extreme and climate-related events such as recurrent floods and droughts (Havnevik, 1993; Parker, 2010). For instance, droughts and rainfall variability were responsible for food shortages in 2007 and 2010 (Parker, 2010). Similarly, the 1997/98 El Niño rains destroyed crop fields and physical

infrastructure and brought food shortages and loss of lives and property. Climate change projections indicate that Rufiji district is among areas expected to receive increased temperature and precipitations. According to Tanzania's National Adaptation Programme of Action (NAPA), the district is expected to experience mean daily temperature increases of between 2.7°C and 3.1°C due to changing climate. Increase in temperature, frequencies and severity of droughts and floods: all have the potential to stress agro-ecological conditions for crop growth and affect farming livelihoods. Studies on the role of local institutions in the district are scant; the available few include Mwamfupe (2014) and Meena & Meela (2008), While Parker (2010) his focus on institutions as a peripheral issue. Being a home to a number of Public, Private and Civic organizations operating within formal and informal institutional frameworks, Rufiji has a relevant experience of working with a diversity of institutions in addressing socio-ecological challenges including climate change. This paper is written to evaluate smallholder farmers' perceptions and interpretation of access to institutional support. This is key to improving institutional strategies towards farmers' adaptability to climate change and variability in the context of Rufiji District.

2. Research Methodology

2.1: Description of the Study Area

The study was conducted in Rufiji district. The district was ideal for this study due to its dominant smallholder crop farming as the main source of livelihood; a history of increasing climatic variations; and with widespread local institutions relevant for providing data matrix for this study.

The district is located between longitudes $37^{0}62'$ and $39^{0}17'$E, and between latitudes$7^{0}47'$ and $8^{0}03'$S (Figure 1).

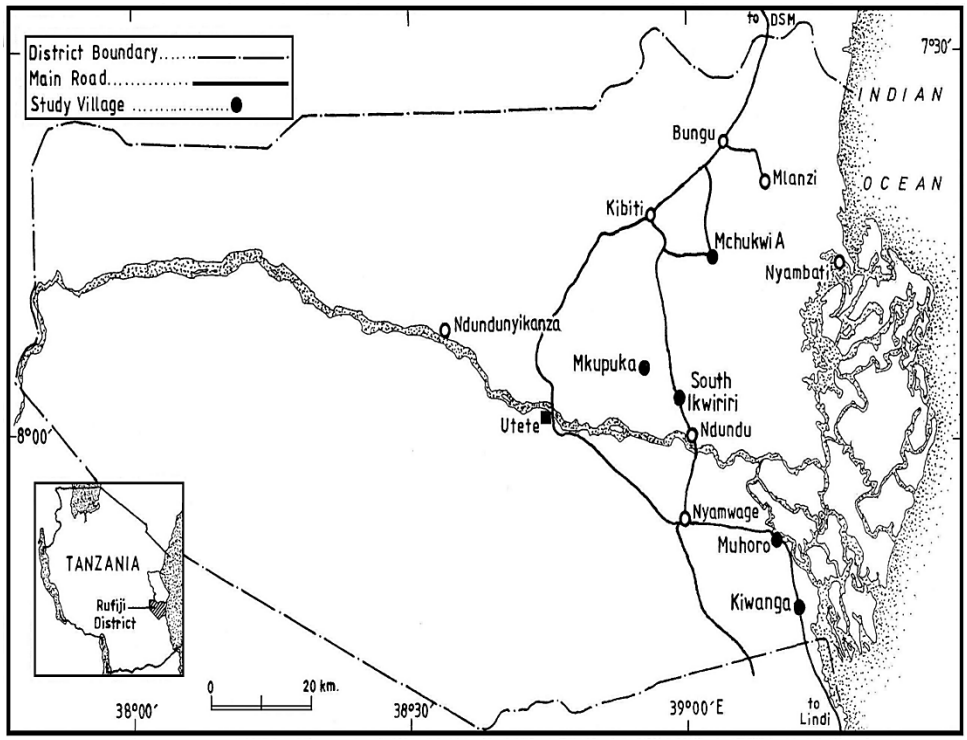

Figure 1: *Study Villages*
Source: *Cartographic Unit, Department of Geography-UDSM*

Rufiji District is at the mean altitude of 500m above sea level. It receives bimodal rainfall with mean annual precipitation estimated between 800mm and 1200mm. The rainfall pattern of Lower Rufiji catchment is controlled by the inter-tropical convergence zone (ITCZ) and the monsoon winds from the Indian Ocean (Shaghude *et al*., 2005). The mean annual temperature is 25^0C. Livelihood is mainly nature-dependent on crop farming; with maize and paddy being the dominant crops while cash crops are sesame and cashew nuts?.

2.2: Sampling Design

In this study I targeted smallholder crop producers (hereafter "farmers") in Rufiji district. Farming households formed a unit of analysis; thus, heads of farming households were focal respondents relevant for informing the study on intra-households' dynamics related to risk perceptions, decisions to adapt and institutional roles. It should be noted that at the time of data collection in 2015,

Rufiji District was in the process of being split into two districts; Rufiji and Kibiti. Mkupuka and Mchukwi A villages now fall into Kibiti District. The choice of study villages was made to represent Highlands, Delta and Floodplain landscapes of Rufiji District. I used stratified random sampling to get 416 heads of households for the survey. Then, I followed the Heckman Procedure and remained with 91.3% of them (380 heads of households) who claimed to be aware of climate change, thus left out 36 heads of households who were not aware.

2.3: Data Collection and Analysis

Data collection and analyses were framed within mixed methods design (Creswell, 2003; Johnson & Christensen, 2012). The protocol of data collection started with Key Informants Interviews (KIIs) and Focused Grouped Discussions (FGDs). This helped me to understand local perceptions of climate change, institutions and adaptation in the area. Preliminary findings informed the design of the questionnaire used to survey 416 heads of farming households selected on stratified random sampling (Johnson & Christensen, 2012; Stapleton, 2010; Kothari, 2004). Then, another round of qualitative data collection followed in aspects that needed further clarification and insights from respondents.

The quantitative analysis involved processing and analyzing data in a coded template structured within the Statistical Package for Social scientists (SPSS v.16) for descriptive and inferential statistical analyses. Qualitative data were analyzed with the assistance of Nvivo 12. Data were transcribed, translated and reviewed for familiarization before exporting them into NVivo 12 software. A codebook related to thematic responses to the study objectives guided the coding before carrying out interpretations in relation to the respective demands of the study. Where necessary, excerpts from narrative accounts or discussions were presented in text boxes as illustrations to deepen understanding.

3. Findings and Discussions

3.1 Farming and Climatic Challenges

From the outset, I aimed at understanding activities portfolios of farming households and how farmers link farming and climatic changes. I asked farmers to *specify the main sources of livelihoods and how they perceive the effects*

of climatic changes on farming productivity. Since I focused on crop farmers, 100% survey respondents identified crop farming as the primary source of livelihood. Maize and Paddy have been grown for decades as subsistence crops while sesame is cultivated for cash. Other important sources of livelihoods include non-farming activities such as charcoal making (45%), petty business (37%) and fishing (*see* Figure2).

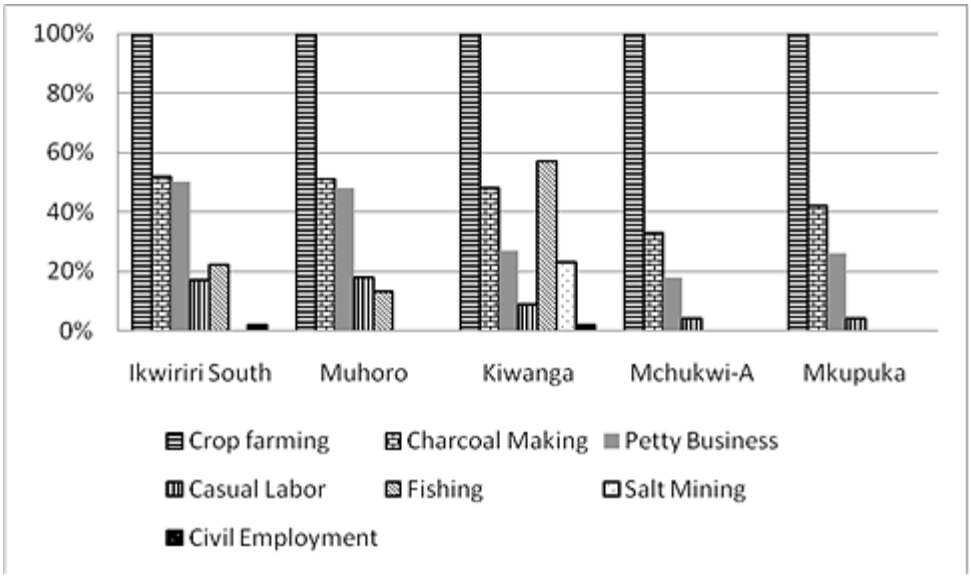

Figure 2: *Main Sources of Income*

Activities portfolios are more diversified in Ikwiriri South and Muhoro, which are the most vibrant commercial areas in Rufiji District compared to the rest of the study villages. There are legal and illegal charcoal making practices which take advantage of endemic coastal forests. Legally, every village is allocated a quarter in a year to make charcoal and sell to customers mainly from outside the district under an agreed set of guidelines between the district government and villages. Illegal charcoal making is driven by the growing demand for charcoal in nearby city centres mainly Dar-es-Salaam. Farming households, legally or illegally, tend to go for charcoal making to compensate for the poorly performing crop farming. Petty businesses are mostly found in Ikwiriri South and Muhoro. Livestock keeping is not popular among the natives of Rufiji, and many households are involved in poultry keeping. There had been an influx of the Maasai, Mang'ati and

Sukuma pastoralists in the early and mid-2000s. This move has mainly served to trigger farmer-herder conflicts rather than for the natives to adopt the practice.

Ninety-one percent of interviewed farmers were aware of climate change mainly through local experience, peer sources of information, non-government organizations and media. The high level of awareness has improved since a study by Meena and Meela (2008). The elder and more educated farmers were significantly more aware of climate change and had greater access to institutional support compared to their respective counterparts. Elderly farmers are more experienced and have indigenous knowledge of climatic trends, while more educated farmers have the ability to comprehend climate information and interpret general atmospheric trends. On the other hand, institutional access provides farmers with exposure to climatic information associated with credits, extension services, and markets.

Famers perceive that the climate is changing and is becoming increasingly variable. For instance, surveyed farmers in the category of those aware of climate change existence were asked to compare the trends of long-term temperature and precipitation for the past 30 years. Seventy-seven percent perceived increased temperature, and 99% perceived decreased precipitation. Farmers' responses were corroborated with findings from analyzed meteorological data for years between 1985 and 2016, which indicated increased and decreased trends in temperature and precipitation, respectively. FGDs and participatory trend analyses with farmers revealed growing concerns of increasing climate-related shocks and stresses. This was also observed by Deressa (2009) in Ethiopia and Gbetibouo (2009) in the Limpopo basin. Table 1 shows some excerpts from transcripts of trend analyses in the study villages.

Table 1: Farmers Perceptions of Climatic Trends

year	*perception*	*source*
1960- 1985	• *"We had plenty of rains...Rains were highly favourable."* • *"...There were droughts but were manageable because they were rarely severe…."* • *"…There have been some damaging floods and useful floods. The floods regime for useful floods was clear that after every three years there could be useful floods we used for floodplain agriculture…"*	➢ *Mkupuka* ➢ *Kiwanga* ➢ *Ikwiriri South*
1986-1995	• *"...Rains were favourable…"* • *"Useful floods were there… enabled us to cultivate twice a year…"*	➢ *Mchukwi-A* ➢ *Ikwiriri South*
1996-2005	• *"...We started experiencing a decline in the rains, and 1997 was the worst we experienced 'since **LangaLanga'** but then El Niño in 1998…"* • *"…We had floods in 1998 due to El Niño, after that the frequency of floods changed instead of three years it started to take longer…"*	➢ *Muhoro* ➢ *Ikwiriri-South*
2006-2016	• *"...Rains have decreased a lot and are more unreliable…"* • *"..Now we have rainfall rationing…"* • *"Rainfall is highly unpredictable… "* • *"...Droughts have been more frequent and severe…"* • *"…Floods may take even longer, this has affected floodplain agriculture, no soil moisture content enough for 'Kichipi ' cultivation…"*	➢ *Mchukwi-A* ➢ *Kiwanga* ➢ *Muhoro* ➢ *Mkupuka* ➢ *Ikwiriri-South*

Source: *Fieldwork (2016)*

The findings are in agreement with conclusions reached by other scholars that the climate in Rufiji District is becoming warmer and drier, rainfall is increasingly becoming unreliable, and drought is more recurrent in the recent past (*See* Mwamfupe, 2014; Parker, 2010). Farmers perceive that climatic variations that are being observed in Rufiji have also affected trends

in crop production. More than 90% perceived decrease in crop yields and attributed the decline to increased drought (77%), increased prevalence of pest attack (68%) and crop diseases (48%), the decline in soil fertility (12%) and poor agronomic practices (11%). With the exception of poor agronomic practices, the rest are linked to climatic factors and increased drought is significantly identified as the most climatic challenge affecting both farming livelihoods.

Farmers have been coping with climate variability and developed some measures to autonomously adapt to climate change. However, in the face of the changing climate, there is a need for effective planned adaptation to climate change. To achieve this, farmers need to access institutional support for adaptation. Rationally, institutional support might be relevant, but in practice, it needs to reflect the contexts in which farming households organize their livelihoods.

3.2 Adaptation needs versus institutional support

Smallholder farmers have been implementing various measures to adapt to climate change and climate variability. The most important options include livelihood diversification to boost household income. There is reduced interest in farming among youth who explore opportunities in motorcycling (*bodaboda*) business. This has a negative implication on labour supply for farming despite appearing to be promising for household income; changes in farming calendars synchronizing rainfall onset (56%); Change in crop varieties by planting early-maturing and/or drought-tolerant varieties, i.e. crop diversification (80%). Apparently, adaptation options are very limited, and those adopted were not fully implemented. I asked farmers to identify other adaptation options that they wished they could have adopted but were not able to, or they managed to implement but to a limited extent. FGDs mentioned conservation agriculture in which soils, water and diversification of species is well utilized; storage of crops to control post-harvest loss; diversification of livelihood sources was found to be less, but farmers perceive it to be critical in easing pressure on agriculture; and improved agronomic practices including application of fertilizers, herbicides and pesticides, as well as irrigation technology for intensive agriculture.

Farmers had different perceptions of local institutions and what they expect of them in the context of responding to challenges related to climate change. In FGDs, I asked farmers *"Why do you think institutional support to climate change adaptation is important to you?"*. Responses were mainly into three things *(i) improve crop productivity following declining trend attributed to climate change (ii) access to reliable markets for their produce in terms of fair prices (iii) climate-resilient livelihood*. During FGDs, farmers identified six institutional requirements necessary to achieve these. The requirements are discussed as follows.

(a) *Resource Management and Tenure Security*

Natural resources form an important asset base for nature dependent communities in Rufiji. In FGDs, I noted that forests, fishing grounds, flood plains, and agricultural land are key resources to livelihood the prosperity of communities in the study area. Governance of the diversified natural resources makes it imperative for local adaptation to climate change, as also noted by Parker (2010). *Resources tenure and access rights* featured multiple times with participants linking access to resources and their associated benefits to farming investment, cultural identity and household income. Fair access and secure resource tenure could play as collateral in accessing agricultural credits; encourage diversification of livelihood sources which in turn could ease pressure on crop farming and earn the much-needed income to fund adaptation initiatives.

Land governance is a contentious issue in Rufiji in general due to its high fertility and potentiality in supporting a diversity of investment opportunities through agro-projects. Sixty percent of respondents were of the view that participatory and more inclusive governance of natural resources would have supported adaptation by organizing farmers' adaptation needs through established or strengthened local institutions; ensuring fair distributions of benefits accrued from natural resources; promote sustainable agriculture and resources conservation. Villages such as Mkupuka, are part of Joint Forest Management (JFM) arrangement for Ngumburuni Forest Reserve. Respondents find that villages do not benefit much from accessing the benefits of the forest, rather suggesting increased deforestation due to peripheral involvement of local communities in the

management arrangement. JFM operates with promises to improve forest income to local communities but barely realized in a practical sense. This observation is also echoed by Tarimo and Ringo (2016). Debates over natural resource governance in Rufiji, especially land issues, are not new in scientific writings and have been presented in multiple ways notably as farmer-herder conflicts; and local communities versus (small to large) investors from outside (Mwansasu and Westerberg, 2014; Walwa, 2020; Mwamfupe, 2014). Inadequate tenure systems fail to fully benefit farmers with access to natural resources and bolster their adaptability to climatic changes and effects.

(b) *Access to actionable climate information and early warning systems*

Access to climate information is critical for farmers' adaptation to climate change. In FGDs, farmers' suggested that climate forecasts would play a vital role in informing farmers' adaptive responses. Regressions indicated that farmers who had access to climate information were 2.4 times (sig. 0.000) more likely to adopt various adaptation strategies compared to those who had no access. Interviews in the study villages revealed that access to timely, quality and relevant climate information has an important role to play in farmers' decision making towards particular adaptation strategies. I found that access to climate information was largely unsatisfactory with 43% saying access is very poor, poor (25%), not poor nor good (11%), good (7%), very good (4%), don't know (10%). The mechanisms through which to get climatic information was mainly limited to radio programmes which only 26% indicated to have ever happened to get information about climate change and agriculture in the past ten years. Another important channel is village assemblies which among several developmental issues they are used to channel climate-related information in the form of expert advice. In-depth interviews with VEOs of Kiwanga, Mchukwi A and Muhoro indicated the assemblies to get information about climate change through AEOs or representatives of NGOs.

Farmers indicated that local institutions were important channels through which climate information could flow between them and other stakeholders for action. NGOs were identified as the most reliable institutions supporting local communities accessing climate information and knowledge on adaptation. The most common in all five study villages were World Wide

Fund for Nature (WWF). The organization had been linking local farmers with national and international research-based information related to climatic trends, adaptation and agricultural marketing. NGOs were found to be well informed of local challenges and had mechanisms in place of presenting the challenges to other stakeholders for research or policy action. The experience of several NGOs operating in the study villages brought them closer to local communities concerns and needs; their community-based approaches in understanding such concerns and needs earned them more trust from local communities.

Similarly, in KIIs with officials in the village council and FGDs, I noted that village governments had a significant role in structuring knowledge and influencing information dissemination to farmers. Village councils have been in place to link local communities and higher levels of governments. Village assemblies have been a critical institution in collecting and disseminating information to and from villagers. For instance, village leaderships in Mkupuka and Kiwanga argued that information on better seeds, availability of markets, extension services, climatic trends, and responses to climate variability and change were more provided through village assemblies and notice boards.

Local Institutions and access to rural credits

Farmers identified access to rural credits as the most important institutional requirement. Facilitation of storage, diversification of crops, and access to drought-tolerant crop cultivars is costly. Access to credits in the study area is through formal and informal sources. Formal sources include Commercial Banks operating from Ikwiriri Township and mainly serve the traders and civil servants. Only 21% of the interviewed farmers had bank accounts 90% of which were from Ikwiriri and Muhoro. None registered access to a loan for agricultural purpose through banks. Rather there are Micro Finance Institutions (MFIs) which have been mobilizing farmers to access loans through groups for entrepreneurial purposes. These, however, are not famous among farmers since the Islam culture, which is dominant in the study villages discourage interest loans and that the conditions are very difficult to fulfil.

Another form of MFIs is Village Community Banks (VICOBAs). VICOBAs are formally registered and village-based established to provide entrepreneurial training and provide small loans for small projects and address social issues such as medical expenses. These are only found in Muhoro and Ikwiriri South villages. The two villages are commercially advanced compared to the rest. However, only 16% and 9% of interviewed farmers in Ikwiriri South and Muhoro were involved with VICOBAs. Farmers with access to VICOBAs were significantly more likely to adapt to climate change through the application of chemical herbicides, use of farming technologies such as hiring tractors for tilling, and diversification of livelihoods through investing in alternative sources of income such as petty trading. The District Council provide loans to youths' groups, but personal communication with the Community Development Officer revealed that most groups invest in petty trades and rarely in agricultural projects. An increase in access to credit raises the probability of adaptation to climate change by 12.78%. This finding collaborates with the observation by Lusiru & Mwamfupe (2014) in northern Tanzania.

Access to Agricultural Inputs, Skills and Technologies

Agronomic practices are key to conservation agriculture and adaptation. Farmers mentioned access to agricultural inputs and technologies as one among key institutional factors to support their agronomic adaptation to climate change.

Table 2: Technologies Used by Smallholder Farmers

	Responses by Villages (%)					
Main Technology	Ikwiriri South	Muhoro	Kiwanga	Mchukwi-A	Mkupuka	Total
Hand-hoe	96	100	100	100	100	99
Tractors and Power-Tillers	46	33	11	27	34	30
Ox-ridges/ draught animals	10	18	10	0	0	8
Pesticides	43	36	24	49	54	37
Fertilizer	27	40	16	27	32	28
Improved Seed	38	32	17	37	32	30
Irrigation	39	12	0	0	0	10

**Based on Multiple Response Analysis*

Almost all surveyed farmers (99%) use hand-hoe technologies as a basic technology for cultivation, while only 30% would at times hire tractors and power-tillers but only during cultivation. Not all farmers could afford to hire a power-tiller or tractor for cultivation. Application of draught is very limited (8%) since I observed that the district government supported farmers with subsidized input voucher system, but the extent of the application was low among surveyed farmers. Only 28% applied fertilizers, 37% applied pesticides, and 30% adopted improved seeds. The locals in Rufiji still hold that land in the district is fertile even without these inputs, but climate change is increasingly forcing them to think of alternatives to improve crop productivity. Some smallholder farmers perceive the voucher scheme for subsidized inputs to be operating with corrupt officials who happened to rig the system to benefit private dealers. Challenges also included late availability of inputs far behind they are needed; failure to afford the subsidized price. Some farmers complained that the system did not pay attention to their needs. One of the FGD participants at Ikwiriri South lamented.

> *"….we do not need fertilizer, our soils are fertile, but the system insists that whoever need to access seeds must also purchase fertilizers…"(FGD participant/Ikwiriri South).*

Farmers also reported cases, whereby seeds and fertilizers supposed to be provided to farmers, were still in village offices even after farmers' appropriate time for use had passed. The question of agronomic skills is linked to the provision of agricultural extension services. The availability of Agricultural Extension Officers (AEOs) was far behind requirement by 75%. I noted that AEOs were stationed at ward headquarters and would have to visit scattered villages within their areas of operations which in the context of rural Tanzania they have to cover wider geographical areas transport among villages is limited mainly to bicycles. AEOs had a motorcycle, but several times farmers had to pay to fuel them if they needed the service which for many could not afford. Farmers identified lack of transport facilities to meet farmers, very few pieces of training on capacity-building and lack of exposure to new knowledge, especially on climate change, and lack of motivations.

NGOs had been working to bridge the gap by supporting and promoting training to farmers and facilitating field visits. However, this support was found in Mkupuka and Mchukwi-A and not in all villages. The support depended on NGOs decision of coverage thus not sustainably provided. Another form of extension service is farmer-to-farmer peer education that is based on experience. Farmer-to-farmer extension services were mainly based on sharing farming experiences, sharing seeds, as well as climate and agricultural information. Farmer-to-farmer extension services were more associated with kinship links and social capital that existed in the studied villages. The findings imply that farmer-to-farmer extension was the main source of information on agriculture and climate change. However, this source could not update information on current and future climate conditions.

(c) *Access to Markets*

Climate change affects crop productivity in terms of quality and quantity of crops produced. From the study, farmers indicated that agricultural marketing is among the most important institutional aspects necessary for their effective adaptability to climate change. I asked farmers to characterize market access. They mentioned three things: (i) *access to reliable customers be it a private enterprise, individuals or government or cooperative unions. (ii) fair prices (iii) timely purchase of produce.* All these three things are not satisfactory among farmers, as revealed in FGDs. Accessibility to agricultural markets in Tanzania has been organized through cooperative unions at different levels. The history of cooperative unions in Tanzania, however, has been discouraging especially since the implementation of market liberalization policies in the mid-1980s. This arguably set smallholder farmers at the losing end since they were not equipped with relevant and timely information on the right markets and limited bargaining skills.

> "….For us, if we sell our cashew and sesame to customers who come here on time and pay the right price; it makes sense to invest in agriculture and earn adequate income for our families….."(FGD participant/Mkupuka Village)

Reliable markets guarantee farmers with household income and thus making crop farming worthy pursuing. Rufji has Agricultural Marketing

Cooperative Societies (AMCOs) which concentrate on buying cashew. However, despite cashew having an organized marketing structure and a Board in place, farmers commented that the prices offered are not fair. In 2018 farmers protested against what they called unfair prices offered by private companies, and the government decided to buy it from farmers. Unfair prices discourage investing in cashew production and have an adverse effect on the household economy. The importance of AMCOs in facilitating adaptation to climate change is through the provision of profitable and timely markets for agricultural products. However, as mentioned above, AMCOs in Rufiji district were only dealing with cashew producers, and not with other crops. Moreover, their cashew marketing was not timely and delayed to meet another season. Crops such as sesame do not have boards rather marketing is through intermediaries who consult individual farmers each bargaining differently.

Furthermore, poor networking of AMCOs was a challenge at the district level. According to the Rufiji DCO, at the time of the study, there were 15 AMCOs in the District. However, out of these, 12 AMCOs were poorly functioning due to incompetent officials, misappropriation of funds and poor management of accounts. Due to the lack of AMCOs for other crops, producers of crops such as paddy and maize always fell in the hands of intermediaries who set the prices of crops and linked farmers with buyers. FGDs with farmers revealed that most do not have adequate skills to access market prices and trends. Thus, their bargaining power is limited and are forced to accept whatever prices set by middlemen. This lack of stability of market prices for agricultural produce negatively impact farmers' decision-making over agronomic practices oriented towards adaptation to climate change as observed by other scholars (*see* Deressa *et al.*,2008; Gbetibuo, 2009; Nzeadibe *et al.,* 2011).

3.3 Barriers to Institutional Performance towards Farmers' Adaptation

Farmers have been adapting to climate change. From survey data, I noted a gap between willingness to adapt and adoption of specific adaptation strategies. Despite farmers' perceptions and characterization of institutional support relevant for their adaptation options, I asked them to explain what

they find to be barriers to accessing institutional support for effective adaptation. Farmers identified and explained the following factors:

*Corruption***:** In KIIs and FGDs strongly addressed corruption as the main hindrance in local access to institutional adaptation support. They gave examples of accessing subsidized inputs to have allowed private dealers to influence the price and availability of the inputs in their favour. I noted that access to extensions services was also determined by the ability of farmers to pay a specific amount of money to cover fuel for AEOs motorcycles. From the survey, 46.5% argued that corruption in the judicial systems involving favouring livestock keepers in the decision-making process that involve resolving farmer-herder conflicts. This exacerbates mistrust and vulnerability among farmers and pastoralists. Farmers argued that pastoralists were favoured in the provision of extension services. On their part, AEOs claimed that it was easier to serve pastoralists since they paid for motorcycle fuel. However, the district livestock officer dismissed the claims and asserted that farmer-pastoral conflicts on land uses were the sole reason for farmers to have such a negative perception. The findings suggest that the perception of corruption among farmers increases their vulnerability as they lose trust in important institutions such as judicial systems and extension services providers.

Limited Capacity of Institutions: While the critical role of village councils is related to enabling farmers' accessibility to institutional support, the councils, however, suffer from inadequate technical, administrative, and resources capabilities. These weaknesses limit the village councils to channel farmers concerns to different stakeholders for actions properly; fail to organize the collective effort and prioritize adaptation needs for the smallholder.

> "…..if local institutions are weak, it renders it impossible for them to help communities transform into climate-resilient societies; failure to have a long-term vision and establish linkages between climate change adaptations and development needs…" (KII with Agricultural Extension Officer/Muhoro Village)

Addressing this barrier, farmers are of the opinion that building institutional capacity is necessary. This is especially through enabling local institutions to develop abilities to comprehend climate change challenges, design mechanisms of addressing the challenges.

The conservativeness of institutions to Change: Institutions have failed to be flexible enough to accommodate new ways of managing climate change. Sticking to the traditional way of addressing agriculture do not incorporate climate change needs by smallholder farmers. Failure to acknowledge and adapt to changes necessitated by the changing climate make institutions fail to suit actions into local conditions. However, I noted that many RLIs were not established with the purpose of addressing climate change, rather multiple other purposes. Micro-finance institutions targeted small and medium business enterprises and farmers. Changes in mechanisms through which they support farmers require structural modification of the organizations, and that should start from the hierarchy of the organizations at the national level.

Limited institutional coordination: Another obstacle for smallholder farmers to realize the potentials of institutions is that local institutions are poorly coordinated amongst themselves leading to duplication of resources and effort and creating voids that are not attended to. NGOs have been visiting villages at different times. Sometimes they happen to implement similar projects that have been implemented by other NGOs prior to their visits. At the same time, other villages do not get support from NGOs.

Political rivalry: Rufiji is having vivid political rivalry between members of the ruling party and opposition parties. Attendance of village assemblies is sometimes hindered by political ideologies. Only 18% were found to have attended village assemblies twice or more in a year with four routine assemblies. This affects various decision-making processes at the village level since decisions for important things such as land leasing to investors, financial reports on village revenues and expenditure are given, and many other developmental issues. The village assembly is the most powerful organ at village level to influence any social and economic matter. Disparities along partisan ideologies make it difficult on collective planning and implementing actions that influence households and farming, which is the main source of livelihood. In KIIs, village executive officers admitted controversies among villagers in expenditure and revenues reports

4. Conclusions

Smallholder farmers in Rufiji depend on crop farming for subsistence purposes and on cashew and sesame as cash crops. However, their dependence on crop farming and with less diverse activities portfolios, make them vulnerable to climatic changes. Changing climatic patterns are posing a major threat to the sustainability of smallholder farming in Rufiji. Safeguarding crop farming from erratic rainfall and recurrent droughts make adaptation a priority.

Given the importance of RLIs in supporting adaptation, farmers perceive a mismatch between their adaptation priorities and institutional support available. While RLIs has been providing support to farmers, but that support is inadequate since it is not focused on what farmers find as areas relevant for institutional roles. Key institutional strengths identified by farmers include support to access credits, agricultural markets, skills and technologies, climate information and as resource tenure securities. For RLIs to support farmers in adapting to adapt to climate change, there is a need for building institutional capacity to comprehend farmers' vulnerability to climate change and coordinate effective efforts. As evidenced in the study, access to institutional support has significant contribution in enhancing farmers' adaptive capacities and adaptabilities.

Weak agricultural organizations hinder smallholder farmers from realizing fair terms of trade and make agriculture profitable. This requires that policies addressing agribusiness to focus on the restructuring of cooperative unions in the way of empowering farmers to achieve fair prices for their products, especially through crop-based or farmers' organizations.

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