

Smallholder Farmers' Susceptibility to Climate Change Variability: Assessing Adaptation Strategies and Impact on livelihoods

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Abstract

Climate change and variability present a new set of obstacles that smallholder farmers in the 21st century have to face, especially hitting farmers in developing countries hard. The livelihoods of many farmers have become exacerbated due to the adverse impact of climate change. Governments and non-governmental agencies have stepped up their roles in helping smallholder farmers rise to the challenge through novel adaptation strategies. Using content analysis of relevant theoretical and empirical literature sources, this paper discusses the concept of climate change adaptation and its impact on the livelihood of smallholder farmers. The susceptibility of smallholder farmers to climate change are discussed and various adaptation options and more importantly, their effect, are explored. The study concludes that interventions by government and non-governmental actors have an impact on the overall livelihood of smallholder farmers in terms of neutralizing the adverse impact brought forth by climate change. The study makes some recommendations, including advancing a combination of traditional and modern practices in adaptation processes; consideration of socio-demographic characteristics of farmers in the adaptation processes.

Keywords: Climate change, Vulnerabilities, Livelihoods, Smallholder farmers, Poverty, Adaptation

1. Introduction

The phenomenon of climate change and its impact on humanity has received wide attention worldwide over, at least in the last few decades (Rademacher-Schulz *et al.*, 2014; Teye & Yaro 2015). This is against a backdrop that climate change impacts are perceived,

acknowledged and significantly felt by people, especially so in developing countries where many vulnerable groups and rural households have limited resources to cope with and adapt to climate change and variability (Adger *et al.*, 2005; UNFCCC, 2007; IPCC, 2007). African countries are hard hit by climate change and this is largely manifested in the agricultural sector, which as a consequence, generates low crop yields and high poverty (Roetter *et al.*, 2007; IPCC, 2007). Climate change involves long-term changes in climate over time; these changes may be due to either natural variability or be a result of human-induced factors (IPCC, 2007). The common climatic elements which mostly affect smallholder farmers in rural areas in Africa involve drought, erratic rainfalls, high temperatures, late onset of rains and the early cessations of rainfalls, lower levels of downpour and excessive downpours causing flooding (AAESCC, 2015). This variability of weather has left farmers with no choice but to adopt measures to might ameliorate the situation. The rate of change in climatic patterns and their elements have rendered communities very vulnerable and the climate figures predict a bleak future, if robust and proactive measures are not put in place. Data demonstrate an increasing rate of global warming, especially over the past two to three decades (UNFCCC, 2007).

The point being made here is that climate change has come to stay and its impact has been widely felt by smallholder farmers who largely rely on the mercy of the weather elements. This point has been brought home by Sharma *et al.* (2009) that explicit information on well-being in rural communities and the impacts of climate change on people's livelihoods and natural resources have been predicted. Climate change adaptation and livelihoods and their various ramifications have received wide attention in the literature. For instance, the literature assesses the limits and barriers as well as opportunities for adaptation (see Adger *et al.*, 2009; Burch, 2010; Moser & Ekstrom, 2010; Nielsen & Reenberg, 2010; Sietz *et al.*, 2011; Marshall *et al.*, 2012). These studies have developed conceptual and theoretical constructs as well as a criteria for the wider comprehension of adaptation, the assessment of the vulnerability of social and ecological systems in forecasted climate change variability in the future, including the development, adoption, and implementation of adaptation strategies. Other studies (Burch, 2010; Eakin & Patt, 2011) discuss the relevance or effectiveness of the above efforts in building understanding and awareness as well as they assess any measurement of vulnerability and adaptive capacities and options and the creation of opportunities for adaptation (Burch, 2010; Eakin & Patt, 2011).

Many of the recent studies on the topic assess adaptation practices, with the main focus on adaptation initiatives and their impact on livelihoods in developed countries (Berrang-Ford *et al.*, 2011; Ford *et al.*, 2011). In the Sub-Saharan African context, climate change and extremes such as drought are responsible for substantial economic, social, and environmental destruction. Managing the risk posed by climate change and extreme events through implementing effective technological, institutional, and policy options are crucial (Shiferaw *et al.*, 2014). An attempt to help farmers adapt to the impact/consequences of climate change will inadvertently/it is hoped, improve their livelihood options and quality of life. Put differently, by introducing rural farmers to adaptation processes, they might be able to improve their livelihood processes. This is because adaptation entails the social, human,

physical, financial and natural capital required for sustainable livelihoods (Chambers, 1989; Chambers & Conway, 1992) that could empower farmers who otherwise would have been left very vulnerable.

This is against the backdrop that climate change is predicted to pose significant harmful socio-economic effects on developing countries (Singh et al., 2010) which will affect the most vulnerable peoples and groups, especially smallholder farmers. Consequently, studies on climate change have focussed on attempts at quantifying climate change and its impact on people's livelihood (Hansen et al., 2006); others have also discussed the biophysical, social and economic costs of climate impacts (see Stern, 2006; Tol, 2010). Studies have discussed methods for the assessment of community and group vulnerability to climate change (Eakin & Luers, 2006; Adger et al., 2007). Fankhauser et al. (1999), Hallegatte, (2009) have provided key measures and strategies for adapting to climate change effects. What remains largely overlooked in the literature is an assessment of the impact of adaptation efforts on the livelihoods of people and groups. For example, several NGOs have embarked on adaptation efforts in many rural communities the world over, especially in developing communities, but the actual impact of their adaptation efforts on people's livelihood remains largely under-studied. The question is, what has been the impact of climate change adaptation efforts on people's livelihood efforts? This paper seeks to discuss climate change adaptation efforts with an emphasis on how these efforts influence the livelihoods of vulnerable people.

2. Literature Review and Theoretical Overview

2.1 Conceptualizing Adaptation

The concept of adaptation has been viewed as a commensurate approach to respond to the adverse effects of climate change on vulnerable people, especially small-holder farmers in rural settlements

(Ozor et al., 2012). Adaptation has been conceptualized to mean the adjustment of natural or anthropogenic systems/processes to respond to real, perceived or predicted climatic stimuli or the impact with a view to moderating the harm thereof (IPCC, 2001; Deressa et al., 2009). The approach to climate change adaptation is varied; in other words, individuals and groups have varying ways to respond to climate change, mostly depending on the underlying contextual conditions and individual/group orientation/demographics. For example, it may involve the introduction of new varieties of crops and livestock species which are more resistant and much better suited to new conditions; adoption or introduction of irrigation to augment poor rainfall and temperature patterns (Elizabeth et al., 2013). It may also involve diversifying the crops being grown and adopting a mixed cropping approach and incorporating insurance policies in farming activities (Deressa et al., 2009).

Adaptation to climate change is context-dependent and it is quintessential/essential to acquire adequate understanding and knowledge of particular communities in order to access their coping and adaptation measures and practices (Muhammad et al., 2014). This is because such knowledge is relevant in the choice of the particular adaptation measures requires to mitigate actual or perceived climate change impacts.

3. Methodology

This paper analyses existing theoretical and empirical studies, (mainly drawn from journal articles and relevant books) to examine the impact of climate change adaptation on the livelihoods of smallholder farmers. The literature search covered all terms and terminologies related to climate change adaptation and livelihoods: ‘climate change adaptation’, ‘CC adaptation’, ‘adaptation and livelihoods’. In the process, the author combined words related to the impact of adaptation measures and livelihoods. The different adjectives and the concept of climate change adaptation were combined in different ways to obtain a pool of more relevant literature on the study. Three key search engines were adopted due to their relevance and accessibility to the researcher: *ScienceDirect*, *Tandonline*, and *Google Scholar*. The large pool of articles from these sources was initially sought for reading through their abstracts.

4. Discussion: Climate Change, Impacts and Livelihoods

4.1 Smallholder Farmers’ Susceptibility to Climate Change Impacts

Livelihood connotes the financial means through which one lives. Most people in rural Africa significantly have their livelihoods hinged on small-holder agriculture. People or community livelihood is said to be sustainable if such group is able to (i) cope with; (ii) or recover from, stress and shocks; (iii) maintain or improve its capabilities and assets; (iv) provide sustainable livelihood opportunities for the next generation (Chambers, 1989; Chambers & Conway, 1992).

People in rural Africa have their livelihood attached to agriculture, which is also dependent on climate elements which impact on livelihoods of individuals in rural Africa. It is therefore important to address the vulnerabilities of people and to encourage them adapt new strategies to cope with erratic climate patterns as they otherwise might lose their livelihood entirely.

Before establishing the impact of adaptation on people’s livelihoods, it is crucial to unpack how the phenomenon affects livelihoods. The vulnerability of a system to climate change is determined by its exposure, by its physical setting and sensitivity, and by its ability and opportunity to adapt to change. The vulnerability may result from natural disasters largely beyond man’s control, over-exploitation and unguarded usage of resources, poverty and lack of access to; marginalisation and social exclusion (Barnett, 2001). Social vulnerability clearly involves such demographic and socio-economic factors that aggravate or mitigate the consequences of harmful events on local populations (Tierney et al., 2001). A climate change context suggests that those who are at risk and the degree to which they can be harmed increase climate variability. Marginalised communities are largely affected by varying factors over which they have no control which could impact their livelihood (DFID, 1999; Hobley, 2002). The impact and susceptibility to climate change effects are compounded in rural Sahelian communities which are already bereft of predictable rains (Pandey, 2009).

In that regard, individuals and groups in these communities need to intensify their climate change adaptation efforts. This increased cost of adaptation efforts puts pressure on farmers and tends to threaten the relationship between the human and the environment in the long term (Parmesan & Yohe, 2003). In that regard, the nature and intensity of climate change

vulnerability largely depend on the costs of coping, the adaptation options as well as the adaptive capacity of the peculiar community, as these may differ between the more prosperous and the poor communities.

4.2 Gender and Climate Change Vulnerability

Among agrarian communities and people, climate change impacts significantly manifest themselves as they contend with far-reaching indeterminate conditions to raise food and earn a decent living. It must be established that although the impact of climate change is widely felt on the livelihoods of agriculture dependent populations and groups, the effects are not uniformly felt (Paavola & Adger 2006; Pelling & High 2005). The contemporary literature on adaptation extensively intimates that patterns of vulnerability to climate change impacts are shaped by roles, responsibilities, as well as by entitlements associated with social demographics, such as gender, class, and caste (see Adger 2006; Reid & Vogel 2006). In the assessment of vulnerabilities, the level of vulnerability depends on social demographics. According to Singh et al. (2010), the susceptibility of people to climate change impacts is gender dependent. This point has already been intimated by Denton (2002) that men and women farmers in many developing countries experience different levels of vulnerability and adaptive capacity to climate change. This suggests that men experience the phenomenon differently from women, the latter mostly become worse off due to climate change and are not able to adapt as well as their male counterparts. In other words, compared to men, women are more vulnerable to the effects of climate change largely due to their restricted access to resources, rights, mobility and their lack of voice in the community and in household decision-making (UNDP, 2008). Other plausible explanatory variables are that access to credit in rural settings of many developing African countries, mostly increases the financial resources of male farmers as against their female counterparts in (Benhin, 2006; Gbetibouo, 2009). This is real and mostly leads to disastrous consequences, especially as women perform significant roles in the stewardship of natural resources and in support of households and communities (Seema, 2011). Consequently, a United Nations (UN) policy brief stresses that it is crucial that adaptation efforts integrate gender issues at all levels (Habtezion, 2013).

It is in view of this that scholars have advanced an argument for a gender-based vulnerability approach to climate change and consequent adaptation measures (see Dankelman, 2010; MacGregor, 2010; UNDP, 2012). Bringing the argument closer to home, Hemmati and Rohr (2007) intimate that policymakers and practitioners need to assess issues of men and women separately in order to adopt gender-specific adaptation measures and strategies which are practicably feasible (Hemmati & Rohr, 2007)

4.3 Challenges Associated with Climate Change Adaptation Efforts

Owing to the challenges that confront small-holder farmers, efforts at strengthening adaptation measures need to be encouraged. However, the literature provides clear examples of the greatest challenges that confront such efforts. In most cases, there is a greater disparity between intended actions and actual practice (O'Brien & Wolf, 2010).

The main causes of this adaptation challenge include poor governance systems (Amundsen et

al., 2010), self-interested leadership (Anguelovski & Carmin, 2011), lack of institutional coordination (Moser & Ekstrom, 2010), poor financial acumen and skill-sets for poor farmers exacerbated by lack of opportunities for realizing these (Bryan et al., 2009; Kabubo-Mariara, 2009). Other studies have identified the poor access to relevant information and data (Deressa et al., 2009; Hammill & Tanner, 2011) and poor problem conceptualization with associated type error (Gorddard et al., 2012). Other studies have advanced the relevance of governance regimes; according to Dobusch and Schußler (2012), it is critical to reckon the role of historical contexts [the policy feedbacks that come with social and cultural practices, technologies, and institutional arrangements].

Scholars have argued that efforts at helping poor farmers to adequately adapt to the excesses of climate change ought to be born out of the contextual or prevailing circumstances and firmed up with science and local knowledge (Sarewitz, 2004; Dessai et al., 2007; Moser, 2010). In doing so, the governance system needs to be more responsive, transparent and participatory in nature (Moser et al., 2012). This suggests that climate change adaptation measures and processes need to adopt a prudent and methodical process of effectively diagnosing and conceptualizing the nature of the problem as well as relevant policy interventions to adapt accordingly. The role of leadership, institutions and governance processes is very crucial in the entire process as poor farmers require a robust institutional regime in order to put most of the ideas into practice or real action. In most cases, farmers appear to possess some level of local knowledge to adapt or respond to emerging climatic threats. This notwithstanding, they mostly remain vulnerable and susceptible to climate change largely due to lack of access to financial resources and the capacity to put their thoughts into action. Given the necessary institutional and governance support, poor farmers will have well-informed policy response as interventions to help them adapt prudently to the variability of climate change. When this is carried out effectively, farmers will improve upon the livelihoods since they greatly depend on small-scale agriculture. What therefore is the impact of the climate change adaptation process?

4.4 Impact of Climate Change Adaptation on Sustainable Livelihoods

In this section, the paper advances the impact of climate change adaptation efforts on the livelihoods of smallholder farmers. Various reports illustrate a deleterious impact of climate change on smallholder farmers in the coming years. For instance, the IPCC (2013) predicts there will be an increase in erratic weather conditions due to the shortening of the rainy season in parts of West Africa. Consequently, the agriculture sector of Sub-Sahara Africa is expected to be hard hit due to the fact that 96% of agricultural land in this region is largely dependent on rain-fed water (see also World Bank, 2008) largely exacerbated by the fact that there is an inappropriate application of technology by farmers (Wallace & Knausenberger, 1997). Consequently, most farmers in rural African countries who significantly depend on rain-fed agriculture for their dietary support and income sustenance have become worse off because their livelihoods have been negatively affected. This is due to the fact that extreme weather conditions, productivity in major crops such as maize, groundnut, millet and cassava has dropped and is predicted to drop by seven to twenty-seven percent by the year 2050 (Schlenker & Lobell, 2010; IPCC, 2007; Ackerman & Stanton, 2012). For instance, AISSEC

(2015) reports that some farmers in 2015 even harvested nothing from their cropped fields as a result of crop failure emanating from the effects of bad weather conditions.

Experts have advanced a need to step up in the enhancement of the adaptive capacity of farmers and groups which is regarded as the panacea for governments' policies in environmental management and socio-economic imperatives (Armitage & Plumber, 2010). According to Lim et al (2004), persons, groups and communities are required to seek relevant and effective adaptation strategies in rural settings of many developing African countries in order to make the lives of people worthwhile. Adaptation to climate change, especially in developing countries remains quintessential and which should be regarded as or be advocated forward to be higher on the agenda on the institutional tables of policy makers, local leaders and at the individual or personal level (UNFCCC, 2007). More relevant to smallholder farmers is the fact that their entire livelihood is tied to rain-fed agriculture, which remains inherently dependent on climate variability and quite sensitive to climate conditions (Reilly, 1995; Smit & Skinner, 2002). As a result, issues of adaptation to climate change in agriculture have a profound impact on agriculture and people's livelihood (Adger et al, 2003). This is even reflected in the conceptualization of climate change as involving an adjustment in response to reduce the impact of climate change on the farming operation, livelihoods, and people's lives (see Grothmann & Patt, 2007; Osbahr et al, 2010).

The rationality here is that rural communities and people in many African countries are into farming to support their families and household income and upkeep. Given present conditions and trends posed by climate change, people and societies in these contexts risk being deprived of their sustainable and decent livelihoods. In many communities, the vegetation is being destroyed, rivers dry up and the humidity content of the air has become less and temperatures keep rising exacerbated by poor or erratic rainfall. Without relevant interventions, the livelihoods of rural farmers will be affected negatively. It is against this backdrop that varying interventions or adaptation strategies have been advanced to deliver vulnerable groups from the livelihood deficits that are feared will pose disaster to/for smallholder farmers.

4.5 Adaptation Options and Livelihood

There are at least four climate change adaptation measures or options that are relevant to the agricultural sector and that may operate hand in hand (Smit & Skinner, 2002): technological developments, early warning signals, government programmes and insurance, and reorientation of farming practices.

4.5.1 Technological Developments

Technological development has been advanced or instituted in many countries in the developing world in order to respond and adapt to the climate change variability. In the agricultural sector, for farmers to be better off in their livelihood option, farmers have been introduced to new crop varieties that are resistant to adverse climate change effect. Through research and innovation, new seeds and crops have been discovered which could withstand long droughts and poor rainfall and other weather variabilities (Smit & Skinner, 2002). In

other words, an adaptation option takes the form of reducing dependence on vulnerable systems such as diversifying food production away from a limited number of drought-prone crops to those that have been improved to withstand drought.

4.5.2 Development of Early Warning Systems

An important adaptation approach relevant to the agricultural sector is the development of early warning systems and developing improved water services for crops (Smit & Skinner, 2002). An early warning system helps to monitor and track weather patterns that may have an impact on farmers' activities. In most cases, poor rainfall or prolonged rainfall cause crops to die or remain stunted, it is, therefore, important to develop innovative structures for water management systems.

4.5.3 Insurance Systems for Crops

Owing to the uncertainties caused by climate change, it is prudent for local governments, NGOs and other actors find ways to help insure the farms and produce of vulnerable farmers. This has been a standard practice in most commercial farms in the developed countries, where farms are insured against some unforeseen circumstances such as bushfires. To reduce the vulnerabilities and to cushion farmers against the vagaries of climate change, it is crucial to develop crop insurance programmes and to modify subsidy and incentive programmes to create leverage for farmers (Smit & Skinner, 2002)

4.5.4 Farming Production Practices

Responding to challenges posed by climate change, farmers should be introduced to newer and innovative farming practices that can stand climate change variability. Farm production practices such as crop or livestock diversification, adopting variation in timing of farm operations as well as innovation in the irrigation systems (Bryan et al, 2009). In an empirical study by AISSEC (2015) in the Atebubu-Amantin District in Ghana, 32% of farmers indicated that they resort to Residue Management, 21% and 10% adopt earthing up/ sticking of crops and composting respectively as the adaptation options. Surprisingly, 16% do nothing whilst another 16% resort to prayers to adapt to climate change impacts. In another district, 27% and 12% resort to prayers and nothing respectively. This suggests that there is more need for sensitization and education of farmers in rural areas on the need for specific strategies and not on just prayers or leaving everything to 'fate'. Key adaptation measures undertaken by farmers are residue management, farmyard manure application, shifting cultivation, rotational cropping, mixed cropping, catching water, planting trees, and alternative income strategies. Farmers in other communities, by catching water increased organic material, and farmyard manure.

4.5.5 Diversifying Livelihood Sources

It is important for farmers to be introduced to varying livelihood options so that their dependence on climate-inspired agriculture reduces. More often than not, small-holder farmers tend to put all their eggs in one basket; this means their entire livelihood is hinged on rain-fed agriculture, which makes them totally worse off during off-season or in periods when

there are erratic rainfall and temperature patterns. Against that backdrop, NGOs, local governments and interest groups need to assist farmers through workshops and training programmes that will introduce them to other livelihood options and choices to supplement agriculture or to improve upon novel farming activities. In that regard, some farmers have also diversified into livestock farming and livestock diversification. Additionally, it is prudent to take farmers through sound financial management, including diversifying sources of household income and supplementary options (Bryan et al, 2009; Thomas et al, 2007)

5. Conclusion and Recommendations

This paper has discussed the concept of as well as the impact of climate change adaptation in agriculture with emphasis on the livelihoods of smallholder farmers. From the discussions above, the paper derives the following key conclusions. Firstly, the study concludes that climate change is real and its consequences are very evident among rural African farmers who do not only go hungry due to crop failure but also do not get any income for livelihood support.

The study concludes that the vulnerability of smallholder farmers to climate change impact could be minimized through a combination of traditional and modern practices. The study argues that it is crucial to adapt the local ecological knowledge and perhaps use this as the starting point or the basis upon which modern/scientific mitigation can build/be adopted and can be introduced.

Additionally, the paper argues that contextual variation among the households of rural farmers suggests that mainstreaming climate change needs to involve the human, social and financial backgrounds of households. This implies that socio-demographic characteristics of smallholder farmers need to be taken into consideration in all climate change mitigation processes as these have implications on farmers' propensity to cope, and apply or adopt a particular affordable intervention strategy. More importantly, improving the coping strategy of farmers requires a steady improvement in their skill level through effective training as well as through the deployment of agricultural extension officers to continue giving practical coaching support for farmers. Key adaptation strategies include water-harvesting techniques, search for alternative income, investment in livestock, increased application of farm-yard manure and of tree-planting strategies.

Thirdly, rural communities should be given priority by both government and donors and this could take the form of distribution of income-generating projects and alternative livelihood programmes in order to reduce poor rural smallholder farmers' vulnerabilities to climate change.

Furthermore, the study has established that intervention by government and non-governmental actors do have an impact on the overall livelihood of smallholder farmers in terms of neutralizing the adverse impact which has been imposed on them by climate change. Interventions must take the form of education, training, and empowerment to undertake various precautionary adaptation and mitigation strategies which cumulatively cushion smallholder farmers against the full rigour of climate change impacts.

Moreover, the study concludes that the shortage in the water supply is a major indicator of climate change and projects aimed at improving water supply to smallholder farmers will go a very long way to reduce the adverse effect of climate change on farmers' livelihood. This kind of project will facilitate regulated and stable soil water and water for irrigating crops in order to ensure all a year-round yield for farmers. Such provisions will ensure certainty and a definitive planning process for farmers and could take the form of small dams or central tanks provision with canals and holes linking farms. It is against such backdrop that the government of Ghana has proposed a 'one-village-one-dam' project, which aims at augmenting the efforts of farmers through uninterrupted access to water for crops.

Finally, the study recommends for strenuous efforts aimed at providing farmers with supplementary livelihood options which will augment their income sources and cushion them from sudden climate variability. This is against a backdrop that the rate of change in climate patterns could pose some unforeseen consequences to crop and animal farming in spite of mitigation measures. Training in other alternative livelihood programmes which are contextually relevant to the rural smallholder farmers will go a long way to improve livelihoods.

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