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# DEFIES AND PROSPECTS IN SUSTAINING A GREEN ECONOMIC DEVELOPMENT AND FOOD SECURITY AMONG SMALLHOLDER FARMERS IN TANZANIA

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**ABSTRACT**
It has been evinced that smallholder farmers are good managers of risks, through experience and alternative responses to climate extremes. Their bequest and local knowledge to successfully adapt to environmental changes is an opportunity for sustaining their livelihood and development of a green economy and food security. However, with their long-term experience still they face a number of challenges. To understand the challenges and opportunities for smallholder farmers in Tanzania, this study used a survey method in gathering information that includes a household questionnaire, Key informant interviews, focus group discussions and documentary review. The investigation revealed the increased stress in farming activities as evidenced by increased agricultural production risk resulted from climate variability, fluctuating market price and increased production cost. The Rio+ 20 seem to be an opportunity to devise strategies for supporting a green economy and food security especially for poor farmers in developing countries. However, implementation of agreements, policies and plans remain in the papers in many places. Attaining these objectives will require effective implementation of strategy, ensure a fair price to farmers for their product, improve access to inputs and optimise logistics to reduce production cost, as well as a smooth transfer of know-how and best practices.

## 1. Introduction

Agriculture is inherently sensitive to climatic conditions and is one of the most affected sectors from the impacts of climate change and variability (Orindi and Murray, 2005; Kangalawe *et al.*, 2007; FAO, 2009b; Bishaw *et al.*, 2013). Though the gains in some crops in the same location are achievable the overall impacts of climate variability on agriculture be negative (Burton *et al.*, 2010; Dai, 2011; Lamboll *et al.*, 2011) and continue to threaten food security in most regions (Word Bank, 2013). The most substantial impact is and will be experienced in developing countries, where climate variability causes a decline in yields for the most important crops and is witnessing different types of pressures that lead to threats of poverty and food security reduction (Gwimbi and Mundoga, 2010; Lamboll *et al.*, 2011; World Bank, 2013).

Tanzania, like many others Sub-Saharan African countries, is highly vulnerable to global environmental risks. Agricultural production, water resources is essential to ensure food security and

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improving community livelihoods. The adverse impacts of ever-changing climate place additional stress and therefore felt more hardly among the smallholder farmers in developing countries (Kangalawe, 2012; URT, 2015). Ostensibly, crop production in such areas is, consequently, sensitive to large year-to-year weather fluctuations. For example, Tanzania's rain-fed agriculture is predicted to decline due to the impacts of climate change and variability (URT, 2007b). A loss of over 10 percent of its grain production is predicted to hit Tanzania by 2080 (URT, 2007b). The decreased average yield by 33 percent indicated to affect the entire country, whereas in the southern highland of Songwe, Mbeya and Ruvuma the decreases have been estimated at 10-15 percent (URT, 2007b; Mbilinyi et al., 2016).

Smallholder farmers described as rural producers, predominantly in developing countries, mostly are those who farm small area mainly using family labor and for whom the farm provides the principal source of income (Morton, 2007). They face many challenges that include limited access to agricultural services, especially improved technology, markets and inputs that have a major influence on the farming production system and development. Improved techniques for crop production, reduce risk about investment decisions, particularly in the light of increased climate variability (Burton *et al.*, 2010; Dai, 2011). Risk is not explicitly considered as a critical factor in small farmers' decision-making. However, a wide range of crops and infrastructure are significantly affected by such risk (Dixon *et al.*, 2001; Pervez et al. 2016). For this moment little progress has been made in creating effective or assurance mechanisms for smallholder farmers undertaking their production in such challenging environments. Therefore more efforts are needed on mechanisms to minimize and mitigate the risk that has low costs, acceptable, feasible and effective in reducing the impacts and cushioning unpredictable shocks.

The fallout of Rio+20 on smallholder farmers in developing country recognizes the importance of good land management and its significance in socioeconomic development (United Nations Global Compact Office, 2012). Proper land management including soil, denoted as an adaptation strategy to the changing environment, particularly its contribution to economic growth, biodiversity, sustainable agriculture and food security (Anley *et al.*, 2007). The Rio+20 created an opportunity for international stakeholders to come together and be involved in the discussion and creating a more sustainable future for all. It takes into account the sustained performance as well as social and environmental sustainability to promote a sustainable future (United Nations Global Compact Office, 2012).

Over time there has been an increase in the frequency of extreme events such as drought and floods which reduced soil fertility and yields from crop production and livestock products (Antle, 2009; Tanzania National Business Council, 2009). Such factors increased socioeconomic challenges among smallholder farmers. The capacity of smallholders' farmers to successfully adapt to environmental changes is an essential opportunity for sustaining their livelihood and development of green smallholder farmers still face a number of challenges. The Rio+20 seem to be an opportunity to change food and agriculture systems, especially for poor smallholders in developing countries through influencing and promoting the development of effective strategies and enabling environment. However, implementation of agreements, policies and plans remain in the papers. Lack of enforcement on agreed procedures coupled with poor agricultural practices, impacts of climate change, population pressure and low technology increased challenges in sustaining agricultural production and food security.

This paper focused on understating the challenges and opportunities in sustaining the development of a green economy and food security among smallholders' farmers in Tanzania. Specifically, the study

aimed at exploring the challenges and opportunities that resulted from environmental change and climate variability with the intention of promoting sustainable agriculture as a key element in sustainable development and environmental management. The need for intensifying agricultural production and produce more sustainable on less land is among the important objectives in the production process. Sustaining and improving agricultural production and productivity, through improving the enabling environment for smallholder farmers would strengthen their capacity to adapt to the environmental changes. This would need to develop effective adaptation measures that build upon, and sustain, existing livelihood strategies and thus take into account existing knowledge and coping strategies of the poor. Governments should encourage the right policies that provide appropriate inputs, particularly weather- tolerant seeds and pesticides, as well as policies that allow fair mode extension services to be easily adapted and accessed by smallholders' farmers.

## 2. Materials and methods

This paper is based on studies undertaken in the southern highlands of Tanzania between 2010 and 2016. The study was conducted in three agro-ecological zones that include lowland zone, midland zone and highland zone in Rungwe district. The zones have different characteristics in terms of climate, soil, terrain and biophysical environment that characterize agricultural production. To understand the challenges and opportunities in smallholder farmers, this study used both primary data (through surveys) and secondary data (in libraries and documentation Centre). Primary data were collected through focus group discussions, key informants, household questionnaire and field observation methods. The interviews with key informants,that include agricultural and natural resources officers at district, ward and village levels in selected zones, including local government and elderly persons found in the study area. These methods complemented each other, for example the use of field observations used a physical informationt in confirming and solicitation of some of the information on agricultural production, environment characteristics and climatic variability.

The data collected from different sources and methods were edited, coded, tabulated, compiled, processed and analyzed using different analysis techniques. Quantitative data were compiled and analyzed by using the Statistical Package for Social Sciences (SPSS) version 20 and Microsoft Excel software. The qualitative data were analyzed during and after data collection using content analysis, factor analysis, as well as cluster analysis. The qualitative data from key informant interviews, focus group discussions, household interviews and observations were examined and presented in summary form and the results were displayed in the form of Table and graphics, before descriptions.

## 3. Results and Discussions

### 3.1 Climate variability and the perceived changes

The local perception in the context of climate related changes and the contribution of the perceived changes on climate variability adaptations is important in crop productivity. Farmers' perceptions of short- and long-term variability in climate, their ability to tell the different trends provide opportunity for addressing the challenges in agricultural production and food shortage.

Meteorological data were analysed to compare with farmer's observations and perceived changes. The responses from interviews farmers indicated a general local awareness of the climate variability, as they were able to explain climate variability, the probabilistic nature of the variability and the impacts of this variability on crop production. The results indicate that farmers are aware of the changes in the trends of rainfall in their area. Farmers' observations in rainfall patterns supported by the observed trends in

meteorological rainfall data and corroborated well with reported perceptions of other places across the region. Such results also supported by FAO (2008); Daniel and David (2011); Yanda and Mubaya (2011).

It was revealed that more than 75% of the interviewed farmers in all the three zones are aware of the significant changes in rainfall and other aspect of weather over ten years. The results show that 65% of the farmers in all surveyed areas perceive that long-term temperatures are warming; 96% of respondents believe precipitation is decreasing with more fluctuation and pronounced changes in the timing. Farmers also perceived the increase of frequency of droughts as compared to the past twenty years. Such farmers' observation on rainfall conditions substantiated by existing evidence of rainfall data analysis is presented in Figure 1.

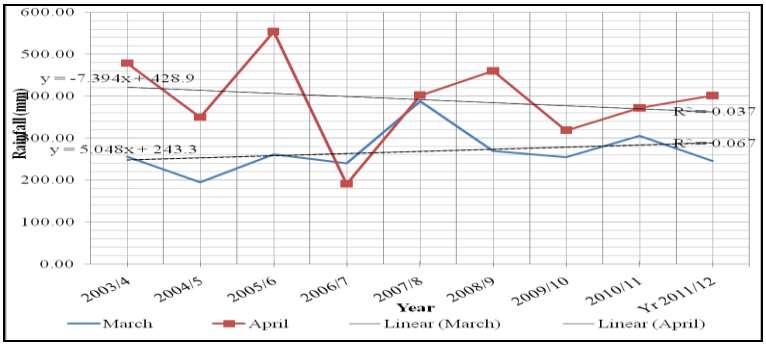


**Figure 1: Rainfall variability in March and April in Rungwe district**

The result of observed rainfall in the area indicates the decrease in amount especially in April rains. The low rainfall was in 2004/5, 2006/7, 2009/10 and 2010/11 April. Such a decline in rainfall has an impact on agricultural production in the study area. In the lowland area, for example, low rainfall means lower rice production as the crop needs enough water for its production.

Different aspects of climate and their trends in lowland, midland and highland zones were analyzed. The analysis across the study area indicates changes in the aspects of environment. The main aspects reported by respondents across the agro-ecological zones include rainfall patterns (96.1%) intra-seasonal dry spells (94.3), strong wind (70.3%), high temperature (64.5%) and seasonal drought (77.6%). The farmer's observation on rainfall amount, pattern and distribution were confirmed with the meteorological data as indicated in Figure 2. The results indicate higher variation in rainfall within the same month for a different period of time. Such changes have an adverse effect on rainfall predictability during the growing season as reported by farmers in all study villages.

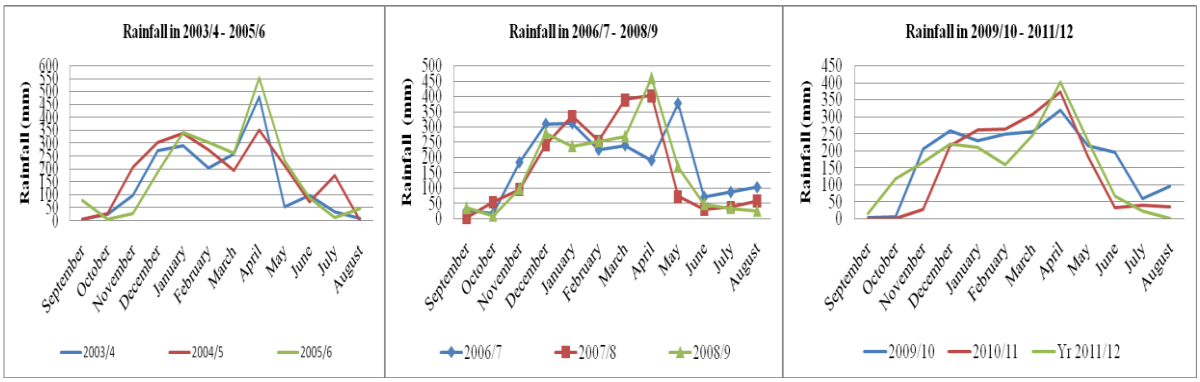


**Figure 2: Monthly rainfall amount, trends and variation in Rungwe District in ten years**

Observation indicates the decrease in rainfall amount and increases fluctuation of monthly rainfall. The first part of the figure in 2003/4 to 2005/6 indicates a high rainfall during a growing season that has a negative effect in planting date. Almost all seasons in the year experienced a fluctuation in rainfall with high rainfall in December, March and April.

Results from Focus Group Discussion also revealed changes on climate in the area, especially in temperature, rainfall and wind that have a great influence on farming activities in the area. Onset rainfall has changed and is becoming unpredictable. In the highland they used to have rainfall in September to May with short dry spells of one to two weeks between December and March, the fog was in May and June, cold season was May to July, and the ice used to fall between June and August. But now there is a significant change for example, there are no September rain (or it can be just in one or two days), rainfall can start early in October or late in January, the normal distribution and pattern has been changed and also the ice and cold have been decreased. Likewise, in Midland the rainfall used to be in November through August, dry season in September and October, winter/ cold season in May and June while the wind was in October to December and February. But now the rain is unpredictable with cold in August. Similarly, in lowland the rainfall reported to be fluctuating and becoming more unpredictable, the temperature has changed, also the frequency of floods has decreased as compared to the past ten to twenty years. The farmer's observations of the variation in rainfall, especially in September to December have been reflected in the results of meteorological data as indicated in Figure 3.

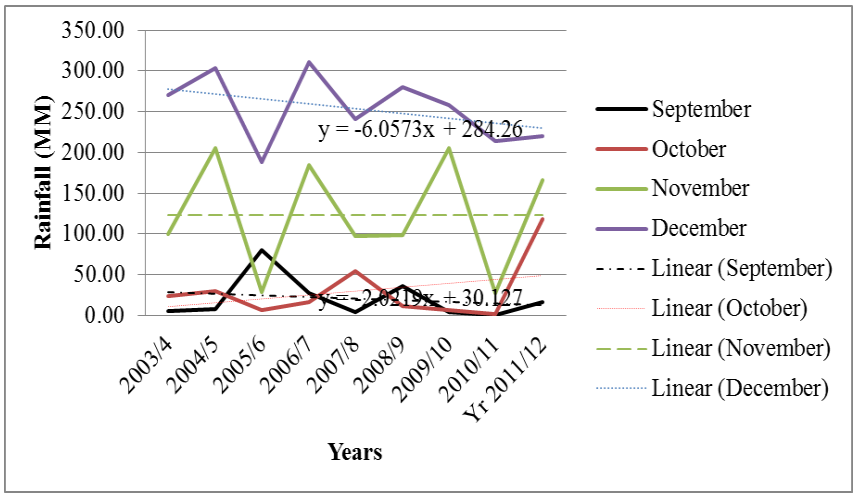


**Figure 3: Rainfall variability in September to December in Rungwe district**

The results indicate higher fluctuation in rainfall with decreasing in rainfall amount in Septembers and December. The lowest rainfall was in 2005/6 and 2010/11 in November and December, while in other years there was a fluctuation. The highest rainfall was observed in 2004/5, 2006/7 and 2009/10 in November and 2004/5 and 2006/7 for December rainfall. The fluctuating rainfall affects the pattern of rainfall that in turn affects growing season in the area. Agricultural production is significantly affected by frequently occurrence extreme weather events such as floods, droughts, and strong wind. For farmers, extreme rainfall events and changes in temperature disrupt the growth, destroy crops, alter cropping patterns and the suitability of the crops and increase the occurrence of diseases and insect pests.

### 3.2 Effects of environmental change and climate variability on smallholder farmers

Changing rainfall patterns and temperatures have forced farmers to shorten the growing season, change production strategies and switch to high value crops. Frequent droughts, floods and changing temperature are eroding assets, produce and knowledge, leaving people more vulnerable to climate variability. These changes, with increased fluctuations, expected to cause more shifts in food production. Most crops are sensitive to changes in climate conditions, including alterations in temperature, moisture, and carbon dioxide levels. In addition to primary agricultural production, climate change will affect the ecology of beneficial and pest organisms altering their abundance and distribution in space and time (IPCC, 2007). Consecutively, increase the burden and vulnerability on poor livelihood, threaten the poverty alleviation efforts and affect food security strategies. Table 1 below indicates reasons for changing in agricultural crop production.

**Table 1: Reason for change in agricultural crop production**

| Reason for change | Lowland % | | Midland % | | Highland % | | Total % |
|---|---|---|---|---|---|---|---|
| | Maize | Rice | Maize | Rice | Maize | Round potatoes | |
| **Land exhaustion** | 16.1 | 9.0 | 15.0 | 1.7 | 22.6 | 7.0 | 71.4 |
| **Use of fertilizers** | 20.0 | 0.0 | 0.0 | 3.3 | 25.8 | 16.1 | 65.2 |
| **Drought** | 17.9 | 19.6 | 0.0 | 0.0 | 3.2 | 1.0 | 41.7 |
| **Climate change** | 12.5 | 8.9 | 5.0 | 0.0 | 3.2 | 1.0 | 30.6 |
| **The use of fake seeds** | | 0.0 | 10.0 | 0.0 | 0.0 | 0.0 | 10.0 |
| **Shortage of land** | 5.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.0 |

The result indicates that land exhaustion and climate variability are the significant factors for change in production in all study zones. Climate change and variability (exposed by shortage of rainfall and drought) and land exhaustion were reported mainly in lowland and middle land while use of chemical fertilizer was reported in middle and highland zones.

Environmental change and climate variability are reported to have posed significant impacts on crop production in smallholder farmers. The rainfall fluctuation during growing season as indicated by September rainfall data in Figure 4 has affected the growing season and cropping patterns/ calendar. For example, in the midland, due to late onset rainfall, farmers planted maize through irrigation to add moisture for seed germination. This was also revealed by a testimonial from the aged man in midland zone who said *'we used to have rainfall in August and September that provides moisture for growing maize, but now the situation has been changed, we are not sure on such rainfall, because of late coming of rainfall and shortage of soil moisture we grow maize by watering to increase moisture for germination. The situation is becoming more complicated because, in our area, we cannot wait for a rain to come because delay in planting maize can result in rotting because of high rainfall in March and April'*.

The result indicates the decline in rainfall amounts and show high fluctuation. The main fluctuation was observed since 2004 in which rainfall continues to decline to a greater extent. Changing temperature and rainfall patterns together with land use changes have significantly altered the hydrology and productivity of crop production in the areas. A similar result also was revealed in other studies (Gwimbi and Mundoga 2010; Van den Bossche and Coetzer, 2008). Among the reported changed aspect of climate that have a significant impacts on crop production includes floods, drought and strong wind. For example, in the lowland floods result in loss of life, crops, animals, outbreaks of pests and diseases; destruction of fish and

wildlife habitat displacement of people and environmental degradation. Droughts cause crop failures, water scarcity, drying of water resources, food shortage, loss of human and animal lives, loss of biodiversity and environmental degradation. Strong winds also result in damaging structures, destruction of crops, especially bananas, forest plantations and natural trees

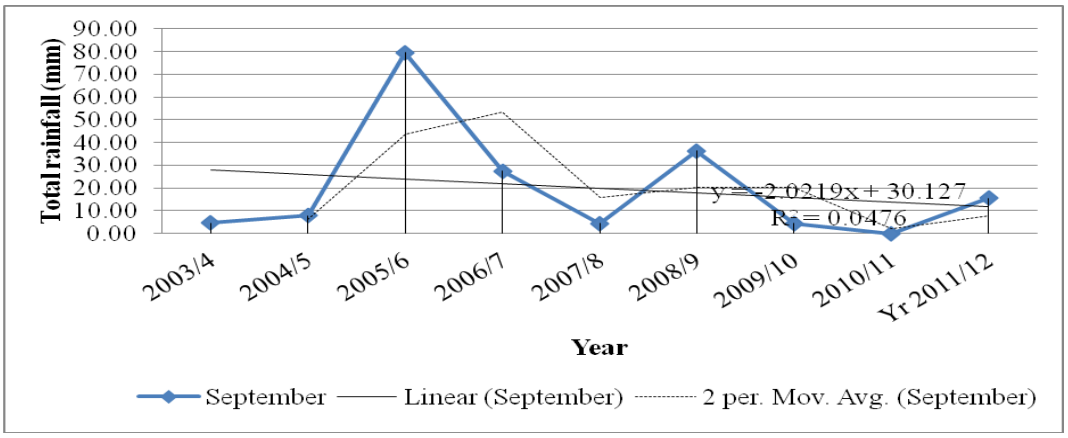


**Figure 4: Rainfall fluctuation during planting period in Rungwe District**

During Focus Group discussions the reported effects of climate change and variability include withered crops, decline in economic and recurrent food shortages among smallholder household farmers. More shifts in food production are expected due to environmental change and climate variability with increased temperature and rainfall fluctuation. These changes also favour the occurrence of diseases and insect pests. In such instances, farmers use more agrochemicals and disease resistant varieties, which increase production costs. The additional cost of pesticides means farming business becomes less profitable. Such changes will need farmers to adhere to improved agronomic practices and better crop management. It was further noted that plan for agricultural activities is becoming more challenging due to climate variability especially, unpredictability and fluctuating precipitation. Understanding the effects and impacts of climate variability on agriculture, therefore, is critical in planning and formulating adaptation options to minimize its adverse effects.

### 3.3 Challenges in sustaining agricultural production and food security

In the past ten to twenty years, farmers have been experiencing fluctuating productivity of crops and mostly a declining trend in crop production, including even the few newly introduced crops in the area which are believed to be drought resistant. Such decline was associated with climate variability, land exhaustion and increased pest and disease pathogens and also attributable to poor and dwindling crop prices as well as lack of crop markets. Understanding the frequent occurrence of extreme climate events and climate change opportunities is among the challenges in crop production. These include understanding farmers' perceptions, attitudes, objective in production, and other cognitive and decision-making information. The reported challenges in crop production in the study area are shown in Figure 5.

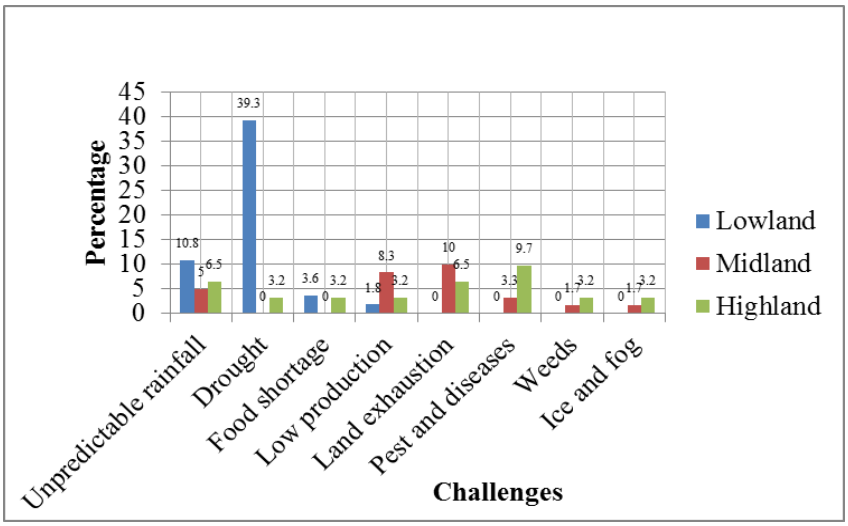


**Figure 5: Perceived challenges of agricultural production**

The result indicates that climate variability is among the most critical challenge, which needs to be addressed so as to increase crop productivity. It was revealed that almost all challenges provided related directly or indirectly to climatic events/aspects, especially rainfall fluctuation and changes in temperature. The other revealed production challenges in smallholder farmers include land exhaustion and fragmentations, access to extension services, access to agricultural inputs, marketing of crops produced, institutional and policy issues, food shortage, access to extension services and access to reliable weather information. Through the discussion with key informant, household survey, focus group discussion and transect observed a number of challenges were revealed that include: unpredictable rainfall, drought, food shortage, low production, land exhaustion, pest and diseases, weeds and ice and fog.

**Land fragmentations, exhaustion and shortage**: Size of land is among the main constraints in mechanization and crop diversification when farmers own small size of land. Larger farm sizes were found to encourage the use of multiple cropping and integration of a livestock component, especially under drought conditions. Large farm sizes allow farmers to diversify their crop and livestock options and help spread the risks of loss associated with changes in climate. The average size owned is less than 4 acres and the large size are found in the highland zone with an average of 3.67 (Std =2.45), and the smallest in the midlands with an average size of 1.65 (Std =1.59). The main challenge is to identify alternative livelihood opportunities either inside or outside the area so as to increase productivity and household income. In addition, there is a need to ensure that degraded land is rehabilitated in order to restore its productivity.

**Marketing and pricing mechanism:** Small farmers' societies face the problems of shortage of capital, need for capacity building, and lack of working markets and exposure to market forces. In the subsistence oriented farming the availability of farm products is limited in terms of a range of products and volume from very small field. Together with uncertain production, attract few incentives for larger private companies to be involved in marketing. The emphasis on the competitive markets on which the Government prioritizes by providing public goods and services as a rational basis for agricultural development increased their vulnerability to low prices for their produce and high price of inputs. Also, it appears that the market forces have failed to support the growth of the required services for small farmers as revealed during the key informant interviews and focus group discussion. It was further revealed that during the time of selling of crops, farmers generally had to agree with the local middlemen's or traders'

price due to low education and lack of access to market information services. Market information aids and places the producer and buyer on more equal bargaining basis and enables the exchange of information, bringing up business related issues with one voice as suggested by Nyunza and Mwakaje (2012). The availability of market information enables farmers to check on the prices they receive vis-à-vis the prevailing market prices. The challenges are on the fluctuating and low price offered to the farm product while the price of inputs increased.

**Access to credit and agricultural inputs:** A lack of investments and access to credit for small farmers was also noted, while major investment is happening for crops such as round potatoes, rice, bananas and maize. Cropping systems of smallholder farmers make little use of improved seeds. Indeed, improved seeds are used by only few farmers, while the rest still relies on traditional seeds. Only 22.7% of farming households have used one or more fertilizers, either chemical or organic. The reasons often given for the low level of fertilizer use are high costs and low knowledge. The high price of inputs is the result of the gradual removal of subsidies on agricultural inputs for smallholder farmers.

**Extension services, agricultural technology and market information:** The study revealed poor access to extension services, agricultural technology and market information to smallholder farmers, the related results also were revealed by Hassan and Nhemachena, (2008). For instance access to extension services ensures farmers have the information for decision making and the means to take up adaptation measures. The results indicate that agricultural extension services, lack the means to fulfill their potential. This means that there is a need for improving extension services and investment in the dissemination of relevant agricultural information particular to small-scale farming systems and rationalization of agricultural land use plans to consider climate-related hazards and risks at the local level. This call for extension services that will reorient their operations basing on facilitative rather than prescriptive techniques; with community participation in forming the keystone in determining priorities and testing possible solutions. Furthermore, generation of location-specific information is needed for risk management strategies such as development of more attractive and reasonable risk-sharing schemes, and localizing innovative and improved adaptation options.

**Institutional and policy issues:** The implementation of the policy, plan, strategies and by-law is still weak especially at local level. The government and local authority have a well-planned and explanatory guidance, policy, strategies and bylaws on agriculture, environmental, adaptation to climate change and land management. The challenge for improvement is on developing and planning sensitization and awareness creation of the target group on the use of the policy, strategies and laws and bylaws.

### 3.4 Food crop production and productivity challenges

Based on the discussion with focus group and key informant the main food crop productivity was reported to decline. The trend shows the decrease in production and productivity due to low rainfall and soil exhaustion (Table 2). Small farmers with small land and low income have less incentive for improving their fields. It was revealed that most smallholder farmers in rural areas are buying food due to changes in productivity that is reported to be a result of increased climate variability and land exhaustion in the area. In general, food security is partly linked with the incomes of people in which better off in terms of income are less vulnerable to food shortage as they use their income to buy food. In this context smallholder farmers face the challenge to increase food production and income for purchasing food and other essentials. Thus, efforts to increase the rural non-farm incomes will have a positive effect on food security and nutrition. Effective adaptation will need to focus on the increasing food crop production, distribution and understanding the complex nature of food security. Awareness of such factors will provide better position to spearhead the generation of information and the development of innovative and improved

technologies. Therefore, to raise people's incomes to such a level that they can afford to purchase enough food or produce more food for all times is among the challenges in increasing food security.

**Table 2: Perceived production and trend on main food crops across the zone**

| S/N | Main crop produced | Lowland | | Midland | | Highland | | Productivity Trends (General) |
|---|---|---|---|---|---|---|---|---|
| | | Past (Kgs/ha$^2$) | Current (Kgs/ha$^2$) | Past (Kgs/ha$^2$) | Current (Kgs/ha$^2$) | Past (Kgs/ha$^2$) | Current (Kgs/ha$^2$) | |
| 1 | Maize | X | X | X | X | 449 | 1483 | Increased |
| 2 | Rice | 4942 | 1235 | NA | NA | NA | NA | Decreased |
| 3 | Banana | X | X | X | X | NA | NA | Decreased |
| 4a | Round potato (improved practices) | NA | NA | X | X | 5436 | 11861 | Increased |
| 4a | Round potato (normal practices) | NA | NA | X | X | 5436 | 1235 | Decreased |

***Key:*** *X = Use without the conventional measurement  1 ac² = 0.4046863 ha²*

*NA = Not produced*

**Source Field Data 2012 - 2016**

The result indicates the decline in main food crop production except the production of round potatoes that has increased. The increase in round potato production under improved practices was associated with the increase of production knowledge and use of inputs such as industrial fertilizers and chemicals. However, due to high production cost only few farmers managed to produce and those who use the normal practices the production has decreased. Due to such decrease in normal practices and increased production cost for improved practices, some farmers have abandoned its production.

### 3.5 Opportunities for sustaining livelihood and food security among smallholder farmers

Rainfall and temperature are important parameters in agricultural production (growth and development). There is an optimum rainfall and the temperature range for maximum yield for any crop. For example, warmer temperatures speed annual crops through their developmental phases and also increase their water requirements. If a crop variety is being grown in a climate near its temperature optimum, a temperature increase of several degrees could reduce photosynthesis and shorten the growing period. High temperature during flowering may lower growing number, size, and quality.

Climate change and variability bring opportunity in the area such as two seasons of growing round potatoes in the highland zone, horticultural production in the middle land zone and irrigation in lowland zone. The local perception of the opportunities resulting from climate variability is still at a low level. Most farmers failed to realize the opportunities that can be utilized as a result of climate variability. This may suggest that farmers are more affected with climate variability in the study area that makes them think about the negative effects. This also could be attributed to the fact that farmers are the ones who depend on climate sensitive activities such as crop production and livestock keeping. Therefore, any changes related to climatic factors result in significant implications on their livelihood activities. The results indicate that farmers know few opportunities resulting from climate variability. The revealed opportunities include business (13%), break making (5%), digging ponds (2%) and irrigation farming (2%). Others are selling firewood (1%), tree planting and selling (1%) and early cultivation (1%). The opportunity differs across the agro-ecological zone as indicated in the Figure 6.

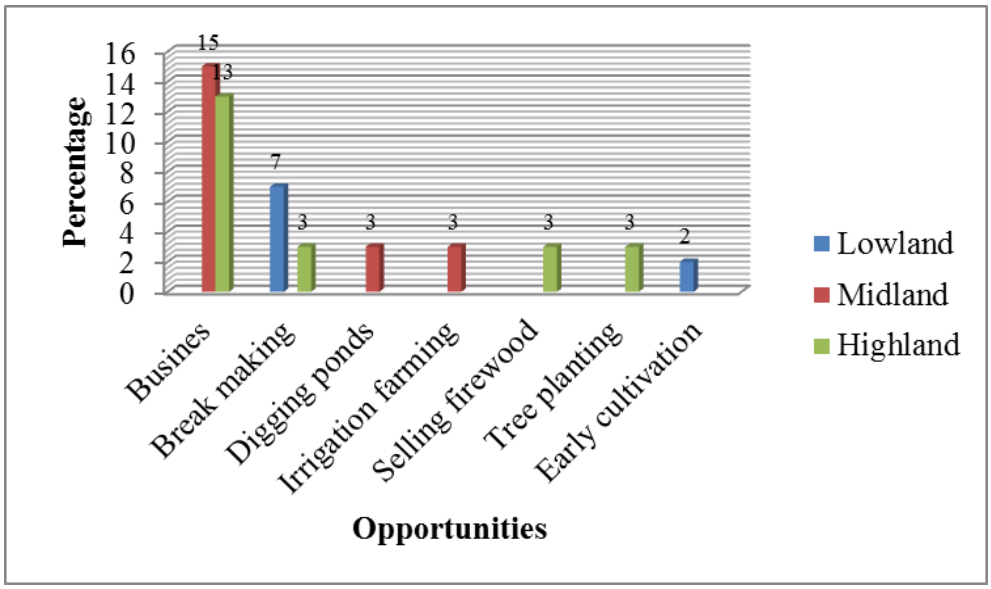


**Figure 6: Perceived opportunity arising from environmental changes and climate variability**

The results indicate that business was the main opportunity in the midland (15%) and highland (13%) zone while break making was the main opportunity in the lowland (7%) and highland (3%). Other mentioned opportunity is an early cultivation in lowland, digging a pond (fish farming) and irrigation farming in midland zone, and selling firewood and tree planting in the highland zone.

There is a general tendency among the farmers to give greater weight to negative impacts leading to higher risk perception. In all study zones the opportunities arising from climate variability were less recognized at a farm level. Most of farmers observed negative effects of climate variability that affects more their crop production than opportunities arising from such changes. There is a need for increasing awareness and exploring more on climate related opportunities resulting from the changing climate. This will increase resilience and adaptive capacity in crop production, food security and livelihood in general.

## 4. Policy implication

Supporting the coping and adaptation strategies of local farmers through appropriate public policy, strategies, investment and collective actions can help to increase the adoption of measures that reduce the negative consequences of predicted changes in future climate, with great benefits to vulnerable rural communities. To address environmental change's effects and modify the future situation, policy and strategies that reduce vulnerability are of importance.

The strategies are well planned and many farming problems were identified, but the main challenge is an implementation of the strategies at the local level where the community differs in perception, demands, and in problems, challenges and obstacles they face. For example, in the study area the farm support in terms of inputs and subsidies to poor farmers so as to increase their adaptability capacity, and improve food security and their livelihood has no impacts among the poor. According to the key informant interviews and FGD in all those zones that receive farm support are in the highest income and are more likely to adapt than the poor. This indicates that government farm support is tailored to meet the needs of wealthier farmers and while the poor are less able to use inputs and subsidies provided by the government to make the necessary changes in their farming practices. Such situation compared with less financial capacity for the poor to contribute that made them to depend on the middle and well-off people by selling their inputs at a cheaper price.

In improving adaptation strategies the policy makers and development practitioners, therefore, should carefully consider the needs of poor farmers and provide support that will enable them to reduce the risks of climate variability. Such support needs to consider the environmental needs and other social factors. For example, in the study area, especially in the midland zone, most of the farmers own less than two acres that need mechanization by increasing production at that small area lather than implement mechanization to cultivate a larger area.

Development decisions, activities, and programs like infrastructure development and seed distribution for farmers play important roles in modifying the adaptive capacity of communities and regions. However, the study established that these do not primarily take into account risks associated with climate variability and change. Furthermore, although the survey established these adaptation measures in response to changes in climate, it is noted that these actions might be primarily profit-driven rather than responses to changes. The study, therefore, suggests the inclusion of climatic risks in the design and implementation of development initiatives to reduce vulnerability and enhance sustainability.

The formulation and implementation of policies should be carefully analyzed to understand their implications at farm and community levels. This suggests the need for provision of education to improve awareness on the potential benefits from the adaptation as an essential policy measure for stimulating farm-level climate adaptation. It is important therefore to consider how weather and crop yield forecasts are used and what spatial and temporal scales be the most appropriate for the user.

## 5. Conclusions

Access to extension services, capital, social services and capacity to access land and inputs to farmers is among the important decision factors in production. Farm-level adaptation involves more than adopting new agricultural technologies, it also needs to take into consideration knowledge, the capacity of the farmers to adapt the strategies and marketing facility and improvement of infrastructure bases. Some of adaptation measures developed by farmers are extremely efficient and some need improvement to sustain agricultural production and improve food security in the context of changing climate. Therefore, optimization of logistics to reduce production cost, as well as an easy transfer of know-how and best practices within smallholder farmers is needed. The Government should encourage the right policies that provide the appropriate knowledge, inputs, mainly weather- tolerant seeds and pesticides, as well as policies that allow fair mode extension services to be easily adapted and access by smallholder farmers.

Coordination between farmers, extensions/ expertise and the government in addressing problems should be improved. Such improvement should include the provision of more training on how to adapt and cope with environmental change and climate variability on agriculture and on the utilization of opportunity arising from climate change and variability. For effectiveness of adapting strategies, promotion of appropriate and environmentally-sound technologies that engage many stakeholders, consider an enabling policy environment and integrated approach are essential to reinforce actions.

The implementation of the policy, plan, strategies and by-law is still a challenge to smallholder farming, especially at local level. The government and local authority have well-planned and explanatory guidance, policy, strategies and bylaws on agriculture, environmental, adaptation to climate change and land management. Such documents are well described with an elaborate framework for its implementation. However, the problem is on the awareness of such documents to the target group expected to implement them. This will need a well-developed and planned sensitization and awareness creation on the documents to all stakeholders (target group).

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