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Challenges and opportunities for up-scaling indigenous farming practices for adaptation to climate change induced food insecurity in Busega District, Simiyu Region, Tanzania

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In spite of their vulnerabilities to the impacts of climate change, smallholder farmers have managed to utilize indigenous farming practices to adapt to the impacts of climate change and variability but only at low scale which needs to be scaled up. This paper explores the challenges and opportunities involved in such scaling up of indigenous farming practices. Specifically, the paper assesses existing indigenous farming practices and their potential in adapting to climate change induced food insecurity. Results indicated that 1.6, 12.9, 55.5, 64.4 and 77.5% of the households interviewed practiced contour bunds, crop rotation, intercropping, zero and minimum tillage and cover crops respectively. These farming practices enabled smallholder farming communities improve crop productivity whereby zero and minimum tillage, intercropping, contour bunds and cover crops produced respectively 0.2-1 metric tons, 1.2-2 metric tons, 2.2-3 metric tons and 3.2 metric tons-4.2 metric tons of maize per acre.

Key words: up-scaling indigenous farming, intercropping, crop rotation

INTRODUCTION

Climate change and its impacts have negatively affected food security especially food crop production (FAO, 2005; IPCC, 2014) in Sub Saharan Africa including Tanzania (URT, 2012, 2015). Smallholder farmers' communities and their livelihoods are the most vulnerable to the impacts of climate change including decline in crop yields for cereal crops especially maize, prevalence of crop pests and diseases, floods, prolonged droughts, decrease in soil fertility and shifting agro-ecological zones.

Tanzania through the Ministry of Agriculture, Livestock and Fisheries has undertaken various initiatives to address the impacts of climate change on agriculture and food security. These include introduction of drought resistant crops such as cassava in Muheza and Vanilla in Muleba districts; introduction of agriculture climate resilience plan 2014-2019; preparing the Tanzania Climate Smart Agriculture Programme 2015- 2025; the Southern Agricultural Growth Corridor of Tanzania

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(SAGCOT) initiative and preparing Tanzania Agriculture and Food Security Initiative Plan of 2010 (URT, 2012).

However, at the local level smallholder farmers in spite of their vulnerabilities to the impacts of climate change have managed to utilize their indigenous farming practices for adaptation to the impacts of climate change. Therefore, these farming practices adopted by smallholder farmers need to be up-scaled for resilience of local communities to the impacts of climate change. Based on that, this paper explores the challenges and opportunities for up scaling indigenous farming practices for adaptation to climate change induced food insecurity.

Indigenous farming practices are farming methods practiced naturally in a particular place including zero tillage, minimum tillage, crop rotation, cover crops, contour bunds and intercropping with leguminous plants (FAO, 2005; Ajani et al., 2013). Indigenous farming practices have multiple benefits which include reduced risk of disease spread and incidences of pests; increased crop yields, enabling nutrients availability for deep rooting crops, improving soil fertility through nitrogen fixation and withstanding climate stresses.

In spite of their benefits, indigenous farming practices have challenges and opportunities for their up scaling in order to enhance resilience of smallholder farmers in the era of climate change. The opportunities include improvement in land tenure security, improvements in access to farm implements and capital, existence of effective and efficient governance systems at all levels; coordination and ultimately mainstreaming and integration of indigenous farming practices in agriculture and food security policies and promoting scientific study, training and knowledge dissemination on indigenous farming practices. The challenges include lack of physical inputs required to implement the indigenous farming practices such as land, labour supply, farming tools and infrastructures, lack of access to disease resistant seed varieties, high yielding seeds, finances which are crucial obstacle in up scaling of indigenous farming practices, lack of vibrant institutions, policies, legislation and regulatory framework, information and skills and inadequacy of agricultural extension officers (Lwoga et al., 2011; Suleman, 2017; IFRC, 2010).

This paper explores the challenges and opportunities for up scaling indigenous farming practices for adaptation to climate change induced food insecurity.

MATERIALS AND METHODS

Location of Busega District in Simiyu region

Busega District is one of the five districts of Simiyu Region of Tanzania. Its administrative centre is the town of Nyashimo. It is bordered to the North by Lake Victoria and Bunda District, to the East by Bariadi District, to the South by Magu district and to the W est by Lake Victoria and Magu District. The location of the district in the national setting and study villages is indicated in Figures 1 and 2. The district lies between latitude 2°10' and 2°50' south of the equator, and Longitude 33°and 34° East of Greenwich. The district has a total area of 2,129 km^2 of which 605 km^2 is covered with water and the remaining 1,525 km^2 is arable land. The district has 55 registered villages, 334 hamlets and 33,376 households (Nyashilu, 2017). Figures 1 and 2 shows the location of Simiyu Region in national setting and study villages in Busega District, respectively.

Methods

The study adopted random sampling procedure to select one district, two divisions out of two, two wards out of fifteen, seven villages out of fifty-nine and 243 households adhering to 5% sampling protocol (Nyashilu, 2017). Data were collected by interview and focused group discussion. The research adopted random sampling procedure of 10% to select one district out of four, two wards out of fifteen wards in Simiyu Region. At the household levels the study selected 243 households out of 4,877 of the study villages adhering to 5% sampling protocol (Nyashilu, 2017). Data were analyzed using Time Series Trend Analysis Software (Mann Kendal Trend Test), Statistical Package for Social Science (SPSS) version 20, MS excel and XLSTAT computer programme.

RESULTS AND DISCUSSION

The results indicated that 1.6, 12.9, 55.5, 64.4 and 77.5% of the sample selected for the study practice contour bunds, crop rotation, intercropping, zero and minimum tillage and cover crops respectively as indigenous farming practices in the villages studied (Nyashilu, 2017).

Existing indigenous farming practices in the study area and their potential in adaptation to climate change induced food insecurity

A diverse of indigenous farming practices were practiced in the study villages as observed in the study area. These were zero tillage, minimum tillage, cover crops, contour bunds, intercropping with leguminous crops, crop rotation and others such as seed broadcasting, furrowing with hand hoe, tractor or cattle plowing. These are indicated in Figures 3 to 7. The proportion of respondents practicing the given farming practices in the study villages are as indicated in Table 1.

Results summarized in Table 1 indicate that 61.7% of the respondent practiced zero and minimum tillage in which 4.0, 11.9, 3.2, 13.4, 20.1, 11.5 and 1.6% were respondents from Chabutwa, Mkula, Ng'wahnale, Kijereshi, Nyaluhande, Ng'wagindi and Mwamkala villages respectively. Similarly, 55.5% practiced intercropping in which 4.4, 14.9, 3.2, 14.2, 6.5, 10.7 and1.6% were from Chabutwa, Mkula, Ng'wahnale, Kijereshi, Nyaluhande, Ng'wagindi and Mwamkala villages respectively. Likewise, 77.5% practice contour bunds in which 8.6, 15.0, 3.2, 17.5, 20.5, 11.1 and 1.6% were respondents from Chabutwa, Mkula, Ng'wahnale, Kijereshi, Nyaluhande, Ng'wagindi and Mwamkala villages correspondingly. Also 12.9% practiced cultivation of cover crops whereby 3.6,

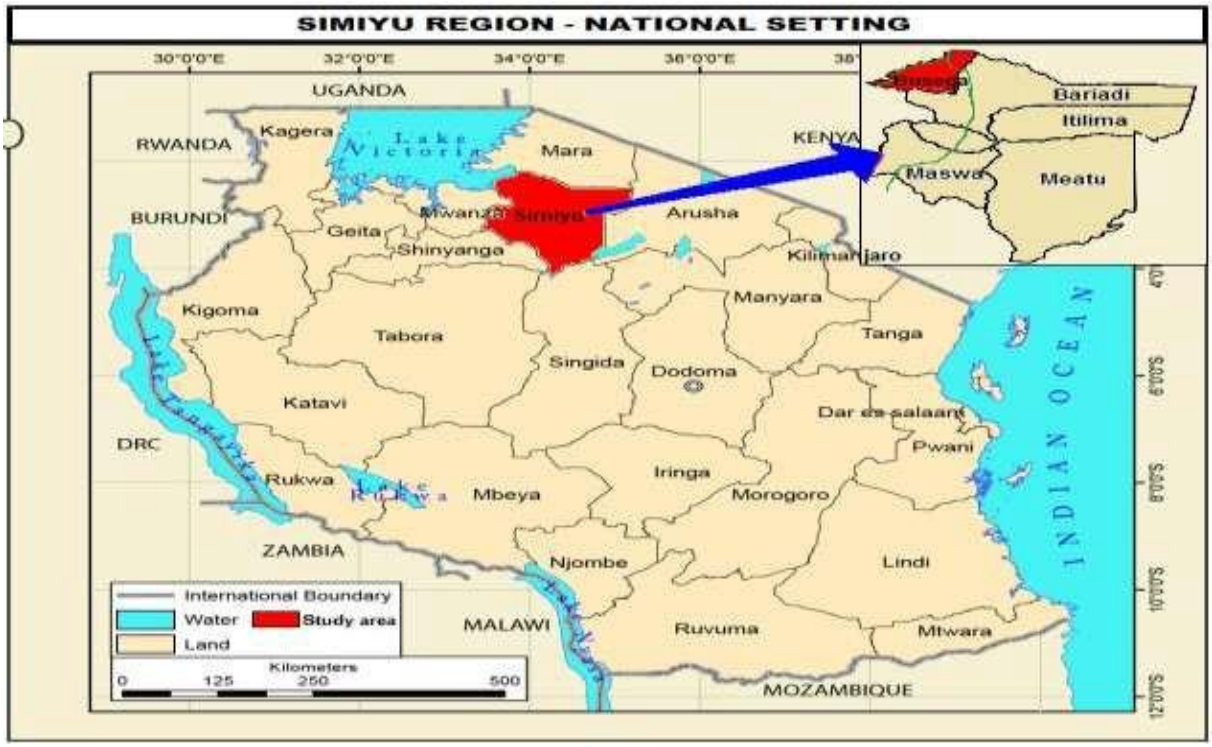

Figure 1. Location of Simiyu Region in national setting of Tanzania.
Source: Nyashilu (2017).

Figure 2. Busega district Map showing the seven study villages.
Source: Nyashilu (2017).

Figure 3. Zero tillage in Chabutwa village.
Source: Field data (2017).

Figure 4. Minimum tillage in Nyaluhande village.
Source: Field data (2017).

Figure 5. Contour bunds in Mkula village Mkula Ward.
Source: Field data, 2017

Figure 6. Intercropping maize, cowpeas and beans in Mkula village.
Source: Field data (2017).

3.6, 0.8, 4.5 and 0.4% were from Chabutwa, Mkula, Ng'wahnale, Kijereshi, and Ng'wagindi villages respectively.

Moreover 67.0% practices crop rotation in which 8.6, 12.7, 16.3, 19.2 and 10.2% were from Chabutwa, Mkula, Ng'wahnale, Kijereshi, Nyaluhande and Ng'wagindi villages. It is evident that contour bunds farming was practiced much more than the others followed by crop rotation, zero and minimum tillage, intercropping and cover crops; the most dominant village being Nyaluhande village in Nyaluhande ward followed by Kijereshi village in Mkula ward. This could be due to the fact that Nyaluhande ward is located in the most drought area in Busega District as seen in Figure 8. The two practices conserve water and moisture and prevent soil erosion during heavy rain; this reduces vulnerability of smallholder farmers to climatic hazards especially droughts and ultimately adaptation to climate change induced food insecurity (Nyashilu, 2017).

Relationship between crop yields and farming systems in the study villages

The study observed that cover crops enabled smallholder farmers to harvest many sacks of maize (3.2-4.2 metric tons/acre) followed by contour bunds (2.1-2.2 metric tons/acre), intercropping (1.2-2.0 metric tons/acre) and

Figure 7. Cover crops in Nyaluhande village.
Source: Field data (2017).

Table 1. The proportion of respondent practicing given farming practices in the study villages.

Farming practices	Name of the Villages							Total
	Chabutwa	Mkula	Ng'wahnale	Kijereshi	Nyaluhande	Ng'wagindi	Mwamkala	
Zero and Minimum tillage	4.0	11.9	3.2	13.4	20.1	11.5	1.6	61.7
Intercropping	4.4	14.9	3.2	14.2	6.5	10.7	1.6	55.5
Contour bunds	8.6	15.0	3.2	17.5	20.5	11.1	1.6	77.5
Cover crops	3.6	3.6	0.8	4.5	0	0	0	12.9
Crop rotation	8.6	12.7	16.3	19.2	10.2	0	0	67.0

Source: Nyashilu, 2017

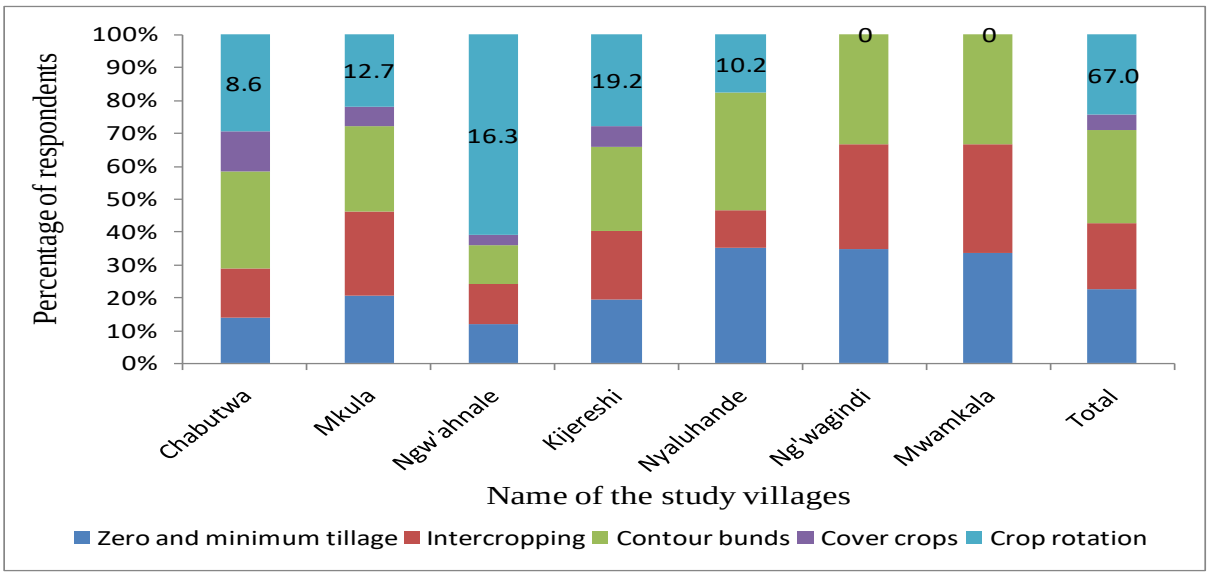

Figure 8. Practices of indigenous farming practiced in the study villages.
Source: Nyashilu, 2017

Table 2: The relationship between crop yields and farming systems in the study villages.

S/N	Farming system	Crop yields (Maize) in Metric Tons
1	Zero and Minimum tillage	0.2 - 1.0
2	Intercropping	1.2 - 2.0
3	Contour bunds	2.2 - 3.0
4	Cover crops	3.2 - 4.2

Source: Field data (February, 2017)

Table 3. Summary of mean crop yields in metric tons/acre from the studied villages.

Ward	Villages	Paddy	Maize	Sorghum	Cassava	Sweet Potatoes	Beans
Mkula	Chabutwa	1.6	1.1	1.2	0.6	0.6	0.6
	Mkula	3.0	3.6	2.4	1.2	1.9	0.4
	Ng'wahnale	1.6	1.1	0.6	1.8	0.4	0.4
	Kijereshi	1.6	1.6	2.4	0	0.6	0.9
Nyaluhande	Nyaluhande	1.2	0.8	1.2	0.6	1.9	0.9
	Ng'wagindi	3.8	1.1	1.2	0.6	1.6	0.2
	Mwamkala	1.8	0.6	1.2	0	0.6	0.3
District		1.4	1.0	0.8	0.7	1.1	0.4

Source: Nyashilu, 2017

zero and minimum tillage (0.2-1.0 metric tons/acre) as indicated in Table 2.

Crop yields in the study villages

Table 3 shows that mean crop yields for the studied crops except sweet potatoes and beans exceeded the district mean set standards for crop yields and this is in an environment where indigenous farming practices were not up scaled. Up-scaling of indigenous farming practices through enhancing opportunities such as improvement in land tenure security and improvements in access to farm implements and capital could manage the challenges and hence promote food crop productivity and enable smallholder farmers to adapt to the impacts of climate change.

Challenges and opportunities for up scaling indigenous farming practices for adaptation to climate change induced food insecurity

Indigenous farming practices if up scaled enhance crop yields and diminish vulnerability of smallholder farmers to climate change induced food insecurity. As stated earlier, cover crops enabled smallholder farmers to harvest more maize (16-21 sacks/acre), contour bunds (11-21 sacks/acre), intercropping (6-10 sacks/acre) and zero and minimum tillage (1-5 sacks/acre). However, up-scaling of indigenous farming practices have associated opportunities and challenges as discussed below.

Opportunities for up scaling indigenous farming practices for adaptation to climate change induced food insecurity

Improvement in land tenure security

Smallholder farmers' face challenges of access to land and hence enabling access to land will enhance their willingness to invest in land and improve crop productivity. Studies suggest that investment in crop diversity, improved livestock and fodder crops, agro-forestry and sustainable land management practices improves land tenure security (Suleman, 2017).

Improvements in access to farm implements and capital

Studies reveal that smallholder's farmers use of poor farming implements such as hand hoe which could not enable sustainable crop yields and hence hedge them in extremely poverty. Also smallholder farmers lack access to financial credits and crop insurance schemes due to lack of security and hence cannot qualify to access capital from financial institutions. Therefore, enabling smallholder farmers to access farm implements and

capital will enhance adoption and up-scaling of indigenous farming practices in agriculture and food security policies (Suleman, 2017).

Existence of effective and efficiency governance systems at all levels

Successful adoption and up-scaling of indigenous farming practices requires enabling environment in the government systems from local to national levels. This requires efficient and effective policies, legislations, regulations and institutions related to agricultural and food security policies that promote adoption and up-scaling of the indigenous farming practices for enabling smallholder farmers' adaptation to climate change induced food insecurity (Suleman, 2017).

Coordination and ultimately mainstreaming and integration of indigenous farming practices in agriculture and food security policies

Most policies, plans and programmers related to agriculture and food security policies do not prioritize the indigenous farming practices and hence proper coordination at all levels and ultimately mainstreaming and integration of indigenous farming practices promotes adoption and up-scaling of indigenous farming practices.

Promoting scientific study, training and knowledge dissemination on indigenous farming practices

Scientific study is important for identifying the best options available for up-scaling indigenous farming practices that fit traditional /cultural and societal values and norms. Similarly, technical training and knowledge dissemination on the best available indigenous farming practices enhance willingness of smallholder farmers to adopt and up-scale indigenous farming practices. This triggers the necessity for understanding the local context and decision making approaches which are found in smallholder farmers livelihoods and indigenous farming practices choices (Suleman, 2017).

Challenges for up scaling indigenous farming practices for adaptation to climate change induced food insecurity

Lack of vibrant institutions, policies, legislation and regulatory framework, information and skills

The successful adoption and up scaling of indigenous farming practices depends on the extent at which adaptation and mitigation are integrated in policies, legislations, regulations and climate change issues are mainstreamed into food security and agricultural policies, plans and programmers. Practices show that unstable transformation of food security and agricultural policies, plans and programmers have escalated the vulnerability of agriculture sector to the impacts of climate change in Sub-Saharan Africa. Also, inefficient political and institutional systems have resulted in the economic deterioration of smallholder farmers communities because of lack of resilience and adaptive capacity to the impacts of climate change and hence an obstacle to up scaling of indigenous farming practices into food security and agricultural policies, plans and programmers (Suleman, 2017).

Inadequacy of agricultural extension officers

Study observed that there is an inadequacy of agricultural extension officer in the study villages. For example, in Nyaluhande ward there is no extension officer and hence smallholder farmers do not access appropriate skills and knowledge for farming activities, climate risks such as periods of droughts, shifting in agro ecological zones, crop pests and diseases. This accelerates vulnerability to climate risks (Nyashilu, 2017). Therefore, inadequacy of agricultural extension officers is a challenge towards up scaling of indigenous farming practices for adaptation to climate change induced food insecurity.

Poor infrastructures (inputs, roads, markets)

Study observed that in the study villages there is poor quality of infrastructures such as roads and markets. Roads are inaccessible seasonally and hence inhibit transport of agricultural products to the markets. Currently, the government has initiated a project for construction of roads which will ease transportation of agro products and hence will improve crop productivity in the study villages. Agricultural markets are available but due to poor road conditions during rainfall are inaccessible and hence more initiatives are needed for up scaling of farming systems to enable resilience of smallholder farmers to the impact of climate change. Agricultural inputs such as drought resistant crops, land and labour force inhibit up scaling of indigenous farming practices. For example, use of indigenous seeds which are not climate resilient accelerates vulnerability to the impacts of climate change because they are easily affected by pests and diseases (Lwoga et al., 2011; URT, 2012). Therefore, poor infrastructures inhibit up scaling of indigenous farming practices and hence increase vulnerability of local communities to the climate risks.

Access to disease resistant seed varieties, high yielding seeds and finances

Study observed that lack of access to disease resistant

seed varieties, high yielding seeds and finances are crucial obstacle in up scaling of indigenous farming practice (Suleman, 2017). For example, in the study villages most of the smallholders do not have access to disease resistant seed varieties, high yielding seeds and finances and hence inhibit up scaling of indigenous farming practices for adaptation to climate change induced food insecurity. Therefore, access to disease resistant seed varieties, high yielding seeds and finances will promote up scaling of indigenous farming practices and hence

CONCLUSION AND RECOMMENDATIONS

At the local levels smallholder farmers in spite of their vulnerabilities to the impacts of climate change have managed to utilize indigenous farming practices for adaptation to the impacts of climate change but these practices are at low scale and they need up-scaling for their sustainable livelihoods in the era of climate change (Nnadi et al., 2013; Suleman, 2017). Results of the study undertaken in Busega District, Simiyu Region indicated that 1.6, 12.9, 55.5, 64.4 and 77.5% of the sample selected for the study practice contour bunds, crop rotation, intercropping, zero and minimum tillage and cover crops respectively (Nyashilu, 2017). The study observed that cover crops enabled smallholder farmers to harvest maize (3.2-4.2 metric tons/acre) followed by contour bunds (2.2-4.2 metric tons/acre), intercropping (1.2-2.0 metric tons/acre) and zero and minimum tillage (0.2-1.0 metric tons/acre). The crop harvests exceed 90% of the district mean crop yields. Therefore this study recommends that improvement in land tenure security, improvements in access to farm implements and capital, existence of effective and efficient governance systems at all levels, coordination and ultimately mainstreaming and integration of indigenous farming practices in agriculture and food security policies, and promoting scientific study, training and knowledge dissemination on indigenous farming practices will manage the challenges and help up-scaling of indigenous farming practices for adaptation to climate change induced food insecurity.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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