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CLIMATE SMART AGRICULTURE, ITS IMPACT TO SMALLHOLDER FARMER'S LIVELIHOOD IN TANZANIA LAKE ZONE REGIONS

Jacob S. Sululu

Assistant Lecturer, Department of Development Studies, School of Social Sciences, College of Humanity and Social Sciences, University of Dodoma (UDOM), P. O Box 259, Dodoma, Tanzania.
***Sululujacob1164@gmail.com**

Abstract*:* Climate change has significantly affect the livelihood of many people across global for many years. Sub Saharan Africa is amongst of the regions of the World where those impacts are apparently. Despites the prevalence of the problem many initiatives to capacitate famers to cope with the situation has been made including dissemination of knowledge and new technologies on climate smart agriculture practices. This study therefore intended to verify the status of Small Holder Farmers livelihood in Tanzania Lake Zone regions (Shinyanga, Simiyu, and Tabora) where many projects on CSA capacity building and support were made since 2014. Six Districts namely Igunga, Shinyanga, Msalala, Maswa and Urambo were randomly selected through which samples were drawn. The study used both probability and non probability sampling design for obtaining all sampled respondents including 160 Small Households Famers (SHFs), and 10 Extension officers. Data were collected from both primary and secondary sources, while instruments for data collection include survey method through the use of questionnaire, interview, Focus group discussion, and observation.

The findings revealed that, climate change has significantly impact SHFs in Tanzania and Lake Zone in particular. This resulted to reduced production. This can be revealed by the status of harvest farmers obtain in the past farming season 2016/2017 where data show that there was variation of harvest among farmers in comparison to their investment (farm size and fund spent). Majority earn low harvest. However the efforts made by many projects including Rural and Urban Development Initiatives (RUDI), Heifer International, JICA, Musoma Food Company, Oxfarm and other development partners in terms of CSA knowledge and technology in some areas especially those with irrigation schemes has slowly changed the situation. On the other hand the survey discovered that, SHFs suffer much from insufficient extension services, pest and diseases, and unreliable government and other development partners' supply of

subsidies. Other challenges involved limited capital, low price of agricultural out puts and presence of low quality seeds in market places which continue to damage their efforts.

The recommended solutions include the following: training on CSA knowledge dissemination should go in line with material support such as provision of improved seeds and fertilizers in contractual basis. During survey it was identified that the majority of SHFs were guilt on receiving training but fail to put in practices due to low income. Inputs and technology are expensive. Further SHF's are highly exploited in market places. It is highly recommended that project in place should link farmers to reliable markets of their produce either through contractual basis or in other appropriate arrangement. Furthermore, training which are going on CSA knowledge dissemination and practices should go hand in hand with fully material supports. During the verification it was identified that, majority of SHF's were guilt on receiving more training but fail to put in practices due to low income. Inputs and technology are expensive. In deed the supply of inputs should go in line with agricultural calendar and the amount to be supplied should depend on farmers request with regards to the targeted farms size. Further SHF's are highly exploited in market places by middle men. It is highly recommended that project in place should link farmers to reliable markets through contract basis or in other appropriate arrangement. To the government, extension services is a challenging issue to most of rural farmers in Tanzania, This is partly due to limited human resources as well as limited transport facilities as witnessed during the survey. It is also recommended that, more extension officers are required to accommodate the required services. The supply of subsides by government also need to be reliable and manageable to farmers. Government should also play part on price control so as farmers can earn considerably.

Key words: Climate change, Small Holder Farmers, Climate Smart Agriculture, Livelihood

I: Introduction and background

Globally there is a growing consent that climate change is devastating rural development, by changing physical and socio-economic landscapes and making smallholder farmers' development stagnant (IPCC, 2007), (Dessler and Parson, 2010), (Flavin and Engelman, 2009). Experience from Brazil shows that climate change resulted to dramatic changes in the potentials for the various crops and increased risks of production to those analyzed crops including (cotton, rice, coffee, beans, sunflower, millet, and soya bean) and a decrease for cassava and sugar cane. (Gornall, 2010; IPCC, 2007a; Beddington *et al.*, 2012b; HLPE, 2012a; Thornton *et al.*, 2012). However there is consensus prevailing among practitioners on how smallholder agriculture practices should change to match with the changing World. The alternative is the adaptation of 'Climate Smart Agriculture (CSA)' strategies which goes beyond regular and normative practices (Guthiga and Newsham, 2011). For effective operation the adaptation of CSA practices however, requires proper national agricultural policy, program and project preparedness to reflect the magnitude of impact and required interventions (IPCCC (2007).

1.1 What does it imply? "CSA"

Climate smart agriculture is an approach for transforming and reorienting agricultural development under the new realities of climate change (Lipper et al 2014). It is an agriculture system that sustainably increases productivity, enhances resilience, reduces green house gasses and enhances achievements of national food security and development goals (FAO, 2013). The three major pillars of CSA includes, Increased agricultural productivity and income, increased adaptation and reduces farmers short term risks and shocks, and reduces /remover green house gas. The approach (CSA) can build climate resilience through managing competing land-use systems at the landscape level, while at the same time reducing poverty, enhancing biodiversity, increasing yields and lowering greenhouse gas emissions (Richardson et al, 2009). To large extent climate change impacted the lives of many people in sub Saharan Africa particularly SHF's (Global Humanitarian Forum, 2009). Thus, this calls for new efforts to enable smallholder farmers to become significant beneficiaries of climate finance inorder to reward multiple-benefit activities and help offset the transition costs and risks of changing agricultural practices and better ways to achieve and then measure a wider range of multiple benefits beyond traditional poverty and yield impacts (IPCCC (2007).

1.2 CSA knowledge, technology and practices, global perspectives

Experience from global scale and sub Saharan Africa shows variation changes that SHFs received from new interventions. Experience from Latin America (Brazil, Mexico, Guatemala and Honduras) proved that adoption of organic fertilization and composting led to increases in maize/wheat yields between 20-250% and in coffee yield by 150% (Altieri, 2011). Altieri (2014) further reported that maize yields in Brazil increased by 20-250% with the use of cover crops, crop rotations and intercropping designed to ensure differential nutrient uptake and use to some crops such as millet and sorghum (Conant 2010). Intercropping maize with legumes also led to increases in both grain yield and total nitrogen content by 100% in the same region. (CIAT, 2015) (Conant 2010) (Altieri (2014).

Adopting organic fertilizers also (compost and animal manure) is widely found to have positive effects on the yields. Hine and Pretty (2008) showed that maize yields increased 100% (from 2 to 4 t/ha) in Kenya. Moreover the cover crops reported to lead to higher yields due to decreased on-farm erosion and nutrient leaching, and reduced grain losses due to pest attacks. Kaumbutho et al. (2007) further showed that maize yield increased from 1.2 to 1.8- 2.0 t/ha in the same region with the use of mucuna (Velvet Bean) cover crop. Experience in Ethiopia also showed that,

introduction of new varieties of crops (vegetables) and trees (fruits) increases yields by 60% and the use of improved seeds varieties is expected to increase average yields. Parrot and Marsden (2002) showed that millet yield increased by 75-195% (from 0.3 to 0.6-1 t/ha) and groundnut by 100-200% (from 0.3 to 0.6-0.9 t/ha) in Senegal.

1.3 Smallholder farmers and climate change vulnerability in sub-Saharan Africa

Over 80% of the farms in SSA are under smallholder ownership and management (AGRA, 2014; Schaffnit-Chatterjee, 2014). Subsequently the region has failed to improve agricultural productivity due to number of reasons that are either directly or indirectly including input and resource poor, under-investment, poor infrastructure, insecure land tenure, unfavorable price policies and weak institutions support (Mignouna et al, 2008, Schaffnit-Chatterjee, 2014, Kahare, 2014). Further, with climate change impacts it is anticipated that by 2025 there will be higher increase of rain water scarcity due to drought persistent which will cause crops decline (rice, soy-bean and maize) up to 72% and (wheat/millet yields) up to 45% (Ward et al., 2014.Thus, enhancing food availability regardless of climate variability is a healthier way to sustainable human development.

1.4 Recent climate trend in Tanzania and resilience strategies

The Fifth National report to the UN Convention on Biological Diversity found that severe droughts have increased pressure on biodiversity and ecosystems loss (Vice-Presidents Office Tanzania, 2014). Frequently prolonged droughts have led to the drying out of water bodies such as rivers, basins, lakes and wetlands with a consequent loss of biodiversity as well as grazing lands have also been diminished(IPCC, 2014). Consequently, studies locate agriculture industry in Tanzania is a major source of food, energy, and feed industrial raw materials regardless of climate vulnerability(World Bank ,2008). It accounts for over 70% of the total economic activities and employs about 90% of the Tanzanians especially those in rural areas (URT, 2015. Therefore improving the sector to cope with climate change remains imperative.

1.5 Adaptation strategies

With response to climate change impacts and vulnerability the government of Tanzania established National Adaptation Programme of Action (NAPA).The institution given mandate to prepare integrated plans, policies, and programmes for sustainable development at the national level and make vulnerability assessments across key sectors (Agriculture, Energy, Forestry and Wetlands, Health, Human Settlements, Coastal, Marine and Freshwater resources). Among the key adaptation options and strategies prepared and consulted at national, regional, and district levels are stipulated in the table below;

Table 1: NAPA addressed adaptation strategies

1. Water efficiency in crop production irrigation to boost production and conserve water	8. Establishment and strengthening of community awareness programmes on preventable major health hazards;
2. Alternative farming systems and water harvesting	9. Implementation of sustainable tourism activities in the coastal areas and relocation of vulnerable communities from low-lying areas
3. Developing alternative water storage programmes and technology for communities	10. Enhanced wildlife extension services and assistance to rural communities in managing wildlife resources;
4. Community based catchments conservation and management programmes;	11. Water harvesting and recycling
5. Exploration and investment in alternative clean energy sources;	12. Construction of artificial structures, e.g. sea walls, artificially placing sand on beaches and coastal drain beach management systems
6. Promotion of co-generation in the industry sector for lost hydro potential	13. Establishment of a good land tenure system and facilitation of human settlements.
7. Afforestation programmes in degraded lands using more adaptive and fast growing tree species	14. Development of community forest fire prevention plans and programmes

Source: URT, (2015a)

Other interventions are made by international and local development partners such as JICA, Rural and Urban Development Initiatives (RUDI), Heifer International, World Vision and Oxfarm. These development partners are playing crucial roles in shaping lives of SHFs by making several interventions on CSA knowledge, technologies, practices and services aiming at changing agricultural practices as alternatives to climate change impact almost to all regions of the country especially to those with severe drought. Among others includes, the use of improved technologies, seeds and fertilizers (organic and scientific seeds and fertilizers), adopting zero

tillage and System of Rice Intensification (SRI) to rice producing areas, considering agricultural calendar, green house technology, irrigation schemes, proper harvest and storage as well as marketing knowledge (Recha *et al*,2017).This study therefore aimed at investigating the status of livelihood among SHF's as a result of climate smart agriculture(CSA) interventions made in terms of training, technology and other support by several local and international development projects partners in Shinyanga, Tabora and Simiyu in Tanzania.

II. MATERIAL AND METHODS

2.1 Study area and approach

This study employed cross sectional survey design whereby data were collected once from sampled areas. The study covered three regions (Shinyanga, Simiyu and Tabora) where Shinyanga rural, Msalala, Maswa, Igunga and Urambo Districts were purposively selected for the study, this is because these are the Districts whereby farmers are highly affected by the climate change (Dessler and Parson, 2010) , thus most of projects such as (Rural and Urban Development Initiatives, Heifer International and Musoma food project) on capacity building development and support where made and others are still operating. Further from the selected Districts eight wards where also purposively selected to cover the total of 160 respondents who reached and ten agricultural extension officers (2 from each District) as key informants. Several methods were adopted for data collection; they include, Household survey, Key Informants' (KIs) interviews, focus group discussion (FGD) and observation from which primary data were gathered. Secondary data were collected through Districts and Wards reports.

Table 1: Distribution of respondents in the selected areas

No.	**Wards**	**Districts**					**Total**
		Igunga	Maswa	Urambo	Msalala	Shinyanga	
1	Nduguti	0	0	0	0	30	30
2	Malampaka	0	30	0	0	0	30
3	Mwanzugi	40	0	0	0	0	40
4	Mbogwe	0	0	0	20	0	20
5	Imalamakoye	0	0	40	0	0	40
Total		40	30	40	20	30	160

2.2 Data processing, analysis, and interpretation

Data of this survey were processed through Statistical Package for Social Science (SPSS version 16.0). Analysis phase adopted descriptive statistics through which measures of central tendency and objectively discussed based on field experience mostly and often though relevant literatures. Presentation of data used frequency and percentage, tables and figures to provide a bigger picture of the situation.

III.FINDINGS AND DISCUSSION

3.1 SHF's characteristics

The survey examined the family characteristics of SHF's in the selected areas. Respondents were appealed to inform if they stand as heads of households and if not what their relationship with the household head. The findings revealed that N=127 (79.3%) of SHF's solicited were household heads. The remaining portion had other relationships with the household heads including being spouses 23(14.4%) and children 10 (6.3%).

3.2 Respondents Level of Education

The analyzed data indicated that the majority of SHFs obtained primary education followed by those with secondary education.

Table 1. Small holder famer's education level

Level of education	Frequency	Percentage (%)
None formal education	35	22
Primary	88	55
Secondary	31	19
Tertiary	6	4
Total	160	100

Source: ***Field survey, 2018***

3.3 Distribution of SHFs in the selected Districts and wards

The survey reached five Districts including Igunga, Maswa, Urambo, Msalala and Shinyanga Districts whereby five wards were also purposively selected including Mwanzugi, Nduguti, Malampaka, Mbogwe and Imalamakoye: Table below clearly highlight the distribution of respondents.

Table 1: Distribution of respondents in the selected areas

NO	Wards	Districts					Total
		Igunga	Maswa	Urambo	Msalala	Shinyanga	
1	Nduguti					30	30
2	Malampaka		30				30
3	Mwanzugi	40					40
4	Mbogwe				20		20
5	Imalamakoye			40			40
Total		40	30	40	20	30	160

Source: ***Field survey, 2018***

3.4 Farming pattern in the selected Areas

Farming activities is the major livelihood pattern to most of households in the selected Districts and wards. Many of SHFs engaged in crop cultivation with experience ranging from 5-20 years, N=87(54.4%). However, observation from the field and District agricultural and extension offices report showed that, prior to the implementation of new farming methods and practices (CSA), agriculture contributed very low on changing SHFs living standard. This might be partly due to low earning from the investment made as a result of climate change and other factors such as limited use of improved inputs and market failure. But after intervention made through different projects on new ways and support on the use of improved seeds, fertilizers and entire training gradual progressive changes get started on increased yield. This is evidenced in the sub section below.

3.5 Harvest Trend in 2016/2017 farming season

For better understand on income increase to SHFs before and after interventions one has to assess harvest/yield trend as key attribute to income. The higher the yield, the higher the income if other condition remains constant. The survey therefore assessed yield/harvest trend for two past farming seasons 2016/2017. The findings revealed that, there was variation between different ecological zones. For rice produced in irrigated areas have predictable harvest of about 30-40 rice bags per acre compared to those cultivating rice in upland whereby estimate ranged from 20-25 bags per acre. Data provided by N=113(70.6) respondents showed that, for 2016 average of 15-20 bags/acre were harvested from irrigation schemes compared to before interventions whereby total harvest ranged from 10-15 bags/acre. In 2017, 25-33 bags of rice N=104(65%) harvested. While in upland areas before interventions famers were able to harvest

5-9 bags of rice/acre, but after interventions from 2016 production increases ranging from 12-18 bags and 15-20 bags in 2017. This trend implies that, with new ways and practices production is expected to shoot if all other factors such as (reliable rainfall, appropriate methods, technology and practices) which contributing to yield increases remain constant.

Photo *depict paddy harvesting process using modern technology and others using tradition ways at Mwamapuli irrigation scheme, Tabora*

Source: ***Field survey, 2018***

3.4 Types of Crops Grown

The survey also examined the type of crops cultivated in the selected areas. The findings exposed that, the frequently food crops grown include Rice, maize and Sorghum to some few areas including Igunga and Simiyu. Commonly cash crops grown include Cotton and Tobacco. However, for food crops, Rice is highly cultivated compared to maize and Sorghum since there is increasing business potential in rice and there are irrigation schemes to most of surveyed areas. Further survey team observed that in all visited areas except Urambo District, rice is the leading crops. There were several reasons for rice to be grown higher than other food crops. Many respondents (SHFs) said that, rice caters for both food and for business N= 136 (85%), maize was the second mostly cultivated for food N=24(15%). Sorghum has just been introduced recently as alternative crop to ensure food security when there is drought.

Table1: Highly crops grown

Types of crops grown	Frequency	Percent
Rice	101	63.1
Maize	59	36.9
Total	160	100.0

Source, ***Field survey, 2018***

Findings from key informants (EO's) also had almost similar observation that, the mostly crops grown were rice and maize. Farmers are now shifting from growing cotton and tobacco to a large extent due to lower earnings from those cash crops compared to what they invest and higher demand of rice and maize in market (District office report).

3.5 Farming assistance and their sources

The survey also sought to examine where SHFs get access to farming training which resulted to increased production as resilience to climate change. Findings revealed that N=142(88.7) SHF's out 160 received training from different sources including partners such as Heifer International, Rural and Urban Development Initiatives (RUDI), Oxfam, Musoma Food Company Limited (MFCL) and government. Others include Agricultural research institutes including Ukirigulu and Sokoine University of Agriculture. Findings are further presented in the figure below.

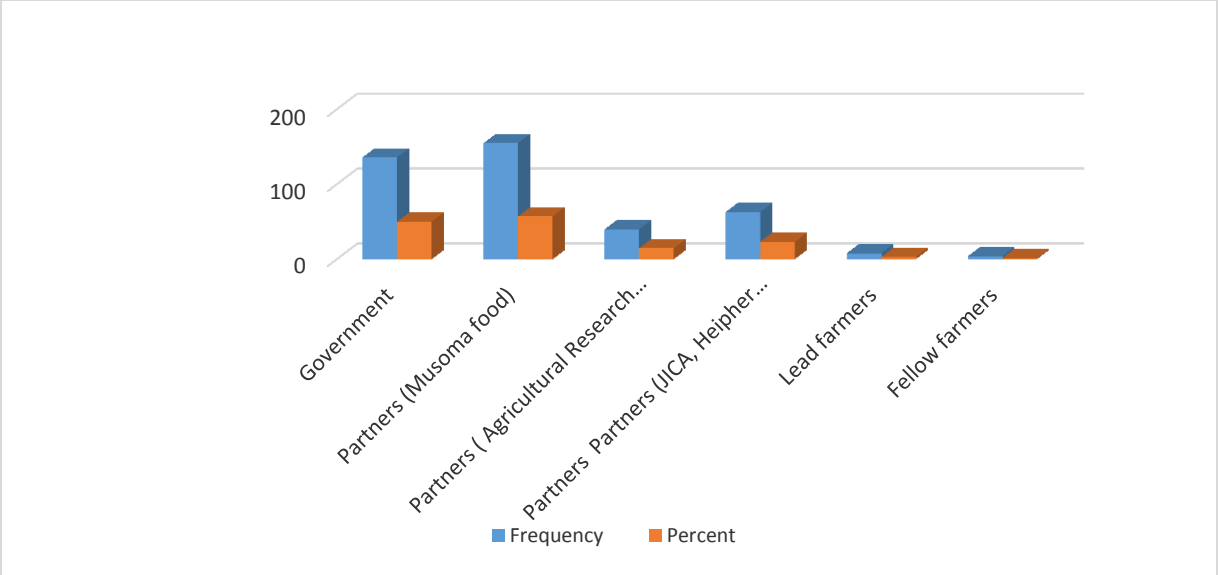

Figure 1: Farming assistance and their sources

For Key Informants (Extension Officers), the survey assessed their experiences in their role to be able to contribute to equip farmers with new ways of farming, skills and practices. The results indicate a statistical average of working experience ranging from 2-3 years. With this finding it is evidently that majority of EOs had experience in their post, thus could have strong inputs in delivering training and make closer supervision of new methods and practices.

It is further evident that along with sources of training, the survey assessed the type of training. The analysis indicates that more training efforts are focusing on production, they includes, proper farms preparation and timing, planting knowledge, weeding, harvesting and post harvest knowledge including storage, marketing and budget planning.

3.6 Farm size and ownership

The study also examine the size of land SHF's posses based on the leading crops (Rice and Maize). The findings revealed that there is higher variation of farm size per acre farmer's posses in those two crops grown. Majorities N=117 (73.2%) possessed 1-3 acres for rice production as maximum land size over 2017/2018 farming season. While on maize production also N=96 (60%) of SHFs possessed land size range from 1.5-4. Further when probing on the status of ownership of land, n= 135 (84.6%) reported to farm on their self-owned land, (7.4%) used to rent mostly from irrigation schemes. The District councils reports from all Districts visited also had

almost similar observation on farm size SHF's possess and status of land ownership as primarily famers self-owned except for few whereby some were migrants who have to rent.

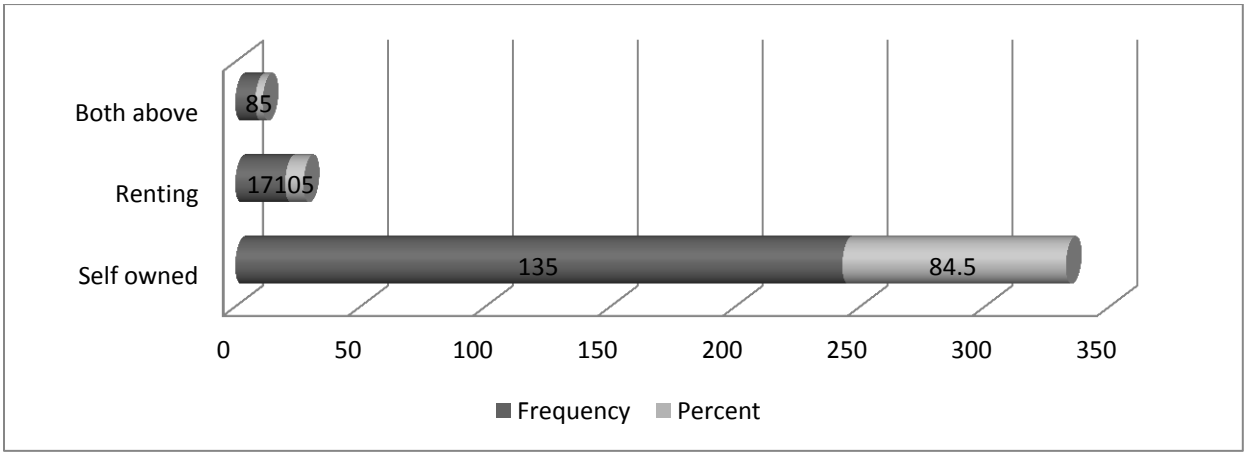

Figure 2: Status of land ownership among SHF's

3.8 Post harvest knowledge

Post harvest knowledge is an essential to farmers for yields safety. In this reason the survey examined the systems which SHFs apply to store their produce. The findings revealed that most of them store their produce at home N=105 (65.6%).The remained percentage N=55 (34.4%) use association and village store/warehouse. For those who stored in ware houses had the reasons that, by storing away from home there was a possibility for avoiding temptation for selling regularly. Other reasons provided was, by storing in ware houses helps to control price and assurance of safety.

Table 2: Status of storage

Response category	Frequency	Percent
Home	105	66
Association and Village/ warehouse	55	34
Total	160	100

Source, ***Field survey, 2018***

Indeed the survey sought to scrutinize how produce are stored in terms of technology used if any. The result showed that, majority uses polethene bags (viroba) N= 153 (96%) which are kept

inside the houses or village warehouses. The remaining percentages were using the improved technology such as Padue Improved Crops Storage (PICS), local storage facilities (vihenge) and adoption of pesticides killers such as shumbashufa.

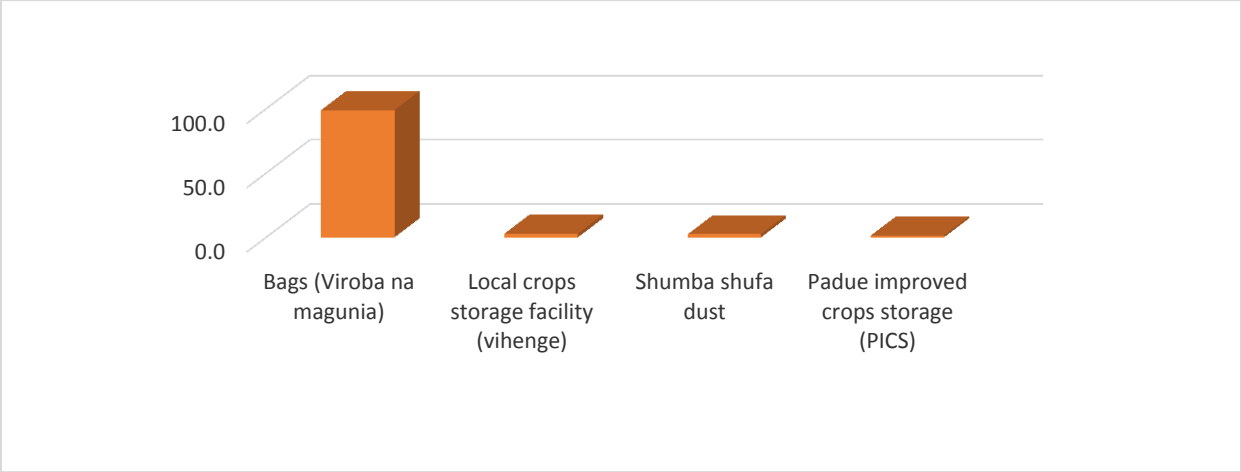

Figure 3: Technology used to store produce

These findings draw conclusion that, most of SHFs produce are stored in unsafe traditions, and therefore probability for losing some percentage of produce is very high. Thus governments and other development partners including various projects operate in these areas need to invest more on post-harvest knowledge and technology so as to maintain the quality and quantity which is essential in increasing farmers' food security and income.

Photos depict *storage technology. The left side image shows the uses of polethene bags (viroba), while the right side shows the use of pics which is considered as safe storage technology from pests.*

Source: ***Field survey, 2018***

3.9 Marketing situation

The survey teams were also interested to investigate the marketing situation by considering whether a farmer sells processed or raw produce. The findings revealed that most of SHF's N=142 (88.8%) sold raw produce, the remaining percentage N=18(11.25%) sold semi processed commodity. When investigating the reasons for selling raw produces to most of SHFs replied that, among the reasons was to avoid expenses, nature of market demand and lack of processing technologies and wherever the technology available located far from their surroundings. Other reasons were due to lack of knowledge on processing and economic hardship because farming is only source of income, so soon after harvest they need to sell so as to cover pending demand and pay back loan taken from middle men during farm preparation.

Further the survey wanted to be familiar on selling status either formalized or not. The results revealed that, most of famers N=136(85%) used informal basis to sell their produce to middle men and other buyers. Very few 24 (15%) sold their produce in contractual basis with food processors. Even Key informant interview with food processors such as Musoma Food Company proved that, had no formalized and operational contract with all farmers for buying produce except for few groups. Buying system is informal determined by quality and quantity of harvest. They provided several reasons including, low quality of produce from farmers due to early harvest, before maturity and influence from middle men were major reasons for the failure to engage in contractual basis.

On the other hand, it was identified that, farmers also had very limited chance on price determination of their produce. To large extent this situation undermines farmers' aspiration in a great deal for improved livelihood because they earn low compared to investment costs.

3.10 The impact of project on food security and income

The verification made in the sampled areas revealed that, CSA knowledge, technology and practices seems to have positive impact on food security and income. The interview made with key informants (extension officers and village/Ward leaders) and focus group discussion with famers revealed that adaptation of new ways of farming especially proper planting, weeding, harvesting, storage and agro business helped to increase quality and quantity of produce. Also famers managed to budget on how much to sell and what to store for the future family consumption. Further with the agro business knowledge obtained farmers managed to store and sell their produce when price become higher as a result continue to earn income which resulted to fulfil other family needs such as sending children to school, access to health services, clothing and even to build modern housing.

However many has been observed as challenges farmers are facing which need more efforts to rectify. They includes, delay and insufficient supply of inputs, unreliable market of their produce, insufficient funds for enlarge their agricultural investment and poor storage facilities. All these need to be improved to make farmers increase production hence generate higher income.

IV. Conclusion and recommendation

4.1 Conclusion

Agricultural sector seems to be an engine of economy to most of rural community in developing World. However for a long time farmers especially SHF's failed to see the positive outcome from the investments made in this sector. This is partly due to several challenges farmers are facing as discussed in previous sections. Generally agricultural sector in Tanzania specifically by looking SHFs is marginalized. For making the sector exciting, well structured interventions are needed as far as the impacts of climate change are concerned.

4.2 Recommendations

It is recommended that, government and other development partners should work together to assist farmers in all aspects including training and material supports for bringing agricultural transformation in Tanzania. Under projects level, more training on CSA knowledge and budgetary allocation on material support are needed to make farmers adopt and put into practice what they have learnt. Farmers also should be trained on how to add values of their rather than continue to sale raw produce as it was witnessed during the survey where 88.8% sale raw produce as a results majorities subjected to low earning compared to investment cots.

To the governments, (both local and central government) more efforts on increased extension services is needed as seem to be more challenging issue to most of rural farmers in Tanzania, this is partly due to limited funds and human resources as well as limited transport facilities as witnessed during the survey. It is therefore recommended that, more extension officers are required to accommodate the required services. The supply of subsides by government also need to be reliable, timely and manageable to farmers. Government should also play part on price control so as to help farmers earn what they expect.

Also irrigation agriculture should be incorporated in agricultural sector development priorities in terms of budgets as an alternative to climate change impacts. Further it is worthwhile if government policies, programmes and projects on agricultural sector development to incorporate more CSA knowledge and practices so as to make farmers aware with the impacts of climate change and to accept new knowledge and practices for improving their livelihoods.

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