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BARRIERS TO THE ADOPTION OF CLIMATE SMART AGRICULTURAL PRACTICES IN THE DRYLAND OF NORTHERN NIGERIA

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ABSTRACT

The study assessed the different barriers that limit the adoption of climate smart agricultural practices. Farmers view on the different barriers that limit the adoption of CSAPs is an important step of determining any action to be taken to reduce the negative effects of extreme weather events. Data for the study were collected through focus group discussion and interview that was administered on 220 smallholder farmers using availability sampling procedure. The data were analyzed using frequencies, percentage and charts. The finding revealed that barriers to CSAPs adoption has been found to be an endemic problem in the drylands of northern Nigeria with poor access to fertilizer, unavailability of extension workers, inadequate capital, unavailability of equipment among others all militating against the ability of the rural dwellers to effectively take up various innovation. Some of the recommendations made that since capital constraint has been the headache of most rural farmers, therefore stakeholders should strategize on how to promote the adoptions of CSAPs in capital constraints farm household. Farmers are also encourage to form cooperative societies to enable them have access to credit facilities and other inputs needed for effective adoption of the practices

KEY WORDS: Climate change; Climate smart agriculture; Barriers; Adoption; Drylands

INTRODUCTION

Climate change and variability normally affect every aspects of the environments. Drought, floods, irregular rainfall pattern, increase in temperature fluctuation of rainfall start and other negative of climate change attested in previous are now common in the world (Oriangi, G.; Albrecht, Di Baldassarre, Bamutaze, Mukwaya, Ardö, and Pilesjö, (2020).). Temperature increase causes rainfall pattern to vary and other extreme weather events such as drought and flood are becoming more common and indense. This has resulted in more pressure on water bodies (Bates, Kundzewicz, Palutikof, (2008); Arnell, Halliday, Battarbee, Skeffington, and Wade, (2015**)**.

Climate change has been one of the key challenges that affect Africa's agricultural sector and food security because of its sensitivity and vulnerability to high temperature and rainfall changes (Mangaza, Sonwa, Batsi, Ebuy & Kahindo, 2021**).**). Higher temperature eventually reduce yields of desirable crops while increasing proliferation of weeds and pests and variation in rainfall pattern increase the likelihood of short run crop failures and long-term output decline (Oriangi *et al*., 2020). Climate change has been a very big problem to agricultural production all over the world. This is because climate change is negatively affecting agricultural development, food security and human's livelihood condition (Saalu, Oriaso & Gyampoh, 2020)

Many actors are encouraging key agro-ecological farming technologies and practices that are highly suitable to enable farmers adapt climate change. The practices include agro-forestry, crop rotation, minimum tillage, soil cover maintenance as well as water conservation are adapted for future climate condition (Forum for Agricultural Research in Africa, 2015). These practices have been found to sustainably increase crop productivity and income and enhance resilience to climate change. All the practices are not necessarily new, but after they have been used in the context of climate change, they have been proven to be innovative for farmers. The technologies and practices are referred to as climate smart agriculture (CSA) (Forum for Agricultural Research in Africa, 2015).

Food and Agricultural Organization (FAO) (2013) identifies CSA as an approach to achieve sustainable agricultural development for food security and increase income level under climate change. The CSA approach is designed with a view to identify and operationalize sustainable agricultural development within the explicit parameters of climate change. FAO (2013) reported that CSA promote the achievement of sustainable development goals by integrating the three dimensions of sustainable development (social, economic and environment) to maximize the benefit by jointly addressing food security and extreme weather challenges.

Low adoption of CSA practices remain a challenge especially among smallholder farmers in Africa. Several barriers were identified that prevent smallholder farmers in Africa from adopting CSA practice and technologies. The policies and actions to tackle these barriers have not been adequately addressed. A good understanding of what these barriers are and how they impinge on adoption of CSA practices is essential. Equally essential are actions that encourage the removal of these barriers, while at the same time promote adoption of CSA practices. For farmers to take up a particular CSA practice and for public and private sector individuals to invest in a given CSA practice, the barriers must be seen not to exist at all. Understanding and critical analysis of the factors that limit adoption of CSA practices and a policy framework will enable policy makers to come up with concrete actions to scale up/out adoption of CSA practices in dryland.

Study Area

The drylands region of Nigeria is geographically located between latitude 12^0 N and 14^0 N of the equator and longitude 4^0 E and 14^0 E of the Greenwich (Prime) meridian. The drylands region is one of the most fragile ecosystems in Nigeria, because of its frequent drought and unreliable rainfall regimes (Abaje, Ati and Iguisi, 2013).

The average annual rainfall in the dryland of Nigeria varies from 500mm in the northeastern part to 1000mm in the southern sub-area, but it is unreliable in many parts (Karkarna and Mohammed, 2018). Temperature throughout Nigeria is generally high but diurnal variations are pronounced than seasonal ones. However, there are variations of temperatures, particularly during the very hot months. Day time temperatures are in the range of 36 to 40°C and night time temperatures fall to 11 to 18°C (Mohammed, 2017). The mean annual temperature is 26^0 C and increases towards the northern Sahel zone. Potential evapo-transpiration exceeds rainfall except for the few months.

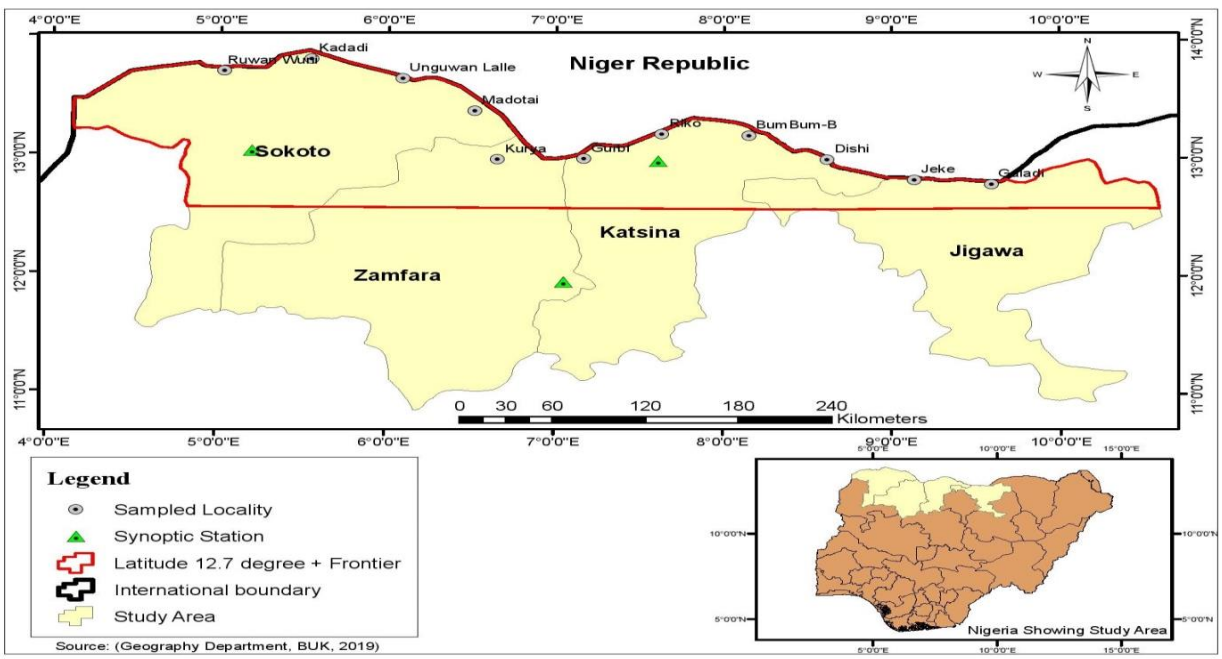

Figure 1: Part of dryland areas of Northern Nigeria with the selected study villages

The soils in the area are predominantly reddish brown or brown soils of the semi-arid and arid regions. They are also known as tropical ferruginous soils and are considered to be comparable to Ferric Luvisols (Adamu, Yusuf and Ahmed, 2014). These are sandy soils that are made up of about 85% sand (Federal Fertilizer Department, 2012).They are characterized by low level of organic matter, total nitrogen and cation exchange capacity(Shehu, Bassam, Jibrin, Kamara, Mohammed, Rurindae, Zingoree, Craufurdf, Vanlauwed, and Merckx, 2019). The climatically defined vegetation types in the area are the Sudan savanna and Sahel. The Sudan Savanna is the predominant ecotype, it has scattered trees in open grassland with grasses under 1.2m tall. The vegetation has been largely cleared for cultivation to form cultivated parkland. Parkland has scattered protected trees at some distance apart in open cultivated land. Small trees and shrubs are more common on fallow land where regeneration may take place.

METHODOLOGY

The study employed mixed method using both qualitative and quantitative data from primary and secondary sources. By primary data, the research obtained data from field information and survey particularly data on the barriers to the adoption of climate smart within the study area were sourced through interview and focus group discussion. The Secondary data has also help the researcher on useful information on the subject matter and information on the villages under study were also obtained to give vivid description of the villages.

Sample frame, Size and Techniques

Multistage sampling was employed in the research. The study area is the dryland of Northern Nigeria; in the first stage, four (4) states (Jigawa, Katsina, Zamfara and Sokoto) from this region were purposely selected as study sample areas based on the prominence of drylands in them. In the second stage, eleven (11) villages from the four states, (based on the area covered by dryland). The villages include: Galadi, Jeke (Jigawa), Dishi, BumBum-B, Riko, Gurbi (Katsina), Kurya (Zamfara) and Madotai, Unguwan lalle, Kudadi, Ruwan Wuni (Sokoto) and were selected through systematic random sampling. The criteria used in the selection of these sample villages include typical farming villages close to Nigeria-Niger boarder because the impact of the climatic variation of the dryland is mostly felt by these rural agricultural communities which required the adoption of new practices. The areas mostly have less influence of any city or big town as there could be less distortion of information as regards to people that are mostly affected by ecological consequences. The selections started from the far north, especially Sokoto State were villages were picked randomly at 10km and less than 10km away from Nigeria-Niger boarder. Then these selections were repeated at 55km interval eastward (figure 1). Thirdly, 20 smallholder farmers were selected randomly and interviewed., A total of two hundred and twenty (220) smallholder farmers were interviewed for the study. The availability sampling technique was used because the study targeted only smallholder farmers with CSA practices experience and the issues considered in their selection includethose respondents who are smallholder farmers of the age of 40 and above years who also have at least 20 years of farming experience. This ensured that the respondents are well experienced and have adequate knowledge to answer the questions they were asked.

Data analysis

Descriptive statistics was used to analyze related barriers on the adoption of Climate Smart Agriculture. The results obtained were presented in tables and chart.

RESULTS AND DISCUSSION

Related Barriers affecting the Adoption of Climate Smart Agriculture

The result finding on the barriers to the adoption of climate smart agriculture practices was divided into two different categories. The first category highlighted the general barriers affecting the adoption of CSA practices and the other category discussed the barriers limiting the adoption of individual CSA practices.

General barriers limiting the adoption of CSA practices

Barriers to climate smart agricultural practices adoption is an endemic problem in the dry lands of northern Nigeria; with poor access to fertilizer, unavailability of extension workers, inadequate capital, unavailability of equipment, all militating against the ability of the rural dwellers to effectively take up various innovations, especially those that are directly linked to the improving agricultural productivity. Such adoption options like organic manure management, intercropping , crop rotation, and agroforestry need all access to fertilizer, availability of extension workers, adequate capital to be effectively adopted, and where such facilities are lacking it becomes impossible to adopt them.

Capital

As might be expected, capital has been the first barriers limiting the adoption of climate agricultural practices mentioned by the smallholder farmers in the study area. It was even confirmed in the literature that capital for investment is a barrier for CSA practices adoption.

Lack of available capital restricts adoption of management practices and is a common theme throughout the agricultural technology literature (Kassie, Teklewold, Jaleta, Marenya, and Erenstein, 2015; Ndiritu, Kassie, and Shiferaw, 2016; Kurgat, Stöber, Mwonga, Lotze-Campen, and Rosenstock, 2018). Unavailability of capital for CSA practices adoption was ranked very high in the farmer's survey where it was cited by 69% percent of farmers. The Smallholder farmers aiming to adopt CSA practices in the Sudan-Sahelian region often are been constrained by inadequate capital to invest on land, equipment, labour, seeds, inorganic fertilizer, pesticides, breeds and other farm inputs. The finding is in agreement with Wamalma, (2017) who reported that limited access to capital, were constrained in terms of investing in farming activities including adopting of innovations, such as climate smart practices. The finding is also consistent with Oluwatimilehin and Ayanlade, (2021) who reported that the major barrier to adoption of new practices for adaptation is centered on capital which influences who can access farm inputs. It has been noted by Akinyemi (2020) that CSA practices in general are profitable in the long-term, but for smallholder farmers to achieve these long-term benefits they have to make initial investment. From the interview, it was revealed that some of the CSA approaches such as inorganic fertilizer and pesticides have been expensive and unavailable. During this conditions farmers abandoned CSA practices and therefore this affect household food security concern therefore inadequate financial means among smallholder farmers in the dryland region constitute an important barrier to the adoption of CSA practices.

In addition, it was also revealed that majority of the smallholder farmers find it difficult to access loan or credit facility from government and other corporate bodies. This signifies that most of the farmers are unable to get loan to adopt CSA practices that requires funding in order to improve their agricultural activities and diversify income sources. Adopting CSA practices as new farming strategies require funds and lack of borrowing capacity from or any other corporate body limit the ability of farmers to embrace adaptation measures that require heavy investments for instances strategies such as fertilizer use, tree planting, pesticides and irrigation.

Extension workers and Services

Extension workers and services relations were highlighted as the key barriers to the adoption across all of the research villages, ranking high in the literature and seen as a barrier to CSA practices adoption during the farmers interview. The smallholder felt strongly about the importance of extension workers and services relations in CSA adoption with 73% percent viewing it as the key barrier.

Smallholder farmer's relationship with extension workers and services influenced farming behavior and character, including investment and adoption of improved practices from CSA. Critically farmers often see the extension workers and services as not only failing to address risk management, but actually being an important source of risk for some farmers. It was revealed that extension workers are not always available in almost all the studied villages and therefore farmers are not getting advice on farming activities. One of the respondents lamented that;

"As a smallholder farmer, I spent more than twenty years without seeing an extension worker, and this had affected most of my farming activities. Also new farming innovations brought about by CSA are not known"

In all the villages visited, farmers viewed extension workers and services as largely absent because there is no evidence on the existence of these extension workers and services since they are unable to visit farmers on a regular and useful basis. When extension workers and services are not in existence, it is often affecting smallholder farmers which in return affect crops productivity that may lead to hunger and starvation. This ineffectiveness limits the long-term benefits of CSA approaches, thus providing a significant risk of dis-adoption of many CSA practices.

Various literatures specified how smallholder farmers felt about the importance of extension workers and services relations in CSA adoption. Some other literature have also stressed the importance of extension services in educating farmers reducing their vulnerability and in adopting better strategies to weather events(Akpan, and Aye. 2016; Maka, Ighodaro, and Ngcobo-Ngotho, 2019; Olorunfemi, Olurunfemi, and Oladele, 2019).

The villages with no access to extension services were all located in the extreme north. However, there were no variations among the villages in terms of having access to extension services. From the interview and focus group discussion, it was revealed that farmers contact with extension services was not sufficiently enough and the minute number of smallholder that have advantage of meeting the extension services personnel were having more experience than their counter part. According to Olayemi, Oyewole, Olusola and Merianchris (2020) majority (89%) of the respondents in Sub-Saharan African communities perceive lack of regular contacts with extension agents and this pose a great challenge to smallholder farmers.

Fertilizer Application

In many parts of the world, chemical fertilizer play a major role in maintaining or increasing soil fertility. It was discovered during the study that the use of chemical fertilizer on smallholder farms in most of the areas remain very low. The reasons for the low use of fertilizer as stated by the respondents were the cost and unavailability on time. It was also stated by some researchers that the low fertilizer usage in sub-saharan region is attributed to lack of financial incentives, weak fertilizer policies, high product price and low fertilizer demand and supply (Liverpool-Tasie, 2015; Minde, 2008). Lack of financial support has also attribute to the low fertilizer usage within the villages under study. Hence, this becomes a serious barrier to the adoption of some other practices such as intercropping, crop rotation among others. The result from the interview and focus group discussion on usage fertilizer revealed that large number of the smallholder farmers were unable to use fertilizer within the last five years due to its unavailability and cost. This therefore made clear that, many crops that require inorganic fertilizer are altered which return affect food security. Moreover, inconsistency in the price of fertilizer in 2020 has made fertilizer usage difficult and hence, this present a risk and substantial predicaments to fertilizer use among smallholder farmers.

Barriers to the adoption of individual CSA Practices

Capital was the most frequently cited barrier to the adoption of all the practices identified within the study villages. Smallholder farmers found it to be not common, but a barrier that affect the adoption of almost all the other practices which make it to be a driving leading to non-adoption. This finding matches with the studies conducted by Zhanga, Katoa, Bianchib, Bhandarya, Gortc, and Werf, (2018) which opined that better organization and allocation of various form of capital would enhance efficiency important for the adoption and diffusion of interventions to achieved the desired impact in the farming system.

CSA often requires substantial initial investments, but the range of costs can be very wide depending on the investment type. For instance, technologies for the successful implementation of CSA practices are often expensive, thereby limit smallholder farmers' ability to access and use them (Akano, Modirwa,Yusuf and Oladele, 2018). There are approaches that normally come with high initial capital investment such as equipment and inputs, all these requires access to capital to encourage farmers adoption of CSA practices. It was gathered that the capital required for farming activities within the study region is completely absent or not well linked with CSA practices adoption. This correspond with a report that was made by united Kingdom's oxford university Human development initiative, multidimensional poverty index Data Bank (2017) that rank the areas under this study as the poorest region in the country. Based on the study, the eleven (11) villages Galadi, Jeke (Jigawa), Dishi, BumBum-B, Riko, Gurbi (Katsina), Kurya (Zamfara) and Madotai, Unguwan lalle, Kudadi, Ruwan Wuni (Sokoto) from where the samples were drawn have been part of the poorest state in the country (NBS, 2019), therefore this affect the adoption of CSA practices, because capital play a significant role in determining the adoptability of smallholder farmers. While majority of the respondent indicated that capital was the major barrier to the adoption of CSA Practices, it was however, found that unavailability of the capital affects farmers in term of coping strategies against climate variability through adopting CSA practices.

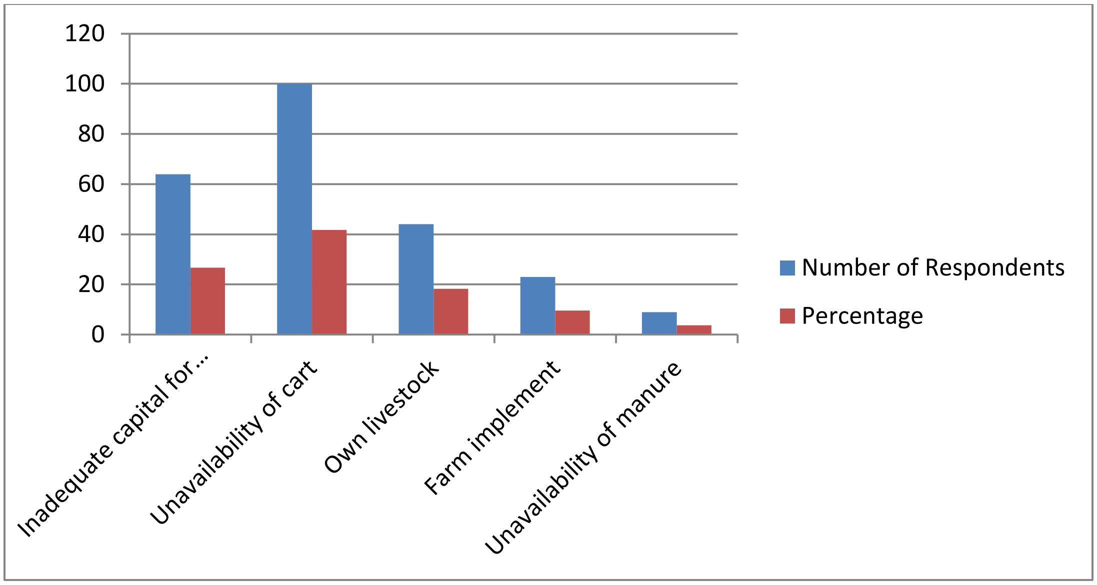

Figure 2: Barriers to the adoption of Organic Manure

Smallholder farmers who adopted CSA practices within the study area gave several reasons that limit their adoption. The most key barriers to the adoption of farm manure management application are provided in figure 2. The major constraints cited by the smallholder farmers were lack of access to capital for transporting organic manure from home to farmland (57%), lack of farm equipment especially cart used in transporting manure to the farm was also cited by the respondents (93%) and no livestock owned (33%). Others include lack of labour for manure collection and broadcasting (7%) and limited manure supply (7%). These barriers generally affected higher adoption of farm yard manure application possibly due to low resources ownership by individual household. The result support the work of Babasola, Olaoye, Alalade, Matanmi and Olorunfemi, (2017) who highlighted that difficulty in transporting organic fertilizer from the source to the point of use was rated high. However, this was found to be in contrary to the finding of Alimi, Ajewole, Olubode-Awosola, and Idowu (2006) who testify that the greatest challenge facing farmers that adopted organic manure were uncertainty of its efficiency and its offensive odour.

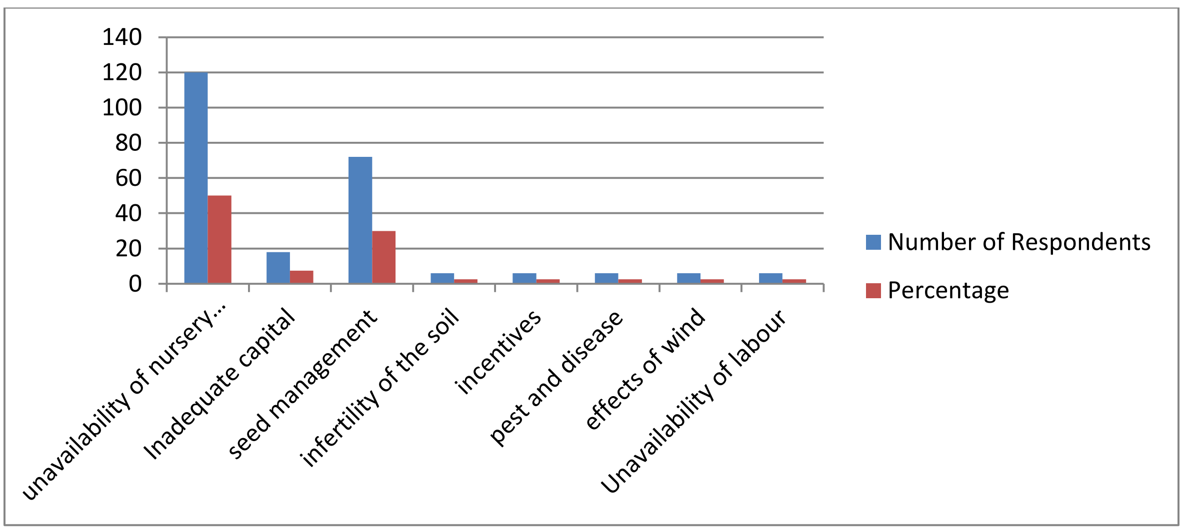

Figure 3: Barriers to the adoption of Tree Planting

Majority of the smallholder farmers in the study area cited unavailability of nursery seeds (50%) in figure 3 as the main barrier to the adoption of tree planting. Other barriers include tree management especially fencing of trees against animals (30%), Lack of capital (7.5%) to pay for labour. These findings are consisted with Olagunju, Ariyo, Emeghara, Olagunju, and Olafemi (2020) who found that inadequate finance, pest and disease, watering problem and complexity in management were the major barriers to the adoption of agroforestry. The least among these barriers include infertility of the soil (2.5%) which affects the growth of trees, lack of labour (2.5%), pest and disease and strong wind (2.5%).

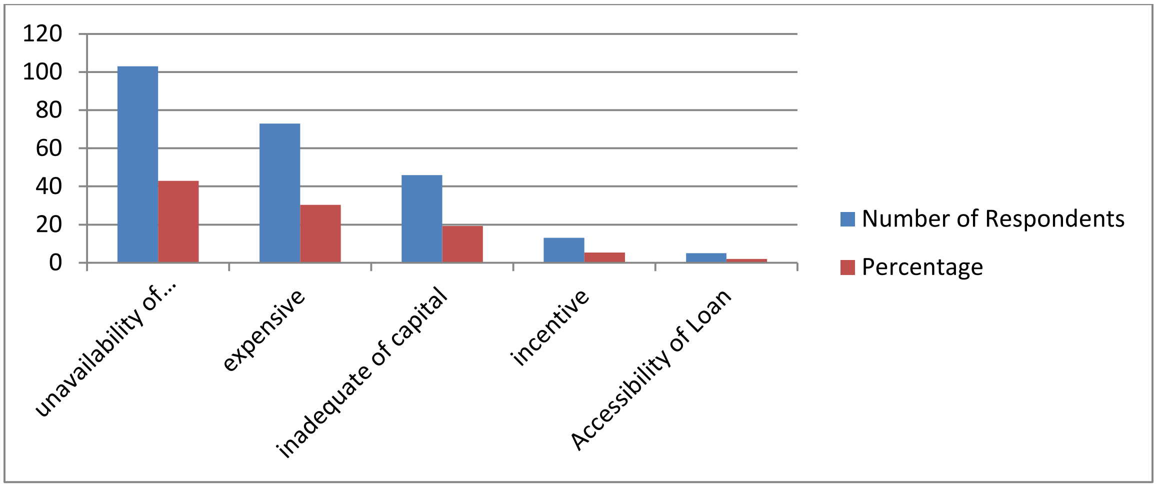

Figure 4: Barriers to the adoption of inorganic fertilizer

Barriers to the adoption of inorganic fertilizer application were presented in figure 4. Unavailability of fertilizer on time and high cost of fertilizer (42.9%) were the major barriers that limited the adoption of inorganic fertilizer. This finding is in line with a report given by the international food policy Research Institute (IFPRI, 2009) that the primary barrier to fertilizer adoption is the physical absence of the product at the time that it is needed rather than problems of affordability or farmer's lack of knowledge about it is importance. Also high cost of fertilizer (30.4%) was perceived as the second most constraints toward the adoption of fertilizer as CSA practice. The finding was supported by a study by McCampbell (2015) who reported that cost of fertilizer was rated high among the barriers that encourage non-adoption of fertilizer. The inorganic fertilizer application was constrained primarily by lack of capital (19.2%) to purchase and apply it on the farm. This is in support of Oluwole, and Shuaib, 2016 who reported that capital unavailability considerably constraints to climate change adaptation. Therefore there is need to financial inclusiveness through, for example, the provision by microfinance institutions of products and services to farmers in need, such that they can build resilience that will maximize agricultural production (Abraham and Fonta, 2018). Incentives (5.4%) and accessibility to loan (2.1%) were the least barriers to the adoption of inorganic fertilizer.

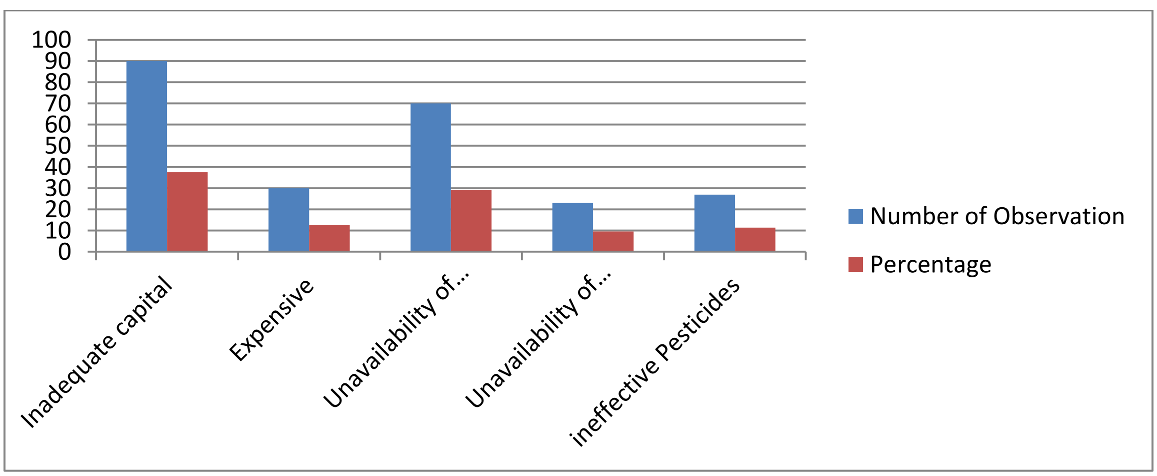

Figure 5: Barriers to the adoption of Pesticide

The main barriers that limited the adoption of pesticide application were inadequate of capital (37.5%), high cost of pesticides (12.5%), unavailability of pesticide (29.2%) and lack of access to effective pesticides (11.3%). The least barriers to the adoption of pesticide application were unavailability of sprayers (9.6%). The response from the smallholder farmers of the region was consistent with the findings of Afolabi, Thompson, Ogunwande, and Olasunkanmi *(*2020) in Nigeria, who worked on Assessment of Barriers to Integrated Pest Management Practice among Maize Farmers in Southwest, Nigeria. He reported that high cost of input, high rate of interest for credit, non-convincing and insufficient credit facilities were ranked to the medium position of fifth, sixth, seventh and eight respectively. The least three constraints faced by the farmers in the study area to adopt Integrated Pest Management are inadequacy of input, high cost of labour and labour scarcity in descending order. Lack of capital was the medium contributing factor to shortage of pesticides. If not solved, these problems would lead to production and post-harvest losses, thereby impacting negatively on household incomes and food supplies.

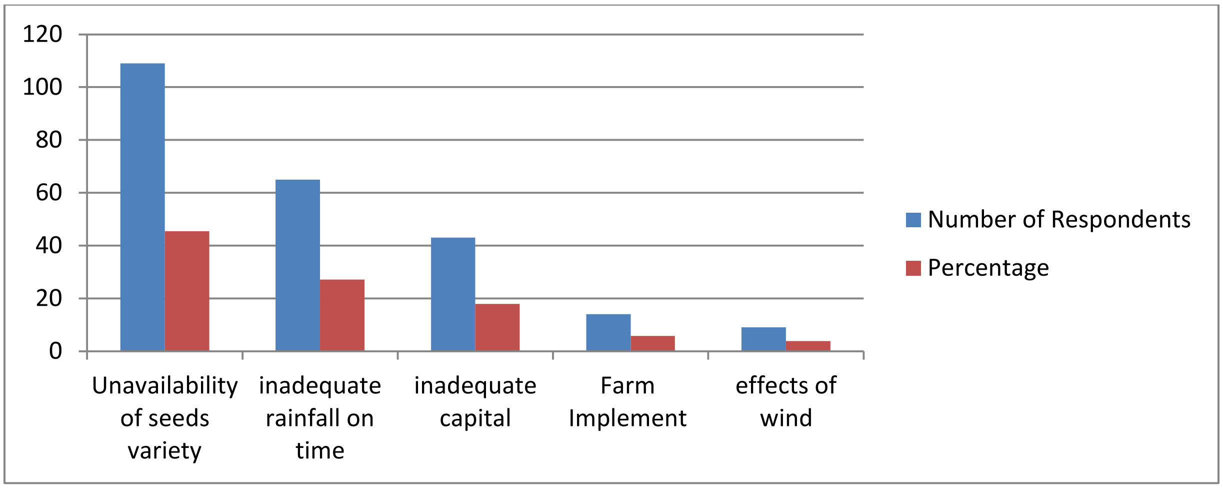

Figure 6: Barriers to the adoption of Early Planting

The survey findings on barriers to the adoption of early planting seeds include unavailability of suitable seeds for early planting (45.4%), inadequate rainfall that is associated with unpredictable rainfall pattern(27.1%) causes a total failure in the germination of seeds the smallholder farmers had planted and lack of access to capital to carry out planting activities (17.9%). Other barriers raised consistently by farmers in all the interviews were the farm equipment (5.8%) and effects of wind on the pit and seeds planted (3.8). This finding coincide with what was found by Kamara Ekeleme, Chikoye and Omoigui (2009) that with limited access to seeds, replanting is virtually impossible in the Sudan savannas of Nigeria. Kamara (2017) also reported that drought, which coincides with flowering and grain-filling periods, can cause serious yield instability at the farm level, as it allows no opportunity for farmers to replant or otherwise compensate for loss of yield.

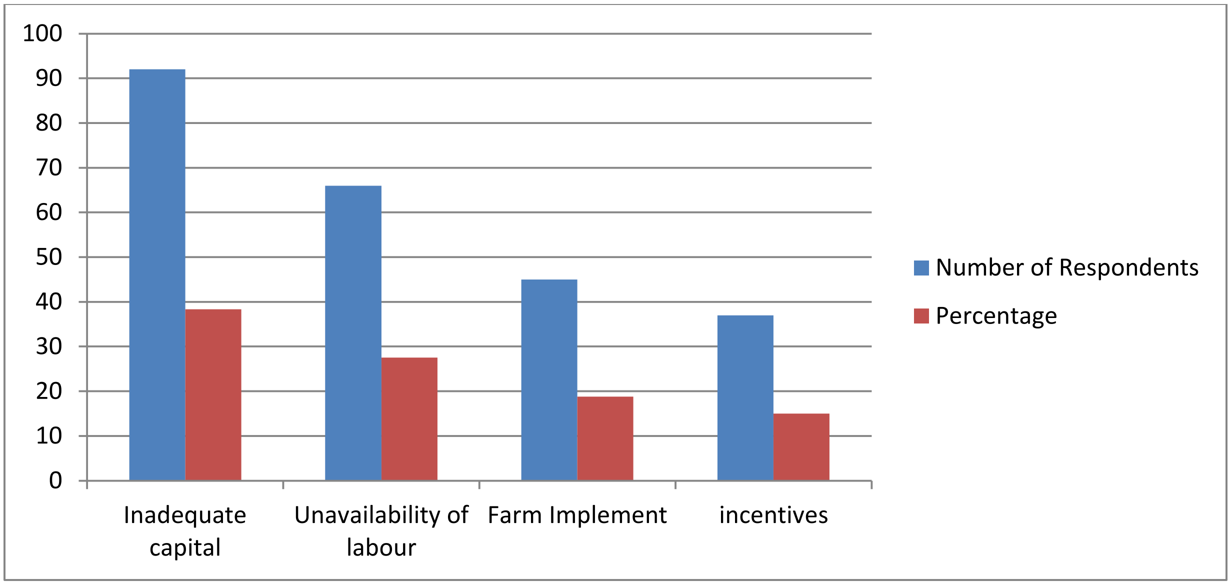

Figure 7: Barriers to the adoption of Minimum Tillage

The participant held the view that inadequate of capital was the major barrier to the adoption of minimum tillage (38.3%) because cash is required to invest in weed control especially if herbicides are not in used. Lack of labour for tillage process was also considered as a barrier to the adoption of minimum tillage (27.5). The study also corroborate the study of Makuvaro *et al. (*2015) who reported that labour shortage in agricultural practices was mainly due to migration to urban areas and shift from farming by younger community members into other activities such as gold panning. Another barrier encountered toward the adoption of minimum tillage revolves around poor access to farm equipment (18.8%). Incentive was the least barrier toward the adoption of minimum tillage with only 15.4%.

CONCLUSION AND RECOMMENDATION RECOMMENDATIONS

It is evident that there are major hindrances limiting the adoption of CSA practices in dryland especially among the smallholder farmers. For CSA to have the desired impact on the adaptation of agricultural systems in the region, it must be applied across geographical, social, economic and political contexts. However, for farming communities within each of these contexts the obstacles that impede or complicate CSA adoption must be addressed. The results of this study are indisputably important to develop policies and strategies that aimed at curtailing the barriers that limit the adoption of climate smart agricultural practices that will at end improve agricultural production and livelihood of smallholder farmers through the adoption of CSAPs. Understanding barriers that limit the adoption of CSAPs has been found to be very important as it help in designing and formulating agricultural plan and policies which can accelerate and improve food security within the region.

In the light of this study, the following recommendations were made:

i. A capital constraint has been the headache of most rural farmers, therefore it is recommended to strategize on how to promote the adoption of CSAPs in capital constraints farm households.
ii. Farmers are also encourage to form cooperative societies to enable them have access to credit facilities and other inputs needed for effective adoption of the practices
iii. Climate information should be provided and be accessible to smallholder farmers so as to ease their adoption challenges including the right combination of practices to adopt.
iv. In view of the fact that effective adoption of climate-smart practices requires some knowledge and skills, enhancing farmer education and access to extension services should be among the policy measures that will facilitate adoption.

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