ADOPTION AND IMPACT OF CHOLOLO PITS TECHNOLOGY IN SEMI-ARID AGRICULTURE: CHAMWINO, DODOMA REGION- TANZANIA

A Research Paper presented by:

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in partial fulfilment of the requirements for obtaining the degree of
MASTER OF ARTS IN DEVELOPMENT STUDIES

Major:

Agrarian, Food and Environmental Studies

(AFES)

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The Hague, The Netherlands
December 2024

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Acknowledgment

First of all, I want to sincerely special thank my supervisor, Dr. Oane Visser and my second reader, Dr. Luisa Cortesi, for their unwavering support and encouragement throughout this journey. Their attitude, eagerness to help, knowledge, advice and patience helped form my work. I should also like to prompt my deep gratitude to the faculty and staff of the International Institute of Social Studies, for building an institutional environment conducive to research training and for making resources available which have enhanced this research.

Additional thanks goes to my AFES course leader and Governor Dr. Helena Perez Nino, fellow students my colleagues, and non ISS teaching Staff for their encouragement and helpful believes, which improved both my experience and my work. My deepest appreciation towards goes to my children, Phideah and Hamisa , and my Dasa family, including all family member in Kinondoni- Dar es salaam Tz, as well as my friends, for their unconditional support, love, trustiest and understanding towards their prayers that helped me to overcome the challenges through this journey.

I am also very grateful to the Orange Knowledge Programme (OKP) for the financial support that made this academic achievement possible. Finally, I thank everyone who supported this study in any way. Your help and encouragement were essential to completing this research.

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List of Acronyms

FAO	Food and Agriculture Organization
ISS	Institute of Social Studies
UNDP	United Nations Development Programme
SSA	Sub-Saharan Africa
GDP	Gross Domestic Product
URT	United Republic of Tanzania
CSA	Climate-Smart Agriculture
MALF	Ministry Of Agriculture, Livestock And Fisheries
TCSAA	Tanzania Climate-Smart Agriculture Alliance
NCCS	National Climate Change Strategy
ACRP	The Agriculture Climate Resilience Plan
UKAID	UK-AID DIRECT
IITA	International Research Organization
USAID	US Agency For International Development
WASA	Water-Smart Agriculture
ICRAF	World Agroforestry Organization
GCCA	Global Climate Alliance
PBCRG	Performance-Based Climate Resilience Grant
UNCDF	United Nations Capital Development Fund

Abstract

This study focuses on how the adoption and impact of chololo pit technology help small farmers to increase crops and go for sustainable agriculture. In this research, I want to know how the farmers were able to benefit from the improvement that occurred in chololo pit technology project in Chamwino district in Dodoma region. The research is important because will highlight where the project ended since was established in the region and the experience of small farmers on perceptions regarding the adoption and impact of chololo pit practices on crop productivity and agricultural resilience.

I got to know many results after finishing the investigation including positive and negative factors that led to the realization that the project is beneficial and ability to continue to bring productivity to the community. Also, Farmers are likely to benefit from improved water retention, soil fertility, and land productivity. The study reveals the presence of social and economic factors that affect the adoption of the technology including income, labour force, and financial costs of the project which may determine the extent to which farmers adopt Chololo Pits technology.

This study was able to be successfully carried out in two wards of Maginga and Ifuda located in chamwino district, Dodoma. The Chololo pit project was able to be done properly and able to bring interest to the community. I suggested using 2 Focus Group Interviews (FGI) and 4 key informatic interviews (KII) which all together point out how the adoption and impact of chololo pit technology. It was able to bring about the agricultural expansion on productivity and resilience aspect. Furthermore, I have been able to learn this agriculture can bring productivity and positive interest in the community even though it has still been through the challenge of not being able to develop due to various challenges facing the beneficiaries on vulnerable groups, especially those smallholder farmers.

Relevance to Development Studies

This topic is relevant for my Master of Development Studies and it is very crucial for the ongoing issue of food security and agricultural economic growth in Tanzania. First, it provides a view of project effectiveness, revealing how climate change affects crop production and agricultural resilience in real-world settings. This investigation has been carried out and has identified the effects of climate change and the use of agricultural practices in bringing crop productivity.

As a student interested in agrarian transformation studies, the study intended to know smallholder farmers' perceptions regarding the impact Chololo pit technology practice. In development studies, it is very imperative to recognize the application of CSA technology and the space for smallholder farmers to adopt new practices and abandon the traditional way of agriculture. From the perspective of small farmers as Vulnerability Group, it has been possible to highlight practical challenges and successes that have occurred during the implementation period and until the end of the project.

Furthermore, this research is important for informing policy decisions and development strategies, to ensure that they are compatible with the method of chololo pit technology practice in the use of increasing crops and agriculture resilience for the local community of Chamwino village. In addition, this is considered that the responses of farmers through research promote a collaborative technological approach with the areas where they have implemented agricultural principles. Ultimately, this research can contribute to the broader goals of enhancing food availability, reducing the risk of climate change, and promoting sustainable development in the region. Studying the results of the development of the Chololo Pit Technology Project through the perspectives of Chamwino farmers, Dodoma Region, Tanzania.

Keywords

Adoption, climate-smart agriculture, Sub-Saharan Africa, Chololo pit, Technology, Resilience and productivity, Smallholder farmer.

Chapter 1
Introduction:

Agriculture has been very productive in the world, especially in the countries of sub-Saharan Africa, being relied upon as a source of economy, although it has been suffering from the upheavals condition, overpopulation and climate change. In this study, we will highlight the problem of climate change and the challenges brought by agricultural experts to ensure that they face a solution to this challenge and ensure sustainable productivity.

1.1 Background to the Study

Agriculture makes the economic expansion and development in Tanzania and other many countries in Sub-Saharan Africa (SSA). Agriculture remains an important sector in African economy because around 60% of the people who live there were engaged in farming and make up 25–34% of the GDP (Feeding Africa, 2015). Agriculture contributes a lot to the national income of Tanzania, in the report of URT (2013) it is clearly stated that 28 percent of agriculture contributed to the national income, but also the nation produces 95 percent of food in parallel and provides employment 75 percent of all jobs nationally and part of these people live in rural areas where 80 percent of its residents are involved in agriculture (URT, 2013).

Agriculture could help fight worldwide climate changes, especially when it comes to the risk of food insecurity caused by environmental warming (Lini W, 2017). Climate change has a lot of effects on farming especially on animals, yields of crops, soil fertility and access to water. Since the coronavirus emerged in many countries, especially developing countries including Sub-Saharan Africa, still have big problems in crop production and food insecurity (Xie et al., 2021). Occurrence of extreme atmosphere events like floods, wind and droughts are predicted to happen more often and be stronger in these countries. This, along with more pests and diseases, will cause more agricultural yields to drop (IPCC, 2014). Regarding, agricultural experts have taken up the task of stimulating farmers' need to use appropriate agricultural practices in technological farming methods to solve this productivity problem. There was firstly an invasion of climate-smart agriculture in 2010 by "UN Food and Agriculture Organization" (FAO) first discussed on ideas of climate-smart agriculture (CSA) at the Hague Convention on food availability, agriculture resilience and climate instability (FAO, 2010). It was a new agricultural technology approach in the early stage since it was introduced due to extreme climate changes that threatened agricultural productivity and livelihood.

1.2 Research Problem Statement

Growing food needs are linked to the rising world population. This is the reason for the food crisis getting worse and the threat that farming may not be able to sustain the growing population. Most agricultural activities in most African countries including Tanzania depend on rainfall. This makes crop yield uncertain, especially in semi-arid areas that are more likely to be affected by climate change (Ogada et al., 2020). Millions of productivity jobs are lost around the world because of climate change which is regarded as a significant risk to crop yield and food security (IPCC, 2014). Precise on several studies, rainfall patterns and adequate climate have been linked to big drops in agricultural production (Lobell et al., 2012). Lower food production in agriculture, higher oil prices, and less land for farming have all led to higher food prices and famine around the world (Fan, 2011). Moreover, people who live in rural areas and depend on subsistence farming are the ones most affected by climate change

(Lema and Majule, 2009). Women, children and disabled people are the ones who most affected by climate change because they cannot adapt as well as men and young people (Abegunde et al., 2020). Most people who live in rural areas are women and their main source of income comes from subsistence rain-fed agriculture (Kalumanga et al., 2014).

In recent years, international agrarian experts have published the adoption of climate-smart agriculture (CSA) under Food Aids Organization (FAO, 2010). CSA has been divided into three primary objectives: Productivity, Mitigation and Resilience included in the CSA framework (Hussain, 2022). They came to rescue countries that were going through and had been affected by a drought that led to a drop in food production within Sub-Saharan countries. As an alternative way to deal with these tough situations and help lessen the effects of climate change use climate-smart agricultural practices. For instance, Tanzania faced agriculture problems caused by climate change then I decided to look for alternative ways by adopting Climate Smart Agricultural (CSA) which is used in places like the Chololo Ecovillage as a case study (Ecovillage, 2014).

The Chololo Ecovillage is part of a project in a semi-arid part of Dodoma that shows works on how the "Global Climate Alliance" (GCCA) can help communities get the tools they need to test, evaluate and use a wide range of new ways of adapting to climate change in the areas of agriculture, water, agroforestry and livestock. Its goal to help vulnerable groups deals with the issues that mostly come up because of climate change (URT, 2013). Climate-smart agriculture (CSA) aims to protect the environment and improve food security. It has technical agricultural approaches include no-till farming, integrated fertile soil management, alternating wetting and drying, utilizing nitrogen efficiency in soil organic carbon, and cultivating crop rotation (Francaviglia et al., 2023).

Also, some scholars explain in different articles, the contribution of CSA practices by expressing exterior capacity toward smallholder farmers in increasing crop productivity and agricultural resilience (Nyasimi et al,. 2014 p8). It was stated by Denish (2015) that CSA has made easier for food projects that happen in the agricultural sector. It can help given its existence charges low prices that people from vulnerable groups can afford and welcoming spaces that can lead to great success. People said that "the CSA method teaches farmers more than just farming techniques and helps to earn more from long-term farming projects (Hisali et al., 2011).

However, the introduction of new CSA technologies is relatively new phenomenon, and the adoption of these technologies is facing various challenges. The adoption process of CSA technologies in Tanzania and its implication have not been studied critically and widely. I hope to contribute to knowledge about adoption of CSA technologies in Tanzania by analytically examining the adoption and implications of chololo Pits Technology in Chamwino district of Dodoma region. Therefore, this study aims to get deeply understanding of the existing perceptions of the farmers from Dodoma region in Chamwino district regarding the adoption and impact of Chololo Pits technology as climate-smart agriculture practices on resilience and crop productivity in semiarid areas.

However, researchers have documented that the presence of Chololo Pits improves soil health through the stimulation and facilitation of the decomposition of organic matter which may result in increasing nutrient endowment hence fostering a better agricultural environment (mkonga et al., 2010).

Therefore, this research intends to assess the project conducted with the use of pits. According to Temu et al., 2022, "Chololo pits technology" practices were aimed at keeping the soil moisture and restoring soil fertility that brought abundant harvests to farmers in Tanzania drylands. I am here to highlight the perception that smallholder farmers were able to benefit and develop sustainable production after the adoption of Chololo Pit technology in the agricultural project.

1.3 Research Objectives and Questions

To explore small-scale farmers' perception regarding the adoption and impact of Chololo Pits technology as climate-smart agriculture practices on resilience and crop productivity in semiarid areas in Tanzania

1.3.1 Objective

a. To experience smallholder farmers' regarding the adoption and impact of chololo pits technology on agricultural resilience.
b. To evaluate the contribution of Chololo pits technology on crop productivity and agricultural

1.3.2 Research Question

What are the experiences of smallholder farmers' perceptions regarding the adoption and impact of chololo Pit practices on crop productivity and agricultural resilience?

1.3.3 Research Sub-Question

a. How do small perceive the contribution of Chololo Pit technology in increasing crop yield and resilience?
b. How did socio-economic and technological factors influence the adoption of Chololo Pit technology among farmers?
c. What is the role of the government's extension officer and other stakeholders in adopting the Chololo Pit practices?

Chapter 2 CLIMATE SMART AGRICULTURE

2.1 Climate Smart Agriculture technology

Climate-smart agriculture (CSA) is a set of techniques for developing agriculture practices to simultaneously deal with food insufficiency and climate change (Lipper et al., 2014). CSA involves comprehensive strategies to accomplish the three major objectives effectively: enhancing agricultural productivity, adopting and increasing resilience in agricultural strategies and eliminating emissions of greenhouse gases when happen (FAO, 2010). CSA brings together methods that have been used for a long time in agriculture, conservation, climate change and environmental ecology.

These samples of CSA practices that have been named by the Food and Agriculture Organization (FAO) are forestry, urban & peri-urban agriculture, integrated practices, proactive drought management, livestock, fisheries & aquaculture, crop production, live-stock, forestry, Genetic resources & biodiversity, land & water management, and nuclear techniques practices (FAO, 2010). Also, this CSA practice differs from one place to an-other depending on socioeconomic, biophysical and cultural factors (Ngaiwi et al., 2023). When combined and used together, climate-smart farming methods could create vamp an agriculture system that resists changes in climate and other factors that lower agricultural production (Teklewold et al., 2013).

Developing countries likely Tanzania are heavily likely to be affected by climate change because most of their people depend on natural resources that are sensitive to climate change. They are less able to adapt (UNFCCC, 2007). In 2015, the United Republic of Tanzania Government created a Climate-Smart Agriculture (CSA) program for Tanzania in response to the needs of food security and climate change (Lamanna et al., 2018). Tanzania successfully introduced some national and community-level programs to create policies, projects and make learning alliances easier for agricultural changes and make CSA policy significant for the country (URT, 2014). Tanzania's government has committed to supporting the agriculture sector to cope with and adapt to climate change by developing relevant policy instruments and national programs

2.2 Initiation of the CSA Program in Tanzania

The government and agricultural experts have decided to introduce several programs under the National Agricultural and Livestock Ministry. "National CSA program" is a program that aims to address outcomes/challenges that occur in the agriculture sector by enacting policies and plans to guide the progress procedures under the national base. According to CIAT & World Bank (2017) Tanzania government in association with the high national administrative authority, "The Ministry of Agriculture, Livestock and Fisheries" (MALF) acts as a policy formulation and implementation Programme and the Guideline of CSA provides favorable mechanisms to promote sustainable productivity. "The Tanzania Climate-Smart Agriculture Alliance" (TCSAA) states the government has a promising chance for better communication, coordination, and sharing of information on CSA through engaging in CSA invectives. Here are among the programmes of CSA in Tanzania "National climate change strategies" (2012-2018), "Agricultural climate resilience plan" (2014-2019) and "National climate-smart agriculture" (2015-2025).

"National Climate Change Strategy" (NCCS) started in 2012-2018, aimed to help the country deal with climate change and cut down GHG emissions, and join global climate change mitigation efforts for sustainable development. It is expected to mitigate vulnerability while improving resilience to climate change. The goals are to increase eco-system, resilience, increase adoption of climate change that contributes to sustainable development, public awareness, information management, institutional arrangements, and mobilizing resources (URT, 2012).

The Agriculture Climate Resilience Plan" (ACRP) was made from 2014-2019, aimed at improved water use and support land, disaster risk, climate-resilient crop varieties and soil & water management, climate-resilient crop varieties, and disaster risk management strategies. As well as pointing up areas where new investments might be required. The ACRP will act as a road map for integrating climate change into agricultural practices, plans and policies. It will serve as the guiding principle for a more encompassing and consistent strategy meant to address one of the main hazards to future agricultural aspects and present crop output (Kahimba, et al., 2015)

"National Climate-Smart Agriculture" (2015-2025) as a program with the main goals in the agricultural sector helps to achieve and maintain food security in the country by increasing crop productivity. Similarly, the Program comprises Water Resources Management Strategies and Act Plans for Adaptation to Climate Change. CSA Program will help Tanzania adapt and be resilient on agriculture activities to climate change. The CSA Program's goal is to ensure that all of the CSA projects being run by different groups work better together (URT et al., 2015).

2.2.1 Agriculture Climate Resilience Plan (2014-2019)

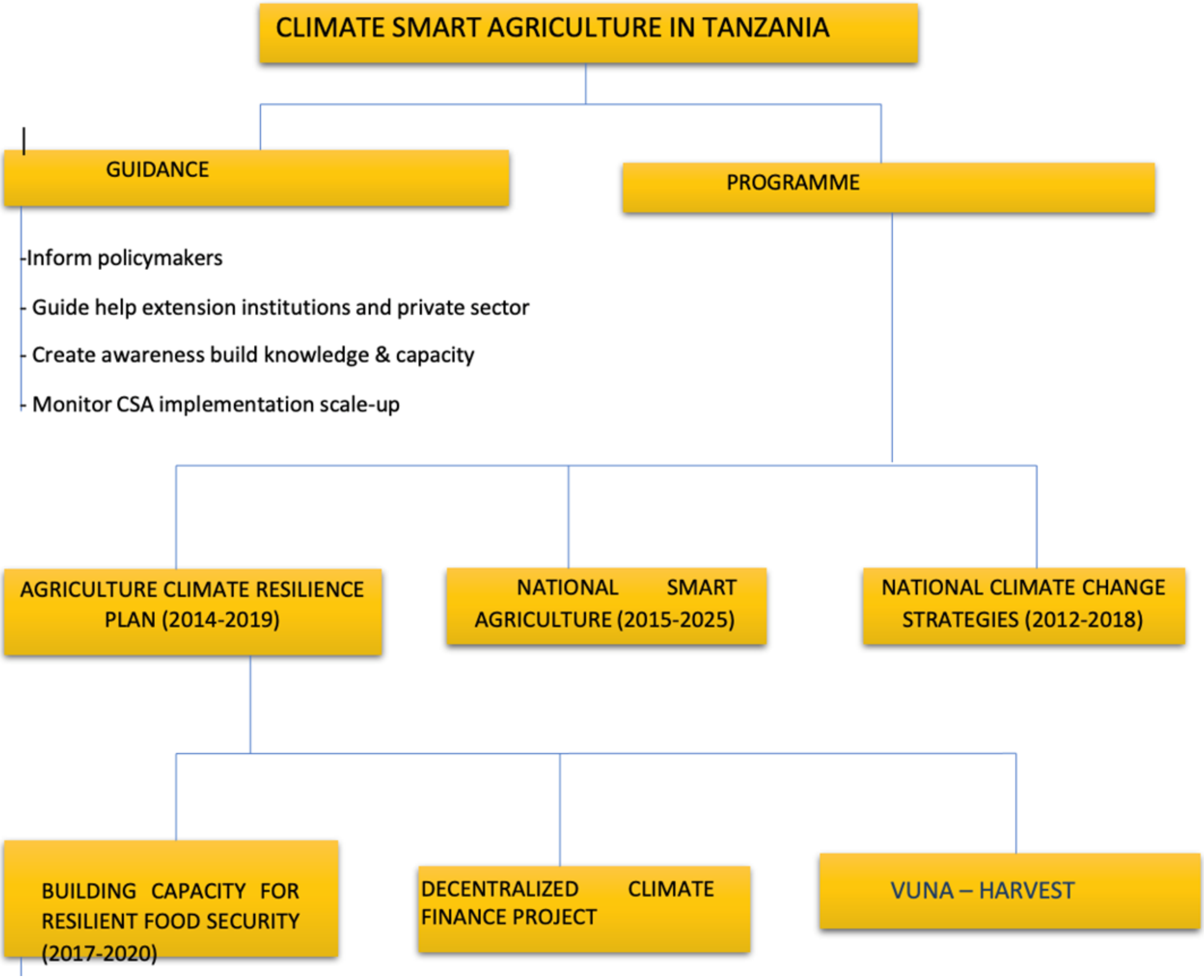
Furthermore, the explanation of the national CSA program held in Tanzania was implemented to help the large and smallholder farmers overcome the agricultural challenges that could lead to obstacles. I decided to select The Agriculture Climate Resilience Plan and check out in detail the projects that were formulated. There are the projects that were implemented under the Agriculture Climate Resilience Plan.

"Decentralized Climate Finance Project" (2016) which is a project funded by the government that intends to facilitate investments in better remedies for global warming through 15 test districts by "UK-AID DIRECT"(UKAID), with technical provision from the "United Nations Capital Development Fund" (UNCDF). It established a "Performance-based Climate Resilience Grant" (PBCRG) in collaboration with the UNCDF "Local Climate Adaptive Living". The project has a life span of 5 years. It improved community resilience and was implemented by the appointed districts to build the capacity to develop the necessary competencies. The scale-up sustainable capacity was decided to promote by providing financial support on climate to communities to help them adapt across Tanzania (Romero-Lankao, P. 2016).

Another project, "VUNA" which in English means "HARVEST" (2016) is a regional CSA project with the main objective of increasing access, promoting and facilitating the environment policy on CSA Strategy. The aim is to improve CSA training for farmers and non-farmers under Department for International Development (DFID) funded for 3 years. It helped the governments to navigate International Climate Finance processes, regulations and requirements for CSA. This is a CSA and Verification (MRV) report on Designing Agricultural Business Models that focuses on farmers' development in maize, sorghum and pulses (Kahimba, et al., 2015).

"Building Capacity for Food Security" is a project implemented by USAID with the association of International Research Organizations (IITA), (ICRAF), (FAO) with a duration of 3 years (USAID, 2015). It intends to identify the potential benefits of CSA practices, emphasizing sustainability and productivity. It is found under different local climate conditions depending on the region and farming system. Also, the selection of CSA practices for specific planting influence areas as related to developing practice specifications for those practices.

Develop community CSA exhibitions to inform policy-makers about CSA practices with the request that all agricultural extension graduates know the methods, practices and uses of CSA (Lwezaura & Amos 2017).



Chololo Pit Technology

Figure 1:Climate Smart Agriculture Chat In Tanzania

2.3 Chololo Pit Technology Project

The Chololo pits technology is an agricultural practice aimed at enhancing soil moisture retention, fertility, and crop productivity. It is well known as water conservation technique and done in arid and semi-arid regions. The technology involves the creation of small, circular pits (usually 20–30 cm in diameter and depth) which are dug into the soil at regular intervals across the field. They stand as reservoirs for rainwater that had to minimizing water runoff and concentrating moisture around the crops' root field.

Through the Chololo pits technique does mostly require extra amount of organic fertilizer compare traditional planting methods. The rationale is going appendicular to improving water retention that organic matter in each pit enriches the soil structure and enhances fertility (Critchley et al., 2012). when its reach the moment to planting had to place Organic fertilizer in the pit with each planting, improves fosters, roots development and nutrient availability that is essential in nutrient for a poor arid soils.

For instance, farmers practicing Chololo pits can use double the amount of compost or manure because whatever is added in those pits will be more readily absorbed by plants as compared to surface application methods (Zougmore et al., 2004). However, the technology comes with advantages namely, higher yields and greater resistance to drought which balance that demand for additional organic input.

2.3.1 Background of Chololo Pit and USAID Project

The Chololo Pits project, part of a comprehensive initiative by USAID to encourage climate-resilient agricultural practices in Tanzania, was an attempt to cub food insecurity and resource degradation in the semi-arid Dodoma region. This mechanism, encouraged traditional water-harvesting techniques which were promoted largely through the project, which began in 2012 as part of the "Feed the Future" program aimed at improving food security and rural livelihoods across East Africa. The USAID initiative dwelled mostly on increasing the capacity of smallholder farmers to cope with drought conditions and un-predictable rainfall, which have increased with climate change (USAID, 2015).

The Chololo pit technology itself is obtained from traditional Zai pit practices that have been used in parts of West Africa for ages, particularly in Burkina Faso and Mali, where similar water-harvesting techniques were used to improve soil moisture and fertility in semi-arid regions (Ali & Bedadi, 2022). This technique was first popularized by international development agencies but its adoption in Tanzania came largely as a result of USAID's bidding. While some Tanzanian farmers might have tested pits on their initiative, large-scale and intensive use of Chololo pits was practically exclusively related to the USAID project. Water-harvesting techniques before the project were limited to terracing and bunding, rather than pit-based methods in the wider region (Critchley et al., 2012).

Furthermore, Chololo pits gained prominence in Tanzania mainly through the targeted project by USAID that provided full promotion for its adoption. Even though the technique showed both value and profitability during the years the project was active, it seems to fade away once support terminated due to the inherent labor intensiveness.

2.3.2 Implementation of the Chololo Pits Project

This study was expressed on the Chololo Pit Project as one of the CSA practices found in Dodoma which is managed by the World Agroforestry Organization (ICRAF). Drylands were brought into overcome the deficit in food production and economic livelihood in the community through the agricultural sector. It has stand as most effective way to increase the amount of rain that falls and decrease the amount that runs off or evaporation. This increases agricultural productivity in the long term (Danquah et al., 2019).

The implementation of project backed up with USAID whose ran intensively from 2012 to around 2015, with subsequent support tapering off as the project concluded. During its active years, the project provided training, materials, and technical support to farmers on the construction and use of Chololo pits. The enterprise included community workshops, field demonstrations, and follow-up sessions to ensure farmers could execute and maintain the mechanism in a solitary state. The technology work towards keeping the soil's moisture and improve fertility so that crops can grow better and drought effects can be reduced (Ismail et al., 2022).

Meanwhile, semiarid regions of Tanzania has had positive results amongst the target-ed groups and valuable communities. The study by Kahimba et al., (2014) shows that 26.2% of smallholder farmers in Dodoma region practice Chololo pits/planting technology. It shows that farmers who used Chololo pits technology began to experience an in-crease in crops country to traditional farming methods. The preceding yield improvement has shown good results considering the shortage of rain and unpredictable rainfall characteristic of this region by enhanced water availability during dry spells.

2.3.3 Steps for Preparation of Chololo Pits

1. Digging Pits: Farmers dig these pits using simple tools, spaced at intervals designed to increase water infiltration while leaving room for crops to grow between pits. The technology involves digging a square hole with sides 20 cm in length and a depth of 30 cm Through the help of agricultural experts, you make the farmers able to properly prepare the holes in preparing the fields.

2. Filling with Organic Material: Adding a handful of farmyard manure or organic matter in each pit filled. In the mixture you put there, you can help the soil become sandy and dry to give it the ability to enrich the soil with nutrients and enhance its water-holding capacity.

3. Sowing Seeds and Periodic Maintenance: In the next step organic material is filled up then seeds are planted directly in the pits. In assisting the growth of the seeds the organic material not only provides nutrients but also protects the seeds from high temperatures that create a micro-environment conducive. Lastly, the pits may need to be nurtured to prevent soil erosion and enhance the capture of retain water effectively.

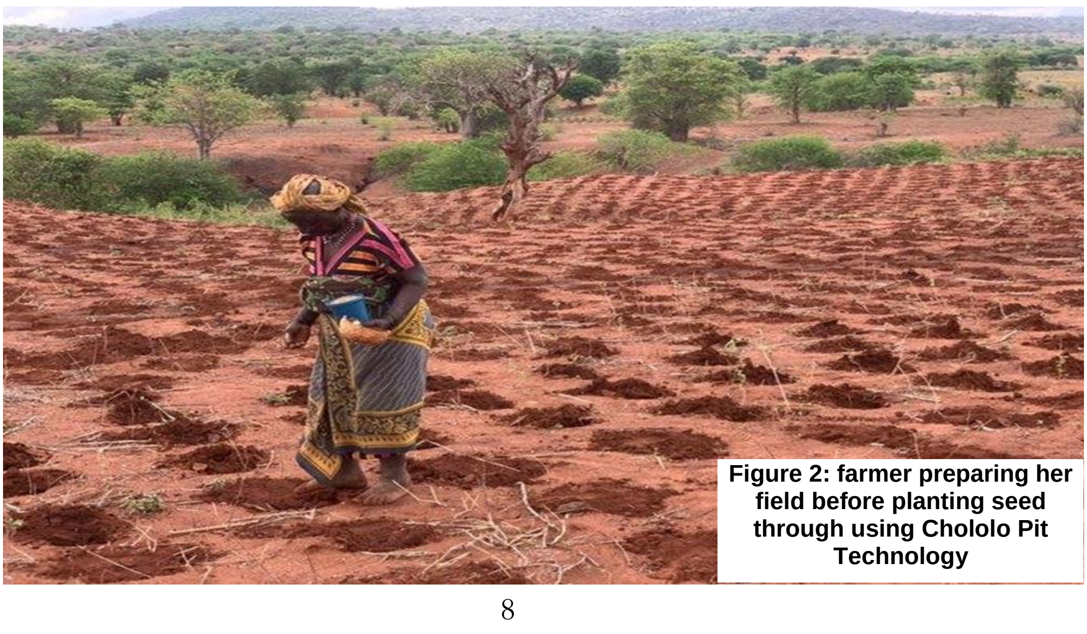


Figure 2: farmer preparing her field before planting seed through using Chololo Pit Technology

Chapter 3: LITERATURE REVIEW

3.1 Context of the Study

The agricultural sector is associated with more frequent environmental natural disasters and human economic activities such as deforestation, land grabbing and land degradation. The huge impact is felt in developing countries where extension agriculture contributes to national GDP and stands as the national economy backbone (Long et al., 2016). However, the persistent threats of food insecurity among smallholder farmers around the world have led to the creation of a new way to deal with the problem of climate change. Small farmers make up 84% of all farmers in the world, and most of them are vulnerable groups living in developing countries (FAO, 2010). It is known that many of the world's poorest people get their food and earnings from farming as labour which is the most important part of the food chain (Bogdanski, 2012).

There are cases where some smallholder farmers in Tanzania have still sought remedies by implementing traditional practices to mitigate the impact of climate change and variability. These practices consist of shifting cultivation, the use of manure from farm yards, and oxen plows for land preparation (Kimaro, 2016). However, such practices have had little impact on overcoming the overall challenge of climate change which is now a global tragedy. In the course of addressing the climate change challenge, Tanzania tried to adopt technical farming methods like agroforestry practices that were suggested as a climate-resilient strategy to alleviate food security and climate change concerns. Adaptation of CSA as phenomenal in agricultural technical which was introduced by FAO in 2010 to increase productivity and defect the changes of climate change (Bongole, 2023).

According to FAO (2010), CSA is a type of technological innovation in agriculture that aims to boost yields, make farms more resilient (for adaptation), lower greenhouse gas emissions (for mitigation), and help countries reach their food security and economic growth goals (URT, 2015). The CSA practices not only focused on the use of modern farming methods to boost output and adaptability but also lower greenhouse gas (GHG) emissions (World Bank, 2011). These agricultural methods are changing to focus on livestock and crop production technologies using new types of agriculture and livestock, soil management techniques and water conservation technologies (Azadi et al., 2021). The technological revolution and the idea of improving African agriculture meant that these problems had to be dealt with in a new way, using an integrated approach as a unique way for African agriculture to change is through sustainable intensification. An effective strategic approach that maximizes environmental service and reduces the adverse environmental effects of agricultural production while increasing output from a given area of land. This will help to find new improved varieties that include important traits that are resistant to disease, drought, pests and short maturity. Therefore, contributing to the increase in agricultural production (Mwamahonje, 2015).

Furthermore, Cook (2015) argued that current interpretations of sustainable development only focus on crop production and not the entire agricultural system including animals needed for food security. The purpose of the CSA is not to provide an extensive set of rules. Instead, smallholder farmers want to be helped to plan using the agricultural differences ways currently in use. It is claimed that regardless of the fact of misalignment in different ideas, the use of CSA has still brought success in increasing long-term yields and becoming widely adopted in semiarid areas where farmers invest in soil fertility and moisturized soil influencing increasing rural population (Humphrey et al., 2008). It shows that many CSA innovations and methods are aimed at improving agriculture and livestock. Possible reforms include promoting traditional and modern climate-resilient information on sustainable cropping management schemes, promoting developing and implementing land use plans throughout the country, and strengthening infrastructure and livestock services (Mugabe, 2020).

Smallholder farmers in arid and semi-arid regions in Tanzania face a number of challenges related to climate change which makes them vulnerable. Irrigation has served as a practice for harnessing availability of water for many decades (Osewe et al., 2020). However, as reported by Maro & Tenge (2023), climate change has resulted in decline in yields with the decrease in water for irrigation being one of the primary factors. Many studies on climate change management and resilience technologies often focus on water scarcity and how the technology can be applied in arid and semi-arid areas. For instance, studies such as Kaswamila & Mswima (2022) and Mkonda & He (2018) explored eco-village initiatives to tackle the issue of water scarcity. As such, it has become necessary for exploration of different adaptation strategies that will help farmers cope and increase their resilience in the face of climate change challenges in addition to water scarcity. Chololo Pits has served as one of the technologies aimed at bridging this gap especially for smallholder farmers in arid and semi-arid regions in Tanzania (Temu et al, 2022).

Studies have also explored the use of Pits practices in terms of their benefit relating to improvement of crop productivity and yields. For instance, the research by Getare et al. (2021) focused on utilisation of Zai pits to manage soil fertility and improve crop production in Kitui, Kenya. The results found increased yields when Zai pits were used as an interventional strategy attributed to improvement in soil fertility management and could facilitate integration of organic and inorganic fertilizers. Similar findings can be seen in the review by Kebenei & Mucheru-Muna (2023) where it was reported that Zai farming techniques have resulted in high crop productivity especially when combined with integrated soil fertility management practices. Nevertheless, the study found that the level adoption and utilisation of the technology was surprisingly low among farmers in sub-Saharan Africa which was speculated to arise from poorly structured extension system (Kebenei & Mucheru-Muna, 2023). The findings create an open question on why adoption is low despite the multiple benefits associated with pits technology.

Some insights can be obtained from the respective studies where they evaluated the potential issues faced by the farmers. For instance, in the study by Getare et al. (2021), the authors acknowledged the installation being labour intensive but suggested that the economic returns are higher compared to conventional tillage systems. This would highlight the critical challenge during implementation as labour costs could be a factor that hinders smallholder farmers. The extent to how labour could be a hindering factor can be extracted from the study by Danjuma & Mohammed (2015) where it was estimated that the labour of 250-300 hours/ha being required to dig the Zai pits and another 250 hours/ha to fertilize them. Thus, it was recommended as a system that could benefit groups of farmers rather than being used by individuals. Similarly, Koome (2017) suggested that many farmers had trouble rolling out the Pits technology in land above one acre. The evidence suggests the potential for labour being a challenge for smallholder farmers due to the level of work and hours needed to make the farm ready for planting.

While exploring the adoption of Zai Pits to enhance food security in Kenya, Getare et al. (2021) found them to be useful farming techniques with the greatest economic returns being seen when farmers combined manure and mineral fertilizer. However, while exploring the use of planting pits in the case of Maize in semi-arid Zimbabwe, Nyakudya et al. (2014) found that conventional tillage yielded 45% more grains than the infiltration pits. The study offers a rather contrasting perspective to the expectation that Pits technology leads to improvement of yields which could make the expectations to farmers seeking to use the practice unclear. Also, the research by Koome (2017) raises another potential extension officers merely offered support to the community trainers and rarely checked directly with farmers.

This created a gap where farmers were unable to grasp the concept of the Pit farming technology resulting in many farmers being unable to roll out the project. As such, there are likely to be a range of challenge farmers encounter in terms of trust in the expected yields and lack of support.

The adoption and utilisation of climate smart technologies is an important consideration when evaluating how smallholder farmers perceive their usefulness. Technology similar to Chololo Pits have been implemented in other regions and countries which can provide insights into their adoption. For example, Lusiru (2022) undertook an investigation to identify factors that influence the adoption of Matengo Pits in Mbinga District, Tanzania. The findings revealed that knowledge of the usefulness and availability of financial resources were key important to factors to practicing Matengo Pits. Other factors were slope of the land, farming experience, and male headed households linked to greater likelihood of using the Pits. The findings reveal that despite the farmers considering the technology useful, the geography of their land together with social factors such as the nature of the household could be modifying factors. The issue of household is further emphasized where the findings showed that difficulty of digging pits in female households and low income as factors hindering their use (Lusiru, 2022). Another perspective can be gained from Ismail et al. (2022) where they investigated the prospects and challenges of Chololo Pits technology in semi-arid areas of central Tanzania and found improvement in the water holding capacity of soil, economic use of fertilizer, and crop yields. Nevertheless, the study also found challenges in maintaining Chololo pits due the need for intensive labour and skills (Ismail et al., 2022). The challenge of adoption is further confirmed in the study by Danjuma & Mohammed (2015) where it was found that despite pits being easy to replicate by farmers, large scale application was hindered due to lack of political commitment, farmers overdependence on external support increasing vulnerability when it ceased, and poverty leading to neglect of labour-intensive projects. While useful, smallholder farmers could encounter a combination of socioeconomic and political variables that could define their ability to effectively utilise pits technology.

Due to few studies exploring the challenges that smallholder farmers encounter in their use of pits technology, it is unclear what factors are likely to hinder adoption and continued use. For example, there is scarce literature on the use of Pit technology in the context of financial support. In the study by Koome (2017), while farmers reported high cost of digging, most had not taken credit at all other than the seed grant in the sponsored pilot project. Indeed, most of the implementations of Pits technology often began sponsored. As such, whether adoption continues after withdrawal of support is an open question. Also, it is unclear whether the expectations of farmers in terms of crop productivity and soil fertility management are likely to result in beneficial outcomes especially due to their small size and limited finances. Moreover, while the role of government extension officers is important to implementation, lack of effective support can hinder the successful adoption and utilisation of climate smart technologies and this has not been extensively explored.

3.2 Theoretical Framework

I decided on the uses approaches for the theoretical framework which are the political economy approach, the knowledge and innovation system approach (KIS), and the adoption of technology theory. By engaging with different scholars who have tried to explain the adoption of CSA practices and smallholder farmers.

The political economy approach offers details on the existence of economic constraints levered smallholder farmers in the application of climate-smart agriculture practices (CSA). In political economy are the main focus on power relation dynamics, social injustices and financial challenges as the main factors influencing the vulnerability of indigenous smallholder farmers (Chandra et al., 2017). According to Escobar (1996), the contribution to social injustice in the post-structuralist political economy looked into the environmental, demographic, economic and historical factors (Escobar, 1996). Also, Taylor (2014) claimed that the marginalization of smallholders is originally based on the power relation dynamic because of political power, capital accumulation and economic hegemony (Taylor, 2014). Mostly, the study is based on the contribution of CSA practice toward smallholder farmers due to the challenges faced in an adaptation of Climate-smart agriculture on the economy of scale and political structure (Eriksen et. al., 2015). Contravene the argument, that smallholder farmers' failure to adopt climate-smart agriculture technology is related to inequality, poverty and Insufficient understanding of contemporary agricultural practices, as the marginalized farmers are being ignored by experts during the formulation of policy (Zerssa et al., 2021).

As such, the political economy can allow examination of how different actors can shape CSA. For instance, governments can have an influential role through policies that prioritise smallholder farmers through providing funding and subsidies. However, Birner & Resnick (2010) argue that financial support tends to generally favour larger farmers due to economies of scale resulting in inequalities in access to CSA technologies for smallholder farmers. Institutions such as non-governmental organizations (NGOS) can play a significant role in providing smallholder farmers with support through subsidizing adoption which can help alleviate some of the inequalities that they may face (Chandra et al., 2017). Hence, interaction between governments and different institutions can influence outcomes in terms of adoption of CSA technology and practices.

Moreover, KIS facilitates identifying the main actors involved in better integrating agricultural knowledge and innovation systems, as well as changes to structures and setting priorities. However, The Center for International Forestry Research and World Agroforestry (CIFOR-ICRAF) improved ways to smoothen the distribution of agricultural knowledge and innovation information from agrarian experts to the farmers on their farms (Sutherland et al., 2023). Furthermore, they grew out of the need to deal with a variable like climate change and build on well-known agronomic principles used on farms. This Chololo pits agricultural practice is designed to handle climate change and extreme events, thus including new technologies for drought-tolerant crops and better ways to run farms (Whitbread et al., 2021). Through encouraging the use of modern innovations like better seeds, soil nutrients, and irrigation systems. This can stimulate the farmers to boost their economy through earning extra income that leads to reduced poverty (Kountious et al., 2023). This can stimulate the farmers to boost their economy through earning extra income that leads to reduced poverty and generates stable livelihood (Kountious et al., 2023).

Despite this, scholars in Political economy like Newell and Talyor (2018) have argued that well understanding of the beneficiaries and formation of climate-smart agriculture (CSA) requires a detailed examination of the power relations and knowledge. So as it shows at the intersection of food governance and climate change. It is a fact that efforts to make the food system more resilient to climate change will depend on their collaboration and backing. State officials with agrarian expertise have power in decisions and even the design of CSA to attract more small-holder farmers who have been marginalized.

Furthermore, these two approaches together help to explain the events focused on the success of chololo pit technology. These have led to the existence of financial incentives that occur on the allocation of resources by agreed benefits from international aid, government policies and agricultural experts. On the contrary, the agricultural knowledge and innovation system promoted awareness of knowledge adoption to smallholder farmers. This scientific methodology and approach based on evidence shall be used for investments and policy decisions about expanding CSA by distributing resources and improving education on self-sufficiency in crop productivity and agricultural resilience in Chamwino District.

3.3 CONCEPTUAL FRAMEWORK

3.3.1 Technology Adoption Theory

This is another important aspect/ theory to consider in the study entails the restrictions and challenges encountered in the adoption of new technologies in the agriculture sector in Tanzania. The adoption of technology theory is an effective analytical framework for investigating how new technology practices are picked up in a given setting (Rogers,2003). As such, the theory is relevant in investigating the impacts of employing Chilolo pits for farmers in the Chamwino District. It focuses on the limitations and challenges faced in the adoption of new technologies explaining that most studies neglect these challenges in their investigation of the impacts of these technologies.

As noted by Glover et al. (2016), adoption of technology theory explains how the main issues in evaluating the effectiveness of new agricultural technologies. Firstly, there is a tendency for the technologies to be viewed as a black box that contains explicit knowledge, tools, and other relevant inputs. From this perspective, it is seen that the technology can be easily transferred to specific settings. However, this is not the case in the real-world setting as Glover et al. (2017) explain that there are factors that affect the adoption of new technologies and practices including cultural, social, epistemological, cognitive, and institutional processes. These are unique for each setting and as such affect the effectiveness of the new technology- Figure 3.

Another issue relating to the adoption of new agricultural technology as identified by Glover et al. (2016) is the misconception that technological changes follow a simple linear progression whereby individuals leave old practices and materials and adopt the new ones. This is seen as an oversimplified understanding of the technology adoption process, and it does not reflect the actual situation in diverse settings. Considering these explanations by the theory of technology adoption and diffusion, the current paper explores the process and outcomes of the adoption of the Chilolo pits in Chamwino District.

CHAPTER 4: METHODOLOGY AND METHODS

4.1 Background of the Study Area

According to Dodoma Region Investment Guide (DRIG, 2019, pp.16), the region is the capital city of Tanzania and is one the Tanzania's 36 administrative regions. According to Census, (2022) Dodoma region had a population of 3,086,525 which shows increasing in population compared to 2012 census which was 2.1 million. The region is surrounded with semi-arid due to very low rainfall and drought. The region experiences a rainy season between November and December also, April to May. The region always experiences rainfall in heavy storms resulting to floods in some part of the region. Total rainfall for Dodoma region ranges from 500mm to 800mm per annum, the temperature generally ranges from 15 cent grade 5ºC in July to 30ºC during October. The land is covered with black soil, clay soil, loamy soil and sandy soil. This kind of soil is preferred most for the growth of crops such as millet, maize, sorghum, pigeon, cassava, groundnuts, sunflower, sweet potatoes, paddy and sesame.

4.2 Selection of the Study Location

This study included two villages, Idafu and Maginga, and was carried out in the Chamwino district of the Dodoma region. These areas are representative of the semi-arid conditions prevalent in the Dodoma region, making them ideal for testing and promoting the application of Chololo pits due to their vulnerability to drought, degraded soils, and reliance on rain-fed agriculture. The soil features are characterized by dark reddish loamy, dark brown sand that is dissimilar to other wards in Dodoma region. Recent efforts have focused on training farmers in these wards to adopt the pits for key crops, leveraging their suitability for enhancing soil fertility and water retention in low-rainfall environments Also, the district features cultivation of several vegetables found in this region such as spinach, amaranth, tomatoes, Chinese, cabbage, onion, okra, lettuce, eggplant, bell pepper, and carrots (Dodoma Region Investment Guide (DRIG, 2019, pp.21).

4.3 Research Design

The research study used qualitative research design and data collection was conducted through Focus Group Discussion and Key informant interviews. Because I took small number of smallholder farmers during group discussion and in-depth interview for agricultural experts. The approach used to gather information related to the perception of smallholder farmers who have experience with climate-smart agriculture practices and the impact of the adoption of Chololo pits practices on crop production and resilience. This research seeks to get the real lived experience of the farmers that why I employed qualitative study. By using a qualitative methodology, I was able to uncover novel facets of procrastination that would balance the shortcomings of the widely used quantitative research methodology (Klingsieck, 2023).

4.4 Sampling Procedure and Sample Size

The research took place in Chamwino District in two villages where CSA practice has been introduced and are mostly cultivated. The study involved smallholder farmers who have experienced climate-smart agriculture and a key informant who has much knowledge and experience on CSA, in each village. The interview involved two agriculture extension officer, a village executive officer, and on representative of trade union leader. The study involved the total of 4 Key informant interviews and 2 focus group discussions from the two villages. The selection of the respondents considered the experience in farming at least 5 years and above.

The study employed snowball sampling, which refers as the most common way to select participants for interviews that characteristics networking and referral within a research. Researchers normally look for people who meet the study's requirements and ask them to participate (Parker & Geddes, 2019). Additionally, purposive sampling used to recruit the participants with specific features in this field which can express information straight and simple. In this regard, it needs to select some of them who represented the group (experts, agricultural and farmers). It was not easy to have them so, the study involved the participants who were be available and who have experience of the Chololo Pit technology practices during the time of data collection and need to participate.

4.5 Data Collection Method

This study used qualitative methods to collect primary data through focus group discussion and in-deep interviews with the farmers and secondary data through agricultural government reports on chololo technology. The Key-informant interviews (KII) composed of an agriculture extension officer, a village executive officer, experts from the Ministry of Agriculture and a trade union leader (cooperatives member). Also, the study involved two focus group discussions (FGD) from two wards. Each ward had 1 FGD and each group composed of 6 smallholder farmers for discussion which the total of 2 FGDs. The semi-structured interview guides used to all participants to get in detail the perceptions of smallholders regarding the failure of adopting climate-smart agriculture. It stands for collecting the information- rich and consistent data that is gathered for statistical processing and to help researchers make decisions (Mazhar., 2021).

4.6 Data Analysis

The analysis of data was done after completing data collection, the researcher re-checked all data and all transcripts, after that I transcribe all transcripts from the local language (Swahili) to English language. The selection of themes and sub-themes were done and writing them down through manual coding and identifying themes through thematic analysis and categorizing all themes which helped to identify patterns, structures and trends from the data. According to (Rabiee, 2004) cited by Yin (1989) says that analyzing data involves several steps, such as looking at, sorting, and tabulating the evidence, or putting it together in some other way to reach the study's main goal and help to sort the bundle of data within a short time.

4.7 Ethical Consideration

Respondent selection considered time, availability and willingness of the participants, the study involved all respondents who had time and were willing to attend on discussion and interview. All participants who accepted to participate on this study were given given a consent form to sign before participating in the study. The participants were assured the confidentiality of his/her data taken during data collection. The study involved permission letter from ISS, Regional commission and District commission, this is because in Tanzania it is not allowed to conduct any study without local authority approval.

4.8 Limitations

The limitation of this area of study was infrastructure because of the rough roads and research assistant took two hours from Dodoma city Centre to Chamwino District to conduct data collection. Even though mobile communication and internet connection were the problem. It was hard also to get participant because the chosen project completed 4 years ago and the farmers decided to stop practices after the donor stopped to provide funds for the empowerment.

4.9 Positionality

As a student, I came from Tanzania and studied in Dodoma region, so am very familiar with the region as well as I can speak the language, and know the background, customs & traditions. Also, I am interested in sustainable agriculture issues, such as using an alternative method for the adoption of CSA practice to increase crop yield and eliminate hunger shortages. I got the ideas from the lessons I took from the Ma program by accessing various concepts, theories, and methodologies in literature.

Even though I wasn't there in person, I introduced Research Assistant to Chawino government authority so that they could be able to facilitate the recruitment of the participants, but I was interviewing through online conversation. Even though I and my team got good support from the community because of my interest and experience in Dodoma region. I introduced myself as a student and I had to follow professional rules and guidelines are for this study. I got blessings and permission from the community and I was able to explain to them the goal and aims of my research study. I decided to do this because they expect to get something like money which was not possible to me to do because of ethical consideration.

4.10 Recruitment Process and Role of Research Assistant

I recruited my research assistant through a policy research organization known as Research On Poverty Alleviation (REPOA) who specialize in agricultural development. The Organization having experience of agricultural research activities have been working in this sector from a long time. REPOA served as a major research partner and advisor for the initial stages of the Chololo pits project, with particular roles focusing on data related to adoption rates and yields as well as aspects of the social outcomes achieved. However, their frequent field presence may have led farmers to view them as part of the extension service, making them undistinguished from extension officers.

I considered the experience of research assistant in climate change as well as knowledge on agricultural research. The successful candidate was given the contract for my data collection exercise. I trained him on about my topic and what supposed to be interviewed that relating to research question and how. The research assistant was given one month contract to do all activities such as follow-up permission from the regional level up to village level, to recruit all participants supposed to attend on the study well as to find the venue for interview. After all were done, research assistant prepared live video for an interview which I conducted myself through WhatsApp call despite I experienced internet challenges, but I was able to finish all interviews. All data were saved in my laptop with a strong password so that the data can be secured and all consent forms were served in my office in Tanzania.

Chapter 5: FINDINGS AND DISCUSSION

5.1 Introduction

This chapter details the findings from the data collection process and discussion in the context of the study's aims and existing literature. An exploration was done into the responses obtained from the participant farmers during the focus group discussion sessions and the interviews with the agricultural extension officers. The discussion is done following the research questions. Hence, the discussion focuses on topics including the perceived contribution of the technology, the socioeconomic and other factors influencing adoption, and the role of government extension services influencing adoption. The study's findings are also discussed concerning existing literature to establish whether they are supported or in contrast with the results from other studies. The chapter also considers the implications of the findings on the proposed conceptual model composed with the practical insights.

DEMOGRAPHIC INFORMATION									
CHOLOLO PITS TECHNOLOGY-CHAMWINO DISTRICT									
S/N	AGE	GENDER	EDUCATION	STATUS	OCCUPATION		FARM SIZE	VILLAGE	CODE
1	28	FEMALE	SECONDARY	MARRIED	ENTERPRENUER	10	3	IDIFU	FGD1
2	36	MALE	PRIMARY	SEPARATED	ENTERPRENUER	10	3	IDIFU	FGD1
3	44	MALE	PRIMARY	MARRIED	CRAFTING	17	4	IDIFU	FGD1
4	43	FEMALE	PRIMARY	MARRIED	ENTERPRENUER	4	5	IDIFU	FGD1
5	57	MALE	PRIMARY	MARRIED	LIVESTOCK KEEPING	20	10	IDIFU	FGD1
6	48	MALE	UNIVERSITY	MARRIED	AGRICULTURE OFFICER	14	N/A	IDIFU	KII
7	37	MALE	UNIVERSITY	MARRIED	AGRICULTURE OFFICER	9	N/A	MUGU	KII
8	45	MALE	PRIMARY	MARRIED	(AMCOS LEADER)	2	N/A	IDIFU	KII
9	61	MALE	MASTERS	MARRIED	PROJECT C'RDINATOR	30	N/A	IDIFU	KII
10	65	MALE	INFORMAL	MARRIED	FARMING	40	4	MUGU	FGD2
11	57	FEMALE	PRIMARY	SEPARATED	FARMING	20	6	MUGU	FGD2
12	66	MALE	INFORMAL	MARRIED	FARMING	30	6	MUGU	FGD2
13	51	MALE	PRIMARY	MARRIED	FARMING	20	3	MUGU	FGD2
14	45	MALE	PRIMARY	SINGLE	FARMING	12	4	MUGU	FGD2
15	35	FEMALE	PRIMARY	MARRIED	FARMING	10	5	MUGU	FGD2
16	46	MALE	INFORMAL	MARRIED	FARMING	25	5	MUGU	FGD2

Table 1.1: Sample of participants interviewed

5.2 Perceived Contribution of Chololo Pit Technology in Increasing Crop Yields and Resilience

This research sought to examine the contribution of the Chololo Pit technology to increasing crop yields and resilience. Participants were asked about their perception on adoption of Chololo Pit technology in terms of the advantages concerning crop yields and resilience. The majority (82%) of respondents agreed that Chololo Pit technology offers advantages in farming in terms of increased crop yields and resilience. I did further analysis of the specific themes arising from the discussion of the technology and its usefulness. The pits can be used to store water that prevents the plants from drying (respondents 3 & 6 IDIFU ward).

> They store water for a long time as the technology was described as allowing those in dry areas to retain moisture for a long time and led crop growing well (respondents 2 & 4 Maginga ward).

As such, the technology was considered important to retaining soil moisture and would help build resistance to dry weather or when there was unpredictable rainfall. The benefits realized could be instrumental in promoting the adaptability of farmers to adverse weather events thus enhancing their resilience. The implications of pit technology on water storage have also been observed by other scholars in other comparable pit farming techniques. For instance, infiltration and planting pits have been found to improve water management in semi-arid regions in Zimbabwe and provide a fall-back method for those without access to draught power (Nyakudya et al., 2014). As a result, critical benefits can be realized for those households who live in drought-prone areas and do not have the resources to purchase irrigation technology, greenhouses and other farming techniques for their farms.

Similarly, Mackio (2022) underscores the water-holding capacity of micro catchment technologies and practices that can enhance agricultural yields in semi-arid areas. Therefore, Chololo pits provide important benefits in promoting water storage and enhancing the availability of moisture during dry weather. This is essential in enhancing the flexibility of farming practices in response to precipitation fluctuations due to weather and climate change.

Also, Chololo pits were found to help improve fertilizer utilization as most of the participants highlighted the benefits of fertilizer utilization after the adoption of the technology

> "applying fertilizer and spray works better with the pits farming technology and while in the holes when you pour the fertilizer stays there… it doesn't flow to someone else's place" (Respondents 4 &6 in Idafu ward).

Also, the extension officers provided insight into how the technology helps improve fertility. The description highlighted how water removes the top layer of the soil and thus Chololo pits would help prevent this movement.

> "They maintain soil's fertility because there is no movement of the soil even when it rains if you compare with old farming is a pure loss because we used to cultivate and scratch when it rains, you lose soil and fertilizer first…". (Respondent KII in Maginga ward)

The creation of pits results in water being captured in the depression which prevents the surface run-off from carrying the soil located in the pits thus reducing erosion (Kebenei & Mucheru-Muna, 2023). In essence, Chololo pits preserve the soil and prevent rain or moving water from eroding the fertile topsoil layer. However, some of the participants did complain about the need to use inorganic fertilizers and the transport costs of fertilizer towards the fields.

> "This technology also involves the whole issue of the use of fertilizers, even if these are subsidies fertilizers, but he has to transport them to the farm, sometimes they don't have transport, so he has to pay the costs of the cart to take it to the farm" (Respondent KII in Maginga ward).

The observation of the key informant references the initial implementation of the technology where Urea fertilizer was provided for free to the farmers. The farmers would collect it from their offices but would still need to transport to their farm which would incur transportation costs.

According to Getare et al. (2021), planting in pits helps improve soil fertility management by reducing the decline in soil fertility, while it also leads to a reduction of the costs incurred in purchasing inorganic fertilizers. Since the fertile top layer is maintained, the need for adding fertilizer is reduced resulting in lower expenses in terms of fertilizer usage. Also, the study by Kebenei & Mucheru-Muna (2023) underscores the impacts of pits technology in promoting integrated soil fertility management which can result in improved yields. Therefore, there is clear evidence favoring the use of Chololo pits in improving soil fertility as part of enhancing crop yields. However, further probing of the farmers revealed that during initial training of the project with, they were provided with Urea fertiliser for free which helped subsidize the cost of implementation.

Moreover, the famers were accustomed to using manure due to it being cheaply available from the cow they keep. The purchasing of Urea fertiliser was considered as additional cost and the farmers reverted back to using cow manure after the programme ended. Hence, farmers a critical challenge in affording the inorganic fertilizer that they had been trained with during implementation of the technology.

The study by Kebenei & Mucheru-Muna (2023) highlights how both organic and inorganic fertilizer can be used for pits technology. However, probing the farmers revealed that they were not aware they could use both and most complained how after being given education initially but were left on their own after conclusion resulting in gaps in their knowledge.

Another theme can be described as increase in yields. All participants agreed with the effects of the technology in increasing yields. Despite growing different crops such as rice, millet and others, the impacts of the technology were reported across the board. Similar views were also obtained from the agricultural extension officers who were interviewed. Respondents provided insights into the impact of Chololo Pit technology on their crop yield where the findings show a positive perception of Chololo Pit technology that could be validated by the increase in the number of sacks of millet harvested per acre. After introduction of technology in their farming, farmers reported harvesting 6–10 sacks of millet per acre**,** compared to 2–4 sacks per acre using traditional farming practices.

> "An increase in the number of sacks when white millet is cultivated using pit farming as compared to conventional farming" and "The technology 'brought productivity to be high' and allowed them to "really get a profit was high unlike the previous period…" (Respondents 5 & 6 in Idifu ward).

Hence, the data collected shows a positive increase in crop productivity once the farmers embrace Chololo Pit technology.

The effects of Chololo Pit Technology on productivity are confirmed in other studies. For example, the implementation of pit technology has been found to increase soil fertility and crop yields in the semi-arid regions of Burkina Faso, Ethiopia, Kenya, Mali, Niger, and South Africa. (Kebenei & Mucheru-Muna, 2023). This goes a long way in substantiating the argument on how the technology can help increase productivity among farmers who use the technology. However, in the study conducted by Gamba et al. (2020) on the effects of Chololo pits on crop yields, it was pointed out that yields had only slightly risen but were still sub-optimal despite the uses of the Pit practices. This would be suggested as there might be other factors that influence crop production apart from the implementation of pits farming technology.

Nevertheless, the effectiveness of Chololo pits in increasing crop yields has been noted by other studies in Tanzania where the yields have been reported to have risen by 12% as compared to other methods (Ismail et al., 2022). Therefore, Chololo Pits technology has numerous advantages even if other factors that influence the yields should be studied to realize the highest level of productivity. The participants in the study also mentioned the advantages of using the Chololo Pits in that it will assist in protecting environmental resilience and improving sustainability through Pit technology practices. They claimed that waterproofing stands for the soil wall's edges and response for preventing water from spreading beyond the existing hole in the relevant area. It could be employed to avoid erosion of the fields during farming. Likewise, the statement of the agricultural extension officers who felt that the technology was good for the environment.

> "The aim of putting the technology in place was to improve the ecological and to support farming in the within region" Because it has been seen first, it restores the ecology of the soil and increases crop yields compared to the agriculture they have been using in the beginning (Respondent KII in Maginga ward).

The improved ecology from the advantages in the local environment concerning moisturizing and soil fertility in land conservation. The extension officer, however, did not provide evidence of how they had measured this impact. Nevertheless, the observation conforms with Kebenei & Mucheru-Muna (2023) who stated that the technology being used was helpful in environmental sustainability in soil conservation for crops. Likewise, the results of the study are in agreement with the findings of Danso-Abbeam, Dagunga, & Ehiakpor (2019) whose found that farmers who had embraced Zai, a form of pit farming technique in Kenya analogous to Chololo Pits technology, led the enhancement of soil conservation. Therefore, the success of pit technology in preserving moisture and soil fertility is empirically confirmed.

5.3 Socioeconomic and technological factor influencing the adoption of Chololo Pit technology among smallholder farmers.

The study aimed to analyze the various factors that may affect the farmer's livelihood by using Pit technology in farming. As shown from the findings, farmers may face several socioeconomic factors that may hinder the continued adoption of innovations.

One of the factors identified from the responses is income. Household income was found to have an important role in influencing continued use of Chololo technology. The majority of the smallholder farmers came from low-income households and relied on farming as their main source of income. As such, understanding the farmer's perspectives were likely to provide critical insights into the experiences of low-income households in adopting the technology. The respondents reported encountering financial barriers in attempting to adopt pit farming practices.

> "I don't continue to practice it because it incur costs especially since coming from low income and the difficult moment is in the process of preparing the farm by digging holes, the soil is so dry and hard to make holes by yourself" (Respondent 4 FDG in Mugu ward).

Respondent 2 in Idifu ward compared the cost of pits stating that it would require 50,000 shilling to dig Chololo pits for one acre while using a traditional practices by hired cow allowed ploughing and planting at the same time which would only cost 20,000 shillings per acre which could be even lower if they had their own cows a for cultivation. This highlights that people from poor households may face barriers due to the financial costs of implementing the project.

The findings reveal economic constraints described under the political economy approach that smallholder farmers face when applying CSA practices such as Chololo pits. The financial challenges act as vulnerabilities that prevent successful implementation and continued use of the technology (Chandra et a., 2017). In particular, the impact of household income and overall endowment of farmers are among the characteristics that could influence farming technology use (Wu, 2022). Due to their low economic status, they smallholder farmers reported difficulties in accessing loan facilities due to high interest costs for those without proof of stable income such as a payslip thus impacting their decisions to use new technology (Wu, 2022). The outcome is manifested in how the farmers who had low income faced challenges in terms of the cost of implementing the project resulting in likelihood of them to stop using this Pits technology after the initial adoption.

The findings are also supported by Marenya et al. (2017) who concluded that socio-economic factors such as income and group memberships affect the continued use of Pits technology. While modeling the determinants of using Matengo pits in Mbinga district, Tanzania, Lusiru (2022) found low income to be among the factors that led to the low practice of pit farming. Therefore, there is clear evidence demonstrating the effect of income on the capacity of farmers to adopt or use new technology. Farmers with resources are less likely to face barriers in implementing the Chololo technology compared to those with fewer resources.

Another theme relating to barriers adoption of Chololo Pits technology was discussed in the context of the labour involved. The majority of respondents highlighted the intensive labour required to construct the Chololo Pits and the challenges faced. The observations are corroborated by results in the existing literature that illustrate how labours-intensive pitting technology can be when adopted by farmers.

> "…the job of digging holes is hard work, so you must have other laborers to help you because if I do it myself, it will take a long time and you find out you dig few holes before the rain comes"(Respondent 1 in Idifu ward).

The additional labour incurred can be inferred from respondent 2 in Idifu ward who stated that when ploughing with a cow, they can plant at the same which makes the process simpler. In contrast, the respondent stated that Chololo Pits would require ploughing to prepare the land hiring labourer who will be involved in measuring and digging the pits. Respondent 1 in Idifu ward provided more information by stating that farming 2.5 acres would normally require one week but one acre under Chololo Pits would take 3 weeks if additional labour was not hired.

Moreover, Respondent 4 in Miganga ward highlighted that he could dig one of his quarter an acre plots alone but found it challenging for the whole three-quarter an acre plot. When asked why they could not start early, respondent 2 in Mugu ward highlighted the challenge of timing due to unpredictable rainfall; where digging too early before the rains would require reworking on the farms where the oxen plough would cover the holes. However, strong winds during in dry season would also cover the holes long before planting starts. On the other hand, starting too late during heavy rains would make digging difficult. This indicated a planning problem as unpredictable weather patterns would make it difficult to determine when to start preparations.

This indicates that the technology requires a higher level of labor and those who cannot hire more workers are likely to be limited in implementation. In the study done by Koome (2017), the required high number of labourers for digging Zai pits practices was described by farmers as being one of the major barriers to adoption in agricultural activities. This would result in farmers becoming unwilling to continue using it and hence dropping it in the subsequent seasons (Koome, 2017). Similarly, Lusiru (2022) found the difficulties of digging pits among farmers with smaller households dur to small labour force to engage in digging the pits.

The financial cost of the technology was also cited as another factor that limited the ability to use the pit technology. The majority of participants agreed that implementing Chololo Pit technology was a costly affair that affected their ability to adapt it and successfully implement it as part of their farming strategies.

> "…it is usually expensive to dig holes first, I don't have a rake…" (Respondent 3 in Idifu ward). "You need to get working equipment which is expensive (Respondend 5 in Idifu ward).

The farmers cited the additional costs associated with acquiring specialized tools for measuring line to line, leaf rakes, pesticides and other materials for the Chololo Pits which they were provided for during the initial project. Some of the materials such as leaf rakes and pesticides are expected in normal farming which would imply that the farmers generally did not have proper farming tools even for their normal agriculture before the Chololo Pits.

The analysis by Kebenei & Mucheru-Muna (2023) reveals that pit technology was easily applied by farmers who had larger households, transportation options, and generally more resources. As such, this implies that people from poor neighbourhoods are likely to be disadvantaged in adoption of pit farming practices due to the additional costs they have to must incur during implementation.

The financial cost of the project is closely related to income as farmers who have resources can easily cover the costs required to adopt the technology in their farms. Chololo Pits technology has been described as being low-cost and affordable with little resources being incurred in its implementation (Ismail et al., 2022). However, this is in contrast with the findings where it is evident that pits technology is not necessarily affordable as reported by the project implementer. The concerns raised by the participants highlight the need for working equipment such as line measuring tools, leaf and weeding rakes, inorganic fertilizers, and pesticides which have to be factored into the cost of implementation.

Agricultural technical knowledge can also be another factor that impacts the adoption of farming pit practices. From the responses, participants narrated different issues relating to technical knowledge as ignorance, unawareness and poverty of using Chololo pit technology. Another challenge arises due to the difficulties in accurately measuring holes.

> "…it is possible that others forget to measure when you start digging holes, we forget the measurements" (Respondent 6 in Idifu ward).

The agricultural extension officers highlighted that they have been involved in providing education and training of farmers which has been successful in promoting the adoption of Chololo Pits technology. However, with some respondents forgetting how accurate to implement practices, there are likely to be challenges in acquiring knowledge to utilize the technology and its true potential. One of the biggest challenges that may hinder the successful implementation of farming technology is the lack of information on how to use the technology. According to Dibbern et al. (2024), there is a lack of knowledge that can be a hindrance to farmers from adopting new technologies in agriculture. Moreover, Mhlanga & Ndhlovu (2023) also explain that lack of skills and experience would reduce the chances of using technologies to enhance farm productivity.

The respondents did not seem to have clear information on how the pits were supposed to be dug with some experienced challenges in attempting to use their cows for digging holes (Respondent 2, Mugu ward) and others describing the need for specific tools that are different from their current ones (Respondents 3 & 5 in Idifu ward). As such, there is a knowledge gap on how the process should be done and which equipment is needed to dig Chololo pits. Hence, knowledge and information are some of the drivers that can play a significant role in the adoption agenda as gleaned from the participants of this study. The Extension Officers served a vital role in disseminating information and conducting training for the farmers in Chololo Pits uses which was important in promoting the adoption of the technology to the farmers. However, a common complaint among the farmers was that there was lack of follow up and the people who had given them education left and did not return. This resulted in some abandoning its use.

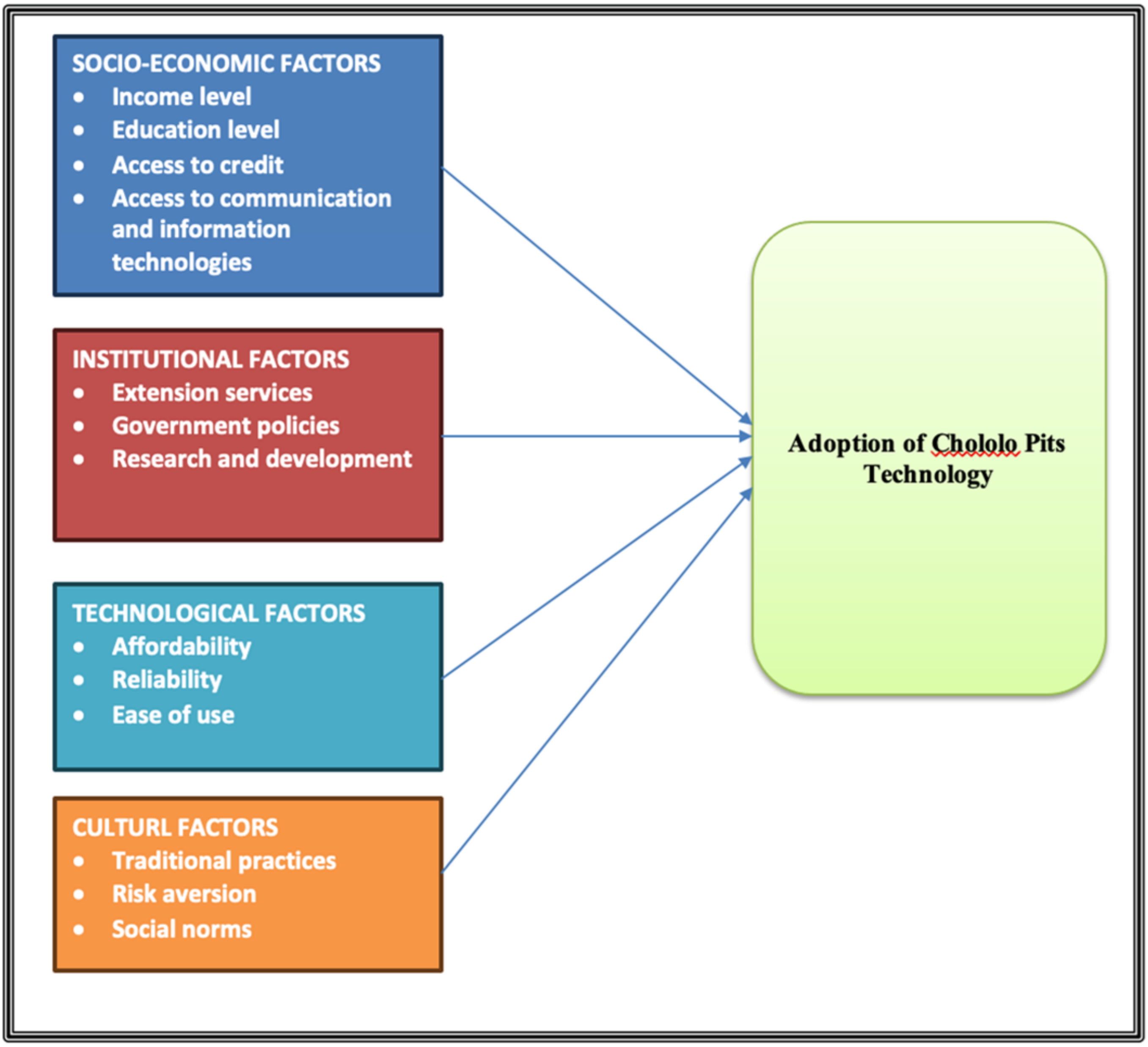


Figure 3: Factors Influencing Adoption of Chololo Pit Technology Among Smallhoder Farmers

5.4 Role of government extension services in adopting Chololo Pit practices

An interview was conducted with 3 agricultural officers who were former implementers of the Chololo Pit practices and were now extension agents in the farmers' wards to understand their contribution to the popularization and adoption of Chololo Pit practices. The results help explore the role of government extension services and providing insights into the political economic landscape between smallholder farmers and their impact to adoption of climate smart agriculture practices in Dodoma region, Tanzania.

Among the different results obtained, one of the themes is the extension services in the enhancement of better farming technologies. Speaking to the agricultural officers they said they were involved in the introduction of the Chololo Pits technology which was adopted in the local wards.

> "We were involved in this project people started from the council level later they came to the region and village level they held a meeting with us Extension Officers and later again they held a meeting with us together with the farmers"(Respondent KII in Maginga ward)

The other function was to encourage farmers to embrace the technology with the view of improving their farming practices and yields. Therefore, the ideas supported in this study add up to the findings from the participant's responses. That effort they received from an agricultural officer encouraged them to go for the Chololo Pit technology.

> "We had Mr. Shamba visit us and formulate a farming group as a union. We agreed and we had leaders who were teaching us and we started a group"(Respondent 3 in Miganga ward)

This is in line with the literature as the agricultural extension officers help in the implementation of new technologies/methods in farming through sensitizing farmers of training courses and programmes and facilitating communication processes that disseminate technology in agriculture (Alam et al. 2024; Altalb et al. 2015; Ullah & Khan 2014). On this aspect, the activities of the extension officers in the facilitation adoption of the Chololo Pits technology attempts to serve as a bridge into the structural political economy surrounding smallholder farming in terms of insufficient understanding of contemporary agricultural practices and reducing marginalization (Zerssa et al., 2021).

The findings demonstrate how the extension officers inform the local people about the uses of new farming technologies which if applied can enhance crop production and land productivity. The officers agreed with the problems that were linked to the low level of education of farmers concerning the crops they grow and the farming methods they employ. In this regard, they helped fill the gap by providing information and training that would assist the farmers in enhancing their farming practices

> "I have a class farm that I have started with (25) farmers, we cooperate with that farm, the class is there, so many farmers go to learn there, but also twenty-five (25) farmer leaders and they have class farms in their areas and it's about thirty-five (35) farmers who benefit from this technology"(Respondent of an agricultural officer in Maginga ward).

Similar to this, other authors have also recognized the role of the extension agents in awareness creation and information sharing that is necessary for the knowledge transfer process (Deepika, 2023). From those responses, it was clear that extension officers educate farmers so that they can be able to understand the technology and use it effectively on their farms.

The officers were in a position to explain some of the other activities that they had embarked on in a bid to ensure that farmers acquired knowledge of new farming techniques. For instance, they informed the public on the existence of Chololo pits technology through trial programs involving a few of them before reaching out to more of them. They also informed that there were forums that the new farmers could attend to be empowered on the technology. It is in agreement with education and training as a method of enhancing the level and utility of sustainable farming practices (Antwi-Agyei & Stringer, 2021; Yadav et al., 2023).

The task of the agricultural extension officers was to offer support such as supplying inputs during the initial implementation phase, intervene in matters relating to acquiring the right information and act as supervisors to the farmers. Particularly, the agricultural extension officers acted like mediators between the policymaker, the government, farmers and the donors who were funding the project. As stated by Davis et al. (2014) extension officers can work together with other stakeholders to make sure that the farmers receive adequate support from them. This role can be best exemplified in the involvement of the agricultural officers in the decision-making process in partnership with other institutions to ensure that the Chololo Pits Technology is implemented. Therefore, they stand in to ensure that the objectives of projects have been met through participation and supervision.

> "… later on I was assigned to supervise my peers and to ascertain the size of the holes. Support services would also be in the form of visits to their farms to take note of what they were doing and give farmers insights on how to improve." "(Respondent of an agricultural officer in Maginga ward).

> "…I have been meeting and visiting them at their places. Also, I advise them to change crops and practice crop rotation ." "(Respondent of an agricultural officer in Idifu ward).

The information would be instrumental in helping farmers determine what crop to grow and combine while implementing Chololo Pits. The advisory role of extension services to farmers is acknowledged by authors such as Emeana et al. (2019) who are described as offering a wide range of advisory activities ranging from policy, practices, transformational agenda, and sustainability farming.

Arguments have been presented regarding the gap between the services extension officers believe they offer to farmers and the interaction farmers feel when receiving agricultural extension services (Ramdwar & Stoute, 2015). This is partly illustrated by the findings where an officer notes that none of the farmers have gone back to their old ways of farming while some responses from farmers highlighted that they had stopped using the technology due to challenges such as intensive labour. The contrast reveals a gap in the implementation of climate smart agriculture practices where the political framework may not necessarily align with the realities of smallholder farmers (Eriksen et al., 2015). Nevertheless, the officers were upfront in acknowledging various challenges faced by farmers in their wards. Hence, there was an overall awareness of the challenges farmers face by extension officers.

> "Farmers are forced to find labour and have to pay money which can become a challenge thus leading them to experience difficult practices during the implementation of the pits farming technology" (Respondent of agricultural office in Idifu ward).

5.5 Research Implications

The findings provide a critical contribution to understanding the relationship between the different factors formulated in the conceptual framework that was formulated earlier in the study. For instance, there is clear evidence validating the impact of socioeconomic factors on the adoption of Chololo Pit technology. Farmers are likely to be influenced by income, knowledge and information. Farmers who have low incomes and lack knowledge and information about new technology have a lower likelihood of adopting Chololo Pits technology.

Hence, the technological aspect of affordability is validated as it plays a role in influencing the likelihood of adoption of farming technology. In the case of the technology, the high costs of digging up the pits and applying appropriate fertilizer are likely to be barriers to successful adoption. Also, there is evidence showing the positive impact factors on institutional aspects such as government, policies and extension services which influence adoption. This is illustrated by the role of agricultural extension officers in promoting new technology, facilitating knowledge transfer, and providing farmers support. The perceived usefulness in terms of increased crop yields and productivity also serves as an important factor in promoting the adoption of the technology. The observations are in line with propositions of the technology adoption model which highlights that perceived usefulness is likely to influence its adoption and use.

The proposed technology adoption model also highlights ease of use as another important factor that influences use and adoption. In the case of Chololo Pits technology, several factors could negatively affect the ease of use thus hindering its adoption. From the findings, aspects such as intensive labour which are likely to negatively influence perceived ease of use can act as one of the barriers to the adoption of Chololo pits technology by farmers. Therefore, the findings of this study provide evidence supporting the proposed model that explains the factors that influence adoption of Chololo Pits technology.

Also, the findings have practical value to farmers, extension officers, and policymakers. In particular, farmers should adopt and continue using Chololo Pit technology due to the advantages it offers in terms of increased crop productivity and yields. However, the negative implications of costs, labour, and knowledge of implementation need to be addressed to enable farmers to realize the benefits of using the Pits technology. For example, the insights on the impact of socioeconomic factors offer an opportunity for the government and institutions to tackle social aspects contributing to poverty to raise income levels and enable farmers in semi-arid regions to possess the capacity to adopt Chololo Pits technology to enhance their crop yields and productivity. It is necessary to implement a policy framework to help subsidize smallholder farmers especially those who do not have proper tools to help improve their agricultural technique and increase their likelihood of benefiting from the use of Chololo Pits technology.

Based on the results, it is essential for the government and other institutions such as NGOs to be involved in promoting knowledge and skills to facilitate the uptake of Chololo pits in a bid to increase farming productivity in the country. It is clear that agricultural extension officers play a significant role in the adoption of farming technology. As such, it will be necessary for the government to ensure that extension officers are allocated enough resources in terms of training programs and other forms of support that will equip them to effectively reach out to farmers to facilitate awareness and knowledge transfer promoting the adoption of new farming technology.

Chapter 6. CONCLUSION

6.1 Conclusion

The purpose of this study was to establish the perception of the farmers on the adoption of Chololo Pit technology and its impacts in Chamwino, Dodoma, Tanzania. Even though agriculture is still one of Tanzania's main economic activities, the food security problem persists and is linked to low productivity due to climatic factors (Lamanna et al., 2018). Since farmers have to deal with factors such as variability in rainfall, it is important to embrace climate-smart agriculture which will enhance production, adaptation and resilience.

Chololo Pit technology is suggested as one the solutions that may assist farmers in practicing climate-smart agriculture and adapt to climate change (Ecovillage, 2014). The ability to store water and maintain soil fertility allows farmers to cope with weather events such as droughts and excessive rains. This enhances the adaptability of farming practices allowing farmers to be better prepared for adverse weather (Nyakudya et al., 2014). From the responses collected from farmers, the study found that there is a perception that Chololo Pit technology helps in increasing crop production and resilience. Also, farmers are likely to benefit from improved water retention, soil fertility, and land productivity. Also, the study reveals that there are social and economic factors that affect the continued adoption of the technology including income, labour force, and financial costs of the programme which may determine the extent to which farmers adopt Chololo Pits technology (Lusiru, 2022).

Despite Chololo Pits technology being considered as low-cost and affordable, the findings reveal that this might not be true for smallholder farmers. The farmers incurred financial and labour costs in preparing the land, digging the holes, and hiring more labourers to help, with costs running up to more than twice in some cases (Danjuma & Mohammed 2015; Koome, 2017). It is also clear that smallholder farmers without proper tools might face greater challenges in undertaking the agricultural activities required under Chololo Pits farming. Therefore, while the goals of climate smart agriculture technology are to enhance productivity and resilience, the findings highlight challenges faced by smallholder farmers can be prevent continued usage after the initial trial period has ended. Development of a policy framework to provide subsidies to farmers and helping them modernize their tools help reduce some of the barriers to using Chololo Pits technology.

It is found that agricultural extension officers have significant contributions to make in the uptake of the technology. This evident in their function in raising the people's awareness of the technology, educating farmers, and providing support services. Therefore, the evidence is consistent with the proposed model that suggest that socioeconomic, institutional, technological, and cultural factors determine the uptake of Chololo Pits technology. However, extension officers can have a greater role in following up farmers and learning about their difficulties which can help in taking action to mitigate barriers to the use of the technology (Deepika, 2023).

Therefore, these challenges are related to providing the support of extension service facilitators can have a very big impact in the whole issue of promoting the desired naturalization and helping small farmers to realize the quality of crops and productivity in their fields. These events form the proposal for the use of well-known pit technology as Chololo Pits Technology. This is possible by developing the skills of small farmers and assisting agricultural extension officers in Chamwino district to increase sufficient resources and provide support to farmers.

6.2 Limitation and Future Research

The uses of the snowball sampling method has still shown great limitations in choosing the number or sample of participants in any study. The method has been used by many researchers, but on the other hand, it is failing to randomize the participants in the research, it has also shown bias in its choices when it is used (Parker & Geddes, 2019). This issue also arises in the use of Focus Group Discussion because this method involves a small number of respondents and it is difficult to generate findings to a larger population (Mazhar et al., 2021). For instance, it is possible that the participants selected were more likely to have a more positive view compared to the general population of farmers especially since many of them were involved in the initial training for the pit technology. As such, the findings from the small sample size could be susceptible to selection bias where the observations of the participants could be different from the target population.

Therefore, applying group discussion contributes to challenges such as influential people in the group will find themselves contributing more to the group discussion than other participants and this leads to the absence of alternative ideas or objections. Future studies could look at an alternative approach that could involve a larger number of samples and increase the breadth of the results. Also, the use of the random sampling method can help reduce sampling bias, which can provide a better representation of the population.

Also, this study does not evaluate the potential causal relationships between continued adoption and the impacts of Chololo Pits technology. As such, it is difficult to establish the significance of the relationship identified, which influences the credibility of recommendations that can be drawn from the study's findings. Future studies can take a step further into using empirical tools to evaluate the causal relationships between the various factors in this study that influence the continued use of Chololo Pits technology. This will help provide a meaningful understanding of which factors are significant, leading to clearer recommendations to stakeholders on how to promote the adoption and continued use of the technology by farmers.

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APPENDICES

Appendix 1: Focus Group Discussion

1. How long have you practiced using chololo pit technology?
2. How was your initial experience with adopting the new agricultural practice as Chololo pit technology?
3. How do you compare chololo pit technology and the previous traditional methods?
4. Are there significant differences between chololo pit and normal agriculture in the crop yield?
5. To what extent has the use of pits practices enabled improving soil fertility?
6. How has the chololo pit technology impacted your reliance on climate?
7. In what ways did the Chololo Pit project help maintain resilience in your farming?
8. Is there any financial cost incurred in implementing the chololo pit technology?
9. How much extra labour is required (if at all) for the chololo pit technology
10. Has the adoption of the chololo pit technology affected your income from farming?
11. How do community dynamics affect the attitudes of small farmers and the adoption of Chololo Pits practices?
12. Are there any difficulties in implementing the Chololo Pits technology currently?

Appendix 2: Interview Guide Agricultural Extension Officer and Head of the Implementation of Project

2.1 Agricultural Extension Officer

1. How do farmers know of the chololo pit technology in agricultural activities?
2. How do you engage in the adoption of chololo pit technology in chamwino District?
3. How has the chololo pit technology been modified compared with the pit technology practiced in Western Africa, where it comes from initially?
4. How can the extension officer and trade union leader help implement the Chololo Pit practice?
5. How are small farmers affected when involved in implementing chololo pits technology, especially on the financial costs and benefits?
6. In what ways did the Chololo Pit project help maintain sustainable agricultural resilience?
7. What are the reactions to the adoption of chololo technology by farmers?
8. What criteria do farmers use to adopt chololo pit technology?
9. How far do smallholder farmers reach on acquiring the chololo pit technology in the community on coverage of adoption rate?
10. What are the obstacles (if any) in applying chololo pit technology?
11. Is there anything else you want to share regarding your experience with Chololo pit technology?
12. What do you suggest in improving the technology of the chololo pit?
13. How do you help farmers address challenges in adopting the technology?

2.2 Head Of Trade Union Guide (*Kiongozi Wa Ushirika Wa Wakulima*)

1. What are the challenges that you have encountered in this project?
2. How can the other relevant stakeholders help implement the Chololo Pit practice?
3. In your opinion, how has this technology influenced agricultural resilience and crop productivity for farmers in this region?
4. Have you received any feedback from farmers using this technology? Please elaborate on the type of feedback received

5. Is there anything else you can share regarding your experience with Chololo Pits technology?
6. Do you have any suggestions on enhancing the implementation of Chololo pits technology in this district?