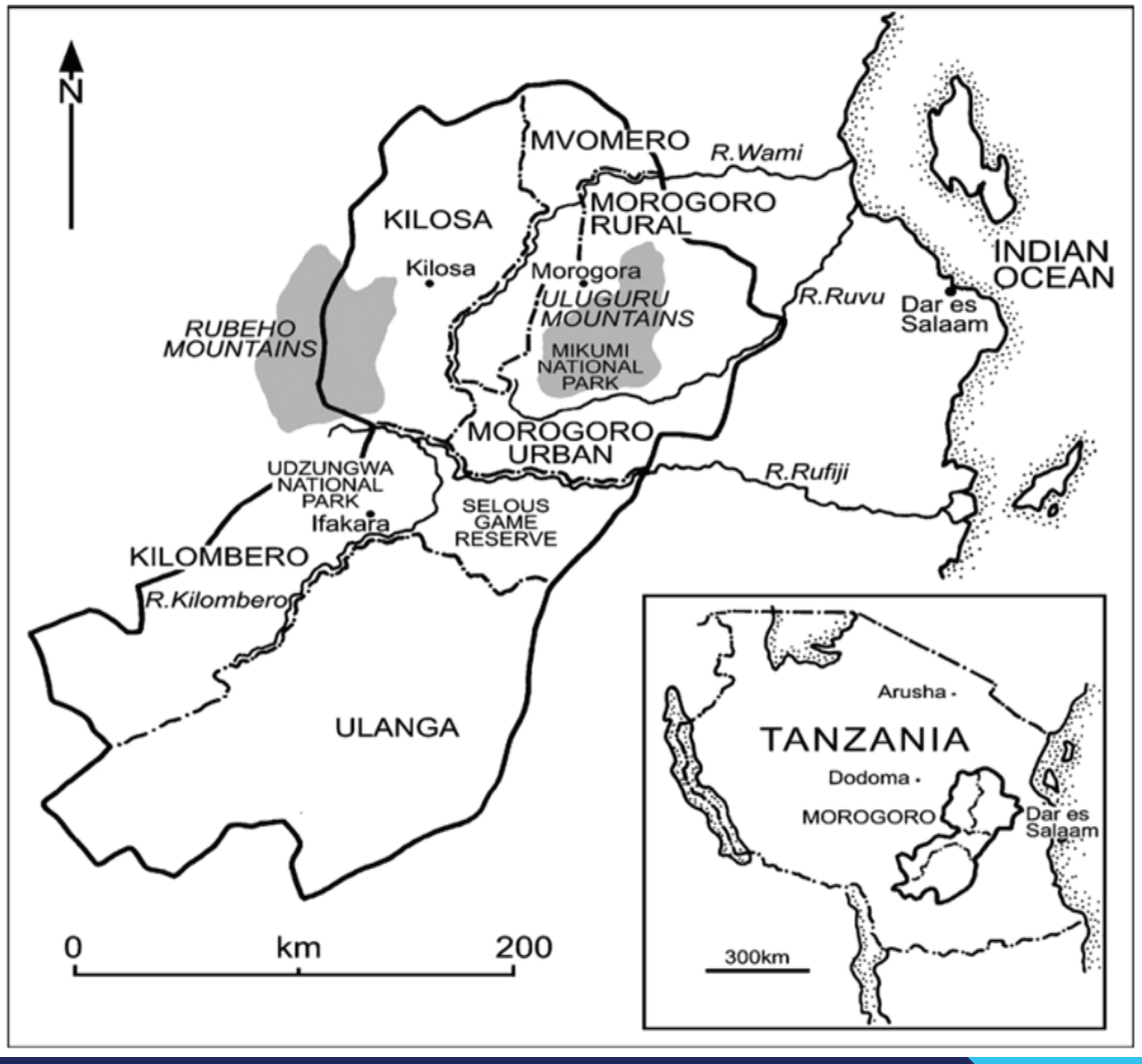
Intrahousehold bargaining and Climate-Smart Agriculture: Productivity outcomes among female paddy farmers in Morogoro Region

Gloria Mapunda & Theresia Mrosso



Research Report 2024/16

Published by:

REPOA
157 Migombani/REPOA Streets, Regent Estate,
P.O. Box 33223
Dar es Salaam.

Authors: Gloria Mapunda & Theresia Mrosso
Copy-editing & initial layout: Vincent Nalwendela | REPOA

Suggested citation:
Mapunda, G., & Mrosso, T. (2024). Intrahousehold bargaining and Climate-Smart Agriculture: productivity outcomes among female paddy farmers in Morogoro Region. REPOA, Tanzania.

Research Report 2024/16

Suggested Keywords:
Intrahousehold bargaining, women, climate-smart agriculture, productivity.

ISBN 978-9987-753-25-3

TABLE OF CONTENTS

ABSTRACT

Climate change and its impact on food security remains a significant concern especially for women who are primarily responsible for food production in developing nations. Women farmers are reported to have lower adoption rates of climate-smart agriculture (CSA) practices, leaving them more exposed to the adverse climate effects. Yet, less is empirically known about how women's bargaining power can influence the adoption of CSA practices and the associated effects on their farm productivity. This study explores the drivers of women's bargaining power in households, and their impact on adoption of CSA practices in Tanzania, focusing on paddy production. The study uses data from 317 women farmers. A Tobit model is employed in examining determinants of women's bargaining power. To investigate drivers of decision and extent of adoption of CSA practices, the Probit model and Poisson model are used, respectively. Furthermore, the Ordinary Least Square (OLS) method is used to investigate whether the level of adoption of CSA practices influences farm productivity. Results reveal that, the adoption of CSA practices is influenced by factors such as women's bargaining power, age, non-farm income, area planted, access to credit, access to information, saving accounts, and membership in a social group. In addition, women's productivity is largely explained by access to information. These results provide key policy implications that can be incorporated by government and non-government interventions for boosting gender equality as well as the uptake of CSA practices by women in Tanzania.

1. INTRODUCTION

Climate change is one of the major challenges affecting agriculture production and food security in Africa. Projections show that in the 21st century, temperature will rise by about 2°C (IPCC, 2014, 2021), rainfall will be reduced, and there will also be disastrous events, such as floods and drought (CIAT and CARE TZ, 2019; CIAT and World Bank, 2017). These possible outcomes are of significant concern to developing countries as majority of people depend on agriculture. In addition, agriculture in these countries is largely rain-fed, which makes them more susceptible to the adverse impacts of climate change (FAO, 2010).

In response to these climate challenges, several climate-smart practices have been proposed (FAO, 2013). These are practices intended to boost agricultural productivity, enhance adaptation, and promote the reduction of greenhouse gases (FAO, 2013). However, the applicability of these practices differs according to socio-cultural, agro-ecological environment, and other factors (Lopez-Ridaura et al., 2018; Thierfelder et al., 2017).

Despite their benefits and relevance, studies show that adaptation rates of climate-smart practices are lower for women compared to men (Jost et al., 2015; Rola-Rubzen et al., 2020 ; (Ogisi & Begho, 2023). As a result, women experience increased vulnerability to climate change. Moreover, since women are the major food producers in developing countries, their vulnerability threatens food security. Studies show that women's increased access to CSA practices could increase yields between 20 per cent to 30 per cent and, thus reduce hunger at a range of between 12 to 17 percent (Jost et al., 2015).

Tanzania is among vulnerable countries as her economy depends on climate sensitive sectors such as agriculture (United Republic of Tanzania (URT), 2021a). Crops production is projected to be heavily affected by climate change, hence threatening food security (United Republic of Tanzania (URT), 2021b). Moreover, as women are disproportionately affected by climate change compared to men, in turn, climate change affects their adaptive capacity. Recent government policy documents regarding climate change responses highlight the political will to mainstream gender-specific issues in climate change adaptation (United Republic of Tanzania(URT), 2013, 2021b) . However, effective implementation of the policies will depend on the deeper understanding of gender specific issues related to adaptation to climate change.

Several studies have examined how women's access to resources would improve their level of adoption of CSA practices. However, the question of how intra-household bargaining influences the adoption of CSA practices remains largely unexplored. Studying women's bargaining power is vital as it gauges women's empowerment conditions within households (Malapit et al., 2014).

This study was therefore intended to specifically examine women's bargaining power in the household context and how it influences the decision and extent of adoption of

CSA practices as well as their productivity outcomes. The study focused on paddy crop, one of the major food staples in Tanzania, which is mostly rain-fed and therefore vulnerable to climatic changes (United Republic of Tanzania (URT), 2021b). Area of the study is Morogoro region, since it is one of the leading regions in paddy production in Tanzania.

Understanding the influence of bargaining power in adoption of CSA practices by women farmers is vital for informing various governmental and non-governmental interventions on promoting the uptake of these practices. This is because efforts towards improving women's conditions have a bearing on improving their agricultural yields by around 30 percent and may contribute to reducing the number of people with hunger globally at a range of between 100 to 150 million (FAO, 2011). Furthermore, evidence-informed efforts in building climate-resilient societies will facilitate attainment of sustainable development goals for climate action (SDG 13) and gender equality (SDG 5) (United Nations, 2015).

1.1 Statement of the Problem

The existing gender roles and responsibilities are predominantly defined by cultural and traditional norms in African societies, such as Tanzania. These culturally defined roles affect the power and responsibilities that men and women have in the community. In most developing countries, including Tanzania, men are more involved with wage labor while women are mostly involved with subsistence farming. This reinforces the disproportional impacts of climate change between men and women, whereby women are much more affected (FAO, 2003; United Republic of Tanzania, 2021). Despite introducing CSA practices as solutions to alleviate the adverse impacts of climate change, adopting these practices is still lower for women than men in Tanzania (Jost et al., 2015: Ogisi & Begho, 2023).

One key reason for the low level of adoption of CSA practices among women is their limited bargaining power. Despite the existing evidence suggesting that improving women's bargaining power can potentially increase the adoption of CSA practices (Kurgat et al., 2020; Pamuk et al., 2021; Shahbaz et al., 2022), the impact remains unclear for climate change vulnerable countries like Tanzania (Van Aelst & Holvoet, 2018). Moreover, little is known on the impact of women's bargaining power for the specific food crops, which majority of women are involved in. This uncertainty arises due to heterogeneity in terms of the intra-household decision-making conditions of a particular society. This implies that the effectiveness of various interventions undertaken to raise women's adoption of CSA practices may be hindered if this vital socio-dynamic factor is not fully considered. This brings forth the need to examine the extent to which women's bargaining power affects the adoption of CSA practices, especially in Tanzania, which still experiences notably low levels of adoption (Kurgat et al., 2020; United Republic of Tanzania, 2015).

Moreover, women still experience low productivity levels compared to men. This is critical since most farmers in Tanzania are women, producing around 70 percent of the country's food needs and, thus, have a great influence on food security conditions in the country (United Republic of Tanzania (URT), 2015). However, there is limited empirical analysis of the link between women's adoption of CSA practices and the associated impacts on agriculture productivity. In addition, it is not yet known if women's bargaining power mediates this link. Thus, it is also essential to examine the effect of the adoption of CSA practices on productivity as this is vital for policies relevant to promoting agriculture and food security in Tanzania.

1.2 Research Objectives

The general objective of this study was to examine the determinants of women's bargaining power, its effect on the adoption of CSA practices and the productivity of women paddy farmers.

1.2.1 Specific Research Objectives

(a)To assess drivers of intra-household bargaining among women farmers.
(b)To examine the effect of intra-household bargaining power on adopting CSA practices among women farmers.
(c)To investigate the effects of the adoption of CSA practices and the mediating effect of women's intrahousehold bargaining on farm productivity.

1.2.2 Research Questions

1. What are the drivers of intra-household bargaining power among women farmers?
2. What is the effect of intra-household bargaining power on the adoption of CSA practices among women farmers?
3. What is the effect of the adoption of CSA practices and the mediating effect of women's intrahousehold bargaining on farm productivity?

1.3 Significance of Study

One of the main contributions of this study lays on providing inputs to various government and non-governmental interventions on climate change adaptation that target women farmers. This is imperative because principally most of the policies that are related to climate change adaptation have been formulated based on the implicit assumption of unitary model of households, whereby, households are taken as a single unit in making production and consumption decisions. However, there are variations in preferences and dynamics that happen between men and women in the households. Thus, this study provides relevant information to guide better designing and targeting of policies, programmes and interventions related to climate change adaptation.

Moreover, this study fills the knowledge gap that exists in literature regarding gender dynamics in the context of adoption of CSA practices. Most previous studies have based gender analysis at the household level (Tsige et al., 2020). As a result, there is

limited analysis at the intra-household level, even in Tanzania. This study therefore extends this scant literature by bringing a deeper insight at the intra-household level.

2. LITERATURE REVIEW

2.1 Theoretical Framework

Theoretical models of household decisions were initially based on the unitary model approach (Becker, 1991). In this model, members of households are assumed to agree in all decisions as they have the same preferences in matters such as production and consumption or one of the members of household decides for his fellow members. In this context, the theory assumes a single household utility function and considers social norms related to gender roles as exogenous.

However, numerous empirical studies that followed led to the development of a bargaining model of decision-making due to the identified differences in preferences among the members of households (Chiappori, 1992). This became possible through development in modelling of household decision-making behavior and the increased availability of sex - disaggregated data on decision-making, which could be used in testing of such models (Doss & Quisumbing, 2019). These led to the development of collective models that have two key assumptions, which are: different household members have varied preferences and that in these models there is no single utility function. These collective models can be divided into cooperative and non-cooperative models (Agarwal, 1997; Doss, 2013).

Non-cooperative models assume individuals make separate decisions based on their preferences as well as the expectations and interests of others (Doss & Quisumbing, 2019), thus, allowing for inefficient outcomes to be realized. This is because, under these models, the assumption is that resources may not be pooled, thus, they allow cases where inefficient outcomes may be realized due to a lack of gains (Doss & Quisumbing, 2019).

On the other hand, cooperative models connote that the outcome of households results from differences in preferences, information asymmetries and power differentials between the members of a household. This model is rooted in game theory (Doss & Quisumbing, 2019). According to this theory, the assumption is that an efficient outcome will be realized by the household. This is because, any household decision outcome will be the one in which no one could be made better-off without making another worse-off (Doss & Quisumbing, 2019; Doss, 2013)). Moreover, it assumes that gender preferences are not the same, and as such, it makes it possible to test how women's bargaining power influences various household outcomes (Doss & Quisumbing, 2019).

This study therefore follows a cooperative bargaining power framework approach since most rural households exhibit cooperative models in the context of production and consumption dynamics.

2.2 Empirical Literature

Studies demonstrate that CSA practices are beneficial to farmers in terms of leveraging productivity, household welfare and resilience to climate change (Teklewold, 2023; Bongole et al., 2020). However, adoption rates are low for farmers in developing countries (Amadu et al., 2020; Brown et al., 2018). These adoption rates are even lower for female smallholder farmers (Ginbo & Hansson, 2023). This reality has adverse implications in farmers' livelihoods since they are already experiencing the hazardous effects of climate change.

Many studies have been undertaken to examine the adoption of CSA practices. Studies demonstrate that the adoption of CSA practices is influenced by many drivers, such as economic viability of the CSA practices, gender, education, household size, extension service, membership in social groups, and access to credit (Mutenje et al. 2019; Thuo et al., 2017)

Gender is among the key variables empirically found to influence the adoption of CSA practices. In this approach, studies usually focus on the household head only whereby women are often found to have lower adoption rates compared to men (Bryan et al., 2013; Kristjanson et al., 2017). In that context, women are treated as a homogenous group, while there may exist differences in terms of access to resources, knowledge as well as some social dimensions that may lead to varied levels of adoption among women (Acosta et al., 2021). Since women's increased participation and contribution in food security is extensively recognized (Khatri-Chhetri et al., 2017), disregarding them in the analysis implies little in-depth empirical examination of how gender influence the adoption of CSA practices. This may consequently result to CSA interventions which are ineffective and unsustainable.

In response to that situation, emerging studies explore on the drivers of CSA adoption among women farmers. In these studies, one approach considered women's needs and priorities in the design of CSA practices (Huyer, 2016). Another indulged in gender analysis in the context of adopting CSA practices and focused on identifying labor-saving techniques that women can employ in implementing CSA (Khatri-Chhetri et al., 2017). However, this still leaves other critical aspects of gender analysis unexplored that require further consideration.

One of the important sources of heterogeneity left out in most studies is examining the drivers of women's bargaining power and how this may influence the adoption of CSA practices. This is because, although women have important roles and responsibilities for their families, they may not have the same bargaining power in households' decisions due to differences in access to resources, utilization and control of resources (Ogisi & Begho, 2023; Teklewold, 2023). Women's bargaining power is defined by the relative economic or social positions that women have in the household in terms of accessing and controlling various household resources (Doss, 2013). Bargaining power aspect is critical since it explains the decision-making process within a household (Lim et al., 2007). It has been noted that heterogeneity in various aspects

that exist in the farmers' household such as bargaining power may influence adoption rate (Ogada et al., 2020). Thus, many studies argue for the need for in-depth gender analysis on the adoption of CSA practices to enhance the closing of the gender gap in CSA adoption (Murray et al., 2016; Teklewold, 2023).

Women's bargaining power is evidenced to influence various household outcomes in Tanzania. For instance, Mukong & Burns (2019) show that women's bargaining power may lead to reduced children's home delivery, while Ringdal & Sjursen (2021) found that an increase in women's intra-household bargaining enhances equality in children's education. Furthermore, other studies show that women's bargaining power reduces child stunting (Mukong & Burns, 2017). However, there are still limited studies that investigate the dynamics of intra-household women's bargaining on various household outcomes in Tanzania.

Specifically on the impact of women's bargaining power on the agriculture, Masamha et al., (2018) explores the level of women's bargaining power in Kigoma region and finds it very low in the participation of the cassava value chain among smallholder farmers. This study analyzed the general situation in the value chain but did not specifically consider the CSA practices in the production part of the value chain.

Teklewold (2023) investigated how bargaining power in form of access to, management and control of farm plots would influence adoption of CSA practices for farmers in general in Tanzania, Ethiopia, Malawi and Nigeria. For the case of Tanzania, he found that in plots where women had bargaining power as reflected by joint ownership of farm plots, adoption of multiple CSA practices was evident. However, the study did not distinguish the likely impacts on plots for specific crop varieties.

Seymour et al. (2016) assessed the impacts of women's bargaining power and found that it influences the adoption of improved maize varieties. Also, Van Aelst & Holvoet (2018) found that women's intrahousehold bargaining influence the adoption of some of CSA practices for farmers in general; but did not distinguish between farmers according to the specific food crops that women farmers cultivate.

As regards to paddy female farmers, Achandi et al., (2019) examines drivers influencing women's bargaining power in Morogoro and finds that age, education, monthly income, group membership, condition of the dwelling, and distance to the nearest town are significant. However, their study did not go further to explore how the enhanced decision-making power could influence agricultural outcomes such as the adoption of CSA practices.

Thus, this shows there is still a knowledge gap as regards to the link between women's intra-household bargaining and CSA practices; and even so for specific food crops that most women engage. Therefore, this study seeks to fill part of that gap by focusing on paddy crop, which is among the major food crops in Tanzania (United Republic of Tanzania (URT), 2021a). It is necessary to study this link since most women are employed in agriculture in Tanzania (United Republic of Tanzania, 2015). Also, it is vital

for food security policy concerns as most women prefer to produce staple foods rather than cash crops (FAO, 2003).

On a related note, studies show there is an existing gender gap in farmer's productivity (Doss, 2018; Huyer, 2016; Tufa et al., 2022; World Bank, 2014). This is attributed to various challenges that women face including decision-making power. According to Arthur-Holmes & Busia (2020), there is potential for boosting agriculture productivity if gender aspects are addressed in the agricultural interventions or else it may exacerbate a low level of the adoption of CSA practices and consequently increase food insecurity.

There are still limited studies in developing countries examining how women's bargaining affects the link between the adoption of CSA practices and their respective productivity. This is also the case in Tanzania. Few studies undertaken in Tanzania focused on understanding the intra-household perception of authority and how land management rights, ownership, and control influence choices of CSA practices (Anderson et al., 2017; Teklewold, 2023). Other studies focused on the impact of interventions on women's bargaining power (Ndossi et al., 2022).

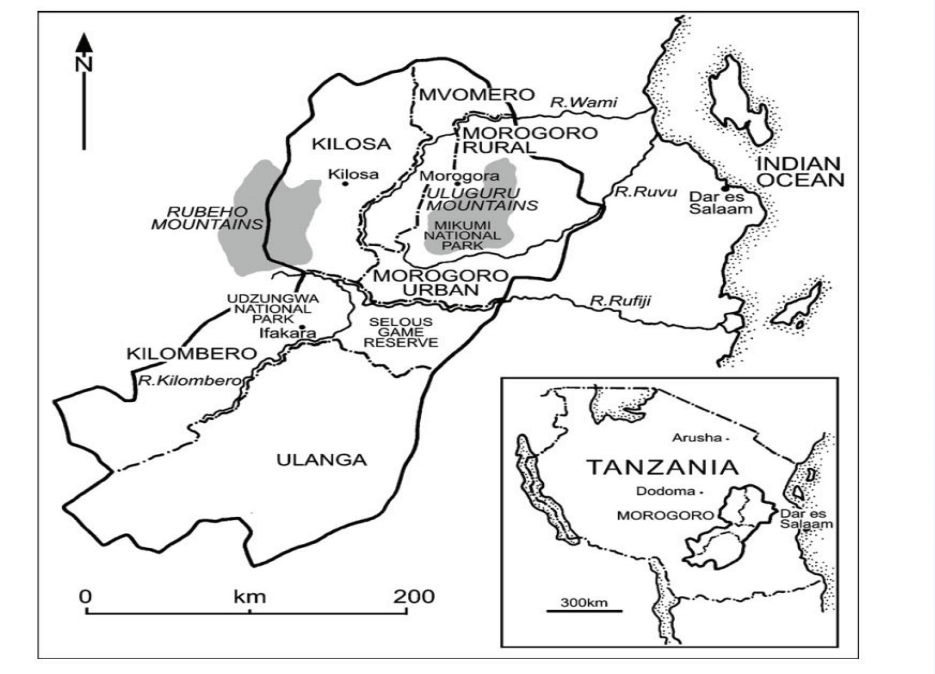
Given that Tanzania is one of the countries that is vulnerable to climate change (United Republic of Tanzania, 2021); and, given that climate change has varied impacts (Ogada et al., 2020), this study was designed to investigate how women's bargaining influences the adoption of CSA practices and whether this has implications on the respective productivity of paddy women farmers.

3. DATA AND METHODS

3.1 Study area

The study was undertaken in Morogoro region, in Tanzania, located between latitude 5° 58′ and 10′ south, and longitude 35° 25′ and 38° 30′ East of Greenwich (NBS, 2007). This region was selected for the reported study because it leads in paddy production, which is the crop of focus for this study. This crop also has a strategic role in food security in Tanzania, as it is one of the major staple foods in the country (United Republic of Tanzania (URT), 2021a). Furthermore, the study selected Kilombero district, which leads in paddy production within Morogoro (NBS, 2007).

Figure 1: Map of Morogoro region as adopted from (Paavola, 2008).



3.2 Sample and Sampling

In August 2023, the researchers collected primary data in a cross-sectional survey of 317 women paddy farmers, from 11 wards of Kilombero district in Morogoro. Specifically, a sample focused on rural women who are farmers and those who were expected to be in position to take part in household decision making (That is either spouse or head of household). Respondents were selected using both purposive and random sampling procedures. This meant purposive sampling was used in selecting households with married or single women, then out of them respondents for the study were randomly selected. Data was collected through direct interview using structured questionnaires. The collected information included socioeconomic characteristics such as age, household size, marital status, education, climate-smart practices, decision-making on various household aspects, farm size, and harvested quantity. A distribution of sample interviewed across ward is shown in Appendix A4.

3.3 Variables

The key variables used in this analysis are defined below:

Women's intra-household bargaining (WIB): Due to the unobserved nature of bargaining within households, the study measures women's participation in household decision-making through a composite measure of their involvement in twelve intra-household decisions (Afoakwah, 2020). Binary values were assigned to each decision, with 1 indicating a woman's participation, either independently or jointly with her spouse, and 0 indicating no participation. The women's intrahousehold bargaining index was calculated by adding up the values of these decisions, where 0 indicated no involvement and 12 indicated full participation. Components of women's Intra-household bargaining are included in Appendix A1.

Adoption of CSA practices was measured in two ways. First, as a binary outcome at the household level where 1 represents if a woman farmer adopted any of CSA practices as defined by the study, and 0 otherwise. Second, as a composite measure of the number of CSA adopted by women farmers, where 0 represents none of CSA practices were adopted and 9 represents full adoption of CSA practices. The number of CSA adopted by farmers is included in Appendix A2. The choice of CSA practices used in the study was based on the number of CSA technologies identified in the Tanzania National Census of Agriculture (United Republic of Tanzania, 2021).

Farm productivity as a continuous variable was measured by dividing the total quantity of paddy harvested by the total area planted. Due to data limitations, we could not obtain data on the cost of labor and the cost of inputs.

$$\text{Farm productivity} = \frac{\text{Total crop yield (kg)}}{\text{Total area planted (Ha)}}$$

Control variables: The study considered a range of demographic, economic, and social variables, including age, education, marital status, household size, distance to road and farm, farm experience, access to information, and credit. These variables were used to help in accounting for any confounding factors that may affect the relationship between women's intrahousehold bargaining, adoption of CSA practices, and farm productivity.

3.4 Analytical Approaches

The study used two analytical approaches: descriptive analysis and econometric analysis. Descriptive statistics on key variables are presented to inform research questions, followed by econometric analysis. The following are the econometric models that were employed in the analysis:

For the first objective, Tobit model was used to analyze factors affecting women's intra-household bargaining among smallholder farmers. This is because the outcome

variable, *women intrahousehold bargaining*, was presented by an index ranging from 0 and 12 household decisions, as such it was a censored outcome. We could not observe all possible household decisions due to study limitations. In this case, our variable is partly continuous but has a positive probability mass at one point which is above 12. Because an outcome variable was censored, Tobit model was used as it produces consistent estimates (Wooldridge, 2010). Therefore, the study estimated a Tobit model with the generic form:

$$\mathrm{WIB_i} = \alpha + \delta \mathrm{X_i} + \varepsilon_\mathrm{i} \quad (1)$$

Where subscript i is an index for individual farmers, WIB_i is women's intrahousehold bargaining, $X_i is$ a set of control characteristics such age, female education, marital status, household size, number of children, access to information, and membership in social groups, and ε_i is the error term.

The second objective examined the effect of women's intra-household bargaining on adoption of CSA practices among women smallholder farmers. This objective was modeled using two econometric approaches:

First, with a binary probit model where outcome variable CSA practices adoption takes binary values, 1 if one adopts and 0 if otherwise. We estimated a model with generic form:

$$\mathrm{CSA_i} = \alpha + \beta \mathrm{WIB_i} + \delta \mathrm{X_i} + \varepsilon_\mathrm{i} \quad (2)$$

Where, subscript i is an index for a farmer, CSA_i is binary value of CSA practices adoption by women farmers, WIB_i is the women's intra-household bargaining index, X_i is a set of control characteristics (age, marital status, household size, the area planted, distance to farm, distance to nearest road and market, farm experience, time spent on farm, off-farm activities, access to information, access to credit, saving, and membership in social groups), and ε_i is the error term.

Second, we model CSA adoption as a count variable, which is an index representing the number of CSA practices adopted by a particular household. The study used the Poisson function to estimate a model as follows:

$$\mathrm{CSA_{ji}} = \alpha + \beta \mathrm{WIB_i} + \delta \mathrm{X_i} + \varepsilon_\mathrm{ji} \quad (3)$$

Where subscript j represents the number of CSA practices adopted by a particular farmer i. Other variables are as specified in equation (2) above.

The aim of modeling it this way was to see whether there is any difference in the effect of WIB on binary CSA adoption and on the number of CSA that households choose to adopt. We were interested in assessing if the simultaneous adoption of practices by

farmers is any different. We used the Poisson model to estimate these effects which enrich our study findings.

The third objective aimed to assess the effects of Women's intra-household bargaining and adoption of CSA practices on farm productivity. We used the OLS model to estimate the effect of women's bargaining and CSA adoption on farm productivity. The study also included an interaction term of WIB and CSA adoption to assess if there is any mediating effect of women's bargaining and CSA adoption on farm productivity. That was intended to answer the research question on if *there is a mediating effect of WIB and the adoption of CSA on farm productivity*. Thus, the study estimated a model with the generic form:

$$\text{Farm productivity}_i = \alpha + \beta \text{WIB}_i + \delta \text{XCSA}_{ji} + \gamma(\text{WIB}_{ji} * \text{CSA}_i) + \lambda \text{X}_i + \varepsilon_i \quad (4)$$

Where subscript i is an index for a farmer, subscript j is an index for *CSA* practices adopted, WIB_i is the women's intra-household bargaining index, , $(WIB_i * CSA_i)$ is the interacting term, X_i is a set of control characteristics such as farmers' perception of effect of climate change, area planted and others as shown in Table 5, and ε_i is the error term.

We were unable to obtain data on the entire farm size due to several factors, including the fact that most women did not own land but rented it during the farming season. In addition, in some cases, women were unaware of the total farm size of their household.

3.5 Results And Discussion

This section presents the results for all the objectives from the analysis of data. Descriptive Analysis of variables used in the study is shown in Tables 1 and 2.

Demographically, the average household size was about five (5) members with an average of 3 children. Females had an average of 42 years of age with a minimum age of 20 and a maximum of 73 years, reflecting a working age being part of rice producers in Kilombero district. The mean household expenditure was around TZS. 638,222

Generally, 70 percent of female farmers in this district completed primary education, and about 30 percent had some secondary education or tertiary/higher education or no education[1]. Results further indicate at least 65 percent of heads of households in this area had completed primary education. This shows fair access to primary education by farmers in the area.

[1] Due to few observations in some levels of education, six levels of education (No formal education, not completed primary, completed Primary, not completed secondary, Secondary or higher education, tertiary/vocational education) where reduced to binary values where 1 if completed primary, and 0 otherwise to further aid study's analysis.

Regarding the nature of the household, male-headed households make up 53 percent and 47 percent were female-headed. Most women (52.1 percent) were married, about 38 percent were single and less than 10 percent were cohabiting/living together with men without formal marriage.

Table 1: Summary statistics of variables used in the study

Variable	Obs	Mean	Std. Dev.	Min	Max
Farm productivity (kg/Ha)	317	407.296	767.7145	0	8571.429
Women intrahousehold Bargain (WIB)	317	9.899	3.381	0	12
Female Age (years)	317	41.656	11.088	20	73
Total Hh members	317	4.669	1.951	1	12
Number of Children	317	3.148265	1.587163	0	9
Distance to the nearest road (minutes)	317	24.502	28.178	0	180
Distance to Farm (minutes)	317	135.334	81.59	1	420
Distance Market (minutes)	317	33.596	27.504	1	180
Area planted (Ha)	317	2.912	2.016	1	15
Total household Expenditure (Shillings)	317	638,222.2	2043275	37025	3.13E+07
CSA adoption index	317	1.205047	1.121809	0	6
CSA adoption binary					
No	317	0.322	0.468	0	1
Yes	317	0.678	0.468	0	1
Female education					
Completed Primary	317	0.7	0.459	0	1
Other (no formal education, not completed primary, secondary or higher education or tertiary)	317	0.3	0.459	0	1
Head of household education	317	0.085	0.28	0	1
Completed Primary	317	0.669	0.471	0	1
Other (no formal education, not completed primary, secondary or higher education or tertiary)	317	0.331	0.471	0	1
Marital Status					
Cohabiting	317	0.095	0.293	0	1
Married	317	0.521	0.5	0	1
Single	317	0.385	0.487	0	1
Household Head					
Male headed	317	0.533	0.5	0	1
Female-headed	317	0.467	0.5	0	1
Farming experience					
Less than 5 years	317	0.164	0.371	0	1
5 years +	317	0.836	0.371	0	1
Non-farm activities					
No	317	0.476	0.5	0	1
Yes	317	0.524	0.5	0	1
Time spent on the farm					
Less than 6 hours	317	0.243	0.43	0	1

More than 6 hours	317	0.757	0.43	0	1
Credit access					
No	317	0.59	0.493	0	1
Yes	317	0.41	0.493	0	1
Saving account					
No	317	0.767	0.424	0	1
Yes	317	0.233	0.424	0	1
Access to information					
No	317	0.315	0.465	0	1
Yes	317	0.685	0.465	0	1
Member of social group					
No	317	0.356	0.48	0	1
Yes	317	0.644	0.48	0	1

Source: Authors' own computation

Economically, about 52 percent of women engaged in non-farm income activities such as business or employed jobs. The majority (68 %) had access to farm information, which was acquired from different channels such as extension officers, own phones, or fellow farmers. While 41 percent had access to credit, only 23.3 percent of farmers were operating using their saving accounts, and 64 percent of women were involved in different social or community saving and credit groups, which include Village Community Banks (VICOBA) and Rotating Savings and Credit Associations (ROSCAs).

Results reveal that, 83% of farmers have farming experience of more than 5 years, and a majority (76%) spend an average of 6 hours working on farms. Farmers reported farms to be distant from their homes, taking an average of 135 minutes, about 34 minutes, and 25 minutes to get to the farm, markets, and the nearest road, respectively. An average of approximately three hectares was the area of paddy planted by each farmer in the previous season.

From the survey, women took part in at least nine out of 12 decision categories of household decisions. 67 percent of farmers have adopted at least one CSA practice and no farmer practices more than 6 CSA practices as indicated by the CSA adoption index. On-farm productivity survey indicates an average of 407 kilograms of rice harvested per hectare was achieved by farmers in this area.

Table 2 shows descriptive statistics of women's participation in different intrahousehold bargaining decisions measured at the household level. Overall results show that, more than 70 percent of women from the sample participate in household decision-making. Specifically, an average of 76 percent of women participate in household decisions to engage in off-farm income-generating activities (such as salary jobs or business), whether to increase female education, and in purchasing large items such as buying a plot, etc.

Table 2: Women's participation in household decisions

Variable	Obs	Mean	Std. Dev.	Min	Max
Decisions					
Participation in off-farm work	317	0.763	0.426	0	1
Increase the level of education	317	0.77	0.422	0	1
Participation in social activities	317	0.826	0.379	0	1
Large purchases	317	0.767	0.424	0	1
Everyday purchases	317	0.896	0.306	0	1
Time spent on the farm	317	0.94	0.238	0	1
What to Plant	317	0.826	0.379	0	1
Technology employed	317	0.804	0.397	0	1
Time Spent in off-farm activities (e.g. domestic works etc.)	317	0.839	0.368	0	1
Land to cultivate	317	0.836	0.371	0	1
Have saving account	317	0.801	0.4	0	1
Manage income	317	0.83	0.377	0	1

Source: Authors' own computation

Moreover, an average of 83 percent take part in social activities (i.e. community gatherings), everyday purchases of the household, have a savings account, and manage household income. As regards to household farming decisions, such as what to plant, 83 percent of women participate. Further, 94 percent of women are involved in deciding the time spent on the farm, 80 percent participate in deciding on which technology to be employed, 84 percent of women take part in deciding time spent off the farm, and 84 percent of women participate in deciding the size of land to be cultivated.

3.5.1 Factors affecting women's intrahousehold bargaining

Table 3 presents the marginal effects results of a Tobit model assessing factors affecting women's intrahousehold bargaining power among smallholder rice farmers.

Table 3: Tobit model for factors affecting Women's bargaining in the household

	(1)
VARIABLES	Mfx
Female age (years)	0.0809*
	(0.0417)
Female education (base=no completed primary) Completed Primary	-0.676
	(0.786)
Head of hh education (base=no completed primary) Completed Primary	-0.993
	(0.770)
Head household (base=male headed) Female-headed	2.474***
	(0.918)
Household size	0.101
	(0.213)
Number of Children	0.142
	(0.294)
Marital Status (base=cohabiting) Married	0.582
	(0.926)
Single	13.58***
	(2.275)
Access information (base=no) Yes	1.689**
	(0.720)
Membership in social groups (base=no) Yes	0.745
	(0.698)
Observations	317

Note: Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Results indicate that women's age is significant and positively affects women's bargaining in household decisions. That is, older women are more likely to engage in decision-making compared to young women. This is consistent with the natural setting where an additional year means approaching more responsibility, which requires an individual to make decisions compared to when one is young and decisions are made by elders on one's behalf. This result is consistent with the results reported by Adekunle (2022) and Kibe (2017). However, this contrasts with outcomes by Murshid (2018) who found that younger women in Bangladesh had more bargaining power than adult women. This shows the drivers of bargaining power are context-specific and, thus, warrant context-specific analysis.

Female-headed households have a significant and positive effect on women's intrahousehold bargain index. This means that, when a woman is a household head, her participation in household decision-making is high. This is logical given that when a woman is the head of the household, household members depend on her to make family decisions. This indirectly highlights the existence of cultural norms where women who are not heads of family are less likely to have decision-making power.

Single women have a positive and significant bargaining power. This finding is similar to what Badstue et al., (2020) obtained. The results mean that, when a woman is single, she is likely to be the head of a household and, therefore, responsible for household decisions. This is consistent with the results obtained earlier of high bargaining power when a woman is the head of the household. Therefore, on account of making household decisions, a single woman has a higher bargaining power than women living with male spouses.

Access to information has a positive and significant impact on women's intrahousehold bargaining. This result is consistent with the work of Raghunathan et al., (2019) who found that in India access to information improved women's bargaining power. That is, women with access to information are more likely to have higher women's bargaining scores, compared to those with no access to information. This shows that the ability to acquire information is vital in influencing household decisions. Moreover, household size, number of children, and being a member of a social group are found to not affect women's bargaining in a household. This contrasts with the results reported by Murshid (2018) and Raghunathan et al., (2019).

Furthermore, results show that having primary education has no statistically significant effect on women's bargaining power compared to those in other levels of education. This is an interesting result as it could mean primary education may not be a sufficient education level to facilitate women to engage in decision-making. Most women in the sample had completed primary education and there were few observations at other education levels. However, this result is not significant. This finding is in contrast to the one found by Kibe (2017) and Murshid (2018), whereby they found that, women's education influence their bargaining power. In this study, the education of the head of the household is also found to be insignificant.

3.5.2 Women's intrahousehold bargaining (WIB) and adoption of CSA practices among smallholder farmers

This objective was analyzed using two econometric approaches: the Probit model and the Poisson model. Table 4 presents the results of this analysis, whereas Model 1 presents the probit model result of the effect of WIB on the decision to adopt CSA practices. Model 2 presents the results of the effect of WIB on the CSA adoption index

(number of climate-smart practices) (*see Section 3.4 for model specifications*). Results for both models are discussed below.

Women's intrahousehold bargaining is significant and positively affects the adoption of CSA practices in model 1[2]. That is, a unit increase in women's intrahousehold bargaining score increases the rate of CSA adoption of a farmer by 0.01. Though the effect is marginal, this implies that women's participation in household decisions plays a facilitating role in ensuring women's performance in the sector, for example adopting appropriate agricultural practices that align with climate change. This result indicates that women in household decision-making influence farmers to adopt CSA practices. However, as it is shown in model 2, women's intrahousehold bargaining power is insignificant in influencing the number of CSA practices a household can undertake[3]. This could mean there are still existing patrilineal cultures that limit the decision-making power of women. This may be attributed to the fact that most households are male headed (see Table 1). This result is similar to what Singh (2023) found, that though Indian women's role in agriculture provided them with agency in agriculture, but it did not change the overall existing gender-power relations. This result is contrary to Nchanji et al., (2023) who found that women could influence the application of some CSA practices in bean production in Burundi.

Area planted by a farmer has a positive and significant effect on CSA adoption in both models. Model 1 indicates that a hectare increase in area planted increases farmers' adoption of CSA practices by 0.04. Furthermore, model 2 shows that one hectare increase in the expected log count of the area planted increases farmers' level of adoption of CSA practices by 0.05. This implies that farmers with a large farm size are more likely to adopt CSA compared to those with a limited farm size. Large farm size can act as insurance that attracts large investments, such as the use of diverse climate-smart practices. This result is similar for paddy growing areas as reported by Jena et al., (2023) and other crops as found in Abegunde et al., (2019); Johnson et al., (2023). However, the size of land that a farmer owns can be an attributing factor to how much land is allocated for farming. Contrary, Kassie et al., (2013) report small farm size to facilitate adoption of some modern agricultural practices.

Women's age is negative and significant in model 1 and insignificant in model 2. That is, a year increase in women's age reduces farmers' likelihood to adopt CSA practices by 0.004. Though the effect is marginal, results indicate that as a woman gets older, the probability of adopting CSA practices decreases. Farmers, especially those who are older, often prefer traditional practices, and this could be why we see this result. Most CSA practices involve the use of new and improved agricultural technologies. Thus, as a woman gets older, she may not want to practice new technologies as she becomes more risk averse. This is consistent with what is reported by Hailemariam et al., (2024).

[2] Binary probit model for binary CSA adoption
[3] Poisson model for CSA adoption index

Farmers' engagement in non-farm income-generating activities increases the adoption of CSA practices by farmers in both models 1 and 2. Compared to those who don't engage in off-farm activities, farmers in off-farm activities are about 0.1 more likely to adopt any of the CSA practices in model 1. In model 2, compared to those who don't engage in off-farm activities, the expected log count for being in off-farm activity increases by about 0.23. This shows that having other income activities compliments farmers' incomes to later invest in their farming activities. Thus, having on-farm income sources becomes important in enabling expansion of adoption of CSA practices. This finding is similar to that of Tambo & Abdoulaye (2012).

In both models 1 and 2, having a savings account has a positive and significant effect on CSA adoption by farmers. Holding other factors constant in model 1, results indicate that a farmer with a savings account is about 0.2 more likely to adopt CSA practices compared to those without saving. In model 2, compared to those without saving accounts, the expected log count for having a saving account increased by 0.377. Thus, savings play a significant role in facilitating farmers to adopt improved practices that are likely to improve their livelihood. This signifies the role of saving in enhancing the level of adoption of CSA practices for women.

Table 4: Effects of women's intrahousehold bargaining on adoption of CSA practices.

VARIABLES	(1) Probit (Mfx)	(2) Poisson (Coef.)
Women intrahousehold Bargaining (WIB)	0.0138*	0.0148
	(0.00836)	(0.0164)
Age of female (years)	-0.00416*	-0.00282
	(0.00247)	(0.00549)
Area planted (Ha)	0.0390***	0.0487**
	(0.0142)	(0.0215)
Marital Status (base=cohabiting)	0.116	0.309
Married		
	(0.0876)	(0.237)
Single	0.0326	0.139
	(0.0977)	(0.248)
Household size	-0.000813	-0.00502
	(0.0126)	(0.0259)
Distance to the nearest road (minutes)	0.00138	-0.00302
	(0.00104)	(0.00221)
Distance to Farm (minutes)	-0.000354	-0.000306
	(0.000310)	(0.000638)
Distance Market (minutes)	0.000468	0.00362
	(0.000992)	(0.00233)
Farming experience (base=Less than 5 years)	0.0203	0.00988
5 years +		
	(0.0773)	(0.142)
Time spent on farm (base= less than 6 hrs.)	0.0525	0.0847
More than 6 hrs.		
	(0.0583)	(0.130)
Non-farm income (base=no)	0.0976*	0.228**
Yes		
	(0.0503)	(0.0977)
Saving account (base=no)	0.190***	0.377***
Yes		
	(0.0537)	(0.111)
Access to credit (base=no)	-0.115**	-0.366***
Yes		
	(0.0559)	(0.108)
Access to information (base=no)	-0.292***	-0.397***
Yes		
	(0.0469)	(0.106)
Membership in social Groups (base=no)	0.102*	0.424***
Yes		
	(0.0572)	(0.114)
Constant		-0.392
		(0.372)
Observations	317	317

Note: Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The effect of access to credit on CSA adoption is found to be negative and significant. This result is consistent in both models. In model 1, a farmer with access to credit is about 0.12 less likely to adopt any CSA practice compared to those without access to credit. In model 2, compared to those without access to credit, the expected log count for having access to credit decreases by 0.366 significantly at 1 percent. This is an interesting finding that raised the question of whether the credit acquired by a farmer is allocated to activities other than farming. We went on and performed a correlation analysis between credit access and engaging in off-farm activities (see results in Appendix A3), where we found a correlation of 1. This implies the likelihood that the credit secured by farmers may not necessarily be for farming purposes but is allocated to other off-farm activities. This may be the reason we observe the negative effect of credit access on the adoption of CSA practices. However, this juncture can be an area of research for future studies. This result is contrary to the reports by Belay et al., (2023) and Jena et al., (2023), who found positive impact of access to credit on adoption of CSA practices and Olutumise (2023) who found positive impact of credit on number of CSA practices.

Access to information is also negative and significant at ($p<0.01$) in both models. In model 1, compared to those without access to information, having access to information reduces the likelihood of a farmer adopting CSA practices by 0.292. This result is also consistent with model 2, where, compared to those without access to information, the expected log count for having access to information decreases by 0.397. However, the nature of the effect of information can be dependent on many factors, including the relevance of information. This raises the question of the nature of information regarding farming received by women farmers and its ability to prompt farmers to adopt CSA practices. This indicates that farmers may be receiving information that facilitates them to improve output but does not directly cause them to adopt CSA practices. This result is contrary to a study by Shiferaw (2015) and Ferrer et al., (2023) that found access to information to be an important factor that enhances the adoption of technologies in Uganda and North-Central Vietnam, respectively.

Furthermore, the results of both models indicate that membership in a social group positively and significantly affects the farmer's adoption of CSA. Model 1 indicates, as compared to those who are not in social groups, being in a social group increases CSA adoption by 0.1. Model 2 shows that the expected log count for being in a social group increases by 0.424 significantly compared to those who are not in social groups. This result is similar to what is reported by (Nchanji et al., 2023). Other studies (Kassie et al., 2013; Nyangena, 2011) show that social groups are sources of information, learning and sharing experiences. In contrast, others show that membership in social groups could hinder the adoption of CSA practices (Ferrer et al., 2023).

3.5.3 *Effects of Women's Intrahousehold Bargaining and Adoption of CSA Practices to Farm Productivity by Farmers in Morogoro, Tanzania.*

Using the ordinary least square method (OLS), results indicate CSA adoption is positive and significant in affecting farm productivity, while women's intrahousehold bargaining is found negative and insignificant. Table 5 presents the coefficient results of the OLS model.

Output of the OLS model shows CSA adoption index positively and significantly affects farm productivity, that is, farmer's farm productivity increases by 224.2 kilograms/ha for every additional CSA practice adopted. Similar results were obtained by Jena et al. (2023) for paddy production as well as Mossie (2022) and Zizinga et al. (2022) for wheat and maize, respectively. This implies that CSA practices can be appropriate tools for farmers to boost their farm productivity in the face of climate change.

However, women's intrahousehold bargaining is found to be negative and insignificant. That is women's involvement in household decision-making did not significantly affect farm productivity. This may indicate that the participation of women in household decisions alone may not suffice to affect farm productivity without necessary resources, such as enough capital, labor, and farm inputs. But also, as Avila-Santamaria & Useche (2016) found, women's bargaining may influence productivity for coffee if women benefit fairly from such agricultural activities. This is contrary to Sneyers & Vandeplas (2015) who found that women's bargaining power enhances their productivity in the dairy sector. The interacting term (CSA adoption * Women's intrahousehold bargaining) is also negative and insignificant. Thus, there is no mediating effect of women's bargaining and adoption of CSA on farm productivity.

Table 5: effect of Women's intrahousehold bargaining and Adoption of CSA on farm productivity

VARIABLES	(1) OLS
CSA adoption index	224.2*
	(122.5)
Women Intrahousehold Bargaining (WIB)	-4.493
	(18.21)
(CSA adoption index * WIB)	-9.103
	(11.67)
Perception 1 (effect of Climate change on productivity) base=no Yes	100.7
	(277.0)
Perception 2 (effect of Climate change on income) base=no Yes	-407.0
	(283.4)
Area planted	37.97*
	(22.95)
Household size	-22.70
	(23.02)
Distance to farm	-0.0394
	(0.548)
Distance to market	-2.005
	(1.581)
Farming experience (base=Less than 5 years) 5 years +	95.39
	(120.4)
Off-farm income (base=no) Yes	55.54
	(88.55)
Saving account (base=no) Yes	66.65
	(111.7)
Access to credit (base=no) Yes	-60.98
	(101.3)
Access to information (base=no) Yes	183.4*
	(101.1)
Membership in social Groups (base=no) Yes	66.57
	(101.3)
Constant	108.4
	(255.1)
Observations	317
R-squared	0.078

Note: Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The area planted has a positive and significant effect on farm productivity where one hectare increases in area planted increases farmer's farm productivity by 37.97 kilograms/ha. This means that farmers who plant on a big plot are more likely to have more output than those planting on small plots. A similar result is also reported by (Wickramaarachchi & Weerahewa, 2018) for paddy farmers in Sri Lanka and Muyanga & Jayne (2019) for maize in Kenya. In contrast, Kumar & Moharaj (2023) finds inverse relationship between the farm size and the productivity of paddy in India and Debrah & Adanu (2022) in Ghana for a variety of crops.

Furthermore, access to information is shown to be positive and significant. That is, farm productivity is higher by 183.4 kilograms/ha for farmers with access to information compared to farmers with no access to information. These results are similar to the findings by Danso-Abbeam et al., (2018).

Household size, distance to farm, distance to market, and access to credit are found to be negative and insignificant while, engaging in off-farm activities, farm experience, having a savings account, and being in a social group are positive and insignificant. Results further found that the perception of farmers on the effect of climate change on productivity and income has an insignificant effect on the respective farm productivity.

4. CONCLUSION AND POLICY RECOMMENDATIONS

4.1 Conclusion

Substantial evidence in the literature points to the fact that women's bargaining improves a myriad of household outcomes. Few empirical studies have examined the effect of women's bargaining dynamics on the adoption of agricultural technologies. Increased adoption of CSA practices is vital in enhancing farmers' resilience to climate change. This paper examined the determinants of women's bargaining power and how it affects the adoption of CSA. It also investigated the effects of the adoption of CSA practices on farm productivity. The study used data from a primary survey that was undertaken on women paddy farmers in Morogoro region, in Tanzania.

The study used the Tobit model to examine determinants of women's bargaining power. Results revealed that access to information, age, and female-household heads influence the bargaining power of women in households. Furthermore, in the context of factors influencing the adoption of CSA practices, the Probit model was used to examine the decision to adopt CSA practices, while the Poisson model was employed in determining the drivers of the level of adoption of CSA practices. The highly adopted practices included the use of chemical fertilizer (46%) followed by early planting (31%), with improved seed (22%), and the rest of the practices (intercropping, crop rotation, irrigation and use of manure) were adopted by less than 10 percent of the surveyed farmers.

As expected, women's bargaining was found to be an important factor in influencing the decision to adopt CSA practices. However, it does not influence the level of adoption of these practices. As a female farmer ages, the likelihood of adopting CSA practices decreases. Other factors such as area planted, off-farm income, saving account, access to credit, and being in a social group were also found to be significant in determining both the decision and the level of adoption of climate-smart practices. Interestingly, access to credit is also an important factor, yet it is less likely to be spent on the adoption of CSA practices. Moreover, the Ordinary Least Square method was used to investigate if the level of adoption of CSA practices influences productivity. Results indicate that the level of adoption influences productivity. In addition, access to information is also found to be an essential factor.

4.2 Policy Recommendations

Access to relevant information is vital in boosting the bargaining power of women, which is necessary for enhancing adoption of CSA practices. In such a context, interventions that seek to leverage women's adoption of CSA practices should prioritize training of extension officers since these are the major sources of information to farmers. Extension officers should be trained to provide relevant and up-to date information on CSA practices, and thus they also need training on communication skills to effectively convey the CSA information to women farmers. Moreover, there should be special extension services specifically designed for women. These could be implemented in the form of training and demonstration farms tailored to women's needs to enhance the knowledge that women have on CSA practices and their benefits. This will widen their understanding and, thus, increase their bargaining power in CSA adoption decisions.

When designing programmes to scale up CSA practices among women farmers, it is important to take a holistic approach. To ensure that these programmes are sustainable, it may be essential to consider the different age groups and varied needs of women farmers. By doing so, it enhances the determination of relevant technologies for each age group, resulting in inclusive and sustainable adoption of farming practices.

Moreover, in promoting farmers' efficient use of credit for CSA practices, CSA intervention programmes should include a financial literacy programme. This will help women farmers to effectively plan and budget the credit received for CSA practices. This could be complemented by putting a long-repayment design that allows farmers to experience the profits from farming before starting to repay the loans. In addition, a well-designed monitoring mechanism should be incorporated to ensure that the credit provided is used appropriately for CSA practices.

To ensure higher productivity levels for women farmers, it is imperative for the government and other stakeholders to create an enabling environment in terms of policy frameworks that encourage the investment in the adoption of a variety of CSA practices. The policies should focus on removing barriers that prevent them from accessing and effectively utilizing CSA technologies such as access to and ownership of land and other key inputs as well as upscaling awareness programmes to promote saving behaviors.

5. LIMITATION OF THE STUDY

This study was limited to female farmers, due to resource constraints that necessitated researchers to collect data from a limited sample of women regarding CSA adoption decisions. Research involving men can be an interesting area for further research.

REFERENCES

Acosta, M., Riley, S., Bonilla-Findji, O., Martínez-Barón, D., Howland, F., Huyer, S., Castellanos, A., David Martínez, J., & Chanana, N. (2021). Exploring women's differentiated access to climate-smart agricultural interventions in selected climate-smart villages of Latin America. *Sustainability*, *13* (19), 10951.

Abegunde, V. O., Sibanda, M., & Obi, A. (2019). Determinants of the adoption of climate- smart agricultural practices by small-scale farming households in King CeTZSwayo District Municipality, South Africa. *Sustainability*, *12* (1), 195.

Achandi, E. L., Kidane, A., Hepelwa, A., & Mujawamariya, G. (2019). Women's empowerment: The case of smallholder rice farmers in Kilombero District, Tanzania. *Agrekon*, *58* (3), 324–339.

Adekunle, C. P., O. T. O., T. E. T., O. S. O., & C. A. S. (2022). Women's livelihood choice, and bargaining power: A case of farm households in Ogun State, Southwest, Nigeria. *South-Eastern Europe Journal of Economics*, *20* (2), 109–125.

Afoakwah, C., D. X., & O. I. (2020). Women's bargaining power and children's schooling outcomes: Evidence from Ghana. *Feminist Economics*, *26* (3), 1–29.

Agarwal, B. (1997). 'Bargaining' and gender relations: Within and

beyond the household. *Feminist Economics*, *3* (1), 1–51.

Amadu, F., McNamara, P., & Miller, D. (2020). Understanding the adoption of climate-smart agriculture: A farm-level typology with empirical evidence from southern Malawi.*World Development*, *126*, 104692.

Anderson, E. P., Marengo, J., Villalba, R., Halloy, S., Young, B., Cordero, D., Gast, F., Jaimes, E., Ruiz, D., & Herzog, S. K. (2017). Climate change and biodiversity in the tropical Andes Field Guide to the Birds of Bolivia. View project Climate vulnerability View project. *Climate Change and Biodiversity in the Tropical Andes*, *1*, 1–18.

Arthur-Holmes, F., & Busia, K. A. (2020). Household dynamics and the bargaining power of women in artisanal and small-scale mining in sub-Saharan Africa: A Ghanaian case study. *Resources Policy*, *69*, 101884.

Badstue, L., Petesch, P., Farnworth, C. R., Roeven, L., & Hailemariam, M. (2020). Women farmers and agricultural innovation: Marital status and normative expectations in rural Ethiopia. *Sustainability*, *12*(23), 9847.

Becker, G. (1991). *A treatise on the family: Enlarged edition*.

Belay, A. D., Kebede, W. M., & Golla, S. Y. (2023). Determinants of climate-smart agricultural practices in smallholder plots: Evidence from Wadla district, northeast Ethiopia. *International Journal of Climate Change Strategies and Management*, *15*(5), 619–637.

Bongole, A., Kitundu, K. M. K., & Hella, J. (2020). Usage of Climate Smart Agriculture Practices: An Analysis of Farm Households' Decisions in Southern Highlands of
Tanzania. *Tanzania Journal of Agricultural Sciences*, *2*, 238–255.

Brown, B., Llewellyn, R., & Nuberg, I. (2018). Global learnings to inform the local adaptation of conservation agriculture in Eastern and Southern Africa. *Global Food Security*, *17*, 213–220.

Bryan, E., Ringler, C., Okoba, B., Koo, J., Herrero, M., & Silvestri, S. (2013). Can agriculture support climate change adaptation, greenhouse gas mitigation and rural livelihoods? insights from Kenya. *Climatic Change*, *118*(2), 151–165.

Chiappori, P.-A. (1992). Collective Labor Supply and Welfare. *Journal of Political Economy*, *100*(3), 437–467.

CIAT and CARE TZ. (2019). *Tanzania Country Climate Risk Profile Series. Iringa District. International Center for Tropical Agriculture (CIAT)*.

CIAT and World Bank. (2017). *Climate-Smart Agriculture in Tanzania. CSA Country Profiles for Africa Series. International Center for Tropical Agriculture (CIAT)*.

Danso-Abbeam, G., Ehiakpor, D. S., & Aidoo, R. (2018). Agricultural extension and its effects on farm productivity and income: Insight from Northern Ghana. *Agriculture & Food Security*, *7*(1), 1–10.

Debrah, G., & Adanu, K. (2022). Does the Inverse Farm Size-Productivity Hypothesis Hold Beyond Five Hectares? Evidence from Ghana. *Journal of Agricultural and Applied Economics*, *54*(3), 548–559.

Doss, C. (2013). Intrahousehold bargaining and resource allocation in developing countries. *The World Bank Research Observer*, *28*, 52–78.

Doss, C., & Quisumbing AR. (2019). Understanding rural household behavior: Beyond Boserup and Becher. *Agricultural Economics*, *51*(1), 47–58.

Doss, C. R. (2018). Women and agricultural productivity: Reframing the Issues. *Development Policy Review*, *36*(1), 35–50.

FAO. (2003). *The state of food insecurity in the World*.

FAO. (2010). *The State of Food Insecurity in the World Addressing food insecurity in protracted crises 2010*.

FAO. (2011). *The State of Food and Agriculture 2010–2011: Women in Agriculture. Closing the Gender Gap for Development*.

FAO. (2013). *Climate-Smart Agriculture Sourcebook; Food and Agriculture Organization of the United Nations*.

Ferrer, A. J. G., Thanh, L. H., Chuong, P. H., Kiet, N. T., Trang, V. T., Duc, T. C., Hopanda, J. C., Carmelita, B. M., & Bernardo, E. B. (2023). Farming household adoption of climate-smart agricultural technologies: Evidence from North-Central Vietnam. *Asia- Pacific Journal of Regional Science*, *7*(2), 641–663.

Ginbo, T., & Hansson, H. (2023). Intra-household risk perceptions and climate change adaptation in sub-Saharan Africa. *European Review of Agricultural Economics*,

Hailemariam, A., Kalsi, J., & Mavisakalyan, A. (2024). Gender gaps in the adoption of climate-smart agricultural practices: Evidence from sub-Saharan Africa. *Journal of Agricultural Economics*.

Huyer, S. (2016). Closing the Gender Gap in Agriculture. *Technology and Development*, *20*(2), 105–116.

IPCC. (2014). *Human Security. In: Field LLW, Barros VR, Dokken DJ, Mach KJ, Mastrandrea MD et al (eds) Climate change 2014: impacts, adaptation, and vulnerability, Part A: Global and sectoral aspects, Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press*.

IPCC. (2021). *Summary for Policymakers. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change; Masson-Delmotte, V., Zhai, P., Pirani, A., Connors, S.L., Péan, C., Berger, S., Caud, N., Chen, Y., Goldfarb, L., Gomis, M.I., et al., Eds.; Cambridge University Press: Cambridge*.

Jena, P. R., Tanti, P. C., & Maharjan, K. L. (2023). Determinants of adoption of climate resilient practices and their impact on yield and household income. *Journal of Agriculture and Food Research*, *14*, 100659.

Johnson, D., Almaraz, M., Rudnick, J., Parker, L. E., Ostoja, S. M., & Khalsa, S. D. S. (2023). Farmer adoption of

climate-smart practices is driven by farm characteristics, information sources, and practice benefits and challenges. *Sustainability*, *15*(10), 8083.

Jost, C., Kyazze, F., Naab, J., Neelormi, S., Kinyangi, J., Zougmore, R., Aggarwal, P., Bhatta, G., Chaudhury, M., Tapio-Bistrom, M.-L., Nelson, S., & Kristjanson, P. (2015). Climate and Development Understanding gender dimensions of agriculture and climate change in smallholder farming communities Understanding gender dimensions of agriculture and climate change in smallholder farming communities. *Climate and Development, 2016*, *8*(2), 133–144.

Karanja Ng'ang', S., Rivera, M., Pamuk, H., & Hella, J. P. (2020). *Costs and benefits of climate-smart agriculture practices Evidence from intercropping and crop rotation of maize with soybean in rural Tanzania*.

Kassie, M., J. M., S. B., M. F., & M. M. (2013). Adoption of interrelated sustainable agricultural practices in smallholder systems: Evidence from rural Tanzania. *Technological Forecasting and Social Change*, *80*(3), 525–540.

Kibe, S. W. (2017). *Essays on Women's Bargaining Power: Evidence from India*.

Khatri-Chhetri, A., Aggarwal, P., Joshi, P., & Vyas, S. (2017). Farmers' prioritization of climate-smart agriculture (CSA) technologies. *Agricultural Systems*, *151*, 184–191.

Kristjanson, P., Bryan, E., Bernier, Q., Twyman, J., Meinzen-Dick, R., Kieran, C., Ringler, C., Jost, C., & Doss, C. (2017). International Journal of Agricultural Sustainability Addressing gender in agricultural research for development in the face of a changing climate: where are we and where should we be going? Addressing gender in agricultural research for development in the face of a changing climate: where are we and where should we be going? *International Journal of Agricultural Sustainability,Taylor&Francis*,*15*(5),482–500.

Kumar, K. K., & Moharaj, P. (2023). Farm size and productivity relationship among the farming communities in India. *Outlook on Agriculture*, *52*(2), 212–227.

Kurgat, B. K., Lamanna, C., Kimaro, A., Namoi, N., Manda, L., & Rosenstock,

T. S. (2020). Adoption of Climate-Smart Agriculture Technologies in Tanzania. *Frontiers in Sustainable Food Systems*.

Lim, S. S., Winter-Nelson, A., & Arends-Kuenning, M. (2007). Household bargaining power and agricultural supply response: Evidence from Ethiopian coffee growers. *World Development*, *35*(7), 1204–1220.

Lopez-Ridaura, S., Frelat, R., Wijk, M. T., Valbuena, D., Krupnik, T. J., & Jat,

M. L. (2018). Climate smart agriculture, farm household typologies and food security: An ex-ante assessment from Eastern India. *Agricultural Systems*, *159*, 57–68.

Malapit, H., Sproule, K., Kovarik, C., & Meinzen-Dick, R. (2014). *Measuring*

Progress toward empowerment: Women's empowerment in agriculture index: Baseline report.

Masamha, B., Uzokwe, V. N., & Thebe, V. (2018). Women's empowerment in traditional food value chains at the micro-level: Evidence from cassava smallholder farming in Tanzania. *Agroecology and Sustainable Food Systems*, *42*(1), 28–47.

Mossie, W. A. (2022). The Impact of Climate-Smart Agriculture Technology on Productivity: Does Row Planting Matter? Evidence from Southern Ethiopia. *The Scientific World Journal*, *2022*(1), 3218287.

Mukong, A. K., & Burns, J. (2017). Parental Bargaining and Rural-Urban Child Health Differential in Tanzania. *Journal of Economic Research Southern Africa (ERSA)*.

Mukong, A. K., & Burns, J. (2019). Bargaining power within couples and health care provider choice in Tanzania. *African Development Review*, *31*(3), 380–392.

Murray, U., Gebremedhin, Z., Brychkova, G., & Spillane, C. (2016). Smallholder Farmers and Climate Smart Agriculture: Technology and Labor-productivity Constraints amongst Women Smallholders in Malawi. *Gender, Technology and Development*, *20*(2), 117–148.

Murshid, N. S. (2018). Microfinance participation and women's decision-making power in the household in Bangladesh. *Journal of Social Service Research*, *44*(3), 308–318.

Mutenje, M., Farnworth, C. R., Stirling, C., Thierfelder, C., Mupangwa, W., & Nyagumbo, I. (2019). A cost-benefit analysis of climate-smart agriculture options in Southern Africa: Balancing gender and technology. *Ecological Economics*, *163*, 126–137.

Muyanga, M., & Jayne, T. S. (2019). Revisiting the farm size-productivity relationship based on a relatively wide range of farm sizes: Evidence from Kenya. *American Journal of Agricultural Economics*, *101*(4), 1140–1163.

NBS. (2007). *National census of Agriculture 2002/2003: Regional Report: Morogoro region*.

Nchanji, E., Nduwarugira, E., Ndabashinze, B., Bararyenya, A., Hakizimana, M. B., Nyamolo, V., & Lutomia, C. (2023). Gender norms and differences in access and use of climate-smart agricultural technology in Burundi. *Frontiers in Sustainable Food Systems*, *7*, 1040977.

Ndossi, M. J., Ahmad, K. A., & Makindara, J. R. (2022). Intra-Household Decision Making on Production and Income Generation Options among Women in Mara Region, Tanzania. *Journal of Agricultural Sciences*, *21*(1), 324–334.

Nyangena, W. (2011). The role of social capital in sustainable development: An analysis of soil conservation in rural Kenya. *Agricultural Investment and Productivity: Building Sustainability in East Africa*, 31–50.

Ogada, M. J., Radeny, M., & Recha, J. (2020). Adoption of climate-smart agricultural technologies in Lushoto Climate-Smart Villages in north-eastern Tanzania. *CCAFS Working Paper*

Ogisi, O. D., & Begho, T. (2023). Adoption of climate-smart agricultural practices in sub- Saharan Africa: A review of the progress, barriers, gender differences and recommendations. *Farming System*, *1*(2), 100019.

Olutumise, A. I. (2023). Impact of credit on the climate adaptation utilization among food crop farmers in Southwest, Nigeria: Application of endogenous treatment Poisson regression model. *Agricultural and Food Economics*, *11*(1), 7.

Osanyinlusi, O. I. , & A. K. O. (2016). *The determinants of rice farmers' productivity in Ekiti State, Nigeria*.

Paavola, J. (2008). Livelihoods, vulnerability and adaptation to climate change in Morogoro, Tanzania. *Environmental Science & Policy*, *11*(7), 642-654.

Pamuk, H., Muijlwijk, M. van, Wattel, C., Deering, K., & Asseldonk, M. van. (2021). *Gender considerations in the promotion of climate-smart agriculture practices: Evidence from rural Tanzania*.

Raghunathan, K., Kannan, S., & Quisumbing, A. R. (2019). Can women's self-help groups improve access to information, decision-making, and agricultural practices? The Indian case. *Agricultural Economics*, *50*(5), 567–580.

Ringdal, C., & Sjursen, I. H. (2021). Household bargaining and spending on children: Experimental evidence from Tanzania. *Economica*, *88*(350), 430–455.

Rola-Rubzen, M. F., Paris, T., Hawkins, J., & Sapkota, B. (2020). Improving Gender Participation in Agricultural Technology Adoption in Asia: From Rhetoric to Practical Action. *Applied Economic Perspectives and Policy*, *42*(1), 113–125.

Seymour, G., Doss, C., Marenya, P. P., Meinzen-Dick, R. S., & Passarelli, S. (2016). *Women's empowerment and the adoption of improved maize varieties: Evidence from Ethiopia, Kenya, and Tanzania*.

Shahbaz, P., Ul Haq, S., Abbas, A., Batool, Z., Alotaibi, B. A., & Nayak, R. K. (2022). Adoption of climate smart agricultural practices through women involvement in decision making process: Exploring the role of empowerment and innovativeness. *Agriculture*, *12*(8), 1161.

Shiferaw, B. , K. T. , K. M. , & F. M. (2015). *Market imperfections, access to information and technology adoption in Uganda: Challenges of overcoming multiple constraints*. *46*(4), 475–488.

Singh, P. (2023). Exploring gender approach to climate change and agroecology: Women farmer's search for agency in India. *Asian Journal of Social Science*, *51*(1), 18–24.

Tambo, J. A., & Abdoulaye, T. (2012). Climate change and agricultural technology adoption: The case of drought tolerant maize in rural Nigeria. *Mitigation and Adaptation Strategies for Global Change*, *17*, 277–292.

Teklewold, H. (2023). Context of the study Understanding Gender Differences on the Choices of a Portfolio of Climate-smart Agricultural Practices in Sub-Saharan Africa Key findings. *World Development Perspectives*, *29*, 100486.

Thierfelder, C., Chivenge, P., Mupangwa, W., Rosenstock, T. S., Lamanna, C., & Eyre, J. X. (2017). How climate-smart is conservation agriculture (CA)? – its potential to deliver on adaptation, mitigation and productivity on smallholder farms in southern Africa.
Springer, *9*(3), 537–560.

Thuo, C. N., Nguluu, S., & Kisangau, P. (2017). *Factors affecting adoption of tissue culture bananas in the semi-arid areas of Lower Eastern region of Kenya*.

Tsige, M., Synnevåg, G., & Aune, J. B. (2020). Is Gender Mainstreaming Viable? Empirical Analysis of the Practicality of Policies for Agriculture-Based Gendered Development in Ethiopia. *Gender Issues*, *37*(2), 125–152.

Tufa, A., Alene, A., Cole, S., Feleke, S., Abdoulaye, T., Chikoye, D., & Manyong, V. (2022). Gender differences in technology adoption and agricultural productivity: Evidence from Malawi. *World Development*, *159*, 102067.

United nations. (2015). *TRANSFORMING OUR WORLD: THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT*.

United Republic of Tanzania. (2015). Tanzania Climate Smart Agriculture Programme 2015- 2025.

United Republic of Tanzania. (2021). National Sample Census of Agriculture 2019/20: National Report.

United Republic of Tanzania. (2021b). National Climate Change Response Strategy 2021- 2026.

United Republic of Tanzania (URT), (2021a). National Climate Change Response Strategy (2021-2026). Vice President's Office, Division of Environment, Government Printer, Dodoma. Tanzania.

United Republic of Tanzania (URT). (2013). National Strategy on Gender and Climate Change

Wickramaarachchi, N., & Weerahewa, J. (2018). Relationship between land size and productivity: Empirical evidence from paddy farms in irrigation settlements of Sri Lanka. *Economic Research*, *5*, 2.

APPENDICES

A.1: **Components of Women's Intrahousehold bargaining**

Questions	Woman Participation	
	Independently/jointly	No
Who in your household makes decisions on whether or not a female should work at a job or business?	1	0
Who decides whether or not to increase the woman's level of education?	1	0
Who decides on the woman's social activity (i.e. participation in Vikoba, Village meetings, and participation in leisure activities)?	1	0
Who is involved in making decisions about large purchases (e.g. Buying a plot, a house, a bicycle)?	1	0
Who is involved in making decisions about everyday purchases? (eg food, clothes)	1	0
Who is involved in making decisions about the amount of time your spouse/partner spends doing unpaid work at home (e.g. household chores, childcare, etc.)"	1	0
Who is involved in making decisions on what to plant on your farm?	1	0
Who makes a decision on whether or not to have a saving account?	1	0
Who is involved in making decisions on what technology (e.g. mixed cropping, improved crop variety, crop rotation, use of fertilizer…) to employ on your farm?	1	0
Who is involved in making decisions on the working hours of the woman's on-farm activities (e.g. planting, weeding, harvest)?	1	0
Who make a decision on how much land to cultivate in a season?	1	0
How do you and your partner/spouse organize your household income?	1	0

A.2: **Components of number of CSA adopted by farmers**

Variable	Obs	percentage	Std. Dev.
Use improved crops			
YES (=1)	320	21.56	0.412
Use intercropping			
YES(=1)	320	3.44	0.182
Use Mulching			
YES(=1)	320	8.4	0.278
Use Crop rotation			
YES(=1)	320	0.31	0.056
Use Chemical Fertilizer			
YES(=1)	320	46.25	0.499
Early planting			
YES(=1)	320	31.56	0.465
Agroforest			
YES(=1)	320	0.94	0.097
Use Irrigation			
YES(=1)	320	2.5	0.156
Use Composting manure			
YES(=1)	320	4.38	0.205

A.3: Matrix of correlations between access to credit and off-farm income by farmers

Variables		
Access to credit	1	
Off-farm activities	0.192	1

A.4: **Summary of number of wards included in the survey.**

Variable	Obs	Mean	Std. Dev.	Min	Max
Wards					
Katindiuka	317	0.038	0.191	0	1
Kibaoni	317	0.035	0.183	0	1
Kiberege	317	0.117	0.322	0	1
Lipangalala	317	0.028	0.166	0	1
Lumemo	317	0.085	0.28	0	1
Mang'ula	317	0.104	0.306	0	1
Mbasa	317	0.155	0.362	0	1
Mwaya	317	0.347	0.477	0	1
Siginali	317	0.088	0.284	0	1
katindiuka	317	0.003	0.056	0	1

REPOA HQs
157 Migombani/REPOA streets, Regent Estate, PO Box 33223,
Dar es Salaam, Tanzania.
Tel: +255 (22) 270 0083 Cell: +255 (0)784 555 655
Website: https://www.repoa.or.tz
Email: repoa@repoa.or.tz

Branch Office
2nd Floor Kilimo Kwanza Building
41105 Makole East, Kisasa,
Dodoma, Tanzania