East African Journal of Education and Social Sciences
EAJESS May–June 2024, Vol. 5, No. 3, pp. 101-114.
ISSN: 2714-2132 (Online), 2714-2183 (Print). Published by G-Card
DOI: https://doi.org/10.46606/eajess2024v05i03.0387.

Influence of Socio-Economic and Institutional Factors on the Adoption of Conservation Agriculture in Bahi District, Tanzania

***Saimon G. Mbaga**
ORCiD: https://orcid.org/0009-0001-0672-6916
Department of Forest and Environmental Economics, Sokoine University of Agriculture, Tanzania
Email: saimonmbaga93@gmail.com

Prof. Yonika M. Ngaga, PhD
ORCiD: https://orcid.org/0009-0008-7581-2915
Department of Forest and Environmental Economics, Sokoine University of Agriculture, Tanzania
Email: ngaga@sua.ac.tz

Greyson Z. Nyamoga, PhD
ORCiD: https://orcid.org/0000-0002-4625-6226
Department of Forest and Environmental Economics, Sokoine University of Agriculture, Tanzania
Email: gnyamoga@sua.ac.tz

***Corresponding author**: saimonmbaga93@gmail.com

Abstract: This study sought to establish the influence of socio-economic and institutional factors on the adoption of conservation agriculture in Bahi District, Tanzania. This study used a cross-sectional research design, using the sample of 176 farming households, where 89 households were CA adopters and the remaining 87 households were non-CA adopters. Data from a questionnaire was analyzed through a binary logistic regression model and descriptive statistics. The study concluded that gender, age market availability, credit accessibility and bylaw awareness influenced the adoption of Conservation Agriculture in the study area. If credit accessibility, extension service and bylaws are present, then adopting CA is done more easily. Therefore, before introducing CA, it is important to assess the presence of these factors for better results. Some of the recommendations are that collaboration between financial institutions and policymakers be encouraged as it is essential to increase farmers' credit accessibility by providing affordable loans and financial services. Extension services need to be improved and expanded by funding the extension programs and employing more extension workers. Information dissemination and training on CA should be tailored to consider the needs of female and young farmers. Additionally, cooperative farming groups or networks of young and female farmers should be created to facilitate resource pooling, knowledge sharing and collective investment in necessary equipment and inputs.

Keywords: Conservation agriculture; Adoption, extension services; households; farmers.

How to cite: Mbaga, S. G., Ngaga, Y. M. and Nyamoga, G. Z. (2024). Influence of Socio-Economic and Institutional Factors on the Adoption of Conservation Agriculture in Bahi District, Tanzania**.** East African Journal of Education and Social Sciences 5(3)101-114. **Doi:** https://doi.org/10.46606/eajess2024v05i03.0387.

Introduction

Agriculture continues to be important and holds promise for fostering social and economic progress in many developing nations. Global agricultural production is anticipated to rise by more than 55% by 2050 because of the rising food demand and human population. According to the projections, to feed the 9.3 billion people that will inhabit the planet by 2050, total food production would require an increase of about 70% (Keating *et al.,* 2014). There is general agreement that to fulfill the increased demand for food in 2050, worldwide

agricultural production must increase by about 60–70% from its current levels. The food gap might be closed by 2050 if advances in crop breeding, soil and water management lead to a 20% faster rise in agricultural yields between 2010 and 2050. This has resulted in the formulation of different types of policies and strategies that could highly influence high-yield production for most of the plants, Conservation Agriculture (CA) being among these technologies (Banjarnahor, 2014).

CA is becoming more widely recognized as a natural resource cropping strategy that aims to provide respectable earnings while also protecting the resource base (Wassie, 2020). CA is made up of three basic principles: minimization of soil disturbance as much as possible, diversification of crop species and rotation crops, and keeping the soil cover as much as possible as reflected in Plate 1 (IRR & ACT, 2005). Although these concepts can be applied in a range of agroecological contexts, their effectiveness depends on the particular site. Therefore, to guarantee good performance, they should always be carefully tailored to the local conditions. However, all CA concepts must be used at once to get good outcomes. Despite the appeal of CA practices, many ideas aimed at encouraging the adoption in Sub-Saharan Africa (SSA) remain constrained (Kuyah *et al.,* 2021). Tanzanian governmental and non-governmental entities have been advocating for the benefits of CA. However, Tanzania still has a low adoption of CA practices despite numerous initiatives to promote CA (Shetto *et al.,* 2022).

Plate 1: Minimum tillage farming at Chiguluka village

Several studies are in favor of the notion that farmers' adoption of conservation agriculture depends on various CA attributes, such as yield and capacity for soil improvement (Lee & Gambiza, 2022). Despite initiatives to promote CA in Bahi District, there has been no empirical evidence on factors that impact the uptake of CA in the district. Therefore, this study sought to determine socio-economic and institutional factors that influence the adoption of CA in Bahi District, Tanzania. Bahi district was selected because it is a semi-arid area and therefore vulnerable to climate change and environmental degradation. According to Derpsch (2007), CA practice is a good adaptation measure in dry areas because permanent soil cover and minimum tillage increase water infiltration, reduce runoff and evaporation and preserve the soil moisture while controlling weeds. Minimal soil disturbance helps to reduce soil erosion, hence helping to control environmental degradation caused by soil erosion.

This study is important in the sense that the information obtained will assist in enhancing the agricultural productivity, promoting environmental sustainability and informing the policy formulation and decision-making not only for Bahi District but also for other dry areas in Tanzania. The study will increase the knowledge, skills and experiences of the farmers that can support the development of targeted interventions for minimizing the effects of climate change on vulnerable communities. In addition, this study's findings have the potential to promote sustainable and efficient agricultural practices to all agriculture stakeholders. Furthermore, the study aligns with SDGs number 1, 2, 12, 13, and 15, which aim to reduce poverty, achieve zero hunger, promote responsible

production and consumption, take efficient climate actions and preserve terrestrial ecosystems respectively.

Review of Literature

This section consists of the conceptual and theoretical frameworks that guided this study. The conceptual framework sheds light on the variables at play in this study and the theoretical framework provides a guide on the theory utilized in carrying out this study.

Conceptual Framework

The conceptual framework shown in Figure 1 illustrates how social, economic and institutional factors influence the adoption or non-adoption of CA practices, creating a clear understanding of this process. The Socio-economic factors are off-farm income, Farm size, sex, age, education level and household size. The institutional factors include credit facilities, extension services, bylaws and the market. Therefore, if farmers adopt CA, the outcomes expected include increased yield, reduced production costs, time savings, increased food security, improved soil fertility, increased income and climate change resilience. Furthermore, for farmers who will not adopt CA, the outcome expected includes lower yields, higher production costs, increased labor intensity, decreased soil fertility and inability to endure the impacts of climate change.

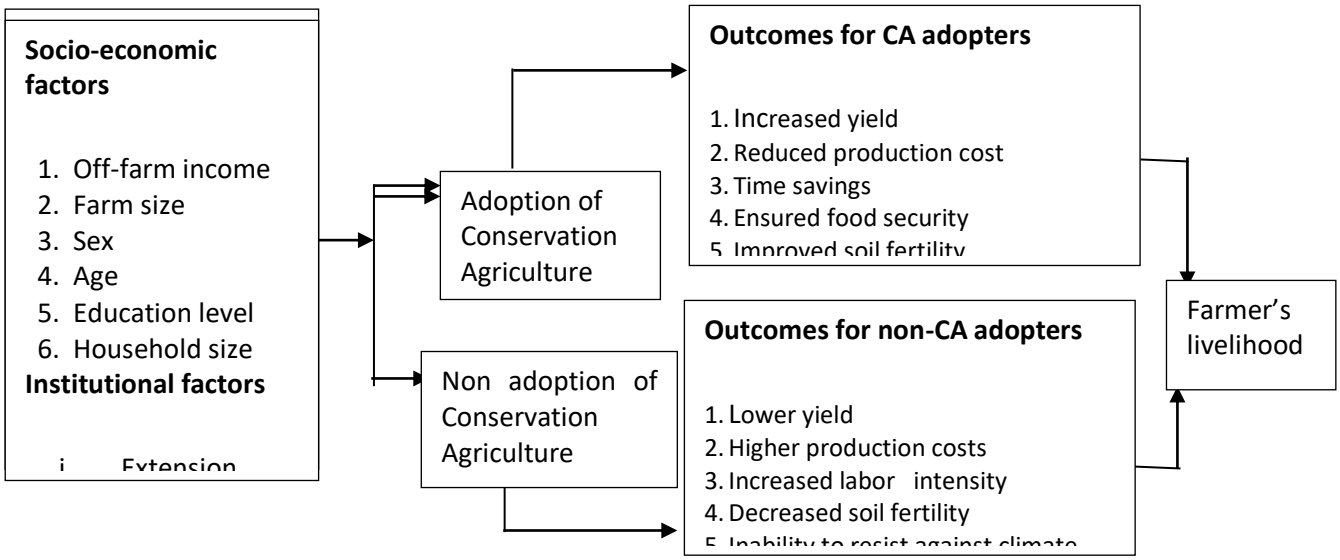

Figure 1: A conceptual framework for the factors influencing the adoption of CA

Theoretical Framework

This study was guided by a modified Penchansky and Thomas's Theory of Access. In this theory, Penchansky and Thomas (1981) suggested five aspects of access, which are acceptability, accessibility, accommodation, affordability and availability. Acceptability is the extent to which the customer finds the provider's fixed attributes tolerable. These characteristics include the diagnosis and type of coverage of the client as well as the provider's ethnicity, sex, age and social class. Accessibility refers to the speed at which a customer can reach a provider's place. The degree to which the provider's activities are set up to take into account the wants and preferences of the client is reflected in the accommodation. This covers operation hours and whether or not patients can receive care without an appointment. How the provider's fees relate to the customer's capacity and willingness to pay for service determines the affordability. Availability investigates the association between a variety of services and the size and the needs of the residents as well as the availability of the services throughout the year.

The concept of availability takes into account the presence and accessibility of goods and services required for conservation agriculture. It entails determining whether inputs including infrastructure, technologies, and conservation strategies are readily available. According to Araya *et al.* (2024), the adoption of conservation agriculture may be impacted by differences in these resources' and services' accessibility across various communities or areas. The proximity of resources and services is connected to conservation agriculture in terms of both their physical location and physical accessibility. It looks at how simple it is for farmers to get access to and utilize these

resources. The accessibility of conservation agriculture methods is influenced by factors like transportation infrastructure, closeness to markets and the availability of extension services year.

The ability to adopt and maintain conservation agriculture methods is determined by affordability. It comprises the expenses related to acquiring inputs, putting innovative methods into practice and keeping up conservation efforts. The affordability examines whether farmers can implement conservation methods and maintain them over the long run at a relatively low cost. The fit between conservation agricultural methods and farmers' socio-cultural contexts is referred to as accommodation. It entails comprehending how conservation techniques mesh with farmers' existing knowledge, expertise and cultural values. It is more probable that farmers will embrace and maintain practices if they are consistent with their tastes, beliefs and local circumstances. The opinions, attitudes and beliefs that farmers and other stakeholders have about conservation agriculture are referred to as acceptance. It takes into account how well-liked and supported these methods are among farmers as well as other important groups including lawmakers, agricultural extension specialists and agribusinesses. The social norms, beliefs and incentives associated with conservation agriculture's implementation are shaped by the acceptability dimension, which has an impact on how widely it is used. Farmers might have a higher probability of embracing them if they can see other farmers in their community successfully growing and selling the crops year (Lugandu, 2013). Other elements such as education, motivation, gender and resource accessibility play a significant role in impacting the acceptance of agricultural innovations (Rizal & Nordin, 2022). Recognizing these aspects is crucial for devising successful strategies aimed at encouraging the uptake of CA

Methodology

Design

This study utilized a cross-sectional research design, which is a type of research designs where data is gathered at one specific moment (Neuman, 2014). This design was chosen to capture a snapshot of the population at that time, investigate connections between different factors and form initial ideas and hypotheses.

Population and Sampling

This study employed both probability sampling (simple random sampling) and non-probability sampling techniques (purposive sampling). Three villages in Bahi district, where Conservation Agriculture projects were implemented were purposively sampled for data collection. These villages were Mwitikira from Mwitikira Ward and Chipanga A and Chiguluka villages from Chipanga Ward as shown in figure 2. Key informants were purposively selected, who were Extension Officers from each village and a representative from an organization that implemented the CA project.

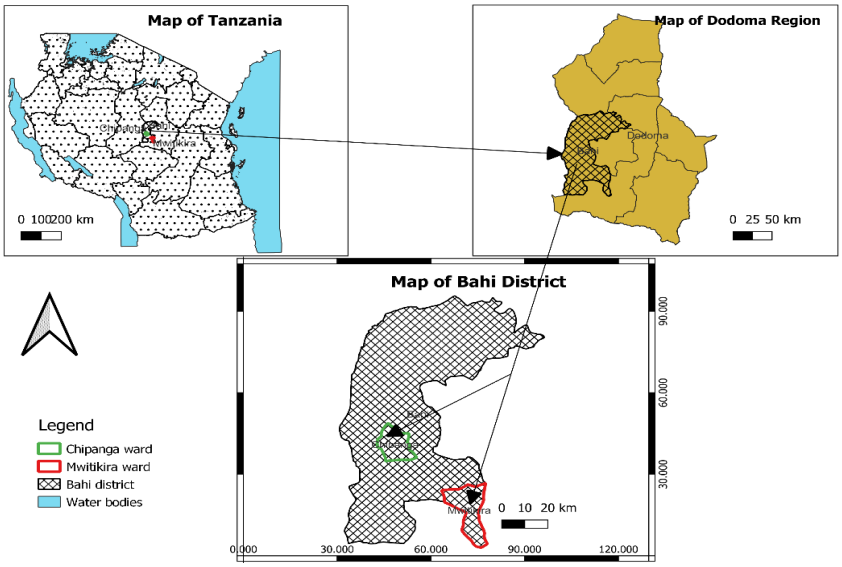

Figure 2: A Map of the study areas – Wards

Description of the Study Area

This study was conducted in Bahi District, Tanzania, located within the Dodoma Region and situated at coordinates of approximately 05⁰ 58′ 58′′ South and 35⁰ 18′ 57′′ East. The region is surrounded by Chamwino District and Dodoma Municipality to the east, Kondoa District to the north, Iringa Region to the southwest and Singida Region (Manyoni District) to the west. Bahi District was chosen due to its location in a semi-arid region, where the effects of climate change and environmental degradation are highly experienced and also conservation agriculture practices have been promoted but with a low rate of adoption (Lugandu *et al.,* 2012).

Research Design

This study utilized a cross-sectional research design, which is a type of research designs where data is gathered at one specific moment (Neuman, 2014). This design was chosen to capture a snapshot of the population at that time, investigate connections between different factors and form initial ideas and hypotheses.

Population and Sampling

This study employed both probability sampling (simple random sampling) and non-probability sampling techniques (purposive sampling). Three villages in Bahi district, where Conservation Agriculture projects were implemented were purposively sampled for data collection. These villages were Mwitikira from Mwitikira Ward and Chipanga A and Chiguluka villages from Chipanga Ward as shown in figure 2. Key informants were purposively selected, who were Extension Officers from each village and a representative from an organization that implemented the CA project.

This study utilized the farming households engaged in CA and those who were not engaged in CA, using a simple random sampling method. An updated list of farming households, which contained about 1716 households from the selected villages served as the sampling frame. The study therefore included 176 farming households as the sample size, where 89 households were CA adopters and the remaining 87 households were non-CA adopters. The sample size calculation followed the formula proposed by Krejcie and Morgan (1970) as indicated below:

$$N = \frac{X^2 NP (1-P)}{d^2 (N-1) + X^2 P (1-P)} \quad \text{……………………………………………………………………} (1)$$

Where:

N = Households (1716)
n = Sample size
X^2 = The chi-square value for one degree of freedom at the specified confidence level (1.96 representing a 95% confidence level) is listed in the table
P = The population proportion (assumed to be 0.5 for the largest possible sample size)
d = The degree of precision represented as a ratio (0.05)

Instruments

Primary data from farmers were gathered through a semi-structured questionnaire in household surveys. The questionnaire was designed to collect data on demographic characteristics as well as socioeconomic and institutional factors that were believed to influence the adoption of CA

Validity and Reliability

This study demonstrated a commitment to establishing the validity of the results by applying suitable research techniques, such as simple random sampling and purposive sampling as well as through meticulous data collection methods. Ensuring the accuracy of the data and outcomes involved carefully selecting variables and instruments, which were validated through expert assessment. To enhance the reliability and credibility of the findings, the researchers addressed internal validity by considering factors like the representativeness and accuracy of the data collected during fieldwork. Furthermore, the researcher's approach ensured external validity by using a representative sample, making it possible to generalize the results to a larger population.

Statistical Treatment of the Data

IBM-SPSS version 20 was utilized for data analysis, employing both a binary logistic regression model and descriptive statistics, based on frequency and percentage. This analysis aimed to establish the impact of socio-economic and institutional factors

on the adoption of CA within Bahi District. The model consisted of dependent and independent variable(s). The dependents and independent variables are presented in the equation below:

$$Y = \beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+\beta_7X_7+\beta_8X_8+ \varepsilon i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where:

Y = dummy dependent variable (1 = adoption, 0 = otherwise)

β = constant variable,

Xi = explanatory variables that are expected to affect the level of adoption (Where, X_1 = sex, X_2 = age, X_3 = farm size, X_4= market availability, X_5= extension services, X_6= credit accessibility, X_7= bylaws and X_8= off-farm income) and

ε = Error Term

Statistically significant was determined based on whether the p-value was below 0.05 or 0.01

Table 1: Categorization and descriptions of explanatory factors

Variables	Descriptions
Off-farm income	The adoption of CA is assumed to have a positive relationship with off-farm income.
Credit accessibility	The adoption of CA is hypothesized to positively correlate with credit availability
Extension services	Visits from extension personnel are anticipated to have a positive impact on adoption by providing farmers with new knowledge
Farm size	It was assumed that small farm owners are more inclined to embrace CA compared with owners of large farm
Household size	It was assumed households with large size that a large size more likely to adopt CA
Education level	It was assumed farmer with education was more likely to adopt CA than an uneducated farmer
Market availability	It was expected that the existence of a market would increase the adoption
Bylaws	It was expected that the existence of bylaws would increase adoption of CA
Sex	It was assumed to have a positive or negative relationship with the adoption of CA
Age	It was assumed to have a negative relationship, as the age increases the rate of uptake of the CA decrease

Findings and Discussion

This section consists of findings, which were obtained after analyzing the collected data. These findings were accompanied by discussions.

Descriptive Statistic Results

This study focused on various demographic characteristics and institutional factors of farmers as outlined in Table 2 (p 107). Those factors include sex, education, age, household size, marital status, land ownership, credit accessibility, bylaws, market availability, extension services and off-farm income.

Research question 1: What are demographic characteristics and institutional factors that influence the adoption of CA in Bahi district?

Findings as presented in Table 2 show the adoption of CA was higher in farming households led by women (60.7%) than in farming households led by male (39.3%). Non-adopters of CA were higher in farming households led by males (59.8%) than farming households led by women (40.2%). The study results imply that females were more inclined to adopt CA than males.

The results in table 2 indicate that most (60.7%) of those who adopted CA belonged to the age group of between 26 and 35. In harmony, the majority (95.4%) of those interviewed who were engaged in farming activities were still in their active years, which is under 46 years of age. Only a few respondents (4.6%) were of the age above 45 years. The adoption rate is high for young farmers (Alexander & Van Mellor, 2005) because they are more inclined to uptake innovations than old farmers. It is possible that older farmers may not be interested in newer technologies or practices. These findings are consistent with the study conducted by Ugwoke *et al.,* (2005) who reported decreasing in engagement in farming activities as the age increases. In addition, a study done by Adesina and Zinnah (1993) found an inverse relationship between age and long-term conservation investment. Gilbert (2013) and Rukuni *et al.,* (2006) also reported a similar case, arguing that farmers' aging bred a conservative mindset and consequent reluctance to change. Furthermore, a study

conducted by Ayuya *et al.,* (2011) and Defrancesco *et al.* (2008) indicated that the primary target group for effectively adopting intricate technologies, such as CA, should be young farmers.

Table 2: Descriptive statistic results of the farmers (N= 176)

Variables	CA adopters		Non-CA adopters		All farmers (N=176)	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Sex						
Household led by Males	35	39.3	52	59.8	87	49.4
Household Led by Female	54	60.7	35	40.2	89	50.6
Age						
18-25	9	10.1	24	27.6	33	18.7
26-35	54	60.7	40	46.0	94	53.4
36-45	20	22.5	21	24.1	41	23.3
46-55	5	5.6	1	1.1	6	3.4
56-65	1	1.1	0	0.0	1	0.6
Above 65	0	0.0	1	1.1	1	0.6
Marital status						
Otherwise	20	22.5	15	17.2	35	19.9
Married	69	77.5	72	82.8	141	80.1
Education level						
None	9	10.1	10	11.5	19	10.8
Primary education and above	80	89.9	77	88.5	157	89.2
Farm size						
0-5	57	64	54	62	111	63.1
>5	32	36	33	38	65	36.9
Household size						
1-3	17	19.2	16	18.4	33	18.8
4-6	51	57.3	50	57.5	101	57.4
7-9	19	21.3	15	17.2	34	19.3
Above 10	2	2.2	6	6.9	8	4.5
Credit accessibility						
Yes	68	76.4	48	55.2	116	65.9
No	21	23.6	39	44.8	60	34.1
Aware of the bylaws						
Yes	66	74.2	9	10.3	75	42.6
No	23	25.8	78	89.7	101	57.4
Extension services						
Yes	64	71.9	14	16.1	78	44.3
No	25	28.1	73	83.9	98	55.7
Market availability						
Yes	56	62.9	44	50.6	100	56.8
No	33	37.1	43	49.4	76	43.2
Off-farm income						
Yes	71	79.8	63	72.4	134	76.1
No	18	20.2	24	27.6	42	23.9

Table 2 further indicates that a large proportion (80.1%) of the respondents who were involved in farming, were married. Conversely, a smaller percentage (19.9%) comprised of single, widowed or divorced individuals. This finding suggests that married individuals were more likely to participate in farming activities compared to their counterparts due to differences in manpower and decision-making. The majority (77.5%) of the CA adopters were married compared to the non-married counterparts (22.5%). The influence of marital status on the uptake of CA techniques can vary significantly depending on cultural, social and economic factors, and may not be universally applicable to farmers across different countries (William *et al.,* 2016). Marital status can influence household decision-making, labor allocation, resource access and social networks, all of which can influence the uptake of CA.

Findings presented in Table 2 indicate that 89.9% of those who embraced CA had received formal education while 10.1% had no formal education. This suggests that farmers who practiced CA were more exposed to, capable of understanding and able to develop the appropriate plans for implementing new technologies that boost production. Aman *et al.* (2005) suggest that agricultural education plays a crucial role in Tanzania's total production. Furthermore, it was also pointed out that among economic factors influencing the adoption of technology, education holds greater importance. In addition, Fernandez-Cornejo et al. (2001) and Wetengere (2009) observed that farmers who had higher levels of education were more inclined to embrace new technologies. There has been a prevalent notion that in farming communities where literacy is common, persuading or educating them about adopting CA has become much easier, as reported by Tegegne (2017).

Results presented in Table 2 reveal that 64% of adopters and 62% of non-adopters possessed farm sizes ranging from 0 to 5 acres. Moreover, the data indicates that 36% of adopters and 38% of non-adopters had farm sizes exceeding 5 acres. The majority of the farmers who adopted CA owned small pieces of land, which range between 0 to 5 acres probably because CA was more productive even in a small piece of land. These results align with the findings of Yaron et al. (1992), which found that farmers with limited land often used CA as an alternative to boost productivity. Small farms tend to embrace new agricultural technology, especially if it involves labor or land-saving methods. In contrast, Kasenge (1998) and Uaiene *et al.* (2009) discovered that farmers with larger holdings are more inclined to adopt new technology since they can allocate a part of their land to test out new methods.

Table 2 further indicates that 18.8% of the participants resided in households of 1 to 3 people while 57.4% were living in households of 4 to 6 people and 19.3% lived in households of 7 to 9 people while only 4.5% lived in households above 10. Household size is a crucial factor in determining labor availability, with larger households typically having more family members to contribute to labor. This can be especially advantageous when introducing new technology as larger households may face fewer labor constraints. Several studies, including those by Bonabana-Wabbi (2002) and Mignouna *et al.* (2011), highlighted this connection. Amsalu and De Jan (2007) also found a positive correlation between household size and the adoption of agricultural technologies.

Table 2 shows that 65.9% of respondents had access to credit while 34.1% did not have. Moreover, 76.4% of CA adopters had access to credit, compared to 55.2% of non-CA adopters. This suggests that a majority of farmers with credit access opted for CA over non-adopters. Credit stimulates the adoption of CA because it helps farmers cover operation costs and purchase all essential inputs required in CA and cover.

Table 2 shows that 71.9% of the farmers who adopted CA had regular contact with the extension officers compared with non-CA adopters (16.1%). Regular visit by the extension officers enhances the capacity of farmers to utilize improved practices including CA. This result aligns with a study conducted by Omotayo *et al.* (2021) who reported the successful implementation of the improved practices resulting in the improvement of farmers' knowledge due to regular visits of the extension officers. In addition, the findings indicate that 74.2% of farmers who adopted CA were conscious of the supportive bylaws whereas 89.7% of non-CA adopters were unaware of such regulations. Therefore, those who are informed about and

follow these bylaws are more inclined to embrace CA compared to those who are unaware of those bylaws.

Findings in Table 2 show that 79.8% of the CA adopters earned income from off-farm activities compared with 72.4% of the non-CA adopters. Off-farm activities have positive impacts on the uptake of improved agriculture practices including CA. Income earned from off-farm activities helps farms purchase essential agricultural inputs such as better seeds, pesticides, fertilizer and farm instruments. This finding aligns with the study conducted by Ellis and Freeman (2004) who reported the use of income gained from non-farming activities as a substitute where the credit market is not functioning well. In addition, Dirro (2021) reported that non-farming activities offer additional income to farmers to purchase essential agricultural inputs like fertilizers and improved seeds. Also, results show that 62.9% of the CA adopters have access to the market compared with 50.6% of the non-CA adopters. The findings suggest that farmers who can access the market were more inclined to embrace CA in contrast to those who have no market access. The majority of the farmers are motivated to adopt CA practices when they perceive financial benefit, the absence of a market diminishes their economic motivation to adopt CA. The results of this study are consistent with Kahimba *et al.,* (2014) study, which identified factors such as permanent and formal markets, market information, market coordination and price play a role in influencing the uptake of CA. Additionally, Nurbekov *et al.,* (2014) emphasized that the availability of markets plays a crucial role in CA adoption.

Research question 2: Do socio-economic and institutional factors influence the adoption of CA in the study area?

A binary logistic regression model was used to identify the social, economic and institutional factors that influence the adoption of CA in Bahi District. The model included variables such as off-farm income, credit access, household size, extension services, farm size, land ownership, market availability and bylaws. The analysis showed a strong fit of the independent variables within the regression model (R^2 = 0.978, Wald = 0.023), with Cox & Snell R Square and Nagelkerke R Square values of 0.514 and 0.685 respectively. The 0.514 R-square value indicates that the predictors in the model can explain approximately 51.4% of the variation in the outcome. The logistic regression model explains roughly 68.5% of the maximum possible variation in the outcome variable, according to the Nagelkerke R-squared value of 0.685. Due to the socioeconomic and institutional characteristics that were utilized as independent variables, the model of logistic regression has a good ability to explain the adoption of CA based on these high values of R-squared. The results in Table 3 show eight variables used in the model. Among those variables, four variables were identified to significantly impact the adoption of CA. Those variables include sex, bylaws, credit accessibility and extension services. On the other hand, four variables were identified to have no significant influence on the CA adoption; those variables include age, farm size, off-farm income and market availability.

Table 3: Binary Logistic Regression Results

Factors	B	S.E.	Wald	df	Sig.	Exp(B)
Sex	1.533	0.540	8.053	1	0.005*	4.631
Age	-0.015	0.032	0.228	1	0.633	0.985
Farm size	-0.549	0.507	1.175	1	0.278	0.577
Market availability	0.079	0.532	0.022	1	0.881	1.083
Extension services	2.512	0.522	23.165	1	0.000**	12.324
Credit accessibility	1.279	0.574	4.972	1	0.026*	3.594
Bylaws	3.100	0.544	32.481	1	0.000**	22.194
Off-farm income	0.369	0.660	0.312	1	0.576	1.446
Constant	-3.928	1.303	9.090	1	0.003	0.020
Overall Wald statistic = 0.023 (p=0.880); Omnibus Tests of Model Coefficients chi-square = 126.846 (p = 0.000); R^2= 0.978; Hosmer and Lemeshow Test chi-square = 27.437 (p = 0.001); Cox & Snell R^2 = 0.514; Nagelkerke R^2 = 0.685						

Significant at *p<0.05 and **p<0.01)

The findings show farmer's sex was statistically significant with a positive influence on the adoption of CA ($p>0.05$). The results indicate that households headed by females have a high possibility of adopting CA over 4.631 times compared to male-headed households. As shown in Table 2, 60.7% of the CA adopters were female-headed households and 59.8% of CA non-adopters were male-headed households. The results prove that despite the disparities in accessing, utilizing and managing household resources as shown by Adesina *et al.,* (2000), a notable portion of the population in African nations comprises women who are actively involved in agricultural activities. These findings align with those by Vuntade and Mzuza (2022), who found an increase in women's involvement in agriculture particularly in CA over time. Another study by the World Bank (2016) indicated that feminization of agriculture increased in Africa. The findings are consistent with the modified Penchansky and Thomas's Theory of Access by Penchansky & Thomas (1981), which suggested that the extension services and policies should consider gender-specific needs and preferences to ensure that women find CA practices acceptable and accessible. Barriers faced by women in accessing extension services, credit, or information related to CA should be considered and effort should be made to address those barriers and promote gender-inclusive access. Therefore, if women access the resources, they can use innovation to boost productivity and ensure a higher return on their labor.

Extension services also showed a significant influence on the uptake of CA ($p<0.01$) with a positive relationship; this means a unit session of extension service training impacts the farmers to adopt CA practices by 12.324 times. Compared to farmers who did not interact with extension officers frequently, those who interacted with the extension officer were more likely to adopt CA. Extension services help farmers become more capable, knowledgeable and capable of making decisions with less uncertainty as shown in plate 2 (p. 111). Extension services improve and add valuable knowledge to the farmers and change their perceptions towards the uptake of various improved practices. The results align with the study by Danso-Abbeam (2022), who reported that extension services play a crucial role in encouraging the adoption of certain agricultural practices as they offer insightful knowledge and information on technologies, provide training and capacity-building programs and make tailored recommendations based on the individual requirements of farmers. Extension specialists offer helpful advice, plan field days and demonstrations, make it easier to access resources and inputs, keep an eye on results, and promote social networks for peer learning (Yitayew *et al.,* 2021). Ahmed (2009) also found a direct correlation between the presence of extension agents and the level of adoption. These agents actively influence farmer's adoption of CA by promoting and maintaining positive attitudes. Moreover, the findings of the study align with the Penchansky and Thomas Theory of Access by Penchansky and Thomas (1981), which proposes designing extension services and programs in a culturally sensitive and acceptable manner to effectively meet the needs of the target audience. It is crucial that extension services are easily accessible to farmers, including those residing in remote areas, and remain consistently available throughout the year.

Access to credit plays a vital role in the adoption of CA in Bahi district, with a significant positive correlation ($p<0.05$). The results imply that as credit accessibility increases by a unit, the adoption of CA increases by 3.594 times. CA requires specific equipment and inputs such as purchasing or hiring tools such as *magoe* ripper, no-till planters, improved seeds and fertilizers. Credit accessibility enables farmers to purchase or rent these tools and inputs. In addition, during the transition period when yield may not immediately increase, credit helps farmers manage the financial risks by providing a buffer during the initial stage. The results align with Tambo and Abdoulaye's (2012) study, which found that there is a positive link between accessing credit and CA adoption. This link arises because farmers may find it difficult to afford essential CA inputs like equipment, fertilizers and improved seeds. The credit aids farmers in expanding their operations and boosting their income. With more money, farmers could buy more land, hire more workers, and make other expenditures that would boost their total productivity and marketability. The findings also align with a study conducted by Nouman et al., (2013) and Ololade and Olagunju (2013), indicating that credit accessibility plays a vital role in generating income for smallholder farmers in their agriculture endeavor. This access is essential for the adoption of modern technologies and improved

farming practices, contributing to agricultural development. Furthermore, the study findings are consistent with the adapted Penchansky and Thomas's Theory of Access by Penchansky and Thomas (1981), which outlines various dimensions of access. Financial institutions are crucial in promoting CA by providing credit products that are suitable and specifically designed for the farmers of the study area. Additionally, financial services need to be easily reachable by farmers and should accommodate their requirements, such as offering tailored loan products that align with their cash flow patterns, crop cycles, and income sources.

Plate 2*:* Farmer's participation in the preparation of CA demo plot (minimum tillage) in Chipanga A Village on the left side and cover crops with sorghum on the right side in Mwitikira village

Furthermore, the existence of bylaws governing the farmers shows a statistically significant influence on the adoption of CA ($p>0.05$). The results imply that a unit increase in the enforcement of bylaws increases the adoption of CA by 22.194 times. The existence of bylaws influences the uptake of CA among small-scale farmers because bylaws make the majority of farmers abide by the set bylaws. Among the bylaws that are in place in study areas include the prohibition of grazing on farms after harvesting, fines and prohibition of cutting trees which are essential in CA. This finding aligns with the study conducted by Owenya *et al.,* (2011) who reported the successful adoption of CA in Karatu. The government and NGOs worked together to create a supportive environment for small-scale farmers. This involved addressing conflicts related to crop residue by educating farmers about livestock management and implementing rules to safeguard farmland from grazing animals. Moreover, according to Rodenburg *et al.,* (2021), bylaws that are effective in one region or agricultural system may not be equally applicable or influential in another. Also, these findings are consistent with Penchansky and Thomas's Theory of Access by Penchansky and Thomas (1981) in the sense that local bylaws and regulations supporting and encouraging the adoption of CA practices should be acceptable and feasible within the legal framework. Moreover, existing bylaws should be easily understandable and relevant to CA for better accessibility. Clear and transparent regulations help farmers access these practices more effectively.

Conclusions and Recommendations

Conclusion

As for the adoption of Conservation Agriculture, households that were headed by females were more likely to adopt it than those headed by males. A majority of the CA adopters were young and had access to credit, market and bylaw awareness. Therefore, gender, age market availability, credit accessibility and bylaws awareness were the major demographic and institutional factors that influenced the adoption of Conservation Agriculture in the study area.

Credit accessibility, extension services, bylaws and sex were positively influential to the adoption of CA. However, age, off-farm income, farm size and market availability did not show a significant influence on the adoption of CA in the study area. If credit accessibility, extension service and bylaws are present, then adopting CA is done more easily. Therefore, before introducing CA, it is important to assess the presence of these factors for better results.

Recommendations

Based on the conclusions the following are recommended:

Collaboration between financial institutions and policymakers must be encouraged as it is essential

to increase farmers' credit accessibility by providing affordable loans and financial services. This can be achieved through the establishment of smallholder credit agencies in the study area to enhance farmer's awareness of the credit services and their accessibility. With affordable loans, farmers will have the capacity to purchase essential inputs for CA like machinery, fertilizer and improved seeds.

Extension services need to be improved and expanded by funding the extension programs and employing more extension workers. In addition, extension workers should be regularly trained and facilitated with means of transport to reach more farmers. Farmers should also have frequent specialized training on CA practices. Effective extension services may address farmers' concerns, provide them with important knowledge and information and raise awareness of the advantages of CA.

Information dissemination and training on CA should be tailored to consider the needs of female and young farmers. Additionally, cooperative farming groups or networks of young and female farmers should be created to facilitate resource pooling, knowledge sharing and collective investment in necessary equipment and inputs.

Finally, there should be effective enforcement of the existing regulations and rules in the study area, which are crucial for the adoption of CA. Awareness creation campaigns on existing bylaws should be done for all farmers in the study area.

References

Adesina A.A., & Zinnah M.M. (1993). Technology characteristics, farmers' perceptions and adoption decisions: A Tobit model application in Sierra Leone. Agric Econ. 1993;9(4): 297–311.

Adesina, A. A., Mbila, D., Nkamleub, G. B. and Endamana, D. (2000). Econometric analysis of the determinants of adoption of alley farming by farmers in the forest zone of southwest Cameroon Agriculture. Ecosystem Environment 80: 255 – 265.

Ahmed S. (2004). Factors and Constraints for Adopting New Agricultural Technology in Assam with Special
Reference to Nalbari District: An Empirical Study: Journal of Contemporary Indian Policy.

Alexander, C., & Van Mellor, T. (2005). Determinants of corn rootworm resistant corn adoption in Indiana.
AgBioForum, 8(4), 197-204

Aman, H. K. R., Mabele, R. B., Rugumisa. S. and Msambichaka, L. A. (2005). Agriculture in Economics Stabilization Policies Perspectives. In: Economic Stabilization Policies in Tanzania (Edited by Lipumba, H. I N, L. A Msambichaka and S.M.Wangwe) Dar es Salaam, Tanzania, Economics Department and Economics Research Bureau. pp. 112-127.

Amsalu, A. & De Jan, G. (2007). Determinants of adoption and continued use of stone terraces for soil and water conservation in an Ethiopian highland watershed. Ecology Economics 61: 294 – 302.

Araya, T., T.E., Ochsner, T. E., Mnkeni, PP. N. S., Hounkpatin, W. A. (2024) Challenges and constraints of conservation agriculture adoption in smallholder farms in sub-Saharan Africa: A review, International Soil and Water Conservation Research.

Ayuya O., Lagat J., Mironga J. and Mutai B. (2011). Socioeconomic factors affecting farmers' awareness of clean development mechanism projects: case of smallholder forest carbon projects. Curr Res J Soc Sci. 2011;3(3):213–8.

Banjarnahor, D. (2014). Adoption and adaptation of conservation agriculture in Tanzania southern highlands: lessons learned from Mshewe ward Mbeya region. Master's thesis: Department of Plant Sciences, Wageningen University.

Bonabana-Wabbi J. (2002). Assessing Factors Affecting Adoption of Agricultural Technologies: The Case of Integrated Pest Management (IPM) in Kumi District, Msc. Thesis Eastern Uganda

Danso-Abbeam, G. (2022). Do agricultural extension services promote the adoption of soil and water conservation practices? Evidence from Northern Ghana. Journal of Agriculture and Food Research, 10, 100381.

Defrancesco E., Gatto P., Runge F. andTrestini S. (2008). Factors affecting farmers' participation in agri-environmental measures: A Northern Italian perspective. J Agric Econ;59(1):114–31.

Diiro, G. (2013). Impact of Off-farm Income on Technology Adoption Intensity and Productivity: Evidence
from Rural Maize Farmers in Uganda. International Food Policy Research Institute, Working Paper
11

Ellis, F., Freeman, H. and Ade, H. (2004). "Rural Livelihoods and Poverty Reduction Strategies in Four African Countries." Journal of Development Studies 40(4):1-30

Fernandez-Cornejo, J., Daberkow, S. G., & McBride, W. D. (2001). Decomposing the size effect on the adoption of innovations: agrobiotechnology and precision farming.

Gilbert, ML. (2013). Factors influencing adoption of conservation agriculture in south Uluguru mountains in Morogoro region, Tanzania. Doctoral dissertation. Morogoro, Tanzania: Sokoine University of Agriculture.

IRR & ACT. (2005). Conservation Agriculture: A manual for farmers and extension workers in Africa. Nairobi Kenya: African Conservation Tillage Network.

Kahimba, F. C., Mutabazi, K. D., Tumbo, S. D., Masuki, K. F. and Mbungu, W. B. (2014). Adoption and scaling-up of conservation agriculture in Tanzania: Case of Arusha and Dodoma regions. Scientific Research Publishing. https://doi.org/10.4236/as.2014.514160

Kasenge, V. (1998). Socio-economic factors influencing the level of Soil Management Practices on Fragile Land. In Proceedings of the 16th Conference of Soil Science Society of East Africa (Eds.: ShayoNgowi, A.J.G. Ley and F.B.R Rwehumbiza), 13th-19th, December 1998, Tanga, Tanzania pp.102- 112, 1998.

Keating, B. A., Herrero, M., Carberry, P. S., Gardner, J., & Cole, M. B. (2014). Food wedges: framing the global food demand and supply challenges towards 2050. Global Food Security, 3(3-4), 125-132.

Krejcie, R. V. and Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement, 30*(3), 607–610.

Kuyah, S., Sileshi, G. W., Nkurunziza, L., Chirinda, N., Ndayisaba, P. C., Dimobe, K., & Öborn, I. (2021). Innovative agronomic practices for sustainable intensification in sub-Saharan Africa. A review. Agronomy for Sustainable Development, 41, 1-21.

Lee, M. and Gambiza, J. (2022). The adoption of conservation agriculture by smallholder farmers in southern Africa: A scoping review of barriers and enablers. Journal of Rural Studies, 92, 214-225.

Lugandu, S. (2013). Factors Influencing the Adoption of Conservation Agriculture by Smallholder Farmers in Karatu and Kongwa Districts of Tanzania; Final Report GD8 Presented at REPOA's 18th Annual Research Workshop held at the Kunduchi Beach Hotel, Dar es Salaam. pp 1-48.

Lugandu, S., Dulla, H., Ngotio, D., & Mkomwa, S. (2012). The extent of adoption of conservation agriculture with trees by smallholder farmers in Tanzania. World Agroforestry Centre Working Paper, Nairobi, 40.

Mignouna, B., Manyong, M., Rusike, J., Mutabazi, S. and Senkondo, M. (2011). Determinants of Adopting Imazapyr-Resistant Maize Technology and its Impact on Household Income in Western Kenya: AgBioforum, 14(3), 158-163. Hall, B. and Khan, B. (2002) Adoption of new technology. New Economy Handbook.

Neuman, W. L. (2014). Social research methods: Qualitative and quantitative approaches. Pearson.

Nouman, M., Siddiqi, M., Asim, S. andHussain, Z. (2013). Impact of socio-economic characteristics of farmers on access to agricultural credit. *Sarhad Journal of Agriculture*, *29*(3), 469-476.

Nurbekov, A., Akramkhanov, A., Lamers, J., Kassam, A., Friedrich, T., Raj Gupta, R. G. and Bekenov, M. (2014). Conservation agriculture in Central Asia. In Conservation agriculture: Global prospects and challenges (pp. 223-247). Wallingford UK: CABI.

Ololade, R. A., and Olagunju, F. I. (2013). Determinants of access to credit among rural farmers in Oyo State, Nigeria. Global Journal of Science Frontier Research Agriculture and Veterinary Sciences, 13(2), 16-22.

Omotayo A.O., Ndhlovu P.T., Tshwene S.C., Olagunju K.O. and Aremu A.O.I. (2021). Determinants of household income and willingness to pay for indigenous plants in North West Province, South Africa: a two-stage Heckman approach. Sustainability 13(10):5458.

Owenya, M.Z., Mariki., Kassam. A., Friedrich, J. and W.L. Kienzie. (2011). Conservation Agriculture (CA) in Tanzania: Case of Mwangaza B, CA farmer field school (FFS), Rhotia Village, Karatu District, Arusha. *International Journal of Agricultural Sustainability*, 145-152.

Penchansky, R. and Thomas, J. W. (1981). The concept of access: definition and relationship to consumer satisfaction. Medical care, 127-140.

Rizal, A. R. A. and Nordin, S. M. (2022). Getting ahead of the pandemic curve: A systematic review of critical determining factors for innovation adoption in ensuring food security. Frontiers in Nutrition, 9.

Rodenburg, J., Büchi, L. and Haggar, J. (2021). Adoption by adaptation: Moving from conservation agriculture to conservation practices. International Journal of Agricultural Sustainability, 19(5-6), 437-455.

Rukuni M., Tawonezvi P., Eicher C., Munyuki-Hungwe M. and Matondi P. (2006). Zimbabwe's agricultural revolution revisited. Harare: University of Zimbabwe Publications p. 119–40.

Shetto, R., Mkomwa, S., Mlengera, N. and Mwakimbwala, R. (2022). Conservation Agriculture in the Southern Highlands of Tanzania: Learnings from Two Decades of Research for Development. Conservation Agriculture in Africa: Climate Smart Agricultural Development, 122-136.

Tambo, J. A. and 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.

Tegegne, F.S. (2017). Factors Affecting Adoption of Dairy Technologies and Their Impact on Farm Household Income and Asset Holdings: The Case of Tehuldedere District, South Wollo Zone, Amhara Region, Ethiopia. Hawassa University, Hawassa, Ethiopia.

Uaiene, R., Arndt, C. and Masters, W. (2009) Determinants of Agricultural Technology Adoption in Mozambique. Discussion papers No. 67E.

Vuntade, D. and Mzuza, M. (2022) Factors Affecting Adoption of Conservation Agriculture Practices in Mpatsa Extension Planning Area, Nsanje, Southern Malawi. Journal of Geoscience and Environment Protection, 10, 96-110. https://doi.org/10.4236/gep.2022.103008.

Wassie, S. B. (2020). Natural resource degradation tendencies in Ethiopia: a review. Environmental systems research, 9, 1-29.

Wetengere, K. (2009). Socio-economic factors critical for adoption of fish farming technology: The case of selected villages in Eastern Tanzania. International Journal of Fisheries and Aquaculture 1 (3): 28-37.

William, A., Donkoh, S. A., & George, N. (2016). Adoption of Bambara groundnut production and its effects on farmers' welfare in Northern Ghana. African Journal of Agricultural Research, 11(7), 583-594.

World Bank. (2016). World Development Report 2016: digital dividends. World Bank, Washington, DC.

Yaron, D., Dinar, A. and Voet, H. (1992). Innovations on Family Farms: The Nazareth Region in Israel. American Journal of Agricultural Economics: 361-370.

Yitayew, A., Abdulai, A., Yigezu, Y. A., Deneke, T. T. and Kassie, G. T. (2021). Impact of agricultural extension services on the adoption of improved wheat variety in Ethiopia: A cluster randomized controlled trial. World Development, 146, 105605.