Motivational Factors Influencing Soil and Water Conservation Technology Practices in Tanzania

I. Introduction

Investments in sustainable agriculture practices (SAP) in sub-Saharan Africa have resulted in increased production over the past years, but shortage of water for agriculture is still posing serious food insecurity to populations living in this area. The use of soil and water conservation (SWC), including bench terraces, double digging, and cover crops, is proven efficiently to reduce soil and water erosion, thus retaining soil moisture (Sanga, 2015). Despite the recognized benefits from sustainable agriculture practices and substantive efforts by national and international organizations to encourage sustainable practices, the adoption of SWC technologies in this area is notably minimal. Tanzania presents as the case where the impact of drought leads to significant crop failures. Consequently, smallholder farmers in the region experience poverty and endure significant challenges related to food insecurity.

Determinants of the acceptance and use of sustainable technologies can vary between different practices. While socio-economic factors (age, gender, education, etc.) are paid considerable attention in the analysis, socio-psychological features (motivation, peer pressure, etc.) are receiving less attention in the adoption decisions. Some studies have underscored the significance of environmental and economic motivations that influence farmers’ adoption decisions (Zabala et al., 2017). However, individual motivations, instead of interacting factors within the community, are given more attention in those studies. Therefore, the objective of this study is to assess the effect of motivations on farmers’ decisions to adopt SWC, using farm household data from Tanzania. We expect the finding would contribute as the supplement to literature on how motivations influence farmers’ decisions to adopt agricultural technologies and farming practices.

II. Literature Review

Common factors that influence the adoption of SAP can be split into three dimensions: socio-economic factors, informational factors, and psychological factors (Tey and Brindal, 2012). The socio-economic dimension characterizes social and economic conditions that shape the lives and opportunities of individual household. Some common factors include: age, gender, education level, household size, and farm size. Male farmers often have greater access to resources and thus more information regarding with sustainable practices. In reality, the impact of gender varies across diverse practices. For example, in Nigeria, female farmers are less likely to adopt improved seeds and mixed cropping technologies, while no disparities are observed in the adoption of inorganic fertilizer (Oyetunde-Usman, 2021). In contrast, female household heads in Malaysia are more likely to adopt intercropping (Tey, 2013). Elderly farmers tend to have a more limited perspective on their future careers and are less likely to accept new technologies (Souza, Cyphers, and Phipps, 2016). Higher education levels provide farmers with enhanced capability to handle new ideas. The significance level of education towards the adoption probability of same technology is not constant through different areas (Mgomenzulu and Machira, 2023). The household size reflects the availability of labor, which plays a key role in labor-intensive SAP technologies. Larger farm size increases the capacity of households to manage benefits and risks associated with SAP technologies (Mellon-Bedi, 2020). Hence, most of those socio-economic factors are expected to exaggerate adoption rate, but the significance is uncertain through different technologies and locations.

Accessing to credit offers stronger capacity to make investment and bear the risk resulting from adoption (Tey, 2013). Livestock can be additional income to cover the cost by applying SAP technologies (Teklewold and Kassie, 2013).

Informational access, including climate information and finance information, can be proxied by access to smartphone, radio, or any training program. Distance to the main market can also reflect the information access in addition to the financial capacity of the household. Farmers are assumed to understand the information and to be able to use it. Generally, access to relevant information on SAP technologies can lead to higher adoption rate (Mgomezum and Machira, 2023).

Psychological factors are based on the idea that individuals adopt innovative technologies when they acknowledge they need to do so (Mellon-Bedi, 2020). The expected benefits and a desire of sustainable farms driven by environmental concerns motivate households to adopt SAPs (Akudugu, 2012). Participation in the farmers’ organizations and considerations over the adoption of neighbor and friends presents the interaction within the community. For example, in Malaysia, members are more likely to adopt cover cropping and integrated pest management than non-members (Tey, 2013).

III. Data and econometric framework

3.1. Data source

This survey employs dataset obtained from the household survey conducted by International Institute of Tropical Agriculture (IITA) in 2022. The survey was to collect data on the adoption of soil and water conservation technologies in Tanzania. The dataset was collected in Kongwa and Kiteto, two representative drought-stricken regions, with a size of 580 households and contains detailed information on agricultural households in terms of socio-economic factors, informational access, and psychological factors.

In this study, we only considered sustainable agriculture practices of soil and water conservation, which is effective in semi-arid area. We incorporated socio-economic, informational, and psychological factors that may influence the adoption of SWC. Specifically, those factors include age of household head, gender of household, education years of household head, household size, farm size, tropical livestock unit, distance to the main market, credit access, climate information, neighbor adopter, and membership in farmer organization.

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Table 1. Definition of variables used in the soil and water conservation adoption model.

3.2. Economic framework

We used the logit model to examine the effect of socio-economic, informational, and psychological factors on households’ decisions to adopt SWC. We assumed respondent households only faced the choice between adopting SWC and not adopting SWC. The use of logit model and assumption of two choices are consistent with several other studies to assess the effects of socio-economic factors on farmers’ decision to adopt sustainable agriculture technologies. The advantage of logit regression over other models is its mathematical simplicity and easier interpretation on the change in the odds ratio of the adoption for one unit change in the independent factors characterized above.

IV. Results

4.1. Socio-economic characteristics of respondent households

The study results show that the majority of household heads aged between 40 and 60 years and are assumed to influence the decision-making of households regarding the adoption of SWC (Appendix 1). This implies that households’ behaviors in adopting SWC play a crucial role in enhancing agricultural productivity and the overall well-being of farm households in the district. The gender ratio of households is not evenly distributed, with men taking the proportion of 75 percent. The mean education years is 1.3 with majority of respondents did not receive any formal education. The average farm size is 2.9 hectares, and most households own land that is so tiny that it could be considered negligible, equivalent to 0 in the data. This means that the findings are used to assess the proportion of the households that are most vulnerable to drought.

4.2. Factors Influencing Households’ Soil and Water Conservation Adoption

The factors influencing households’ SWC technology adoption is grouped into three categories, socio-economic, informational, and psychological factors. The log-likelihood ratio test was found to be significant at the one percent level, which means that the model is jointly significant in impacting households’ probability of adoption of SWCs (Appendix 2).

4.2.1. Socio-economic factors

Gender was found to have a negative relationship with the probability of adoption of SWC and is significant at one percent level, which means that females are 8 percent more probably to adopt SWC than males. This finding is consistent with literature that female household heads are more likely to adopt some of SAP techniques but is inconsistent with other literature that finds males are more likely to adopt SAPs (Tey, 2013; Oyetunde-Useman, 2021). This implies that the gender factor of the household head in influencing adoption of SWC should be practice and location specific.

The education level of household head is found to be positively related to probability of adoption. This means that every one year increase in education of household head, the probability of adoption of SWC would increase 0.8 percent. However, it was found to be insignificant at 1 percent level. This finding is consistent with majority of literature in determining factors influencing adoption rate of SAP techniques (Mellon-Bedi, 2020). However, the finding is inconsistent with the study in Malawi, which notified the significance of education over the adoption of mulching (Machira, 2023).

The household size is found to be positively related to probability of adoption but not significant. Larger household sizes reflect more labor the households have, which is important in the labor-intensive field of SWC. Though many studies have taken household size into account, little of them marked the significance of household size in predicting adoption probability (Nigeria, 2021).

Farm size is found to be negatively correlated with probability of adoption and is found to be insignificant at 1 percent level. This finding is inconsistent with literature that large scale farmers are more likely to adopt SAPs than small scale farmers (Abara and Singh, 1993; Kasenge, 1998). The reason for the inconsistency might be minimal land owned by a high proportion of households.

4.2.2. Informational factors

The access to climate information is found to be highly positively related to the probability of adoption at 1 percent significance level. Households that can get access to climate information are 11 percent more likely to adopt SWC. This is consistent with study’s finding that owing smartphone and radio is highly related to adoption probability (Mgomezum, 2023), which can be explained by the relationship between owning those devices and getting access to agricultural information so that households with those devices are more likely to hear from outside.

4.2.3. Psychological factors

Participating in farmers’ organization is positive and significant to adoption of SWC. The positive sign suggests that members of farmers’ organizations have 21 percent more likely to become adopters. Members in the organization have more access to different information. At the same time, the early adopters play as incentives to other members when the expected benefits with adopting SWC technologies are observed by the rest of members (Kassie et al., 2009).

Whether neighbors and friends are adopters is a relatively new idea in assessing the interaction within the community. It is found to be highly relative with the adopting probability. This means that if neighbors and friends are adopters, households are 15.6 percent more likely to adopt new technologies.

V. Conclusion and further investigation

The factors that influence the adoption of soil and water conservation technologies are broadly categorized into socio-economic factors, informational factors, and psychological factors. The socio-economic factors include age, gender, education level of the household head, household size, farm size, livestock ownership, distance to main market, and whether access to credit. The informational factors include all climate information, agricultural new from any kind of sources. The psychological factors include participation in farmer organization, and whether neighbors and friends are adopted or not. Only gender in socio-economic factors is found to be significant and have a positive relationship with adoption probability. Informational factors and psychological factors are found to be highly correlated with adoption probability.

For further investigation, the data over farm size can be improved as a really high percent of people have minimal land that can be negligible. In this case, the analysis of the influence of farm size towards the adoption probability of SWC can be only based on household size with minimal land ownership.

VI. Bibliography

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Appendix 1 Summary of socio-economic factors of households

Table 2. summary of socio-economic factors of households

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Mean | Standard Error | Min | Max |
| ageh | 49.14731 | 13.42178 | 20 | 94 |
| sexhh | .7521664 | 4321293 | 0 | 1 |
| educationhh | 1.320624 | 2.787523 | 0 | 12 |
| farmsize | 2.864818 | 4.777962 | 0 | 61 |
| household size | 1.847487 | 0.4052153 | 0 | 3 |
| tlu | 1.055459 | 2.671293 | 0 | 27 |
| dist. to market | 259.4139 | 218.9914 | 3 | 3360 |
| credit | .0482759 | .2145336 | 0 | 1 |

Appendix 2 regression results on determinants of adoption of SWC

LR chi2(12) = 94.22

Prob > chi2 = 0.0000

Table 3. marginal effects of variables with associated significance

|  |  |  |  |
| --- | --- | --- | --- |
| Variable | dy/dx | std.error | P>|z| |
| ageh | .000157 | .0012193 | 0.898 |
| sexhh | -.0808719 | .0356798 | 0.023\* |
| educationhh | .008199 | .0056387 | 0.146 |
| household size | .025624 | .0428019 | 0.549 |
| farmsize | -.0102074 | .0052261 | 0.051 |
| tlu | .0055714 | .0058134 | 0.338 |
| dist. to market | -.0000477 | .0001052 | 0.650 |
| credit | .0539978 | .0627938 | 0.390 |
| climate infor | .1128574 | .0386431 | 0.003\*\* |
| neighbor adopter | .1557424 | .0606898 | 0.010\*\* |
| member | .2146778 | .0292321 | 0.000\*\* |

\*indicates that the variable is significant at 5 percent level, \*\* indicates that the variable is significant at 1 percent level