

Effects of Agricultural Shifts on Environmental Conservation Practices; A Case Study of the CDAT Project in Gatsibo District, Rwanda

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Abstract: This study examined how agricultural shifts promoted through the CDAT-RAB Project influence environmental conservation practices among smallholder farmers in Gatsibo District, Rwanda. The project encourages a transition from subsistence farming to more diversified and market-oriented agriculture by supporting farmers with improved inputs, training, and market access. Despite these efforts, limited evidence existed on whether such agricultural changes contribute to sustainable land management, creating a research gap addressed by this study. A descriptive cross-sectional design was used, and data were collected from 394 households using structured questionnaires. Both descriptive and inferential statistical analyses, including correlation and regression, were applied. Findings revealed a strong shift toward market-oriented production, with 32.5% of farmers selling 51–75% of their produce and 25.8% selling more than 75%. Weekly market participation was reported by 44.3% of respondents, while many farmers benefited from CDAT-supported markets (61.3%), improved agricultural inputs (71.1%), and participation in value chains (55.2%). The study also found high adoption of environmental conservation practices. Soil erosion control measures were practiced by 70.6% of farmers, use of organic manure by 63.9%, mulching by 60.8%, and agroforestry by 58.8%. In addition, 68.0% of respondents reported practicing conservation methods frequently, showing strong engagement in sustainable farming. Inferential results indicated a significant positive relationship between agricultural shifts and environmental conservation practices ($R = 0.735$, $R^2 = 0.540$, $p < 0.001$). Market participation ($\beta = 0.301$) and the proportion of produce sold ($\beta = 0.264$) emerged as the strongest predictors of conservation practice adoption. Overall, the findings demonstrate that agricultural transformation under the CDAT Project not only improves farmers' livelihoods and market integration but also promotes sustainable environmental management. The study therefore recommends continued support for integrated agricultural policies that combine productivity enhancement with environmental sustainability in Rwanda.

Keywords: Agricultural Shifts, Environment, Conservation Practices, CDAT Project, Rwanda.

1. INTRODUCTION

Agricultural shifts, which involve transitions from traditional subsistence farming to more intensive and market-oriented production systems, are widely promoted as strategies for increasing rural incomes, improving food security, and stimulating national economic growth (Ogutu & Qaim, 2019; Jaleta et al., 2018). However, these transformations also have significant implications for environmental sustainability, particularly when agricultural intensification increases pressure on natural resources without adequate conservation measures. Understanding these interactions is essential for balancing economic development with environmental sustainability (Tittonell et al., 2018). Empirical studies from low- and middle-income countries demonstrate the complexity of these relationships. For instance, the adoption of improved agricultural technologies, such as inorganic fertilizers, remains relatively low among maize farmers in Western Uganda, with adoption estimated at approximately 32%. This low uptake is mainly attributed to socioeconomic constraints, limited access to credit, and inadequate extension services, despite the productivity benefits associated with these technologies (Sheahan & Barrett, 2017). Similarly, in southern Tanzania, increasing commercialization of food crops has been associated with declining natural resource bases and persistent low agricultural productivity, emphasizing the need for integrated conservation and productivity-enhancing interventions (Andersson Djurfeldt et al., 2018; Tittonell et al., 2018). Furthermore, agricultural

commercialization may encourage farmers to shift from diversified traditional cropping systems to specialized cash crop production, thereby increasing vulnerability to market fluctuations, climate shocks, and environmental degradation (Bellemare & Novak, 2017).

In Africa, agriculture remains a major source of employment and livelihoods, with more than 60% of the population depending directly or indirectly on the sector (AGRA, 2020; Nkonya et al., 2016). This heavy dependence places considerable pressure on ecosystems, particularly land and water resources, contributing to soil erosion, deforestation, and declining soil fertility. These environmental challenges are often intensified by cultivation on marginal lands, rapid population growth, and the limited adoption of sustainable land management practices (Montanarella et al., 2016; Borrelli et al., 2017). Consequently, these factors threaten long-term agricultural productivity, resilience, and food security.

In Rwanda, agriculture continues to play a central role in national economic development, contributing approximately 33% of the country's GDP, employing nearly 60% of the population, and accounting for a significant share of export earnings (Clay et al., 2019; Nsabimana et al., 2020). However, Rwanda's steep terrain and high population density increase environmental vulnerability. Studies indicate that between 16% and 40% of the country's land is located on steep slopes that are highly susceptible to soil erosion, resulting in an estimated annual loss of about 1.4 million tons of fertile topsoil. This situation undermines agricultural sustainability and highlights the need for intensive soil and water conservation measures (Rutebuka et al., 2021; Nilsson et al., 2022). These conditions demonstrate the importance of integrating environmental conservation practices into agricultural development programs.

At the local level, Gatsibo District relies heavily on agriculture as the primary livelihood activity, with smallholder farmers increasingly participating in organized agricultural programs aimed at improving market access. The CDAT project under RAB seeks to strengthen market participation, improve access to agricultural inputs and output markets, and promote risk-mitigation strategies among farmers. Although these agricultural transformations have the potential to improve household incomes, productivity, and resilience, their influence on the adoption of environmental conservation practices, such as terracing, agroforestry, cover cropping, mulching, and sustainable water management, remains insufficiently explored. Addressing this knowledge gap is essential to ensure that agricultural transformation contributes to both economic development and long-term environmental sustainability.

2. METHODOLOGY

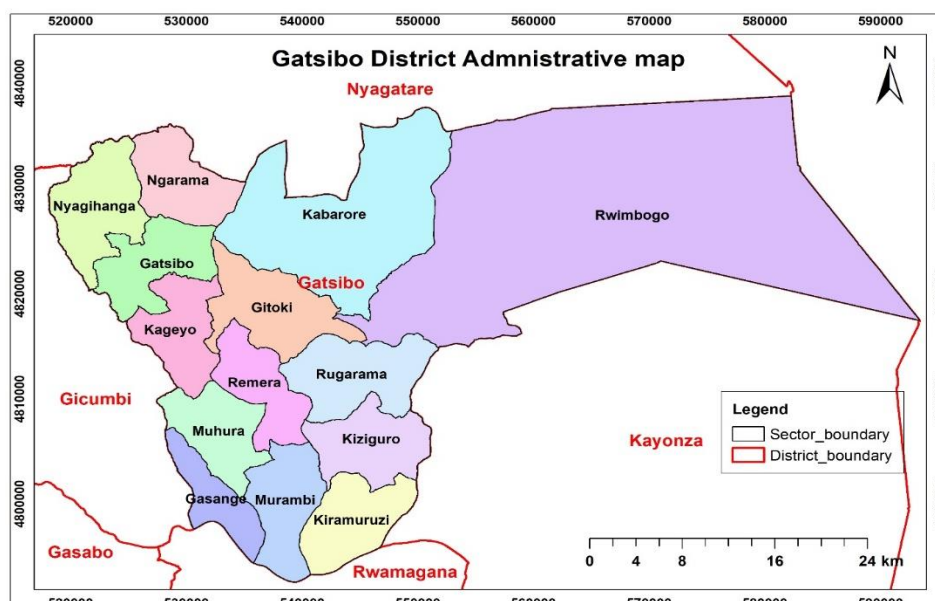
2.1 Research Design

This study adopted a cross-sectional descriptive research design with an analytical approach to examine the effects of agricultural shifts under the CDAT Project on environmental conservation practices among farmers in Gatsibo District.

2.2 Study Area

The study was conducted in Gatsibo District, which is located in the Eastern Province of Rwanda.

Figure1: Study Area map (Gatsibo Administrative map)



2.3 Target Population

The target population for this study consists of smallholder farmers participating in the CDAT Project within Gatsibo District, Eastern Province, Rwanda.

2.4 Sampling Techniques

The study used stratified random sampling for smallholder farmers. The sample allocation for each sector was calculated using proportional stratified sampling.

2.5 Sample size Calculation

The sample size for the study was determined using Yamane's (1967) formula, which provides a simplified method for calculating a statistically valid sample size with a specified level of precision. This formula ensures that the selected sample is representative of the target population while maintaining a manageable and feasible number of respondents for data collection.

$$n = \frac{N}{1 + N(e)^2}$$

Where:

- n = required sample size
- N = total population (smallholder participating in CDAT–RAB project in the district)
- e = level of precision (margin of error), typically 5% (0.05)

$$n = \frac{25,393}{1 + 25,393(0.05)^2} = 393.88 = 394$$

Therefore, the sample size of the study is 394 smallholders, calculated from the target population of 25,393 smallholders in the concerned sectors of Gatsibo District using Yamane's (1967) formula at a 5% margin of error. This sample size is sufficient to provide statistically reliable results while remaining manageable for data collection across the relevant sectors within the district. The households were proportionally distributed across sectors to ensure that the sample accurately represents the population's characteristics.

2.6 Data Collection Techniques

The study employed primary data collection techniques using a structured questionnaire as the sole instrument. The questionnaire was administered directly to the selected smallholder farmers participating in the CDAT Project in Gatsibo District.

3. FINDINGS AND DISCUSSIONS

3.1 Demographic Characteristics of Respondents

The demographic characteristics of the respondents are presented in Table 4.1. These characteristics include age, gender, education level, household size, and main occupation. Understanding these characteristics provides context for interpreting patterns of agricultural shifts and the adoption of environmental conservation practices among the farmers.

Table 1: Demographic Characteristics of Respondents (n = 394)

Demographic variable	Category	Frequency (n)	Percentage (%)
Age (years)	<30	103	26.1
	31–45	158	40.1
	46+	133	33.8
Gender	Male	233	59.1
	Female	161	40.9
Education Level	No formal education	49	12.4
	Primary	201	51.0

	Secondary	118	29.9
	Tertiary	26	6.6
Household Size	1–4 members	93	23.6
	5–7 members	218	55.3
	8+ members	83	21.1
Main Occupation	Farming	315	79.9
	Farming + Trading	45	11.4
	Farming + Civil Service	24	6.1
	Other	10	2.5

Source: Primary data, 2026

The findings in Table 1 indicate that most respondents were aged between 31 and 45 years (40.1%), with a majority being male (59.1%). Over half of the respondents had only attained primary education (51.0%). The average household size was moderate, with most households comprising 5–7 members (55.3%), and the vast majority of respondents were primarily engaged in farming (79.9%). These demographic characteristics provide important context for understanding household income generation, adaptation strategies, and the associated economic impacts in Gatsibo District, Rwanda.

3.2 Level and Nature of Agricultural Shifts among Farmers

This section presents the findings related to the first research objective, which is to assess the level and nature of agricultural shifts among farmers participating in the CDAT Project in Gatsibo District, Rwanda. The analysis focuses on key indicators of agricultural shifts, including the proportion of produce sold, frequency of market participation, access to CDAT-supported markets, use of improved agricultural inputs, and participation in value chains.

Table 2: Level and Nature of Agricultural Shifts among Farmers (n = 394)

Indicator	Category	Frequency (n)	Percentage (%)
Proportion of production sold	Less than 25%	59	15.0
	25–50%	106	26.9
	51–75%	128	32.5
	More than 75%	101	25.6
Market participation	Weekly	174	44.2
	Bi-weekly	97	24.6
	Monthly	79	20.1
	Occasionally	44	11.2
Access to CDAT-supported markets	Yes	242	61.4
	No	152	38.6
Use of improved inputs	Yes	281	71.3
	No	113	28.7
Participation in value chains	Yes	218	55.3
	No	176	44.7

Source: Primary data, 2026

The findings in Table 2 indicate that agricultural shifts among farmers in Gatsibo District, Rwanda, are moderate to high. A considerable proportion of respondents (128 farmers, 32.5%) reported selling 51–75% of their production, while 101 farmers (25.6%) sold more than 75%, reflecting a transition from subsistence-oriented farming toward more market-oriented production systems. In terms of market participation, the majority of farmers (174 farmers, 44.2%) reported engaging in markets on a weekly basis, indicating increased interaction with agricultural markets and regular commercialization activities. Furthermore, a significant proportion of respondents (242 farmers, 61.4%) reported having access to CDAT-supported markets, suggesting that the project has improved market linkages for farmers. The findings also reveal that 281 farmers (71.3%) use improved seeds and agricultural inputs, highlighting the adoption of modern farming practices promoted under the CDAT Project. Additionally, more than half of the respondents (218 farmers, 55.3%) reported participation in CDAT-supported value chains, indicating growing integration into organized agricultural production and marketing systems.

Overall, these findings demonstrate that the CDAT Project has facilitated notable agricultural shifts among farmers, characterized by increased market engagement, adoption of improved inputs, and participation in value chains. However, variations still exist in the level of participation and access to these opportunities across respondents.

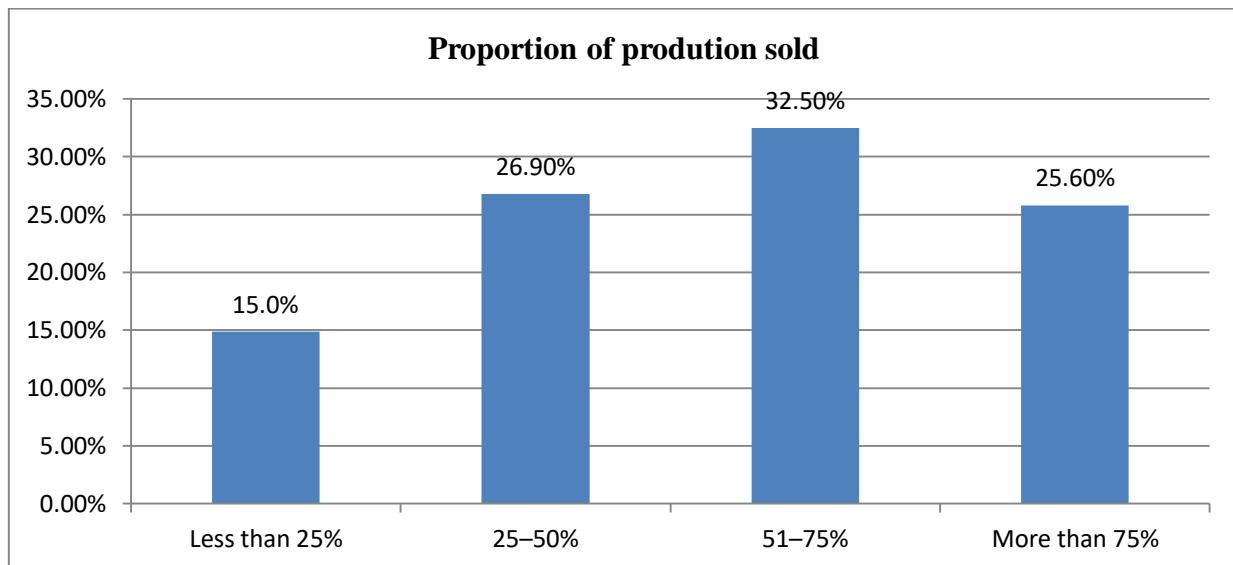


Figure 1: Proportion of production sold among CDAT farmers in Gatsibo District

Source: Primary data, 2026

Figure 1 presents the distribution of CDAT project linked farmers according to the proportion of agricultural production sold in Gatsibo District. The findings indicate that the largest proportion of respondents (32.5%) sold between 51–75% of their produce, suggesting a strong level of market engagement among farmers. This is followed by 26.9% of respondents who sold between 25–50% of their produce, while 25.6% reported selling more than 75%, reflecting a substantial group of highly commercialized farmers. A smaller proportion (15.0%) sold less than 25% of their produce, indicating that only a minority of farmers remain primarily subsistence-oriented. Overall, the results suggest that most farmers are actively participating in agricultural markets, with varying degrees of commercialization.

Qualitative findings from key informant interviews supported the quantitative results by showing that farmers in Gatsibo District have increasingly shifted from subsistence farming to more market-oriented agriculture due to the interventions of the CDAT Project. One agronomist explained that *“many farmers who used to produce mainly for home consumption are now farming with the aim of selling their produce in organized markets because the project has connected them to reliable buyers and provided training on commercial farming.”* Key informants further noted that regular market participation has motivated farmers to adopt improved seeds and modern farming practices in order to increase productivity and meet market demand. The Ntende cooperative leader also stated that *“farmers have become more engaged in value chains and cooperative marketing systems, which has improved their income and encouraged them to invest more in agriculture.”* Another respondent emphasized that *“the use of improved seeds and agricultural inputs has increased significantly because farmers now understand the benefits of modern farming and have better access to these inputs through the project.”* These qualitative findings confirm that the CDAT Project has played an important role in promoting agricultural transformation and commercialization among farmers in the study.

These findings are consistent with results from Ogutu and Qaim (2019), who used data from 805 smallholder households in Kenya and reported that increased market orientation and higher proportions of produce sold were significantly associated with improved welfare outcomes among farm families, including reductions in multidimensional poverty. Their study found that households with greater market engagement tended to sell larger shares of their output, reflecting similar patterns of agricultural shifts observed in Gatsibo District (Ogutu & Qaim, 2019). Likewise, evidence from Ghana shows very high levels of marketed output among smallholders, with some studies reporting that farmers sold on average over 80% of their produce in commercial contexts, particularly for high-value cash crops (APRA data from Ghana sample, as cited in relevant literature).

Smallholder farmers in Tanzania have also been shown to sell substantial proportions of their output, with average sales ratios exceeding 50% in contexts where rice and other staples are both consumed and marketed, illustrating the gradual transition from subsistence to market-oriented production (APRA panel data descriptive results).

The pattern observed in Gatsibo District, where many farmers engage in weekly market activities and sell moderate to large proportions of their production, reinforces the argument that frequent and sustained market participation is a key dimension of agricultural shifts. However, as in other contexts, such as Tanzania and Ghana, variations in sales intensity and market engagement remain, often linked to differences in access to resources, infrastructure, and institutional support. Overall, the study findings align with existing empirical evidence across Sub-Saharan Africa showing that agricultural shifts, as reflected in increased proportions of output sold, regular market participation, and adoption of improved inputs, are strongly associated with deeper market engagement and productive transformation among smallholders. These results support the notion that interventions like the CDAT Project contribute to facilitating agricultural shifts by improving market linkages, input use, and participation in value chains, though structural and socio-economic constraints continue to shape the pace and extent of these transitions (Ogutu & Qaim, 2019; APRA descriptive evidence for Ghana and Tanzania contexts).

3.3 Extent of Environmental Conservation Practices Adopted by Farmers

This section presents the findings related to the second research objective, which is to determine the extent of environmental conservation practices adopted by farmers participating in the CDAT Project in Gatsibo District, Rwanda. The analysis focuses on key indicators such as soil erosion control, agroforestry, mulching, organic manure use, water conservation, and frequency of adoption of these practices.

Table 3: Extent of Environmental Conservation Practices Adopted by Farmers (n = 394)

Indicator	Category	Frequency (n)	Percentage (%)
Soil erosion control	Yes	278	70.6
	No	116	29.4
Mulching	Yes	240	60.9
	No	154	39.1
Use of organic manure	Yes	252	64.0
	No	142	36.0
Agroforestry	Yes	232	58.9
	No	162	41.1
Water conservation	Yes	210	53.3
	No	184	46.7
Frequency of adoption	Always	124	31.5
	Often	144	36.5
	Sometimes	78	19.8
	Rarely/Never	48	12.2

Source: Primary data, 2026

The findings in Table 3 indicate that a considerable proportion of farmers have adopted environmental conservation practices, reflecting the influence of the CDAT Project in promoting sustainable agriculture. Soil erosion control was the most widely adopted practice (70.6%), followed by the use of organic manure (64.0%) and mulching (60.9%), highlighting strong engagement in soil fertility and land management practices. Agroforestry was adopted by 58.9% of respondents, indicating a growing integration of trees into farming systems, while water conservation practices recorded a relatively moderate adoption level (53.3%).

Regarding frequency of implementation, the majority of farmers reported practicing conservation methods either often (36.5%) or always (31.5%), suggesting a relatively high level of consistent adoption. However, a smaller proportion (12.2%) reported rarely or never adopting such practices, indicating that some barriers to full adoption still exist. Overall, the findings suggest that the level of adoption of environmental conservation practices among farmers is moderate to high, although variations across practices highlight the need for continued support and awareness to ensure broader and more consistent adoption.

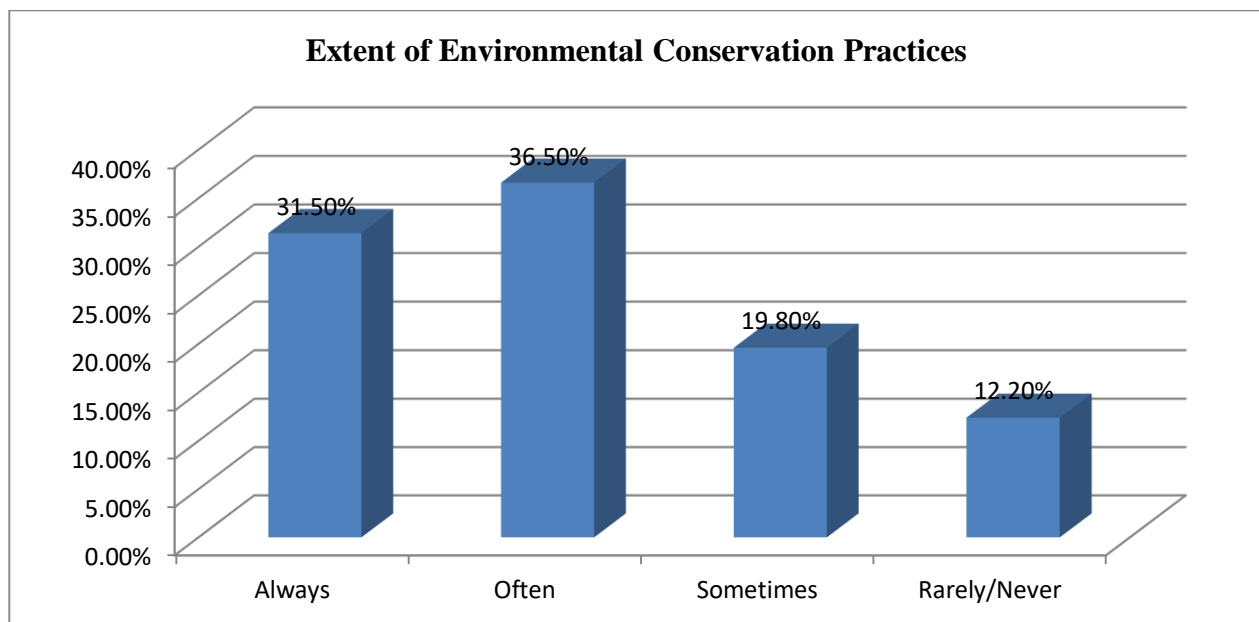


Figure 2: Extent of Environmental Conservation Practices among farmers in Gatsibo District

Source: Primary data, 2026

Figure 2 presents the extent to which farmers in Gatsibo District practice environmental conservation measures. The findings indicate that the largest proportion of respondents (36.5%) reported often implementing conservation practices, followed by 31.5% who indicated that they always apply such practices. Additionally, 19.8% of farmers reported sometimes practicing environmental conservation, while a smaller proportion (12.2%) indicated that they rarely or never adopt these practices. Overall, the results suggest that the majority of farmers are consistently engaged in environmental conservation activities, although a notable minority still exhibits low levels of adoption, highlighting the need for continued support and awareness.

Qualitative findings from key informant interviews supported the quantitative results by revealing that the CDAT Project has significantly increased farmers' awareness and adoption of environmental conservation practices in Gatsibo District.

One agronomist explained that *"most farmers have adopted soil erosion control measures such as terraces and contour farming because they have seen improvements in soil fertility and reduced land degradation."* Key informants further noted that the promotion of organic manure and mulching has helped farmers maintain soil moisture and improve crop productivity, especially during periods of low rainfall.

A cooperative leader stated that *"farmers are increasingly practicing agroforestry because they now understand the importance of trees in protecting the environment and improving agricultural productivity."* Another respondent emphasized that *"although many farmers regularly apply conservation practices, some still face challenges such as limited financial resources, lack of equipment, and inadequate technical knowledge, especially in water conservation activities."* These qualitative findings confirm that the CDAT Project has contributed to the promotion of sustainable agricultural practices, although continued training and support are still needed to improve the consistency and extent of adoption among all farmers.

These findings contrast with the study by Sheahan and Barrett (2017) in Uganda, which reported that only 34% of farmers adopted soil conservation practices. The relatively higher adoption levels observed in Gatsibo District may be attributed to the structured support provided by the CDAT Project, including training, input provision, and extension services, which appear to have strengthened farmers' capacity and motivation to engage in sustainable practices.

This suggests that institutional interventions can substantially improve adoption rates beyond what is observed in less-supported contexts (Sheahan & Barrett, 2017). The findings are also broadly consistent with Kassie, Zikhali, Pender, and Köhlin (2016) in Ethiopia, who reported moderate adoption levels of organic manure (40%) and agroforestry (28%), with lower uptake of water conservation technologies.

Adoption rates in Gatsibo, however, are comparatively higher across all practices, particularly for soil conservation and agroforestry, likely due to stronger project-driven support and greater integration of farmers into structured agricultural programs, which enhance both awareness and access to necessary inputs (Kassie et al., 2016).

Similarly, the results differ from Tittonell, Giller, and Vanlauwe (2018) in Nigeria, where less than 25% of farmers adopted integrated soil and water management practices. The higher adoption levels observed in Gatsibo support the argument that access to extension services, improved inputs, and increased income from agricultural shifts significantly influence conservation behavior. Farmers benefiting from CDAT interventions appear better positioned to invest in sustainable practices compared to farmers in contexts with limited institutional and financial support (Tittonell et al., 2018). Overall, these findings align with the broader literature demonstrating that environmental conservation practices are influenced by economic capacity, access to information, and institutional support. The relatively higher adoption levels in Gatsibo highlight the effectiveness of integrated agricultural programs like CDAT in promoting sustainable land management. Nonetheless, variations across specific practices indicate the need for continued efforts to address remaining barriers and ensure more uniform adoption among farmers.

3.4 Relationship between Agricultural Shifts and Environmental Conservation Practices

This section presents the findings related to the third research objective, which is to analyze the relationship between agricultural shifts under the CDAT Project and the adoption of environmental conservation practices among farmers in Gatsibo District, Rwanda. The analysis employs inferential statistical techniques, specifically Pearson's correlation and linear regression analysis, to determine the strength and direction of the relationship, as well as the predictive influence of agricultural shift indicators on environmental conservation practices. Statistical significance was tested at a threshold of $p < 0.05$.

Table 4. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.735	0.540	0.534	0.368

a. Predictors: (Constant), Proportion of Produce Sold, Market Participation, Income from Agricultural Sales, Access to CDAT-supported Markets

b. Dependent Variable: Environmental Conservation Practices

The model summary indicates a strong positive relationship between agricultural shifts and environmental conservation practices, with a correlation coefficient (R) of 0.735. The R Square value of 0.540 implies that 54.0% of the variation in the adoption of environmental conservation practices among farmers is explained by the combined effect of agricultural shift indicators included in the model. The Adjusted R Square of 0.534 further confirms that the model remains robust even after adjusting for the number of predictors, suggesting that the included variables provide a reliable explanation of the dependent variable. Additionally, the standard error of estimate (0.368) indicates a reasonable level of accuracy in predicting environmental conservation practices based on agricultural shifts among farmers in Gatsibo District, Rwanda.

Table 5. ANOVA

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	24.672	4	6.168	112.70	0.000
Residual	21.828	389	0.056		
Total	46.500	393			

a. Predictors: (Constant), Proportion of Produce Sold, Market Participation, Income from Agricultural Sales, Access to CDAT-supported Markets

b. Dependent Variable: Environmental Conservation Practices

The ANOVA results indicate that the regression model is statistically significant ($F = 112.70$, $p < 0.001$). This implies that agricultural shift indicators jointly provide a significant explanation of variations in environmental conservation practices among farmers in Gatsibo District, Rwanda. Therefore, the overall regression model is considered a good fit for predicting the adoption of environmental conservation practices based on agricultural shifts.

Table 6: Coefficients

n	Unstandardized Coefficients (B)	Std. Error	Standardized Coefficients (Beta)	t	Sig.
(Constant)	0.486	0.118	-	4.12	0.000
Proportion of produce sold	0.271	0.046	0.264	5.87	0.000
Market participation	0.315	0.045	0.301	6.92	0.000
Income from agricultural sales	0.223	0.047	0.219	4.76	0.000
Access to CDAT-supported markets	0.164	0.053	0.178	3.12	0.002

a. Dependent Variable: Environmental Conservation Practices

The regression coefficients indicate that all agricultural shift indicators have a positive and statistically significant influence on the adoption of environmental conservation practices. Market participation had the strongest effect ($\beta = 0.301$, $p < 0.001$), indicating that more frequent engagement in markets significantly enhances the likelihood of adopting conservation practices.

The proportion of produce sold also showed a strong positive influence ($\beta = 0.264$, $p < 0.001$), suggesting that farmers who sell a larger share of their produce are more likely to invest in sustainable environmental practices. Income from agricultural sales was another significant predictor ($\beta = 0.219$, $p < 0.001$), highlighting the role of financial capacity in facilitating investments in conservation practices. Access to CDAT-supported markets also had a significant positive effect ($\beta = 0.178$, $p = 0.002$), demonstrating the importance of institutional support and improved market linkages.

Overall, the inferential analysis confirms that agricultural shifts significantly influence the adoption of environmental conservation practices among farmers in Gatsibo District, Rwanda. Collectively, the agricultural shift indicators explain 54.0% of the variation in environmental conservation practices, indicating strong explanatory power of the model. Among the predictors, market participation emerged as the most influential factor, followed by proportion of produce sold, income from agricultural sales, and access to CDAT-supported markets. These findings support the study hypothesis and demonstrate that increased market engagement, improved income levels, and strengthened institutional support enhance farmers' capacity and motivation to adopt sustainable environmental conservation practices.

Qualitative findings from key informant interviews supported the regression results by indicating that agricultural transformation and increased market engagement have encouraged farmers to adopt environmental conservation practices in Gatsibo District. One agronomist explained that *"farmers who regularly participate in markets are more willing to invest in soil conservation and agroforestry because they understand that maintaining land productivity is important for sustaining their income."* Key informants further noted that farmers who sell a larger proportion of their produce are more likely to adopt sustainable farming practices in order to maintain product quality and long-term productivity.

A cooperative leader stated that *"when farmers earn better income from agricultural sales, they are able to buy improved inputs, establish terraces, plant trees, and implement water conservation measures."* Another respondent emphasized that *"the CDAT Project has improved farmers' access to markets and training, which has motivated many farmers to practice environmentally friendly agriculture because they now see farming as a business that must be sustained."* These qualitative findings confirm that increased commercialization, improved income, and institutional market support positively influence the adoption of environmental conservation practices among farmers in the study area.

These findings are consistent with Andersson et al. (2021) in Kenya, who found that market-oriented farmers were significantly more likely to adopt soil conservation practices, with agricultural shifts exerting a positive effect on adoption ($\beta = 0.29$, $p < 0.01$). Their study emphasized that access to inputs and extension services strengthens this relationship, which aligns with the Gatsibo findings, where changes in farming practices and institutional support play a central role in promoting conservation practices.

Similarly, the results correspond with findings from Tanzania by Tittonell, Giller, and Vanlauwe (2018), who reported a positive and significant correlation between the intensity of agricultural practice changes and the adoption of agroforestry and soil fertility management practices ($r = 0.42$, $p < 0.05$). The strength of the relationship observed in Gatsibo ($R = 0.735$)

is higher, suggesting that the integration of farmers into structured programs such as CDAT may amplify the positive effects of agricultural shifts on environmental conservation.

The findings also align with Martey, Etwire, and Kuwornu (2020) in Ghana, who reported that participation in changing crop and production practices significantly increased the likelihood of adopting conservation practices such as organic fertilization and mulching ($\beta = 0.27$, $p < 0.01$). However, their study also highlighted potential trade-offs, noting that excessive shifts toward certain crops or production methods can negatively affect biodiversity and soil cover. While such trade-offs were not directly examined in the present study, the relatively balanced adoption of multiple conservation practices in Gatsibo suggests that agricultural shifts, when supported by appropriate institutional frameworks, can promote sustainability rather than undermine it.

Overall, the study findings reinforce existing empirical evidence that agricultural shifts can serve as a key driver of environmental conservation, particularly when supported by access to inputs, income generation, and institutional interventions. The strong explanatory power of the model ($R^2 = 0.540$) further confirms that changes in farming practices are a critical factor influencing farmers' environmental behavior in Gatsibo District.

4. CONCLUSION

This study concludes that agricultural shifts have a significant and positive effect on the adoption of environmental conservation practices among farmers participating in the CDAT Project in Gatsibo District. The findings demonstrate that farmers who access CDAT-supported markets, use improved inputs and participate in value chains, sell a larger proportion of their produce, and earn higher agricultural incomes are more likely to implement sustainable practices such as soil erosion control, agroforestry, mulching, and water conservation. The strong explanatory power of the regression model further confirms that agricultural shifts are a key driver of environmentally responsible farming behavior. Overall, the study establishes that, when supported by appropriate institutional mechanisms such as market access, input provision, and training, agricultural shifts can contribute not only to improved livelihoods but also to enhanced environmental sustainability.

5. SUGGESTIONS FOR FUTURE RESEARCH

Longitudinal studies could better capture the causal effects of agricultural shifts on conservation practices and examine moderating factors such as climate variability, land tenure, and policy influences. Research should also explore potential trade-offs between agricultural shifts and environmental sustainability.

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