African Journal of Agriculture and Food Science
ISSN: 2689-5331
Volume 6, Issue 2, 2023 (pp. 1-22)
www.abjournals.org

THE ADOPTION OF STRATEGIES TO REDUCE DEFORESTATION FROM TOBACCO PRODUCTION: A CASE OF SMALLHOLDER FARMERS IN HEADLANDS AREA OF MAKONI DISTRICT

Brenda Nyakatonje and Newettie Jambo*

Agricultural Economics and Development, Manicaland State University of Applied Sciences, Mutare, Manicaland, 7001, Zimbabwe.

*Corresponding Email: jambonewettie@gmail.com

Cite this article:

Brenda N., Newettie J. (2023), The Adoption of Strategies to Reduce Deforestation from Tobacco Production: A Case of Smallholder Farmers in Headlands Area of Makoni District. African Journal of Agriculture and Food Science 6(2), 1-22. DOI: 10.52589/AJAFS-BBFL7WRS

Manuscript History

Received: 17 Feb 2023

Accepted: 7 April 2023

Published: 20 June 2023

ABSTRACT: *Smallholder tobacco farmers in Zimbabwe have not yet fully adopted the strategies to reduce deforestation as recommended by tobacco contracting companies and government agencies such as the Tobacco Industry and Marketing Board (TIMB), Forestry Commission of Zimbabwe (FCZ) and Environmental Management Agency (EMA). The majority of them continue to use wood fuel for curing, leading to high rates of deforestation. This study focused on assessing the factors influencing the adoption of strategies to reduce the rate of deforestation from tobacco production, including gum plantations and coal for tobacco curing in the Makoni district's Headlands area. The target population was tobacco farmers in the study area, and the sample size was 320. Descriptive statistics and logistic regression were used to analyze the data. Based on the results, the factors that were significant in influencing farmers to adopt were the farmer's age, farming experience, agricultural training, education level and occupation. The study recommends that government agencies, including the FCZ, enforce the implementation of afforestation events like tree planting day across the country to help protect the environment from deforestation.*

KEYWORDS: Tobacco, smallholder farmers, adoption, environmental effects, deforestation

Paper Type: Original Research Paper

Article DOI: 10.52589/AJAFS-BBFL7WRS
DOI URL: https://doi.org/10.52589/AJAFS-BBFL7WRS

African Journal of Agriculture and Food Science
ISSN: 2689-5331
Volume 6, Issue 2, 2023 (pp. 1-22)

www.abjournals.org

INTRODUCTION

Zimbabwe's economy is primarily reliant on agriculture for economic growth. The agricultural sector is seen as the backbone of the economy of Zimbabwe as it provides a livelihood for most people in rural areas (Runganga and Mhaka, 2021). Tobacco is Zimbabwe's most important cash crop, providing foreign currency and employment (Nyambara and Nyandoro, 2019). The government continues to support the production of the crop as it remains one of the country's biggest foreign currency earners, second to gold (Shati et al., 2021). Most farmers in Zimbabwe are diversifying their crops to include tobacco because they believe it is profitable (Chitongo, 2017). According to TIMB (2018), active growers increased from 75,392 to 140,895 from 2015 to 2018. As a result, exports increased from 152 million kilograms to 184.2 million kilograms for the same period. This increase in tobacco farmers each year leads has been accompanied by an increase in the rate of deforestation (Nyambara and Nyandoro, 2019, Kapfupi, 2022).

Tobacco production is associated with several negative environmental consequences. Wood is needed in tobacco cultivation for various purposes, including curing and making poles and sticks for barn construction (Sacchetto, 2012). This wood is taken mainly from indigenous trees, resulting in deforestation, soil erosion, and biodiversity loss (Sacchetto, 2012; Madamombe et al., 2019) Soil degradation and deforestation have resulted from tobacco-related farming practices in low and middle-income countries. (Chivuraise, 2011; Zvobgo and Tsoka, 2021; Kamuti, 2022). The increased demand for natural forest firewood used in tobacco curing has increased the rate of deforestation in Zimbabwe. Tobacco leaf is cured in Zimbabwe using various fuels, including coal, exotic plantations, and natural forests. However, most farmers prefer natural forests as a firewood source since it is less expensive to obtain than other options such as coal. Coal is logistically and financially out of reach for the rural majority, resulting in high deforestation rates (Deke, 2015).

Deforestation is rampant in Zimbabwe, with an estimated 70,000 to 100,000 hectares of forest being removed yearly for tobacco production at a rate of 1.5 percent (Chivaurise et al., 2016). Deforestation that arises from tobacco production leads to climate change, erosion and biodiversity loss (Rashikayi, 2018). The loss of biodiversity and soil and water damage is a significant consequence of the drastically diminished forest cover. This is because polluted rivers and streams endanger aquatic life and the health of people who drink the water. Environmental damage caused by chemical leaching from the soil and pollution from pesticides and fertilizers is further detrimental to tobacco cultivation (Stigler et al., 2019; Kugedera et al., 2020). If tobacco production is to be sustainable, such effects must be taken into account.

The Environmental Management Agency (EMA), incepted in 2002, and the Forestry Commission in Zimbabwe (FCZ), established in 1954, are the two major agencies under the Ministry of Environment, Water and Climate aiding in environmental protection (Gotore et al., 2019). These two organizations have crucial roles to play in tackling the challenge of deforestation. Traditional leaders are also essential in controlling deforestation through the Traditional Leaders Act and using their traditional norms and beliefs (Gotore et al., 2019). Furthermore, the TIMB also encourages all tobacco farmers to stop curing tobacco using firewood obtained from natural indigenous forests.

Even though many tobacco companies provide continuous support for tobacco production through financing and market access, there is still less emphasis on sustainable conservation measures (Mutenyo, 2016). There are no plans to track and evaluate the performance of various

Article DOI: 10.52589/AJAFS-BBFL7WRS
DOI URL: https://doi.org/10.52589/AJAFS-BBFL7WRS

solutions, such as reforestation efforts. Farmers remain confused by the reforestation projects as they rely on the same trees for wood fuel used in tobacco curing (Mutenyo, 2016).

The Government of Zimbabwe, through TIMB, EMA, and Forestry Commission, together with tobacco companies, have introduced various strategies or measures to mitigate the tobacco production effects on the environment through deforestation (TIMB, 2015). Gum plantation is one of the possible solutions recommended to promote the regeneration of depleting forests (Saccheto, 2012; TIMB, 2016; Lawrence et al., 2020; Matiashe, 2022). The FCZ launched the Tobacco Wood Energy Program (TWEP) in 2005 in an attempt to curb the challenges of deforestation by encouraging smallholders to establish woodlots. Each farmer was to establish 0.2 hectares of exotic species, such as Eucalyptus, for each hectare of tobacco planted (TIMB, 2015). The FCZ has been providing the farmers with free seeds of the Australian Eucalyptus to encourage the planting of gum trees on these woodlots. The eucalyptus is a fast-growing tree that can be used by farmers for reforestation. Farmers would expect to use them within 5 years as compared to other trees, which may take up to 20 years (Saccheto, 2012). Both the TIMB and the FCZ have also been collecting an obligatory levy fee since 2005 from the tobacco farmers, which goes towards reforestation, thereby further encouraging the farmers to set up woodlots on their lands (Matiashe, 2022).

Apart from gum plantation, smallholder farmers have also been encouraged to use coal as an alternative to firewood to reduce the depletion of forests in Zimbabwe (TIMB, 2016). According to Munanga et al., (2014), a significant number of farmers transitioned from the use of coal to wood fuel due to the cost and unavailability of electricity as well as the collapse of the railway system in Zimbabwe. A study by Lawrence et al., (2020) recommended the government and tobacco companies provide coal to tobacco farmers at a subsidized price to encourage its adoption by smallholders, thereby reducing deforestation. According to Saccheto (2012), coal has been used as a common alternative to wood for flue-curing in China.

However, not all farmers have been implementing the recommended strategies to help reduce the rate of deforestation from tobacco production. The government, tobacco companies and forest companies continue to bemoan the extensive deforestation resulting from the use of indigenous trees by a significant number of smallholder farmers for curing tobacco. These government agencies have been promoting the use of gum plantation and the use of coal as the two main strategies to reduce deforestation from tobacco production. This study aims to assess the factors influencing the adoption of these two strategies to reduce deforestation from tobacco production in the Makoni district of the Headlands area. Understanding the local community's perspective on forest management and the variables influencing their decision to accept deforestation prevention measures is critical in developing management policies that can bring sustainability to tobacco production. The study further examines the challenges faced by smallholder tobacco farmers in the Headlands area. The headlands area was chosen because it is one of the areas facing the major challenges of deforestation as a result of tobacco production. The area is dominated by smallholder farmers, and tobacco is the major cash crop grown (Kaunye, 2015).

Studies on policies that could address the negative environmental effects associated with tobacco farming have been insufficiently performed in low to medium-income countries. This study contributes to the current literature by examining the strategies recommended by government agencies, including the TIMB, EMA and FCZ, to reduce the negative effects of tobacco production in the context of Zimbabwe, particularly focusing on deforestation.

Article DOI: 10.52589/AJAFS-BBFL7WRS
DOI URL: https://doi.org/10.52589/AJAFS-BBFL7WRS

Overview of Global Production and Issues

Tobacco is a valuable crop because it is essential to the economies of many countries (Rashikayi, 2018). Tobacco (*Nicotiana tabacum*) is a plant that originated in South America (Mishra and Mishra, 2013). Its production is concentrated primarily in areas with a mild and sunny climate. Tobacco is grown in various varieties depending on its intended use. Flue-cured tobacco is primarily grown in China, India, Brazil, the United States, and Zimbabwe (Rashikayi, 2018).

The top tobacco producers are the United States, China, Brazil, India, Turkey, Zimbabwe, and Malawi, which produce more than 80% of the world's tobacco (Saccheto, 2012; WHO, 2021). This suggests that intensive tobacco production is limited to a few countries. Table 1 shows tobacco production between 2012 and 2018. From 2012 to 2018, the global area under cultivation of tobacco declined by 15.66 percent, while it increased by 3.40 percent in Africa (WHO, 2021).

Table 1: Harvested area under tobacco in hectares

	Year	
Region	2012	2018
World (total)	4111818	3468101
Africa (total)	609687	630432

Source: *WHO (2021)*

According to WHO (2017), commercial tobacco farming produced nearly 7.5 million metric tonnes of tobacco leaf in 2012 on 4.3 million hectares of agricultural land in at least 124 countries. According to DAFF (2015), China produced and exported 54% of all tobacco in 2015, followed by Brazil (13%), India (7%), the United States (5%), and Zimbabwe (3%). Over the last few decades, global tobacco production has gradually increased, with developing countries accounting for a larger share of the increase. According to WHO (2017), in recent decades, transnational tobacco corporations have reduced production costs by shifting tobacco leaf production from high-income to low-income countries, where approximately 90% of tobacco is produced.

The past years have witnessed a growing number of anti-tobacco campaigns, especially in countries with a High Human Development Index (HDI). The tobacco control initiatives, including an increase in tobacco excise tax, have resulted in a decline in tobacco consumption in these countries (Magati et al., 2020). This caused the tobacco companies to shift their focus to low HDI countries in an attempt to mitigate their losses from the tobacco control measures. The expansion of tobacco production is witnessed in countries with low HDI because of the perception that tobacco increases both foreign currency and foreign direct investment as well as enhancing the livelihoods of farmers (Drope et al., 2018; Magati et al., 2020).

In Indonesia, tobacco farming is concentrated in specific regions. The share of tobacco farmers to total farmers in the agricultural sector is low (1.6%), and tobacco farming contributed to 0.7% of employment in 2018 (Drope et al., 2020).

Article DOI: 10.52589/AJAFS-BBFL7WRS
DOI URL: https://doi.org/10.52589/AJAFS-BBFL7WRS

African Journal of Agriculture and Food Science
ISSN: 2689-5331
Volume 6, Issue 2, 2023 (pp. 1-22)
www.abjournals.org

Overview of Regional and Zimbabwe Tobacco Production

Tobacco production in Africa

According to WHO (2021), Africa's share of tobacco production was 722187 tonnes in 2018, representing 11.4% of the global output of 6.3 million tonnes (88.58%). The countries include Zimbabwe (2.96%), Malawi (1.52%), Zambia (1.87%), Mozambique (1.47%), Tanzania (1.65%) and others (1.95%). (WHO, 2021). Flue-cured, burley and oriental tobacco are the most common tobacco grown in Africa. Contrary to most countries outside Africa, these produce flue-cured rather than naturally dried tobacco. As a result, there is a high rate of deforestation in natural forests from tobacco production (Chivuraise, 2011)

According to WHO (2021), the major tobacco-growing countries in Africa are Zimbabwe, Zambia, Tanzania, Malawi, and Mozambique, as shown in Figure 1. More than 70% of African countries are members of the World Trade Organization (WTO). Between 2012 and 2018, African tobacco leaf imports fell by 32.6 percent compared to global figures, which fell by 5.93 percent (WHO, 2021). On the other hand, between 2012 and 2018, the value of African tobacco leaf exports increased by 10.51 percent, from US$ 1883 million to US$ 2081 million. As a result, Africa remains a net exporter of tobacco leaf, resulting in a positive trade balance of approximately US$ 1261 million in 2018 (WHO, 2021).

Tobacco is commonly grown on small African farms, and farm workers are family members, including women and children. Their harvest is typically sold through the contract or auction system (Scoones et al., 2016). Tobacco farmers are contracted under the contract system to sell their leaves to companies, often local subsidiaries of international tobacco leaf companies or cigarette manufacturers (Scoones et al., 2016).

According to Goma et al., (2017), tobacco is viewed as the most viable crop in Zambia as it brings more cash compared to other crops. The market of tobacco is readily available hence a lot of farmers are tobacco growers. From the results found by Goma et al., (2017), tobacco farmers in Zambia produced 1,272.1kgs of tobacco in the 2013/2014 season. 73.6% of the tobacco growers are under contract.

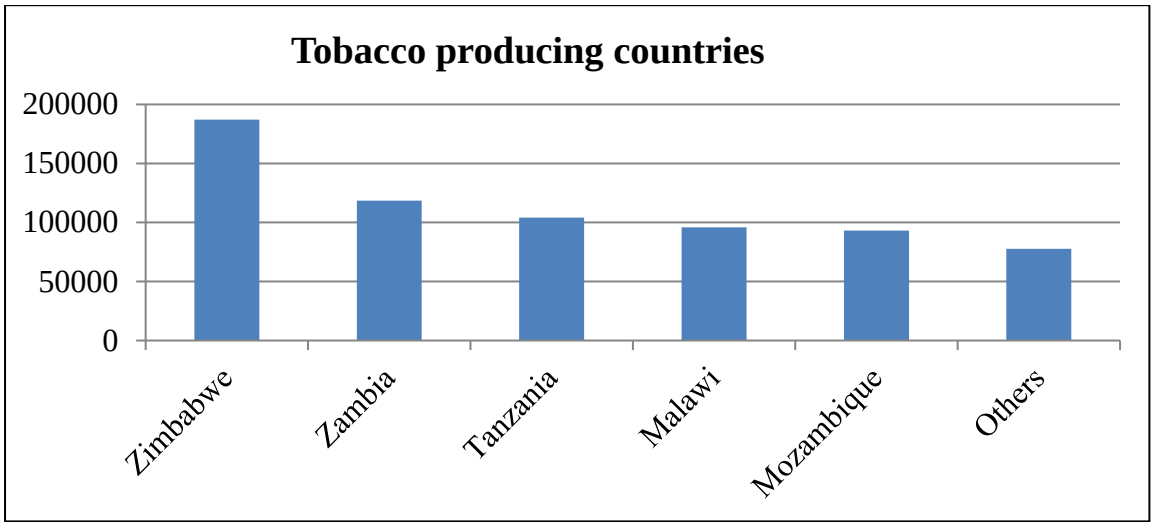

Figure 1: Main tobacco-producing countries in Africa

Source*: WHO (2021)*

Article DOI: 10.52589/AJAFS-BBFL7WRS
DOI URL: https://doi.org/10.52589/AJAFS-BBFL7WRS

African Journal of Agriculture and Food Science
ISSN: 2689-5331
Volume 6, Issue 2, 2023 (pp. 1-22)
www.abjournals.org

Tobacco production in Zimbabwe

By 1918, most commercial farming in Zimbabwe was devoted to cultivating flue-cured tobacco (Deke, 2015). By this time, the projections of the Zimbabwean tobacco industry had been identified by a British Tobacco Company, which had been invited to set up the infrastructure required for tobacco curing and grading. By 1930, various institutions had been established to regulate the tobacco industry, such as the Tobacco Control Board [later replaced by the Tobacco Marketing Board (now known as the Tobacco Industry and Marketing Board), with which all growers are required to register (Deke, 2015).

Zimbabwe is Africa's largest flue-cured tobacco producer and the world's fifth (WHO, 2021). Figure 2 depicts Zimbabwe's average annual tobacco yield from 2010 to 2018, according to TIMB (2018). Slight gradual fluctuations in tobacco yields occurred between 2010 and 2018. Changes in rainfall patterns, poor management skills, particularly among smallholder farmers, and under-investment in irrigation and curing facilities, particularly among medium to large-scale farmers, can all contribute to these fluctuations (Rashikayi, 2018).

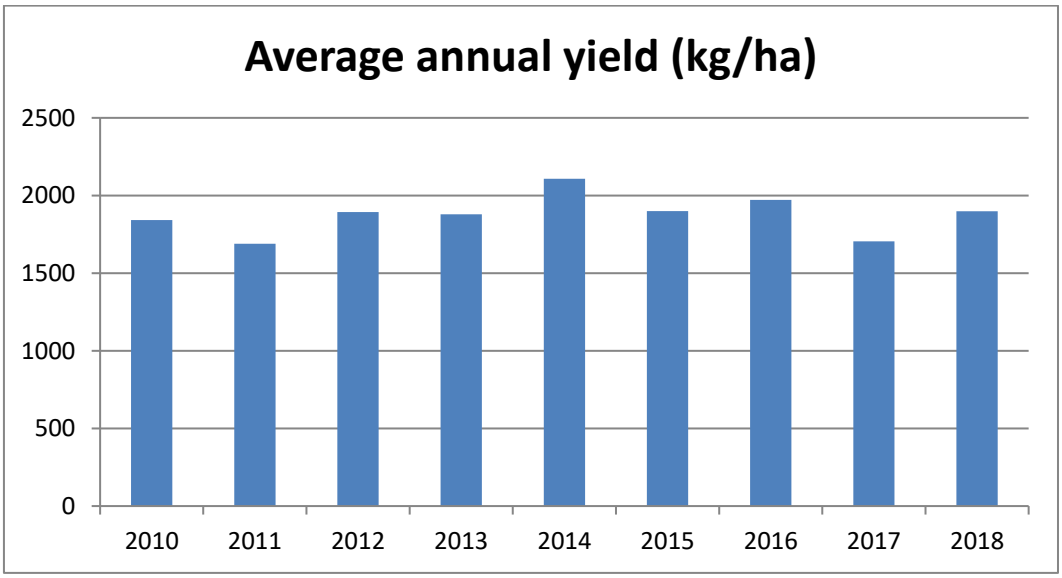

Figure 2: Average annual yield (kg/ha)

Source: TIMB Annual statistical report 2018

Table 2 shows that Mashonaland West province and Mashonaland Central province are the leading tobacco producers in Zimbabwe (TIMB, 2018). Climatic variations may be the primary cause of poor performance in other provinces, as the top provinces are located in the same agro-ecological region, which has favourable climatic conditions for tobacco production (Rashikayi, 2018)

Article DOI: 10.52589/AJAFS-BBFL7WRS
DOI URL: https://doi.org/10.52589/AJAFS-BBFL7WRS

Table 2: Performance of grower by province

Province	Number of growers	Yield (kg/ha)	Mass sold (kg)
Manicaland	21517	2321	38199321
Mashonaland East	17261	2063	49689877
Mashonaland West	50462	1995	89736973
Mashonaland Central	51086	1574	74218619
Matebeleland	3	3889	3578
Midlands	400	2868	588620
Masvingo	166	1550	166262

Source: *TIMB Annual statistical report, 2018*

METHODOLOGY

Research Design

The primary goal of this research is to identify the factors that influence the adoption of strategies to reduce deforestation from tobacco production. In addition, the study aims to provide policy strategies and recommendations for long-term agricultural development by taking into account the environmental impacts of tobacco farming. The study applied descriptive research in examining farmers' perception of the environmental effects of tobacco farming as well as the awareness of farmers towards the strategies to mitigate these effects. A causal research design was also implemented in this study to assess the causal relationship between farmers' adoption of strategies to reduce deforestation and various socio-economic factors.

The study employed qualitative data to assess smallholder farmers' perception of the adverse environmental effects of tobacco production and the challenges they face in tobacco production. In addition, a quantitative approach was used to determine the factors influencing the adoption of preventative strategies associated with deforestation due to tobacco farming. Survey data was collected from a sample of respondents from a target population. Information on farmers' characteristics and other factors related to the environmental effects of tobacco production was gathered using structured questionnaires.

Description of the study area

The study was carried out in the Headlands area located in the Makoni district. The area is in Zimbabwe's Manicaland province. It is situated on the main Harare-Mutare road, approximately 136 kilometres from Harare, Zimbabwe's capital city. It is located in natural farming region IIb, with a mean annual rainfall of 650mm (Kaunye, 2015). This district's soil types range from clay to sandy loam, making it suitable for growing crops such as maize, field beans, tobacco, and sunflower. Most of the farmers in headlands are smallholders, and tobacco is the major cash crop grown in the area (Kaunye, 2015). Therefore, there is a need for investigation on strategies to help reduce deforestation by these smallholder farmers in Headlands.

Article DOI: 10.52589/AJAFS-BBFL7WRS
DOI URL: https://doi.org/10.52589/AJAFS-BBFL7WRS

Sampling and Data collection methods

The research used a two-stage sampling technique where the Headlands area was purposively selected in the first stage because the majority of the smallholders in the area are into tobacco production. Simple random sampling was then employed in the second stage to select households from the four wards within Headlands (Wards 6,8,12, and 32). Table 3 shows the wards and their number of households and sample sizes.

Table 3: Wards and sample size

Ward	Number of households who grow tobacco	Sample size
6	402	80
8	345	80
12	205	80
32	319	80
Total	1271	320

Source: *Calculations from own study.*

According to the Agricultural Technical and Extension Services Department (AGRITEX) extension workers, there were 1271 tobacco-producing households. A structured questionnaire was used to collect primary data from 320 randomly selected smallholder farmers. The survey data collected provide information about the following variables: smallholder farmers' demographic information, land area under tobacco production, period into tobacco production, measures taken by farmers to implement strategies to mitigate the adverse effects of tobacco production on the environment, methods of curing tobacco, challenges in tobacco production, and other questions about tobacco production and the environment. In addition, secondary data was gathered from previous tobacco production studies and records or publications from TIMB and EMA to supplement the primary data collected.

CONCEPTUAL FRAMEWORK

Studies on adoption have demonstrated that the attributes of the farmer, such as age, gender, household size, education level, land size, extension, and influence adoption. As a result, the adoption of gum plantation and coal for tobacco curing (dependent variable) can be influenced by the following variables: age of the farmer, gender, level of education, land size, farming experience, marital status, number of household members and agricultural training (independent variables). Making a decision is likely influenced by some social-economic attributes such as gender, household size and education level of the household head. The concept is shown in Figure 3.

Article DOI: 10.52589/AJAFS-BBFL7WRS
DOI URL: https://doi.org/10.52589/AJAFS-BBFL7WRS

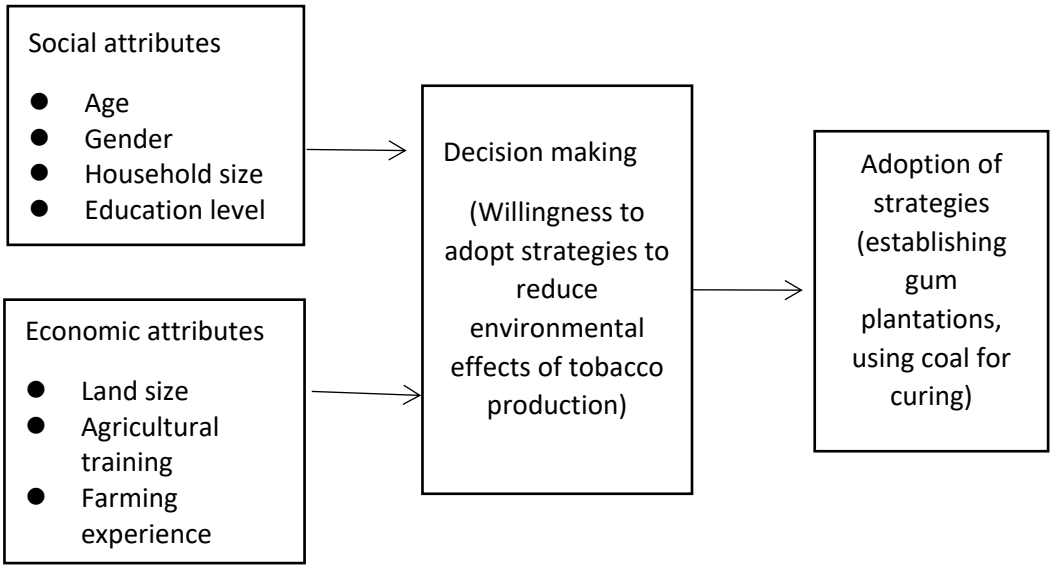

Figure 3: Conceptual framework

Source: *Adapted and modified from Mariba (2017)*

Analytical framework

For the qualitative approach, analysis was done by grouping data collected through interviews and discussions under the guidance of the research questions. Responses to questions on the farmers' awareness of the environmental impacts of tobacco farming and the preventive strategies were organized and explained.

The quantitative data collected from questionnaires were analyzed using descriptive statistics and regression. The data gathered through the questionnaire surveys were coded in Microsoft Excel before being analyzed. After that, descriptive statistics such as mean, percentage, standard deviation, tabulation, and frequency distribution were used to analyze it. Finally, regression analysis was used to determine the combination of variables that best explains the adoption of preventative strategies associated with the environmental damage caused by tobacco farming.

Analytical model

A binary logistic regression model is used in this research because the dependent variable is a discrete binary variable, i.e. it takes two values: one if yes and 0 if no (Gujarati, 2011). The model predicts the impacts of different factors on adopting the strategies implemented to mitigate the problem of deforestation resulting from tobacco production. The government bodies such as TIMB, EMA and FCZ, as well as tobacco contracting companies, have been encouraging the use of gum plantations and coal as alternatives to wood fuel (TIMB, 2016). The government agencies have been providing free seeds to the tobacco farmers for afforestation while some of the contract companies have been providing coal to the farmers for

Article DOI: 10.52589/AJAFS-BBFL7WRS
DOI URL: https://doi.org/10.52589/AJAFS-BBFL7WRS

curing. This study, therefore, examines the factors influencing the decision of farmers to adopt these two strategies for tobacco curing.

Respondents were asked if they had adopted the use of gum plantation and coal for tobacco curing to come up with the dependent variable. The farmer's decision regarding the adoption of gum plantation and coal is represented by a dummy variable (Yi) as shown below:

$$Y_i = \{1 \quad if\ the\ ith\ farmer\ adopted\ the\ use\ of\ gum\ plantation\ and\ coal\ 0$$

$$if\ the\ ith\ farmer\ does\ not\ adopt\} \quad \textbf{(1)}$$

The dummy dependent variable (Yi) is not modelled directly using the logit model; instead, we model the ratio $\frac{(Yi}{1-Yi}$). This ratio represents the likelihood of a successful outcome: a farmer adopting the use of gum plantation and coal. Theoretically, the logistic model is written as shown in equation 2 (Tranmer and Elliot, 2005)

$$L = ln\ ln\left(\frac{P_i}{1-P_i}\right) = Bo + \beta_i X_i + \mu_i \quad \textbf{(2)}$$

Where $P_i = Pr(Y = 1|X = xi)$: which is the conditional probability that the farmer will adopt the use of coal or gum plantation given the variable Xi. L is referred to as the logit (Gujarati, 2022).

Where: 1-Pi is the probability of not adopting gum plantation and coal., βo is a constant term or intercept parameter, Xi is various factors to be considered as independent variables, μi is the error term, and βi shows the regression coefficients.

The following logistic regression model is estimated to determine the factors influencing farmers' gum plantation and coal adoption. Rather than using odd ratios, this study employed the average marginal effects to interpret the impact of the various factors on the dependent variable. The model is estimated using STATA statistical software. In estimating the model, the focus is on the coefficients' behaviour and the p-value.

$$ln\ ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \beta_1 Gen + \beta_2 Age + \beta_3 FE + \beta_4 Con + \beta_5 Edu + \beta_6 MS + \beta_7 HS + \beta_8 LS + \beta_9 Occ + \beta_{10} AUT + \beta_{11} AT + \mu_i \quad \textbf{(3)}$$

Table 4 summarizes the description of the independent variables used in the logit model.

Article DOI: 10.52589/AJAFS-BBFL7WRS
DOI URL: https://doi.org/10.52589/AJAFS-BBFL7WRS

Table 4: Variables expected to influence gum plantation and coal adoption by farmers

Symbol	Variable	Description	Expected Results
Gen	Gender	Dummy variable: 1 = male. 0 = female	Positive
Ag	Age	Age of the farmer in years	Positive/ negative
FE	Farming Experience	Farming experience in years	Positive
Con	Contracted farmer	Dummy variable: 1 = contracted farmer 0 = non-contracted farmer	Positive
Edu	Highest level of education	1 = none. 2 = primary. 3 = secondary. 4 = tertiary	Positive
MS	Marital status	1 = single. 2 = married. 3 = divorced. 4 = widow	Negative
HS	Size of household	Number of people in a household	Positive
LS	Land size	Total hectares of land owned by a farmer	Positive/ negative
Occ	Occupation	1 = family farm work. 2 = rural agricultural work 3 = rural non-agricultural work. 4 = employed in the town	Positive / negative
AUT	Area under tobacco	Total hectares of tobacco grown by a farmer	Negative
AT	Agricultural training	1 = yes. 0 = no	Positive

RESULTS

The descriptive statistics present the data collected, including demographic information, tobacco farming activities and environmental effects. The regression was then estimated using Stata software version 13 to determine the significant factors which affected the adoption of strategies to reduce the environmental effects of tobacco production in Headlands.

Socio-economic characteristics of respondents related to adoption

The study grouped the participants of the survey into adopters and non-adopters. Adopters are those who established a gum plantation or were using coal, while non-adopters are those who did not use any of the strategies. Table 5 indicates that those who adopted were 210, while 110 respondents were non-adopters.

Table 5: Sample households grouped by adoption

Adoption	Frequency	Percentage

Article DOI: 10.52589/AJAFS-BBFL7WRS
DOI URL: https://doi.org/10.52589/AJAFS-BBFL7WRS

Adopters	210	65.62
Non-adopters	110	34.38
Total	320	100.00

Source: *Calculations from own study*

Challenges Faced by the Smallholder Tobacco Farmers in the Headlands area

The problems faced by the farmers were discussed after the interviews. Economic theory suggests that the quantity demanded increases due to a price decrease. The adoption of technology is dependent on cost and resources (Manyuwa et al., 2013). This study highlights some of the problems hindering farmers from adopting the use of gum plantation and coal for tobacco curing. Coal is expensive; hence farmers fail to embrace it, especially those not in contracts. Gum plantation establishment is affected by labour availability. The average household size is six members; hence farmers fail to adopt due to labour shortages.

The challenges faced by smallholder tobacco farmers in the Headlands area are highlighted in figure 4 and their respective frequencies of respondents. The problems emphasized by farmers include lack of access to energy (100%), technical and economic problems (93.75%), natural problems (87.5%), transportation and marketing problems (76.88%) and other problems (34.38%), respectively.

Deke (2015) researched the challenges faced by tobacco farmers and found economic problems to be the primary problem, followed by accessibility and technical issues, political and legal problems, natural problems and other problems, respectively. A study by Chitongo (2017) also examined problems faced by smallholder farmers, such as lack of access to energy, marketing of produce, lack of curing infrastructure and other issues.

Article DOI: 10.52589/AJAFS-BBFL7WRS
DOI URL: https://doi.org/10.52589/AJAFS-BBFL7WRS

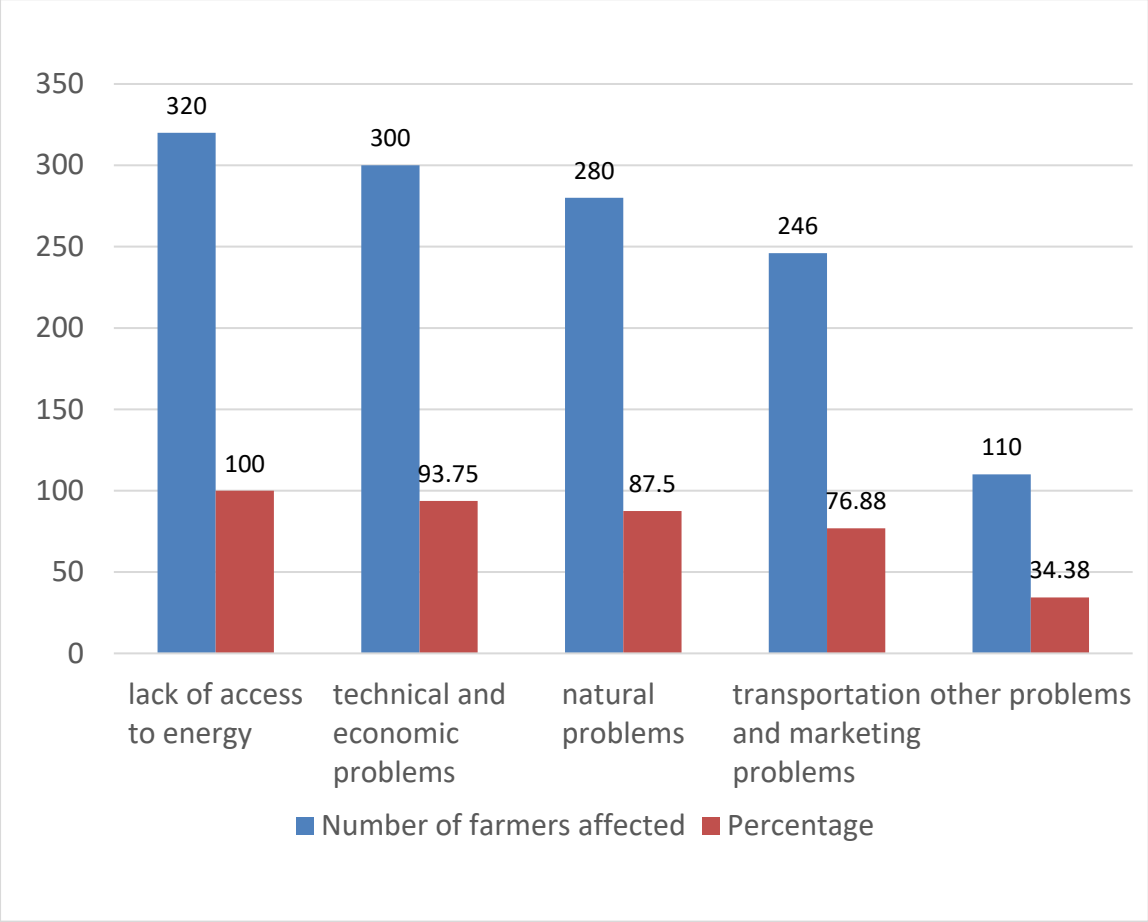

Figure 4: Constraints faced by farmers in Headlands

Source: *Calculation from own study*

Lack of access to energy

The major challenge influencing the smallholder tobacco farmers in Headlands is the shortage of energy for curing tobacco. All respondents (100%) alluded to this problem. From Table 6, 228 farmers are curing using natural forests, with 110 using natural forests only and 118 using natural forests with a combination of coal or gum plantation. The challenge highlighted by farmers is that natural forests are depleting due to the addition of more farmers each year, and the tobacco curing process consumes a lot of firewood. The areas that used to be densely forested are now bare due to deforestation caused by tobacco curing. Mountainous areas are now depleting with exposed roads to carry firewood for tobacco curing.

Farmers also highlighted that coal is expensive, and those contracted will only have access to it. However, the contracted farmers indicated that the amount of coal their contracting companies give them is inadequate hence they tend to use it in combination with natural forests. Those farmers who have land without forests tend to purchase gum trees from the council so they can cure their tobacco. However, this is a challenge for them because it is expensive.

Article DOI: 10.52589/AJAFS-BBFL7WRS
DOI URL: https://doi.org/10.52589/AJAFS-BBFL7WRS

Table 6: Curing methods

Curing method	Frequency	Percentage
Gum plantation	38	11.88
Natural forests	110	34.38
Coal and gum plantation	54	16.88
Coal and natural forests	105	32.81
Gum plantation and natural forests	13	4.05

Source: *Calculations from own study*

Transportation and marketing problems

Ward 8 is remote, making it difficult for farmers to transport inputs to their homes and outputs to the market. The respondents reported poor road networks as a major challenge. As a result, transporters charge very high prices because they have no other choice. Another issue is the marketing of produce. Harare has centralized auction floors. The high transportation costs harm farmers' profits they incur when transporting tobacco to auction floors.

In the case of tobacco marketing, farmers are primarily concerned with pricing issues. The buyers engage in unethical pricing practices, thereby shifting the burden to the tobacco farmers. The respondents complained about mispricing on the auction floors, claiming they received low prices for their produce. The farmers also revealed that the buyers' behaviour is unethical because they demand bribes to price the tobacco crop correctly.

Farmers also highlighted that tobacco pricing is unstable as compared to maize prices. They pointed out that the time when tobacco was bought reasonably priced was unpredictable, sometimes at the beginning or end of the season, and other times in the middle. Farmers are price takers; they cannot decide the price.

Those farmers under contract also face a challenge: the company decides the price according to product quality classification set by them, and at times, the farmers will remain indebted at the end of the season. In every situation, the benefit goes to the company rather than the farmers. Ultimately, their tobacco brings less income, just enough for a living but not for savings.

Technical and Economic Problems

Another issue that smallholder farmers in the Headlands face are technical difficulties. Technical issues usually revolve around labour issues and tobacco cultivation knowledge (Deke, 2015). Since excessive deforestation is rampant, tobacco farmers lack knowledge of alternative strategies for curing tobacco, such as rocket barn technology. Farmers also lack knowledge on how to use and apply chemicals, fertilizers, irrigation, and curing to improve the quality of their tobacco and, as a result, get higher prices. In addition, 68 respondents admitted to lacking detailed technical knowledge of how tobacco is grown.

Tobacco is grown as a secondary source of income by 33 and 35 respondents who are involved in rural non-agricultural work and employed in town, respectively. These participants admitted

Article DOI: 10.52589/AJAFS-BBFL7WRS
DOI URL: https://doi.org/10.52589/AJAFS-BBFL7WRS

that they rely heavily on labourers because they are unfamiliar with the technical knowledge of tobacco production.

Tobacco growers are also experiencing liquidity issues. They do not have funds available for purchasing inputs, paying labourers, or paying transporters of inputs and outputs. According to the respondents, inputs are costly, especially for farmers with other financial obligations, such as paying school fees for their children. As a result, most farmers (63.13 percent) have turned to contract farming to address economic issues. Technical and financial problems also hinder the establishment of gum plantations and the use of coal for tobacco curing as farmers have scarce labour, lack knowledge and do not have money to purchase coal.

Natural Problems

These were also identified as additional challenges in tobacco cultivation. Natural problems include hail storms, as depicted in Figure 5, floods, and drought. For example, 37 respondents from Ward 8 stated that the hail storm impacted them. Among them, 23 have enrolled in insurance, while 14 have lost everything. In addition, most farmers who cannot afford irrigation equipment see unpredictable climatic conditions as challenging, although rainfall variability is not generally regarded as a significant problem in Manicaland. Farmers also stated that they are experiencing low yields as a result of relying on natural rains and that there is a need to ensure their crops.

Figure 5: Hail storm in ward 8, December 2021

Source: Primary data

Other Problems

Other issues mentioned include tobacco crop theft, destruction of tobacco crops by livestock and health problems of the farmers due to tobacco farming. The health problems include green tobacco sickness caused by having contact with the green tobacco plant with high nicotine content. Another health problem that emanates from tobacco cultivation is tuberculosis.

The Empirical Results from Regression analysis

The study explains the results from the logistic regression model showing the significant variables influencing the adoption of strategies by smallholder farmers and those which are insignificant. The essential variables are age, level of education, agricultural training, occupation and farming experience. On the other hand, the area under tobacco, marital status,

Article DOI: 10.52589/AJAFS-BBFL7WRS
DOI URL: https://doi.org/10.52589/AJAFS-BBFL7WRS

size of household, land size and gender were insignificant (Table 7). Finally, empirical results are discussed with the marginal effects presented in table 7.

Average Marginal Effects

The odd ratios explain how the log-odds in favour of adopting the strategies of reducing the harmful effects change as the respective covariate changes by one unit. Explaining the effect of the independent variables on adopting the strategies using odd ratios tends to be misleading (Norton et al., 2019). Marginal effects for the regressors were computed using STATA to interpret the effect of the covariates on the dependent variable. Changes in response to a change in a covariate are referred to as marginal effects and can be reported as a derivative or elasticity. The marginal effects are represented by dy/dx in table 7. They estimate and report average predicted probabilities.

Table 7: Logistic regression analysis with average marginal effect (dy/dx) to examine drivers of adoption of deforestation preventive measures.

Adoption	Odds Ratio	Std.Error	Z	P>|z|	dy/dx	P>|z|
Gender: male	1.95	0.877	1.49	0.136	0.0937	0.151
Age	1.04	0.237	1.82	0.069*	0.00551	0.064
Farming experience	0.795	0.493	-3.70	0.000***	-0.0307	0.000
Contracted farmer	0.969	0.486	-0.06	0.949	-0.0423	0.949
Agricultural training: yes	16.0	7.47	5.95	0.000***	0.488	0.000
Education level						
Primary	9.46	8.96	2.37	0.018**	0.327	0.021
Secondary	7.28	6.77	2.13	0.033**	0.292	0.038
Tertiary	13.0	17.8	1.87	0.062*	0.367	0.045
Occupation						
Rural agric work	0.161	0.115	-2.55	0.011**	-0.291	0.020
Rural non-agric work	0.607	0.423	-0.72	0.473	-0.0726	0.495
Employed in town	0.352	0.280	-1.31	0.190	-0.160	0.229
Marital status						
Married	2.00	1.26	1.10	0.272	0.102	0.300
Divorced	1.36	1.21	0.35	0.728	0.0464	0.729
Widow	0.437	0.467	-0.77	0.439	-0.129	0.434
Size of household	0.881	0.0912	-1.23	0.220	-0.0439	0.217
Land size	1.04	0.0496	0.72	0.470	-0.00790	0.470
Area under tobacco	1.13	0.311	0.43	0.666	-0.0562	0.666

LR chi2 (17) = 143.43, P>chi2 = 0.0000, pseudoR2 = 0.35. P<0.01 □□□, p<0.05□□, P<0.1□

Article DOI: 10.52589/AJAFS-BBFL7WRS
DOI URL: https://doi.org/10.52589/AJAFS-BBFL7WRS

As shown in Table 7, age positively influenced adoption at a 10% significance level ($p<0.1$. The marginal effect for age is 0.00551. Thus, an increase in the age of the household head by one year, holding everything constant, increases the probability of adopting the strategies by 0.551%. As expected, the variable age had a positive sign which shows that the age of the farmer positively impacts the adoption of the preventive strategies. This implies that as farmers' age increases, the likelihood of them adopting alternative tobacco curing strategies increases. This is because younger generations have more opportunities to migrate to towns searching for work, leaving older generations in tobacco production. After all, employment opportunities are limited. The study by Mariba (2017) found similar results whereby age significantly influenced the adoption of alternative crops to tobacco farming. This indicates that as the farmer's age increases, the farmer will likely adopt alternative technologies.

However, a study by Kugedera et al. (2020) discovered that age had a significant negative impact on forest harvesting. According to Kugedera et al. (2020), younger ages are more sensitive to forest protection because their education makes them concerned about forest conservation. Manyumwa et al. (2013) discovered that the farmer's age has a negative and significant impact on adopting floating tray technology in tobacco farming. Younger farmers tend to adopt more than older farmers. Older farmers constitute most laggards when innovation or technology adoption is concerned. In addition, older farmers have conservative feelings and are resistant to change. They tend to be risk-averse and may avoid innovations. Furthermore, Namwata et al. (2012) discovered that age influences the adoption of tobacco-recommended varieties.

Primary education and secondary education positively affected adoption at a 5% level while tertiary education positively influence the adoption of strategies at a 10% significant level. The findings show that the farmer's education level positively influences the adoption of alternative strategies to protect the environment from tobacco farming. This means that if farmers have attained at least primary school, they are more likely to adopt the strategies compared to someone without any formal education. The marginal effects for education are 0.327, 0.292 and 0.367 for primary, secondary and tertiary education, respectively. This means having a primary school education increases the probability of adopting by 32.7%, attending secondary education increases the chances of adopting by 29.2% and having tertiary education increases the probability of adopting the strategies by 36.7%, ceteris paribus.

If a farmer is educated, he or she will be aware of the environmental effects of tobacco farming, influencing his or her decision to adopt them. Mariba (2017) discovered similar results, where the farmer's education level positively influenced the adoption of alternative crops to tobacco farming. This means that the rate of adoption increases with the level of education. On the other hand, lack of education hinders information dissemination on the modification of livelihoods, including adopting strategies to reduce deforestation from tobacco production. Education was found to be significant in adopting improved maize varieties in a study by Lopes (2010). This suggests that farmers who spent more years in formal education are more likely to adopt than the less educated because educated farmers assess the profitability of new technologies

Results showed a positive and significant relationship between agricultural training and adopting strategies to reduce deforestation from tobacco production. Agricultural training positively affected adoption at a 1% significant level ($P<0.01$). Having agricultural training on tobacco farming increases the rate of adoption by 48.8%, ceteris paribus (marginal effects = 0.488). Kugedera et al. (2020) found the same results where agricultural training was a

Article DOI: 10.52589/AJAFS-BBFL7WRS
DOI URL: https://doi.org/10.52589/AJAFS-BBFL7WRS

significant and positive factor in reducing the harvesting of forests. This implies the fact that current training programs for farmers are effective in promoting environmental awareness and conservation.

The more training the farmer receives, the fewer the number of trees cut. This also applies to this research as the increase in the farmers' adoption rate is supported by more training services received by the farmer. Chivuraise (2011) also found that agricultural training significantly influenced natural forest harvesting. The farmers' knowledge acquired through these training services results in a reduction in natural forest harvesting.

Farming experience had a negative relationship with the adoption of strategies and is significant at a 1% level, ($P<0.01$). The marginal effect for farming experience was -0.0307, meaning that an increase in farming experience by one year reduces the level of adoption by 3.07%. This is because as the number of years in tobacco production increases, the farmers will become resistant to change as they are used to their way of doing things. Therefore, experienced farmers tend to avoid switching to other fuel sources such as coal and gum plantations thereby causing an increase in the rate of deforestation. Chivuraise (2011) also discovered that the farmer's experience was negative and significant. Farmers' farming experience grows, so they are less likely to rely on natural forests for tobacco curing. Farmers with little farming experience are less likely to increase deforestation because of their willingness to learn about the new strategies of sustainable farming.

The study found a negative relationship between rural agricultural work and adoption, reflected in table 7. The marginal effect was negative, meaning the probability of adopting decreases by 29.1% when someone is involved in rural agricultural work. The variables of rural non-agricultural work and working in town were found to be insignificant in this study. Farmers with other jobs in town have little time to carry out agricultural activities; therefore, they do not adopt the strategies and end up curing with natural forests only.

In this study, gender, household size, marital status, land size, contract farming, and cultivation had an insignificant relationship with adoption. In table 7, LR chi2(17) shows the likelihood ratio (LR) chi-square test while the P>chi2 shows the probability of obtaining the chi-square statistic (71.05) given H_0 is true. The model in this study is statistically significant since P>chi2=0000.

CONCLUSION AND RECOMMENDATIONS

The main objective of this research was to evaluate the factors influencing the adoption of strategies to reduce the deforestation resulting from tobacco production in the Makoni district's Headlands area. The factors that were significant in influencing the farmers' decision to adopt were the farmer's age, farming experience, agricultural training, level of education of the farmer and occupation of the farmer involved in rural agricultural work. On the other hand, the factors that had an insignificant relationship with the farmers' adoption of strategies were marital status, contract farming, size of the household, land size, the area under tobacco and gender. The study recommends that policymakers take into consideration these factors to improve the target effectiveness of their intervention when encouraging farmers to adopt their strategies.

Article DOI: 10.52589/AJAFS-BBFL7WRS
DOI URL: https://doi.org/10.52589/AJAFS-BBFL7WRS

The challenges faced by the smallholder tobacco farmers in the Headlands area include technical and economic problems, natural problems, lack of access to energy, transportation and marketing problems and other problems. When considering possible solutions to assist the farmers, it is vital to take note of the nature of smallholder farmers as they tend to be conservative towards changing to new ways of farming, and the majority of them face constraints of low income.

Farmers are also encouraged to participate in agricultural training programs to gain experience sustaining the environment from tobacco production. The training can help with demonstrations of how gum trees are planted. Farmers would then be able to establish gum plantations as a replacement for the indigenous forests that are being destroyed.

The study further recommends that the government improve its public awareness campaigns. This will help raise awareness among smallholder farmers about the effects of tobacco farming on deforestation and mitigation strategies such as gum plantations and coal use. In addition, the government should provide adequate agricultural training services to farmers. This could be accomplished by hiring more extension officers to train the farmers. These officers should be inspired with adequate resources to reach out to more farmers needing information on sustainable livelihoods, including adopting environmental protection strategies against tobacco production.

The study also found that other farmers are not establishing gum plantations because they do not have enough land to start plantations. Therefore, the government should encourage farmers to plant gum trees by allocating land for collective afforestation projects per community to ensure inclusive involvement in afforestation.

Whilst government agencies and tobacco companies continue to recommend farmers adopt coal and gum plantations as alternatives for tobacco curing to reduce deforestation, these strategies have also been associated with certain negative externalities. Even though eucalyptus is a fast-growing tree that is beneficial for afforestation, it has also been regarded as inefficient. Coal is a fossil fuel that also contributes to greenhouse gas emissions. This study recommends that tobacco contracting companies and government bodies, including TIMB, FCZ and EMA, venture into other sources of energy that can be both affordable for smallholder farmers and climate-friendly.

Rocket barns have also been seen as more efficient in the consumption of woodfuel compared to conventional barns. TIMB and tobacco companies such as British American Tobacco (BAT) have stated that using rocket barn technology can reduce the environmental effects of tobacco production. The Impact of the strategies such as rocket barn usage as a better alternative to reduce deforestation calls for further investigation. Since tobacco has become a controversial crop, it is also suggestable for farmers to transition to other cash crops. However, this transition may take a while as tobacco production is currently regarded as the most important industry in the country due to its contribution to foreign currency.

The study examined only 320 farmers in the Headlands area in the Makoni district. Additional research can cover the entire district to capture socio-economic attributes that were not captured in this study. The study could also be undertaken in other tobacco farming regions to determine the differences in challenges faced by farmers who want to implement strategies to reduce environmental degradation caused by tobacco farming.

Article DOI: 10.52589/AJAFS-BBFL7WRS
DOI URL: https://doi.org/10.52589/AJAFS-BBFL7WRS

REFERENCES

Chitongo, L. (2017). The efficacy of smallholder tobacco farmers on rural development in Zimbabwe (Doctoral dissertation, University of the Free State (Qwaqwa Campus).

Chivuraise, C. (2011). Economics of smallholder tobacco production and implications of tobacco growing on deforestation in Hurungwe district of Zimbabwe, University of Zimbabwe.

Chivuraise, C., Chamboko, T., & Chagwiza, G. (2016). An assessment of factors influencing forest harvesting in smallholder tobacco production in Hurungwe District, Zimbabwe: An application of binary logistic regression model. Advances in Agriculture, 2016.

DAFF. (2015). A framework for the development of smallholder farmers through cooperative development. Department of Agriculture, Forestry and Fisheries, Republic of South Africa.

Deke, P. (2015). The perception of tobacco farming as livelihoods strategy: a case for Yorkshire 10 in Headlands (Doctoral dissertation, BUSE).

Drope, Jeffrey, Qing Li, Edson Correia Araujo, Pandu Harimurti, Gumilang Aryo Sahadewo, Nigar Nargis, Josefine Durazo, Firman Witoelar, and Bondan Supraptilah Sikoki. (2018). The Economics of Tobacco Farming in Indonesia. Washington, D.C. http://documents.worldbank.org/curat- ed/en/161981507529328872/The economics of tobacco-farming-in-Indonesia.

Goma, Fastone, Jeffrey Drope, Richard Zulu, Qing Li, Grieve Chelwa, Ronald Labonté, and Johnny Banda. (2017). The Economics of Tobacco Farming in Zambia. Lusaka. https://www.cancer.org/content/dam/can-cerorg/research/economic-and-healthy-policy/economics-tobacco-farming-zambia-2017.pdf.

Gotore, T., Muchawona, A., Murepa, R., Tembani, M., Mutete, P., Muchena, R., ... & Mujuru, L. (2019). Drivers of deforestation and forest degradation in Zimbabwe. http://www.forestry.co.zw/wp-content/uploads/2022/01/Report-on-drivers-of-deforestation-and-forest-degradation-in-Zimbabwe.pdf

Gujarati, D. N. (2011). Econometrics by example (Vol. 1). New York: Palgrave Macmillan

Gujarathi, D. M. (2022). Gujarati: Basic Econometrics. McGraw-hill.

Kamuti, T. (2022). A Checkered Pathway to Prosperity: The Institutional Challenges of Smallholder Tobacco Production in Zimbabwe. In Rural Transformations (pp. 71-87). Routledge.

Kaunye, F. N. (2015). Assessing the sustainability of contract farming as a tool for poverty reduction in Yorkshire resettlement (ward 6) area of Headlands, Manicaland, Zimbabwe (Doctoral dissertation, BUSE).

Kugedera, A. T., Sakadzo, N., Museva, T., Chivhenge, E., Kugara, S. L., & Chimbwanda, F. (2020). The link between Indigenous Knowledge Systems and sustainable agricultural production in Zimbabwe. African Journal of Religion, Philosophy and Culture, 2(2), 19.

Lawrence, M., Tapiwa, K. A., Lovemore, M., & Michael, M. (2020). Smallholder tobacco farmers and forest conservation in Mutasa District, Zimbabwe. landscape, 30, 33.

Lopes, H. (2010). Adoption of improved maize and common bean varieties in Mozambique, Michigan State University

Manyumwa et al., (2013). Extent and adoption determinants of floating tray technology by smallholder tobacco farmers: A case of Zimbabwe, Department of Agricultural Economics, Education and extension, Bindura University of Science Education, Bindura, Zimbabwe

Article DOI: 10.52589/AJAFS-BBFL7WRS
DOI URL: https://doi.org/10.52589/AJAFS-BBFL7WRS

Madamombe, G. T., Chipfupi, E., Utete, B., & Olorunnissola, A. O. (2019). The potential of agro-waste briquetting for domestic heating and cooking as an environmental management strategy in Rushinga, Zimbabwe.

Magati P, Hecock RD, Li Q, Drope J. (2020). The Economics of Tobacco Farming in Kenya: A Longitudinal Study. Nairobi: International Institute of Legislative Affairs // Chicago: Tobacconomics, University of Illinois at Chicago.

Mariba, J.M (2017). Socio-economic attributes hindering adoption of alternative crops to tobacco farming in Kehancha Division Kuria west sub-county, Kenya, School of environmental studies of Kenyatta University

Matiashe, F.S. (2022). Zimbabwe: Tobacco farming is fuelling deforestation. The Africa Report. https://www.theafricareport.com/214001/zimbabwe-tobacco-farming-is-fueling-deforestation/.

Mishra, S., & Mishra, M. B. (2013). Tobacco: its historical, cultural, oral, and periodontal health association. Journal of International Society of Preventive & Community Dentistry, 3(1), 12.

Mutenyo, S.A (2016). Environmental, Health and Safety implications of tobacco production in Malakisi division, Bungoma county, Kenya.

Namwata et al., (2012). Adoption and Impact of tobacco recommended varieties among smallholder farmers in Tabora Region, Journal of Agricultural science and technology, Tanzania

Norton, E. C., Dowd, B. E., & Maciejewski, M. L. (2019). Marginal effects—quantifying the effect of changes in risk factors in logistic regression models. Jama, 321(13), 1304-1305.

Nyambara, P. S., & Nyandoro, M. (2019). 'Tobacco Thrives, but the Environment Cries': The Sustainability of Livelihoods from Small-Scale Tobacco Growing in Zimbabwe, 2000–2017. Global Environment, 12(2), 304-320.

Rashikayi, F. (2018). The Impact of tobacco farming on local forests in ward 1, Makonde district, Zimbabwe (Doctoral dissertation, BUSE).

Runganga, R., & Mhaka, S. (2021). Impact of agricultural production on economic growth in Zimbabwe. MPRA Paper No. 106988. Available online at https://mpra.ub.uni-muenchen.de/106988/. [Accessed on 20 January 2022]

Sacchetto, C. (2012). The impact of tobacco-growing on deforestation: Assessment of the situation based on independent publicly available information. Rome, UNITAB-FETRATAB.

Scoones et al., (2016). Tobacco, contract farming and agrarian change in Zimbabwe, Journal of Agrarian Change. Available at https://doi.org/10.1111/joac.12210

Shati, N., Madanhire, I., & Mashonjowa, E. (2021). Selection Criteria for a Tobacco Curing Solar Thermal Collector Energy System in Zimbabwe: Criterios de selección de un sistema de energía solar térmica para el curado del tabaco en Zimbabue. South Florida Journal of Development, 2(3), 3998-4013.

Stigler Granados, P., Fulton, L., Nunez Patlan, E., Terzyk, M., & Novotny, T. E. (2019). Global health perspectives on cigarette butts and the environment. International journal of environmental research and public health, 16(10), 1858.

TIMB. (2015). Tobacco industry and marketing Board annual statistical report, 2013–15. Available online. http://www.timb.co.zw/ [Accessed: 19 September 2021]

TIMB. (2018). Tobacco industry and marketing Board annual report, 2018. Available online, http://www.timb.co.zw/. [Accessed: 20 September 2021].

Article DOI: 10.52589/AJAFS-BBFL7WRS
DOI URL: https://doi.org/10.52589/AJAFS-BBFL7WRS

TIMB. (2016). Tobacco industry initiatives to reduce the negative environmental footprint caused by tobacco production. Available online. https://www.timb.co.zw/storage/app/media/downloads/Initiatives%20for%20Reducing%20the%20Negative%20Environmental%20Footprint%20of%20Tobacco.pdf.

Tranmer, M., & Elliot, M. (2008). Binary logistic regression. Cathie Marsh for census and survey research, paper, 20.

WHO. (2017). Tobacco and its environmental Impact: An overview. Geneva: World Health Organization; 2017.

WHO. (2021). Status of tobacco production and trade in Africa. Geneva: World Health Organization; 2021.

Zvobgo, L., & Tsoka, J. (2021). Deforestation rate and causes in Upper Manyame Sub-Catchment, Zimbabwe: Implications on achieving national climate change mitigation targets. Trees, Forests and People, 5, 100090.

Article DOI: 10.52589/AJAFS-BBFL7WRS
DOI URL: https://doi.org/10.52589/AJAFS-BBFL7WRS