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Determinants of Tobacco Cultivation and the Associated Impacts of Adoption in Hurungwe District, Zimbabwe

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Abstract

Tobacco is an essential cash crop in Zimbabwe and a strategic livelihood option for hundreds of thousands of rural households. However, the crop is linked to negative environmental, economic, and social impacts. The existing studies on tobacco cultivation in Zimbabwe present contradictory findings on the determinants and impacts of adoption, leaving unanswered questions about the crop's sustainability impact in the country. This article investigates the determinants of smallholder farmers' decisions to grow tobacco and the associated impacts of adoption. Random and purposive sampling were used to select 273 household surveys, including tobacco and non-tobacco smallholder farmers, and 56 expert interviews to answer the research questions. We employed regression models alongside expert interviews and document analysis to identify the determinants influencing the decision-making process of smallholder farmers in Zimbabwe regarding tobacco cultivation. Additionally, our investigation aimed to elucidate the perceived impacts associated with the adoption of this agricultural practice. The regression analysis indicated that the farmer's age, education level, farming experience, family size, household income, and perceived high farm profitability are significant drivers of tobacco adoption. We also discovered divergent and convergent perceptions of the critical impacts of tobacco cultivation. The study highlights the need for proactive multi-stakeholder collaboration and sustainable financial arrangements to address the negative impacts of tobacco production. As the primary stakeholder responsible for regulating and promoting agricultural activities, the Zimbabwean government should provide meaningful financial support, increase access to credit, and ensure better market facilities for alternative crops to reduce the over-dependence on tobacco.

1. Introduction

Agricultural activities in Sub-Saharan Africa (SSA) have witnessed substantial growth in recent decades, with a notable emphasis on cultivating cash crops such as tobacco, coffee, cocoa, cotton, palm oil, and sugarcane. This upsurge can be attributed to many factors driven by context-specific institutional, socioeconomic, biophysical, and ecological elements [1]. From historical pre- and post-colonial dynamics to contemporary land redistribution initiatives, tenure systems, and prominence of small-scale farmer [2] several low-income countries are actively encouraging cash crop production to respond to global market demands, stimulate national economies, modernize their agricultural sectors, and expedite overall development [3].

However, it is imperative to acknowledge that cash crops substantially influence environmental, economic, social, and institutional transformations [4]. For example, tobacco, a contentious cash crop in various regions of the globe, particularly developing nations, plays a crucial role in farmers' economic livelihoods and is a vital source of foreign exchange in countries like Bangladesh, Tanzania, Malawi, and Zimbabwe [5] [6] [7] [8]. Despite its substantial socioeconomic contributions, tobacco poses severe environmental harm, health hazards, and economic burdens due to expanding populations, lax tobacco controls, and an escalating smoking burden [8] [9]. In Zimbabwe, the tobacco industry carries profound economic significance, contributing to over 10% of the Gross Domestic Product (GDP), providing livelihoods for more than 1.2 million people, and supporting up to five million dependents. Illustrating its pivotal role, in the year 2021 alone, this sector emerged as the nation's foremost export, yielding a substantial sum of around US$819.7 million [10]. The paradox of tobacco lies in its dual role of simultaneously causing harm and serving as a livelihood option for millions of people. This duality creates barriers against stringent regulatory policies due to fears regarding adverse economic consequences for smallholder farmers. This predicament places farmers at the juncture of environmental sustainability, income stability, food security, poverty alleviation, and health outcomes [11].

An increasing number of studies in Africa examine the political economy and impacts of tobacco farming [8] [12] [13] [14]. These studies highlight the negative effects of tobacco production and raise the fundamental question of why farmers continue tobacco cultivation despite the negative impacts directly linked to the cash crop. Context-dependent factors such as institutional factors and high farm profitability have been cited as the most significant drivers of adop-

tion [6] [15] [16] [17] [18]. This research builds on the existing literature to better understand what influences smallholder farmers to grow tobacco in the Hurungwe district, Zimbabwe. By examining the local factors unique to the Hurungwe district, this analysis can shed light on the complex interplay of social, economic, and environmental factors that influence farmers' decision-making processes in the Sub-Saharan context. Moreover, it is essential to understand the existing connections among stakeholders and perceptions of drivers and impacts of tobacco cultivation. Ultimately, this research can inform policy and practice to promote sustainable agriculture and mitigate the negative sustainability impacts of tobacco cultivation in Zimbabwe.

2. Methods

2.1. Research Approach

This study employs the theoretical framework of social embeddedness to investigate the determinants of tobacco cultivation adoption behaviors in Zimbabwe. The social embeddedness theory, as proposed by Granovetter in 1985, provides a systematic and scientifically robust approach to examining socioeconomic behaviors and actions of individuals. This approach underscores the significance of social relations and networks in shaping economic outcomes, positing that economic actions are deeply rooted within the networks of interpersonal relationships [19].

In this context, the theory is applied to understand how the political-economic environment in Zimbabwe influences farmers' decisions to take up tobacco cultivation. Drawing from the social embeddedness theory, our conceptual framework emphasizes that tobacco cultivation adoption behaviors are significantly influenced by a combination of institutional, socioeconomic, bio-physical, and environmental factors, which in turn are impacted by the individual and family characteristics of farmers, including age, gender, education, and family size, respectively (Figure 1). The process of tobacco adoption encompasses various sequential stages, where socioeconomic factors play a role in the initial decision to adopt tobacco farming. In contrast, perceptions of tobacco farming outcomes ultimately determine whether adoption or rejection occurs. Tobacco cultivation can result in augmented high agricultural income, improved food security, diversification of livelihoods, increased biodiversity loss, and health risks [14]. Conversely, the non-adoption of tobacco cultivation may lead to decreased farm income but can play a crucial role in mitigating biodiversity loss, land degradation, and water pollution, as well as Greenhouse Gas (GHG) emissions [8] [20] [21] [22].

2.2. Data Collection

This research was carried out in the Hurungwe District of Zimbabwe, a prominent hub for tobacco cultivation, contributing significantly to the agricultural landscape with 35% of the registered tobacco growers. As of 2021, the district

What factors influence smallholder farmers' decisions to cultivate tobacco, and what are the perceived impacts of adoption?
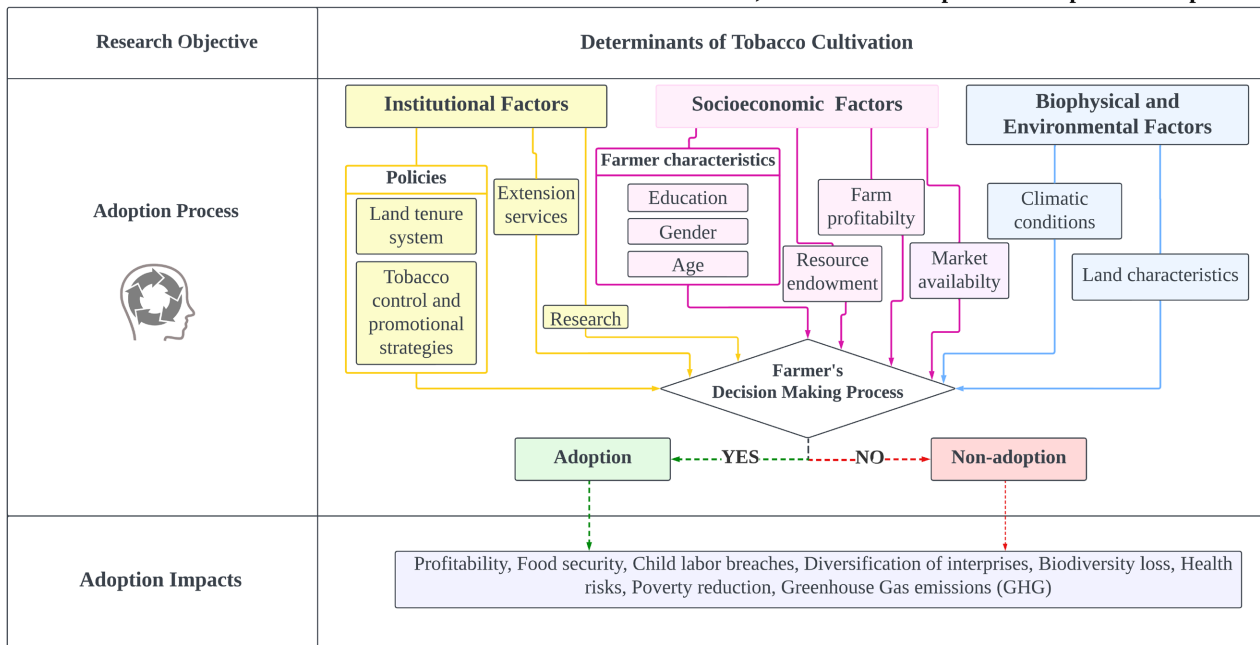

Figure 1. Conceptual framework related to tobacco adoption and the associated impacts in Zimbabwe.

had 33,452 registered tobacco farmers, managing 26,244 hectares under the crop [23]. Given the promising economic prospects associated with tobacco farming, it serves as the primary source of livelihood for the majority of the local population [14] [23] [24] [25] [26].

The primary data collection method employed a semi-structured household questionnaire survey designed based on stakeholder input and a comprehensive review of pertinent literature about tobacco cultivation [27] [28]. The selection of research sites within the district involved the identification of six administrative wards, chosen based on the density of tobacco cultivation and the number of participating farmers in each locale [27]. A list of registered tobacco and non-tobacco farmers in the selected wards was obtained from the Department of Agricultural Technical and Extension Services (AGRITEX) and the Tobacco Industry and Marketing Board (TIMB).

Cochran's formula [29] was utilized to ascertain the appropriate sample size, randomly selecting 300 small-scale farmers from the registered pool of smallholder farmers. Face-to-face interviews were conducted with the assistance of local enumerators, and a total of 273 smallholder farmers were included in the final analysis. The survey included 201 small-scale tobacco farmers with at least three years of tobacco farming experience and 72 non-tobacco farmers. Before the final survey, the questionnaire was piloted in the city of Karoi and revised to ensure the collection of relevant data to address the research objectives.

2.3. Document Analysis

To capture the dynamics of tobacco production and forest loss, we started by

understanding the policies, regulations, and critical actors associated with tobacco production in Zimbabwe. Document analysis tracked historical policy changes from 1989 to the present study period (1989-2022). The analysis and document gathering were streamlined to follow [30] and [31] consisting of three stages: partial screening and locating the relevant documents, in-depth screening, summarizing, and identifying key findings and inconsistencies Figure 2.

The policy exploration was multidimensional and cross-sectional, including, but not limited to, agricultural production, forestry, health and welfare, and land management strategies, directly and indirectly affecting tobacco production in Zimbabwe. We also identified significant policies and Structural Adjustment Programs (SAPs) in the country's social, economic, and political landscape to demonstrate their coherence or conflict in relation to tobacco production. Finally, we analyzed the roles of the main stakeholders, including the government and its agencies, multilateral institutions (British American Tobacco, Tian Ze (China Tobacco), US Universal Leaf Tobacco, and Japan Tobacco), the Tobacco Industry Marketing Board (TIMB), the private sector, Non-Government Organization (NGOs) and other Civil Society Organizations (CSOs) who may have an influence or interest in tobacco farming in Zimbabwe.

2.4. Key Expert Interviews

Based on the literature review and purposive sampling [32], fifty-six (n = 56) stakeholder respondents consented to be interviewed and audio recorded between August 2020 and March 2022. The substantial sample size provided a diverse data set and viewpoints based on the different organizations and cross-sectoral stakeholders interviewed. The stakeholders consisted of the government and parastatal agencies (n = 7), the private sector (licensed tobacco purchasing companies) (n = 11), Non-Government Organizations (NGOs) (n = 9), Civil Society Organizations (CSOs) and farmers (n = 21), and research institutions (n = 8) (Table 1). The individual respondents in each organization were either directly involved in tobacco farming or making the mandates related to
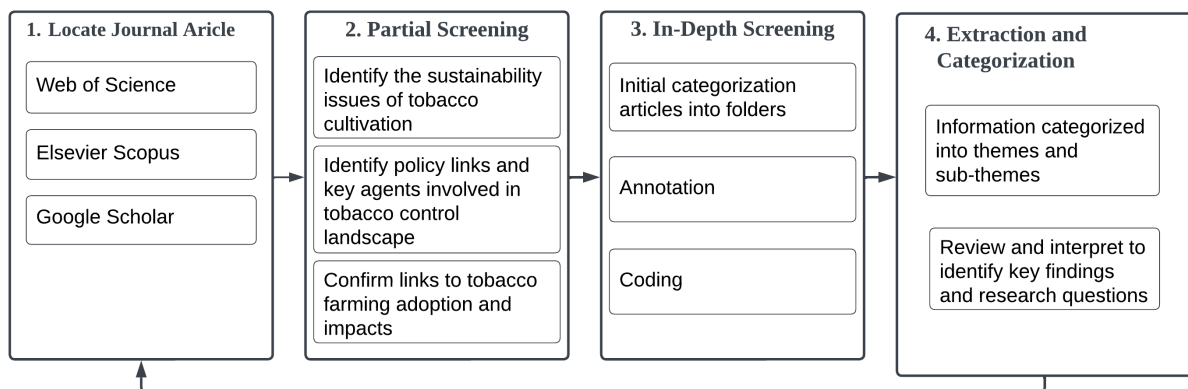

Figure 2. Four-step research method for literature review and document analysis approach.

Table 1. Description of interviewed stakeholders.

Organization	Department	Position	Reference code
Government institutions			
Tobacco Industry Marketing Board (Main)	Research, Monitoring, and Evaluation	Principal Research Officer Senior Research Officer	TIMB
Environmental Management Agency	Environmental Management Services Department	Chief Programme Officer	EMA
Forestry Commission Zimbabwe	Research and training	REDD + Consultation Specialist	FCZ
Ministry of Lands, Agriculture, Water, Climate and Rural Resettlement	AGRITEX	Extension officers	MoA
Zimbabwe Farmers Union (ZFU)	Field and Operations	Field Researcher	ZFU
Department of The Surveyors General	GIS and Mapping	Director	DSG
Rural District Councils	District Administrator's Office	Deputy District Administrator	RDC
Technical companies/licensed purchasing companies			
Zimbabwe Leaf Tobacco Company (ZLTC)	Extension and Contract farming	Technical Trainer	ZLTC
Northern Tobacco (NT)	Contract farming	Project leader	NT
Premium	Operations Department	Project Manger	Pr
Tian Ze	Contract farming	Tobacco Buyer	TZ
Shasha	Extension Services	Tobacco Buyer	Sha
Research institutions			
University of Zimbabwe	Department of Economics	Research Scientist	UZ
Tobacco Research Board	Research and Extension Services	Agricultural Economist	TRB
Civil Society Organizations/Non-Governmental Organizations			
Environmental Buddies, Zimbabwe	Field Operations	Field staff	EBZ
Rift Valley	Operations Department	Project Manger	RV
Smallholder Tobacco Farmers	Farmer (SSA)	Extension Officer	STF

tobacco regulation and control, forest management, conservation, and development planning efforts. These stakeholder interviews captured the scope of stakeholder perspectives on the drivers and impacts of tobacco cultivation. Respondents were asked to reflect on their organization's position rather than their personal opinion. As a result, open-ended questions were employed to enable respondents to expound on their responses. Each respondent's initial questions

were the same to provide uniform perception across stakeholder groups. Selective probing questions were then utilized to extract some of the respondents' specific knowledge of drivers and the impacts of tobacco farming in Zimbabwe. Most interviews were conducted in person (54), while two (2) were conducted remotely via Zoom or Skype.

2.5. Statistical Analysis

Different models have been used to predict and describe the factors affecting the decision-making process of an individual, whether to adopt a new technology, given a set of characteristics [33]. The widely used models include Probit, Discriminant, and Logistic [34] [35]. Analysts often utilize Ordinary Least Squares (OLS) for predicting binary outcomes. However, it is worth noting that OLS predictions may sometimes generate probabilities beyond the plausible range of zero to one, rendering such results nonsensical [36]. In this analysis, however, the linear probability model (LPM), a component of the OLS model, was used to validate the plausibility and robustness of the coefficients. A cross reference of the two models was done to determine the structural validity of the logistic regression model [37]. For this study, the adoption of tobacco farming is modeled around a binary choice approach where the farmers measure the level of utility as a result of adoption compared to non-adoption [38]. Based on this premise, the adoption of tobacco cultivation was measured utilizing a binary dependent variable, where a value of 1 denotes adoption, and 0 signifies non-adoption. Specifically, a farmer qualifies as an adopter if they have engaged in tobacco cultivation for a minimum of three consecutive years, actively participating during the data collection period.

The models are specified as follows:

$$Y_i = \frac{e^{(\alpha + \beta_i \chi_{ij})}}{1 + e^{(\alpha + \beta_i \chi_{ij})}} \tag{1}$$

The transformation of the model into a binary logistic regression model involves expressing it as a linear function of explanatory variables:

$$\text{Logit}(Y_i) = \alpha + \beta_i \chi_{ij} \tag{2}$$

where:

Y_i represents the adoption decision of a farmer.

X_{ij} = jth encompasses all explanatory variables considered in the research.

α is the constant term of the regression equation to be predicted.

β_i are coefficients to be estimated.

The coefficients can be interpreted either as the change in the odds log or as changes in probability in favor of success after calculating marginal effects. Marginal effects for the logit model are estimated as follows:

$$\frac{\partial P_i}{\partial \chi_i} = \hat{\alpha} \frac{\partial F(\chi_i \hat{\alpha})}{\partial \chi_i} = \hat{\alpha} \frac{\exp(-\chi_i \hat{\alpha})}{(1 + \exp(-\chi_i \hat{\alpha}))^2} \tag{3}$$

The slope coefficients in this study are interpreted as marginal effects as estimated in the equation above.

Linear Probability Model (LMP) predicting tobacco cultivation decisions.

$$Y_i = \alpha + \beta_i \chi_{ij} \tag{4}$$

2.6. Variable Selection

The study used a combination of document analysis and empirical evidence from local and regional studies on tobacco farming adoption to select the measurement variables. The document analysis was limited to local to regional studies focusing on tobacco farming adoption. The assumption was that the identified variables in local and regional contexts would potentially apply and influence our study area's tobacco cultivation decision-making process. The identified variables included farmers' demographic characteristics, institutional factors, and farm agronomic factors [39] [40]. Specifically, the explanatory variables included the age of farmers, gender of farmers, education level of farmers, access to credit, household size, farm productivity, farm Income, distance from the main road, proximity to the forest, amount of credit, and contract farming (Table 2). Employing the maximum likelihood method, the relationships were predicted utilizing the STATA version 17 computer program (Copyright 1996-2023 Stata Corp LLC).

3. Results

3.1. The Institutional Landscape of the Tobacco Sector in Zimbabwe

Our findings reveal that the tobacco industry involves various actors, including the government, private sector, non-governmental organizations, and civil society stakeholders, all of whom are either directly or indirectly engaged in tobacco control and production (Table 1). These stakeholders are interconnected in various ways, but the relationships are poorly understood because there is little research on this topic. The mapping exercise presented in this paper (Figure 3) is the first to comprehensively gather and synthesize all the different perspectives of stakeholders. The map also takes into consideration their varying roles and interests in Zimbabwe's tobacco production and control landscape. It is critical to acknowledge that these stakeholder perspectives are influenced by their vested interests and partial knowledge of the subject matter [41]. While this is not inherently a limitation, recognizing these factors is essential to prevent any misrepresentation of the study's findings, particularly in multi-stakeholder environments. Understanding the diverse nature of these relationships among stakeholders is imperative to comprehensively discern how tobacco is adopted, propagated, and regulated in Zimbabwe. By identifying issues associated with the tobacco production system, policymakers can develop effective strategies to address sustainability challenges linked to tobacco production.

Table 2. Description of the variables used in the regression model.

Domain	Explanatory variables	Description	Measurement
Demographic factors	Gender	Gender of the household head	Male = 1 Female = 0
	Age	Age of the household head	Number of years
	Household size	The number of household members	The adult equivalent of household members
Socioeconomic factors	Education	Education level of the household head	Years of schooling (Number)
	Farming experience	Number of years engaged in all agricultural activities	Years of engaging in farming (Number)
	Income	Household income in the US dollars	Total household income
	Farm size	Size of household farming land	Hectares (Ha)
	Land tenure	Legal regime of land ownership	1 if the land is purchased or inherited; 0 if rented or leased.
Geographical factors	Access to the forest	Total distance to the most used woodland for fuelwood collection	Kilometers (Km)
	Distance to the nearest main road	Total distance to the nearest main road or town center	Kilometers (Km)
	Farm distance	Total distance to the farm	Kilometers (Km)
Institutional factors	Extension visits	Access to farm management extension services offered by government agencies.	Number of visits
	Credit	Money obtained as loan from formal and informal sources (contract farming or financial institutions)	Amount in US dollars
	Access to internet	Access to mobile or home internet	1 if has access to any kind of internet; 0 otherwise.
	Participation in contract farming	Access to credit and inputs from formal and informal sources (contract farming)	1 if participating in contract farming; 0 otherwise

A complex network consisting of the government, parastatals, the private sector, and civil society organizations supports tobacco production in various ways; as a result, these stakeholders are connected through policy lines, implementation, research, funding, and advocacy. At the international level, there are transnational corporations (TNCs) such as British American Tobacco (BAT), the China National Tobacco Company (CNTC), the United States Universal Leaf
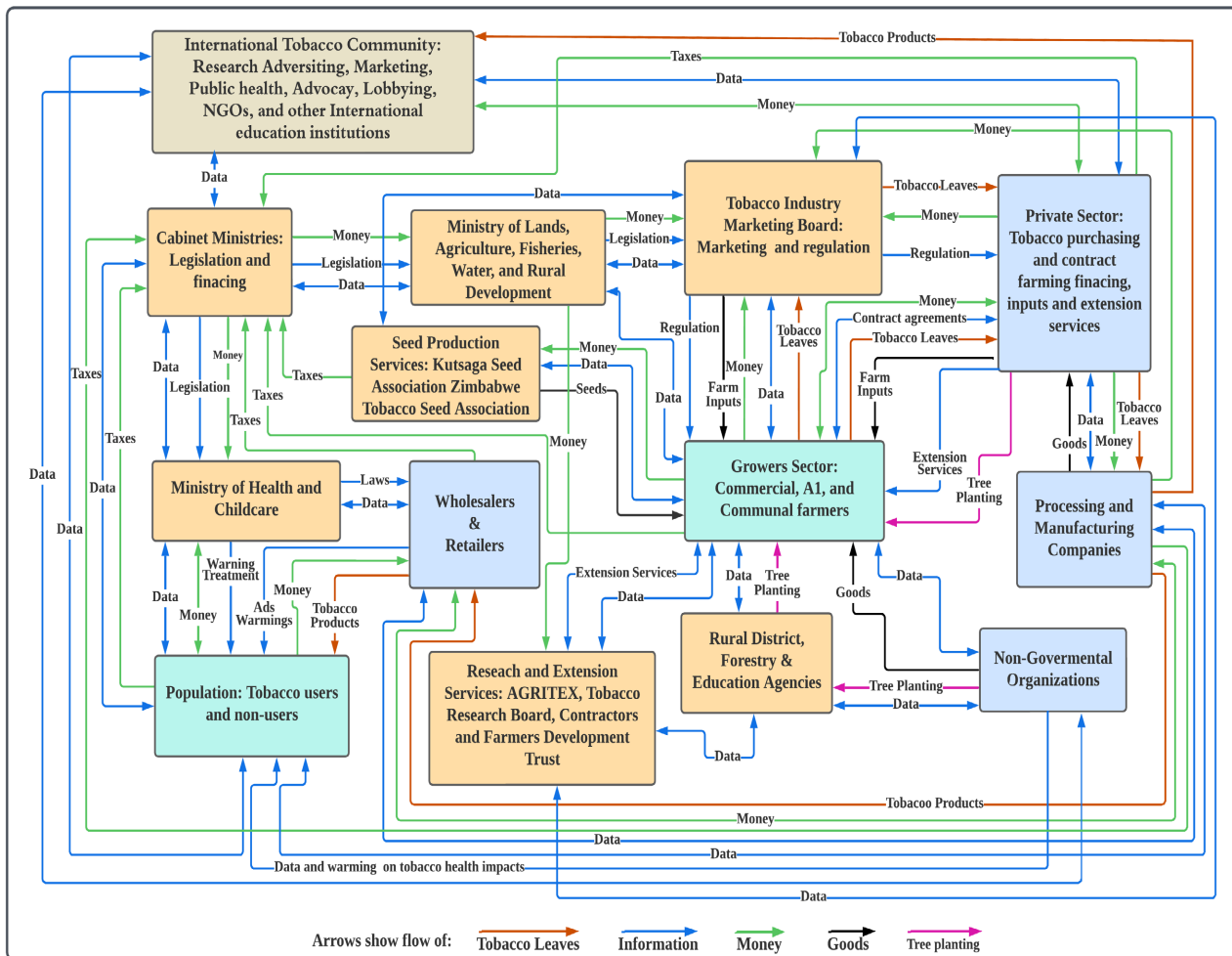
Figure 3. Interactions and dynamics among key stakeholders in Zimbabwe's tobacco cultivation and control landscape.

Tobacco, and Tribac (Japan Tobacco) tobacco-purchasing companies that promote tobacco production through lobbying, funding, and research. At the international level, transnational companies (TNCs) downplay deforestation associated with the tobacco industry, declaring that deforestation causes are diverse and unrelated to tobacco production by noting beneficial afforestation projects in which they are actively involved [8].

At the national level, the government of Zimbabwe is the primary custodian of the policy and legislation in the country. Policy development and implementation are done in collaboration with other Ministries. The Ministry of Lands, Agriculture, Fisheries, Water, Climate, and Rural Development focuses on implementing and regulating all agricultural activities in the country. The Tobacco Industry Marketing Board (TIMB) is directly involved in regulating and promoting the development of the tobacco sector. The TIMB is the focal government agency responsible for regulating tobacco farming, registering farmers, and creating a conducive environment for tobacco production (**Figure 3**) [27]. Comparable to Ruckert *et al.* [14], this study emphasizes the restricted engage-

ment of non-governmental organizations (NGOs) in the control and oversight of tobacco production within the tobacco production landscape in Zimbabwe. NGOs are actively engaged in the advancement of research, technical expertise dissemination, and intellectual capacity building for smallholder farmers. Their primary emphasis lies in poverty alleviation by facilitating external funding from international donors, which is channeled towards initiatives fostering alternative income streams. These endeavors are deliberately detached from tobacco cultivation, aligning with the objective of sustaining, and backing farmers through projects unrelated to tobacco-related pursuits.

The private sector plays a pivotal role in the tobacco industry by offering financial support through contract farming arrangements, establishing itself as a prominent stakeholder within the sector. Contract farming serves as a means of extending direct financial assistance from private entities, as documented in several previous studies in the country [26] [27] [42] [43]. These contractual agreements, which involve collaboration between farmers and leading international tobacco corporations like Tian Ze and Japan Tobacco, encompass the provision of essential agricultural resources, including seedlings and agrochemicals, alongside monetary advances for farm labor and transportation expenses. According to the TIMB, the contract farming system has prompted the widespread adoption and expansion of the tobacco industry in Zimbabwe.

The Ministry of Health and Childcare is primarily responsible for developing and implementing policies and regulations to control tobacco consumption and marketing in the country. For example, the 2002 Public Health Control Act prohibits smoking in public and selling or promoting tobacco to minors (under 18). Despite the health risks associated with tobacco farming, none of the Ministry of Health's objectives directly seek to limit tobacco production at the farm level, as this would contradict the government's strategic aims of keeping tobacco production as a critical source of foreign currency.

However, the health effects of tobacco are not confined to consumption (smoking) alone; growers are also exposed to pesticides and agrochemicals associated with respiratory problems and skin diseases. Green Tobacco Sickness (GTS) is a tobacco-related health condition resulting from nicotine dermal absorption owing to skin contact with tobacco leaves during cultivation [44]. Given that the current policy does not give the Ministry a direct line of communication with the farmers, these medical issues cannot be addressed beyond hospital treatment.

Finally, other important players include forest conservation organizations and NGOs (Forestry Commission of Zimbabwe (FCZ)) and Sustainable Afforestation Association (SAA)) and research institutions (Tobacco Research Board (TRB)) that promote afforestation activities to mitigate the impact of tobacco curing on forest loss and provide data on the most effective tobacco agronomic practices. For instance, the SSA's mission is to reduce the impact of tobacco curing on forests by planting more trees, educating the public about the value of

natural forest resources, and advocating for forest conservation regulations. Since its creation in 2013, the SSA has partnered with small-scale farmers and other NGOs, such as the Rift Valley Corporation, to restore 20,000 hectares of eucalyptus plantations [14].

The TRB is the premier research institute driving tobacco research in Zimbabwe. TRB primarily supports government efforts to increase tobacco productivity by researching the most effective tobacco agronomic practices and providing tobacco farmers with the necessary knowledge to maximize their productivity and profitability. TRB also conducts experimental wood fuel consumption efficiency studies comparing new tobacco curing (drying) technology, such as the rocket barn, to the traditional barn. Improving curing technologies is necessary to reduce tobacco-related deforestation in Zimbabwe [45]. Organizations such as universities and independent researchers perform agronomic studies on tobacco farming practices, highlighting tobacco cultivation's social, economic, and environmental effects. Our quantitative research on the impact of small-scale tobacco cultivation falls in this category.

3.2. Demographic Characteristics

The gender breakdown of the household questionnaire survey showed that 34.4% of respondents were female and 65.6% were male, indicating that men continue to be the primary household decision-makers in Zimbabwean society due to social and cultural barriers. The average age of the farmers surveyed was 41 years, with an average education of 7 years and an average household size of 6 people. These factors may impact farmers' ability to adopt new technologies and improved crop production methods, although the larger household size may increase access to family labor resources, which is important for agricultural production.

3.3. Factors Influencing Tobacco Cultivation Decisions

To identify the factors statistically influencing involvement in tobacco cultivation, two regression models were applied. Before fitting the models, we computed the pairwise correlation matrix to determine whether the explanatory variables were intercorrelated. Multicollinearity makes it challenging to isolate the effect of a single independent variable on the dependent variable. Correlation statistics revealed no serious multicollinearity issues; therefore, the Binary Logistic Regression (Logit) and Linear Probability Model (LPM) were applied. The maximum likelihood estimates and odds ratios of our model are displayed in Table 3. From this table, we observe that a farmer's age has a positive effect on tobacco cultivation.

That is, as the farmer's age increases, the odds of tobacco farming also increase significantly ($p < 0.01$). To be specific, for every yearly increase in age, the likelihood of choosing tobacco cultivation rises by 2.1%. However, this trend reverses as farmers reach old age, likely due to their reduced inclination for labor-intensive crops like tobacco.

Table 3. Regression coefficients of factors influencing tobacco cultivation decisions.

Explanatory variables	Binary Logistic Regression		LPM
	Marginal Effects		
Gender	0.388	0.036	0.053
	(0.415)	(0.039)	(0.044)
Farmer's Age	0.227**	0.021**	0.024**
	(0.108)	(0.010)	(0.009)
Age squared	−0.002*	−0.000*	0.000**
	(0.001)	(0.000)	(0.000)
Education level	0.224***	0.021***	0.03***
	(0.056)	(0.004)	(0.006)
Farming experience	−0.165**	−0.016**	−0.01
	(0.075)	(0.007)	(0.007)
Household size	0.387 ***	0.036***	0.03***
	(0.117)	(0.010)	(0.009)
Total household income	1.607***	0.151***	0.181***
	(0.277)	(0.019)	(0.025)
Credit	−1.75*	−0.164*	−0.106*
	(0.901)	(0.083)	(0.098)
Extension support	1.913**	0.179**	0.101
	(0.93)	(0.085)	(0.098)
Access to forest	−0.068	0.036	−0.005
	(0.066)	(0.006)	(0.006)
Constant	−18.956***		0.000***
	(3.443)		(0.282)

Note: Significance levels are denoted as follows: *** $p < 0.001$, ** $p < 0.01$, and * $p < 0.05$, with standard errors presented in parentheses (). LPM shorthand references the Linear Regression Model.

Education plays a pivotal role in farmers' crop choices, as those with higher education levels are more inclined toward tobacco farming compared to those without primary education ($p < 0.001$). For each increase in education level, the likelihood of tobacco farming increases by 2.1%, indicating that educated farmers are rational beings capable of comprehending the best agricultural practices and the economic advantages of tobacco farming. Surprisingly, farming experience exerts a negative influence on tobacco adoption ($p < 0.01$). An additional year in tobacco farming reduces the probability of future involvement by 1.6% and 13.6% in the two models, respectively. Credit also negatively impacts tobacco adoption, decreasing the probability by 10.6%. Household size and income exhibit positive effects on tobacco cultivation ($p < 0.001$). Farmers who perceive tobacco as profitable and have higher household incomes are 15.1% more likely to adopt tobacco production. Additionally, larger households, likely reliant on family labor, are 3.6% more inclined to start tobacco farming.

Extension support significantly enhances the likelihood of tobacco cultivation adoption by 17.9%. This assistance provides farmers with valuable information and guidance for efficient crop cultivation. Notably, distance from the nearest forest and gender does not significantly influence the decision to cultivate tobacco in this analysis (p > 0.10). To ensure the reliability of our logistic regression model, we conducted further analysis using the LPM. The results align with the binary logistic regression model, confirming the statistical significance of age, age squared, education, household size, and income, except for household size, farming experience, and extension support in the LPM.

3.4. Institutional Landscape and Perceived Impacts of Tobacco Farming

The primary sustainability impacts of tobacco cultivation in Zimbabwe are well-acknowledged by most stakeholders. Table 4 elucidates these main impacts and their underlying mechanisms, as emphasized by the stakeholders interviewed. Out of 56 stakeholders, 48 cited deforestation as the primary negative impact associated with tobacco cultivation (Figure 4). Other negative impacts directly linked to tobacco cultivation include biodiversity loss (n = 26), soil degradation (n = 22), low farm crop diversity and health challenges (GTS) (n = 15), and frequent breaches of child labor laws (n = 19). For example, some stakeholders pointed out that Zimbabwe has robust mechanisms for monitoring child labor violations across different sectors. However, lack of awareness and adequate funding, enforcing such laws becomes challenging in an economy where children often work to support their families (personal communication: MoA; TIMB; EBZ; RV; STF).
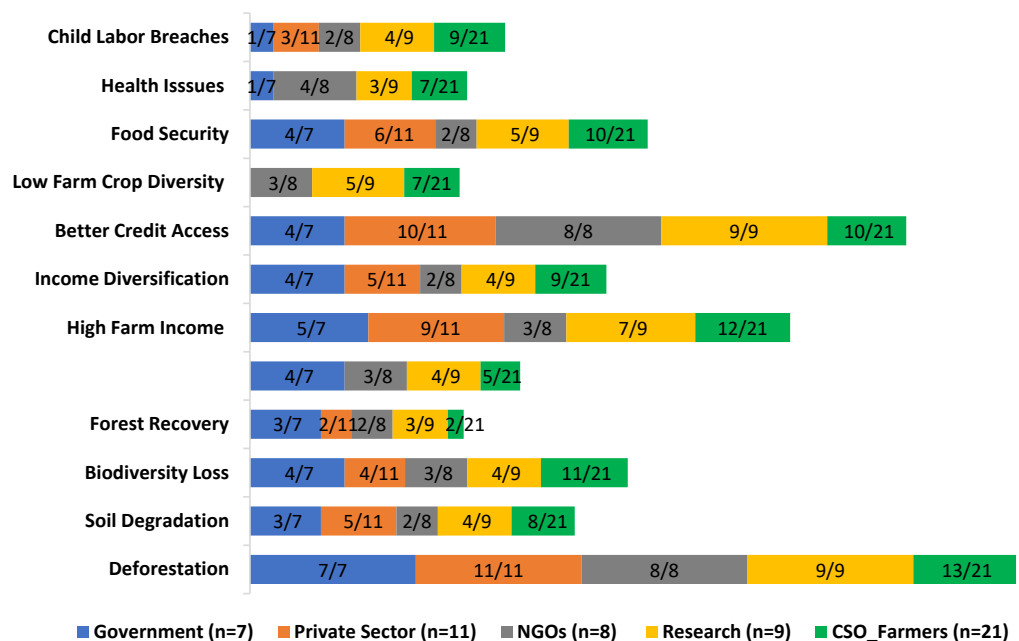

Figure 4. Key perceived impacts of tobacco cultivation in Zimbabwe.

Table 4. Sustainability impacts and mechanisms of tobacco cultivation in Zimbabwe: perceptions and realities.

Dimensions	Impact category	Impact mechanisms	Stakeholder citation
Economic	Better technical extension support	-Timely access to agricultural inputs -Adoption of improved agricultural methods taught via extension and training.	TIMB; MoA; EMA; FCZ; ZFU; ZLTC; NT; Pr; TZ; Sha; EBZ; RV; STF
	High farm income	-Tobacco has a high market price -Global market and paid in United States Dollars ($US).	TIMB; MoA; EMA; FCZ; ZFU; ZLTC; NT; Pr; TZ; Sha; EBZ; RV
	Better access to credit	-Better access to market, credit, and financial schemes under contract farming.	TIMB; MoA; EMA; FCZ; ZFU; ZLTC; NT; Pr; TZ; Sha; EBZ; RV; STF
Social	Food security	-Improve household nutrition due to high farm income and crop diversification.	TIMB; MoA; EMA; FCZ; ZFU; ZLTC; NT; Pr; TZ; Sha; EBZ; RV; STF
	Child labor breaches	-High child labor violations by farmers due to unstable economic conditions. -Mechanisms have been established to monitor child labor violations, yet children frequently assist their parents on tobacco farms.	TIMB; MoA; FCZ; ZFU; ZLTC; NT; Pr; TZ; Sha; EBZ; RV; STF
	Nutrition	-Adoption of tobacco cultivation leads to the reallocation of food croplands for tobacco production, which has negative implications for food prices and food security.	TIMB; MoA; EMA; FCZ; ZFU; ZLTC; NT; Pr; TZ; Sha; RV; STF
	Green Tobacco Sickness (GTS)	-GTS is a uniquely tobacco-related health issue caused by nicotine dermal absorption due to skin contact with tobacco leaves.	TIMB; ZFU; EBZ; STF
	Exposure to Pesticides and Other Chemicals	-Due to the increased need for agrochemicals, tobacco farmers are exposed to high levels of chemicals. -Tobacco farmers' exposure to agrochemicals has been linked to a small number of incidences of cutaneous and respiratory disorders.	TIMB; ZFU; EBZ; STF TZ; Sha;
Environment	Biodiversity loss	-Deforestation for tobacco curing has severe environmental repercussions, including the loss of biodiversity.	TIMB; MoA EMA; FCZ; ZFU; ZLTC; NT; Pr; TZ; Sha; EBZ; RV; STF
	Deforestation	-Tobacco contributes to deforestation by clearing forests for the wood fuel necessary for curing tobacco.	TIMB; MoA EMA; FCZ; ZFU; ZLTC; NT; Pr; TZ; Sha; EBZ; RV; STF

Continued

Pollution	-Tobacco is responsible for environmental pollution due to the extensive use of agrochemicals, which include pesticides (insecticides, herbicides, fungicides, fumigants, and chemical fertilizers).	TIMB; MoA; MoH; EMA; FCZ; ZFU; ZLTC; NT; Pr; TZ; Sha; EBZ; RV; STF
Soil degradation	-Tobacco reduces soil quality as overuse of agrochemicals destroys the organisms that are necessary for maintaining healthy soils.	TIMB; MoA; EMA; FCZ; ZFU; ZLTC; NT; Pr; TZ; EBZ; RV; STF
Forest recovery	-Afforestation projects have intensified because of the growth of the tobacco industry.	TIMB; MoA; EMA; FCZ; ZFU; ZLTC; NT; Pr; TZ; Sha; EBZ; STF

The stakeholder interviews also underscored the potential benefits associated with tobacco cultivation. For example, 36 stakeholders emphasized that most small-scale farmers choose to cultivate tobacco because of its perceived potential for high-income generation. Many stakeholders also outlined positive impacts directly associated with tobacco farming, such as improved access to credit (n = 41) and better extension service and support (n = 16) through contract companies. Several stakeholders also mentioned the benefits of tobacco farming, including improved forest recovery initiatives (n = 12), improved food security (n = 27), and diversified farm income (n = 24) for tobacco farming households. Additionally, a stakeholder highlighted the contrast between tobacco and non-tobacco farmers, noting that those solely reliant on food crops like maize struggle to generate high farm income due to poor market prices. In contrast, hybrid farmers combining tobacco and food crops are less susceptible to production losses and more resilient to climate change (personal communication: TIMB; MoA; Sha; Pr). These diverse perspectives on the impacts of tobacco cultivation reflect the various roles and positions held by key stakeholders within Zimbabwe's tobacco production landscape. Notably, the TIMB perceives challenges in all the major impact categories (Figure 4). This may be because they are the primary organization responsible for controlling and regulating tobacco cultivation in Zimbabwe, giving them a better understanding of the various impacts of tobacco cultivation involvement.

4. Discussions

4.1. Factors Influencing Tobacco Cultivation Decisions

Based on the binary logistic regression model, the results show that the farmer's age, education level, household size, household income, and extension support positively affect tobacco cultivation decisions. Studies have found that the age of a farmer positively influences the decision to adopt tobacco farming [25] [46]. Older farmers will likely have accumulated knowledge influencing their decision

to adopt agricultural innovations [47]. As farmers continue growing a specific crop, they believe they know how to grow it well and maximize profitability [48]. Furthermore, older farmers are risk-averse and often reluctant to change. Different adoption studies reveal conflicting results on the influence of age on adoption. [49] in a comprehensive study on the impact of labor availability on fruit crop production, observed that younger farmers exhibit a greater propensity to embrace innovative technologies. This inclination is primarily driven by high labor requirements associated with labor-intensive agricultural practices, including but not limited to tobacco cultivation. These findings add further insights into the importance of age in farming decision-making processes. Depending on the context and location, an individual's age plays a fundamental role in adoption decisions that can positively or negatively affect new technology adoption.

In contrast to the results obtained in this study, which revealed a negative coefficient associated with farming experience, a study conducted by Issa *et al.* [50] reported a positive coefficient for the same variable concerning the adoption of tobacco contract farming. Our findings indicate a noteworthy negative and statistically significant relationship, suggesting that farmers with greater experience were less inclined to engage in tobacco cultivation. Insights gathered from our data collection interviews support this trend, as farmers articulated that the more time they invested in tobacco farming, the greater the challenges they encountered. These challenges encompassed intensive labor demands, shifting government policies, and an unpredictable tobacco market. Consequently, experienced farmers tended to reduce their involvement in tobacco farming compared to their less-experienced counterparts.

Higher education enhances awareness and decision-making and indicates the farmers' ability to choose the best farming practices, given their intellectual and rational capabilities. Comparable to Muroiwa *et al.* [51], the findings of this study reveal a positive and significant relationship between education and tobacco cultivation. Based on the regression model applied in this research, higher education increases the probability of tobacco farming adoption, given educated farmers' practical awareness and critical ability to understand the benefits and incentives of participating in tobacco cultivation. From a financial point of view, this study identified total household income, with a specific emphasis on farm income, as one of the most significant drivers for tobacco cultivation. These findings underscore the economic incentives motivating farmers in the study area to cultivate tobacco, as it substantially boosts their farm income, significantly enhancing their livelihood options. This aligns with a study by Talukder *et al.* [47], which concluded that farmers are primarily driven to cultivate tobacco due to the perceived potential for increased farm profitability.

Tobacco cultivation decisions are influenced by specific demographic factors, as indicated by existing research [7] [17]. Often, these decisions are supported through contract farming arrangements, which provide credit for tobac-

co-related farming activities. This support has a direct impact on tobacco yields, income, and, on occasion, other socioeconomic outcomes. Surprisingly, our study suggests that credit negatively influences tobacco cultivation (Table 3). Extension officers' (government and private) insights indicate that many tobacco contract farmers incur losses and are often trapped in tobacco-related debts, perpetuating a cycle of never-ending poverty. These findings align with previous research by [7] [18], and [52], who observed similar debt issues among tobacco contract farmers due to loan repayment challenges at the end of the growing season.

Delving deeper into other factors influencing tobacco cultivation, this study outlines the importance of extension services and training in tobacco cultivation. Similar results were revealed by [53] who argued that the government's introduction of contract farming changed the decision-making landscape in favor of tobacco cultivation compared to other crops. Extension services provided by contract companies and the government significantly influence tobacco cultivation. Farmers heavily depend on extension agents to stay informed about the latest agricultural practices and market dynamics.

Our field survey reveals a striking contrast: a more significant portion of tobacco farmers enjoyed access to extension services and training. At the same time, non-adopters were bereft of such vital support. These findings resonate with the conclusions drawn by [25] and [54] who also highlighted the central role of extension services in motivating households to engage in tobacco farming.

4.2. Institutional Landscape and Perceived Impacts of Tobacco Farming

The institutional analysis of the tobacco landscape identified interconnected international and domestic stakeholders that regulate and control crop production in Zimbabwe across many sectors. The network includes regulators, tobacco farmers, lobbyists and control societies, healthcare professionals, and researchers. Similar to other geographical contexts, the web of relationships in the tobacco sector is governed by politics, policy formulation and implementation, finance, advocacy, and research, as revealed by our findings. Figure 3 illustrates that the political landscape of tobacco production in Zimbabwe is highly centralized under the control and regulation of the Tobacco Industry Marketing Board (TIMB). However, as cited by most of the stakeholders interviewed, international tobacco companies such as British American Tobacco (BAT), Tian Ze (China National Tobacco Company), and Tribac (Japan Tobacco) play an essential role in providing finance through contract farming [14]. Contract farming is now the primary form of financing tobacco production since the system provides stability in output and quality in a failing economy (personal comm: TIMB; MoA; EMA; FCZ; ZFU; ZLTC; NT; Pr; TZ; Sha; EBZ; RV).

Furthermore, the lack of capital and resources among tobacco small-scale

farmers in Zimbabwe necessitates the involvement of international organizations to promote and finance the crop. This has also been observed in other locations such as Malawi, Kenya, Zambia, and Mozambique [7] [14] [17] [26]. However, other interviews also noted negative issues stemming from the dominance of contract farming in small-scale tobacco farming, increasing debt dependence as farmers are enticed into contracts that may not be in their best interests (personal comm: TIMB; EBZ; STF TZ; Sha). It is essential to understand these divergent perceptions to improve the adoption and performance of contract farming in Zimbabwe's tobacco production environment.

Concerning tobacco control measures, much progress has been made in regulating health risks associated with tobacco use. The state continues to tighten tobacco control measures and enhance public awareness of the dangers of smoking through the Ministry of Health. High tariffs, such as the sin tax, have been implemented to discourage tobacco use as a practical step toward changing tobacco consumption behaviors [14] [26]. This study also highlights the underlying laws, legislation, and support programs that promote tobacco production and sustainable forest resource use. The government of Zimbabwe has consistently provided financial support to the tobacco industry as part of economic stabilization efforts. Some stakeholders have praised measures such as Command Agriculture, the COVID-19 Stimulus Package, and the 2010 Medium-Term Plan (MTP) because the Zimbabwean government is taking holistic and sustainable agricultural strategies to increase economic stability (personal comm: TIMB; MoA; EMA; FCZ; ZFU). However, the extent of influence these general policies may have had on tobacco farmers and forest initiatives cannot be determined from this study. Additional research is required to assess the significance of these measures in promoting tobacco production and forest conservation.

Most stakeholders focused on tobacco cultivation's negative environmental and social impacts. Deforestation, biodiversity loss, and soil degradation are perceived as the most critical environmental impacts (Figure 4). This is particularly relevant in the Zimbabwean context, considering the high adoption rates and the associated ecological threats of tobacco curing [55]. Some stakeholders also mentioned negative social impacts regarding health, low farm crop diversity, and increased child labor violations, where minors (under 18) tend to assist their families in tobacco farming activities [44]. Consequently, family dynamics must be carefully examined when establishing policies and initiatives to prevent family-related child labor infractions on Zimbabwean tobacco farms. Regarding the economics of tobacco production, most stakeholders argue that better technical extension support, improved access to credit, and higher farm income are tobacco farming adoption's most substantial economic impacts, as illustrated in Figure 4. This is particularly important for small-scale farmers in the Zimbabwean context, considering that farm productivity has dropped over the last three decades, and farmers are always searching for avenues to improve yields and

farm income [56].

5. Study Limitations

While our study design is robust, it has limitations. First, this study employs a perception mapping exercise to gather diverse stakeholder perspectives in the tobacco control and production domain. Recognizing the influence of stakeholders' partial knowledge and vested interests, we aimed to comprehensively document these viewpoints without categorizing them as absolute truths. While some limitations exist, such as potential selection bias and varying capacities among stakeholders, we have engaged experts from key organizations involved in tobacco-related processes in Zimbabwe to ensure the quality and depth of responses. Secondly, although rigorously chosen with assistance from experienced local collaborators, our sample size may only partially represent Hurungwe district's tobacco adoption dynamics. This could limit the generalizability of our findings.

Our sample's unequal representation of tobacco and non-tobacco farmers introduces potential bias. Finally, respondents struggled to recall key income indicators, and self-reported income may suffer from recall bias. However, any such biases are likely evenly distributed across all study groups, thus minimizing their impact on the overall reliability of our findings.

6. Conclusion

Despite the negative environmental and socioeconomic impacts, tobacco remains one of the most strategic cash crops in Zimbabwe. To facilitate a shift towards more sustainable agricultural practices, government policies and other stakeholder initiatives in the tobacco sector should target behavioral change among smallholder farmers. This can be achieved by establishing better market access and solid funding mechanisms for tobacco and non-tobacco crops, ensuring the sustainability of the entire agricultural sector. Our investigation reveals the intricate nature of the tobacco control and production landscape, characterized by a network of interconnected international and domestic stakeholders across multiple sectors. This study underscores the critical role played by smallholder farmers, whose perspectives are frequently marginalized in this complex web of interests. Significantly, there is a shared understanding regarding the detrimental sustainability effects of tobacco cultivation, serving as a valuable basis for the development of relevant policies and interventions. This study underscores key factors influencing smallholder farmers' decisions on tobacco cultivation. Notably socioeconomic and demographic elements such as age, education, farming experience, household size, and access to extension support services play significant roles in shaping these decisions. This information is essential for various stakeholders, especially the government, as it aims to implement effective mechanisms to mitigate the heavy reliance on tobacco while

minimizing its adverse impacts on sustainability. In conclusion, this research recommends enacting policies and practical strategies targeting the identified demographic factors that motivate smallholder farmers to cultivate tobacco. Moreover, the impact areas highlighted in this study are crucial for mitigating the adverse sustainability impacts of tobacco production in Zimbabwe.

Informed Consent Statement

During the research protocol development, we followed the best practices proposed by different organizations. All participants were provided with an extensive explanation about the research (and how the results would be used), oral consent was required to be part of the study, and it was clear that participants could decline to participate at any point. Furthermore, the information was anonymized to prevent the location of the households.

Data Availability Statement

The data presented in this study will be available on request from the first author.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix

Table A1. Binary logistic regression model for factors influencing tobacco adoption.

Adoption	Coef.	St. Err.	t-value	p-value	[95% Conf Interval]		Sig
Gender	0.388	0.415	0.94	0.349	−0.425	1.202	
Age (F_age)	0.227	0.108	2.10	0.035	0.016	0.439	**
Age Squared (Age2)	−0.002	0.001	−1.82	0.069	−0.004	0.000	*
Education (F_edu)	0.224	0.056	4.02	0.000	0.114	0.333	***
Farming experience (F_exp)	−0.165	0.075	−2.21	0.027	−0.312	−0.019	**
Household size (HHsize)	0.387	0.117	3.31	0.001	0.158	0.616	***
Income (H_Income)	1.607	0.277	5.80	0.000	1.064	2.15	***
Access to credit	−1.75	0.901	−1.94	0.052	−3.515	0.015	*
Extension support	1.913	0.93	2.06	0.040	0.091	3.735	**
Access to Forest (Dist_forest)	−0.068	0.066	−1.03	0.303	−0.196	0.061	
Constant	−18.956	3.443	−5.50	0.000	−25.706	−12.207	***
Mean dependent var		0.736	SD dependent var		0.441		
Pseudo r-squared		0.478	Number of observations		273		
Chi-square		150.600	Prob > chi2		0.000		
Akaike crit. (AIC)		186.404	Bayesian crit. (BIC)		226.108		

*** = 1% level of significance; ** = 5% significance level; * = 10% significance level.

Table A2. Linear Probability Model for factors influencing tobacco cultivation.

Adoption	dy/dx	St. Err.	z	p > z	[95% ConfInterval]		Sig
Gender	0.036	0.039	0.940	0.346	−0.039	0.112	
Age (F_age)	0.021	0.010	2.160	0.031	0.002	0.041	**
Age Squared (Age2)	−0.000	0.000	−1.850	0.064	−0.000	0.000	*
Education (F_edu)	0.021	0.004	4.690	0.000	0.012	0.030	***
Farming experience (F_exp)	−0.016	0.007	−2.270	0.023	−0.029	−0.002	**
Household size (HHsize)	0.036	0.010	3.550	0.000	0.016	0.056	***
Income(H_Income)	0.151	0.019	8.130	0.000	0.114	0.187	***
Access to credit	−0.164	0.083	−1.970	0.048	−0.327	−0.001	*
Extension support	0.179	0.085	2.100	0.036	0.012	0.347	**
Access to Forest (Dist_forest)	−0.006	0.006	−1.030	0.301	−0.018	0.006	

*** = 1% level of significance; ** = 5% significance level; * = 10% significance level.

Table A3. Average marginal effects from the logistic regression model.

Adoption	Coef.	St. Err.	t-value	p-value	[95% Conf Interval]		Sig
Gender	0.053	0.044	1.19	0.236	−0.035	0.14	
Age (F_age)	0.024	0.009	2.57	0.011	0.006	0.043	**
Age Squared (Age2)	0.000	0.000	−2.39	0.018	0.000	0.000	**
Education (F_edu)	0.03	0.006	5.31	0.000	0.019	0.041	***
Farming experience (F_exp)	−0.01	0.007	−1.49	0.136	−0.023	0.003	
Household size (HHsize)	0.03	0.009	3.23	0.001	0.012	0.049	***
Income(H_Income)	0.181	0.025	7.21	0.000	0.132	0.231	***
Access to credit	−0.106	0.098	−1.08	0.281	−0.298	0.087	
Extension support	0.101	0.098	1.03	0.306	−0.093	0.295	
Access to Forest (Dist_forest)	−0.005	0.006	−0.84	0.403	−0.017	0.007	
Constant	−1.614	0.282	−5.73	0.000	−2.169	−1.059	***
Mean dependent var		0.736	SD dependent var			0.441	
Pseudo r-squared		0.438	Number of observations			273	
Chi-square		20.448	Prob > chi2			0.000	
Akaike crit. (AIC)		191.816	Bayesian crit. (BIC)			231.520	

*** = 1% level of significance; ** = 5% significance level; * = 10% significance level.