

*Full Length Research Paper*

# **Determinants of agricultural commercialization in smallholder farmers in Zimbabwe: The case of Zhombe North Rural District**

**Pamela Madududu<sup>1\*</sup>, Faustino Madzokere<sup>2</sup>, Newettie Jambo<sup>2</sup> and Freddy Ruzhani<sup>2</sup>**

<sup>1</sup>Agricultural Economics, Extension and Rural Development, University of Pretoria, Private Bag x 20, Hatfield, 0028, South Africa.

<sup>2</sup>Agricultural Economics and Development, Manicaland State University of Applied Sciences, Mutare, Manicaland, 7001, Zimbabwe.

Received 29 January, 2022; Accepted 13 May, 2022

**Agricultural commercialization raises farm incomes and improves living standards in African farming populations. Despite its importance, it remains low in Africa. Limited studies in agricultural commercialization have explored different tools for analysis given the agricultural commercialization indicators with zeros and fractions. This paper addresses methodological issue and adds literature on factors affecting agricultural commercialization. Agricultural commercialization is explored in Zhombe North Rural District using 2017/2018 cross-sectional data collected from 165 households. The zero-inflated beta regression model was used to find the drivers of agricultural commercialization. Crop output market participation share served as a proxy for agricultural commercialization. Land size, fertilizer use, use of credit, and certified seed proportion had significant positive effects on agricultural commercialization. In contrast, household head age, food cropping land size, and off-farm employment significantly influenced agricultural commercialization. The results for the model are similar to the results in previous studies using the Tobit model. The study recommends policies that promote the availability and usage of inputs to improve agricultural commercialization in the study area.**

**Key words:** Agriculture, commercialization, smallholder farmers, zero-inflated beta regression.

## **INTRODUCTION**

The historical role of agriculture indicates that no country transitioned from poverty without increasing agricultural productivity (Abdullah et al., 2019). The prominent role of agriculture in developing countries includes supplying

labor and a market for non-agricultural goods and services (Adong et al., 2014). The sector can provide food for domestic consumption, promote industrial investments through domestic savings, and act as a

\*Corresponding author. E-mail: [u18395351@tuks.co.za](mailto:u18395351@tuks.co.za).

source of foreign currency for a country that imports intermediate and capital goods (Alberto et al., 2017). Africa's agriculture and food sector challenges include the food production-population imbalance, rural unemployment, and low agricultural productivity (Alexander et al., 2017). These problems require a long-term solution by achieving economic development, calling for significantly high public investments in the agricultural sector and rural development, and prioritizing the agriculture sector's commercialization for increased productivity and competitiveness (Aryemo et al., 2019). Zimbabwe has an agricultural sector that needs attention to be improved (Bekele and Alemu, 2015).

Agriculture contributes approximately 18% to Zimbabwe's gross domestic product (GDP) (Carletto et al., 2017). The country has 39.6 million hectares, 42.1% under agricultural activities (Dyke et al., 2020). Over a million smallholder farmers depend on rain-fed agriculture (FAO, IFAD, UNICEF, WFP, 2018). Agricultural commercialization can raise farm incomes and achieve overall economic development (Gani and Hossain, 2015). Agricultural commercialization involves changing from producing to satisfying household consumption to producing for the market (Government of Zimbabwe, 2018).

As households commercialize, their farming systems pave the way for more specialized forms of production meant to respond rapidly to the market phenomena and use of quality inputs. Despite that, the levels of agricultural commercialization are still deficient in most African countries, including Zimbabwe, and more studies are needed to find ways to enhance agricultural commercialization (Hailua et al., 2015).

Zimbabwe needs a vibrant agricultural sector, the crucial driver for the pro-poor economic growth pathway, poverty reduction, food, nutrition security, and employment creation. Zimbabwe has five agro-ecological regions based on various factors, including rainfall amounts received per year, average temperatures, the quantity and variability of average rainfall in an area, and soil quality and vegetation (Dyke et al., 2020). The main crops in Zimbabwe include maize, groundnuts, small grains (millets and sorghum) and wheat as food crops, while tobacco, sugar, cotton and horticulture are cash crops. Crop production in Zimbabwe is highly variable due to a reliance on rain-fed agriculture (Ingabire et al., 2017). Frequent droughts and the changing climatic conditions contribute to instability in crop production, and Zimbabwean agriculture is gradually declining (Janssen and Linderhof, 2018). The Zimbabwean agricultural policy framework (ZAPF) provides policy guidelines to improve the agricultural sector, which gradually declined throughout 2002 (Dyke et al., 2020).

Inspired by these concerns, understanding the factors affecting agricultural commercialization help policymakers in crafting solutions to revamp the agro-based economy.

This paper aims to analyze the key drivers of agricultural commercialization in rural Zimbabwe using primary data collected in Zhombe North Rural District in the Midlands Province through a field survey. This area is one of the rural districts targeted by ZAPF for agricultural growth promotion. The paper's contribution will be by adding literature to the already known body of knowledge, especially for Zimbabwe, and providing knowledge on how to analyze dependent variables with proportions or percentages by applying the zero-inflated beta regression technique.

Agriculture's transition from subsistence to more commercialized farming systems has been viewed as beneficial to rural economies through increased efficiencies in production, creation of labor markets, and increasing the demand for other non-agricultural goods and services that can enhance development (Gani and Hossain, 2015). Some of the identified factors that enhance agricultural commercialization include technical and financial assistance, farmer organizations, and market access (Madududu, 2019).

Due to this high productivity, there is a bidirectional relationship between crop productivity and households' commercialization level. Households accumulate a more significant surplus to sell on the market. The Crop Output Market Participation share (COMPS), also known as the household commercialization index (HCI), is commonly used to measure agricultural commercialization in the 21st century. It is calculated as the total value of crop sales by households over the full value of crop production in a year (Mapfumo, 2015; Mchugh, 2013; Gani and Hossain, 2015).

A study done in Mashonaland Central Province of Zimbabwe applying a Tobit regression model indicated that gender, access to draft power, extension services, closeness to markets, access to finance, and several crops had a significant favorable influence on agricultural commercialization (Hailua et al., 2015). Male-headed households are more likely to grow labor-intensive crops such as tobacco. The result concurred with studies performed in Kenya that showed that male-headed households were more into agricultural commercialization than female-headed households if the crop is labor-intensive (Melo and Tsikata, 2014). On the other hand, age, cattle, and off-farm income negatively influenced agricultural commercialization (Hailua et al., 2015).

Evidence shows that age is negatively associated with commercialization, with younger farmers more likely to participate in agricultural commercialization than older farmers (Mutami, 2015). Another study in Ethiopia using a Tobit regression model indicated that land size and family size positively affected commercialization while old age negatively affected commercialization (Mutami, 2015). Studies in South Africa, Bangladesh, and Zimbabwe concur that land size affects commercialization positively (Hailua et al., 2015; Noort et

al., 2022; Ochieng et al., 2016). The authors indicated that farmers would likely produce more surplus channeled to the markets as land size increases.

The primary reason for this study was to add a new analytical method to data, including zeros and fractions like agricultural commercialization indicators. The other reason was to add literature on the factors affecting agricultural commercialization. Agricultural commercialization is measured using indicators based on the amounts of agricultural produce sold by households relative to their total annual production. As a result, households that do not sell will record zeros, and fractions will have fractional values. The zero-inflated beta regression model fits the dependent variable in agricultural commercialization studies. The study also adds to the current body of literature on the determinants of agricultural commercialization. The study used a cross-sectional survey design. The conclusions made were that the results from this model were similar to other studies using the competing models, such as the Tobit model. Land size, fertilizer use, use of credit, and certified seed proportion had significant positive effects on agricultural commercialization. In contrast, household head age, food cropping land size, and off-farm employment significantly influenced agricultural commercialization. Further studies may compare the competing models in measuring determinants of agricultural commercialization using large-scale samples.

## METHODS

Zhombe North Rural District is 155 kilometers North West of the Midlands provincial capital of Gweru. Agricultural commercialization occurs in the area through cash crops and food crops. The site lies at 18.667° S and 29.349° E latitudes of the subtropics, and it is in the natural farming region three that experiences severe mid-season dry spells, receiving an average of 600-650mm of rainfall per year. The climatic condition in Zhombe North Rural District is a hot semi-arid or steppe climate as the area receives precipitation below the area's potential evapotranspiration but cannot be as low as in desert climate. Major livelihood activities in this area include agriculture and mining. In this study, the focus was on farming smallholder households that own agriculture fields. Zhombe North Rural District has three wards which are ward 6 (also known as Mabura/Columbina), ward 7 (also known as Sidhakeni), and ward 8 (also known as Empress mine) (Figures 1 and 2).

Crops grown in Zhombe North Rural District include maize, cotton, round nuts, sorghum, groundnuts, and millet. Maize is the main food crop, and cotton is the main cash crop. There are three cotton depots in the Zhombe area where cotton farmers sell cotton.

This study used the 2017/2018 season cross-sectional data in Zhombe North Rural District collected from wards numbers 6, 7, and 8. The survey captured qualitative and quantitative data on household socioeconomic characteristics, farming activities, and agricultural commercialization. The two-stage sampling procedure was used whereby in the first stage, purposive sampling was used to select Zhombe North Rural District in the Midlands province based on agricultural commercialization practice. In the second stage, households were randomly selected from the three wards in Zhombe North Rural District. The researcher acquired a sampling

frame from extension workers, and a sampling size of 165 households was obtained.

This study adopted the COMPS to proxy agricultural commercialization, following the definition that as households commercialize, their farming systems become responsive to the market phenomena through market participation. The COMPS indicator captures commercialization from any crop, whether it is through food crops or cash crops (Mchugh, 2013). COMPS are the total value of crops commercialized over the full value of crops produced yearly. The indicator focuses on the intensity of how a household is commercialized and provides a better measure of agricultural commercialization determinants based on the intensity of COMPS.

The explanatory variables were identified following the empirical evidence on the factors affecting agricultural commercialization in smallholder farmers. The studies indicated that household external and internal factors influence agricultural commercialization. Other factors that can shape how a household can commercialize include land size, transaction costs, household size, access to credit, and household head age. Table 1 shows the variables likely to influence agricultural commercialization.

Agricultural commercialization indicators often come in the form of proportions or percentages depending on the approach followed by the researcher. From the literature search, ratio and rate data have challenges to analyzing. Models to explore data with zeros and other numbers include the Tobit model, fractional logit models, fractional probit models, and the generalized linear model (GLM) with a family link for transformations (Olumeh et al., 2018). These models produce unbiased estimates and reasonable p values when using normally distributed data.

The Tobit model allows data censoring while maintaining the critical assumptions for linear regression. However, the most common cases would be skewed data, and the dependent variable contains many zeros. Under this circumstance, the transformations done in the models will produce biased results, and the most appropriate model will be the zero-inflated beta regression model (Ospina and Ferrari, 2010). Handling proportion dependent variables with many zeros were first suggested in 1996 after realizing that the STATA generalized linear regression model could not be used effectively.

Few studies have applied the Zero-inflated beta regression model that suits a dependent variable with proportions and many zeros in the agricultural commercialization studies. Many studies applied Tobit, probit, ordered probit, and Heckman selection models (Ospina and Ferrari, 2012; Hailua et al., 2015). Failure to use appropriate models given a dependent variable in the form of proportions can create problems in data analysis. Against this background, this paper applies the zero-inflated beta regression model to find the critical determinants of agricultural commercialization. The researcher applies the zero-inflated beta regression model, a new technique and an extension of the GLM with a gamma distribution that uses dependent variables with fractions and zeros (Otchia, 2014).

The zero-inflated beta regression model is used to analyze data with excess zeros. It adequately addresses the counting of zero observations. The model is a mixture of beta and logistic regression models (Rubhara and Mudhara, 2019). It examines the associations or finds the presence of factors that influence the behavior of Y, where Y is a proportion that ranges from zero to one. The zero-inflated beta regression model has been applied in many instances. It has been used in trade, business cycles, socioeconomic factors, agronomy, meteorology, and climatology (Rubhara and Mudhara, 2019).

The zero-inflated beta regression model is amongst the GLM theory extensions designed to accommodate regressions for a dependent variable that contains proportions and zeros and ones

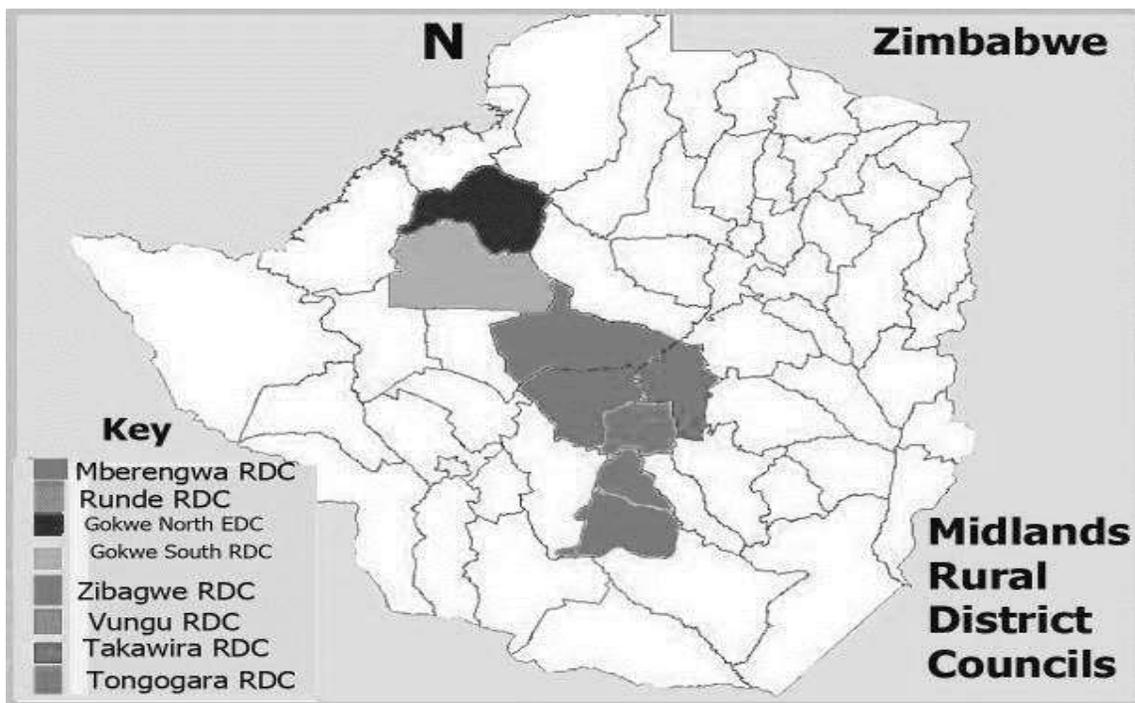


Figure 1. Zibagwe Rural District location in Zimbabwe.  
Source: Google Maps (en.wikipedia.org/wiki/Zibagwe\_RDC#/media).

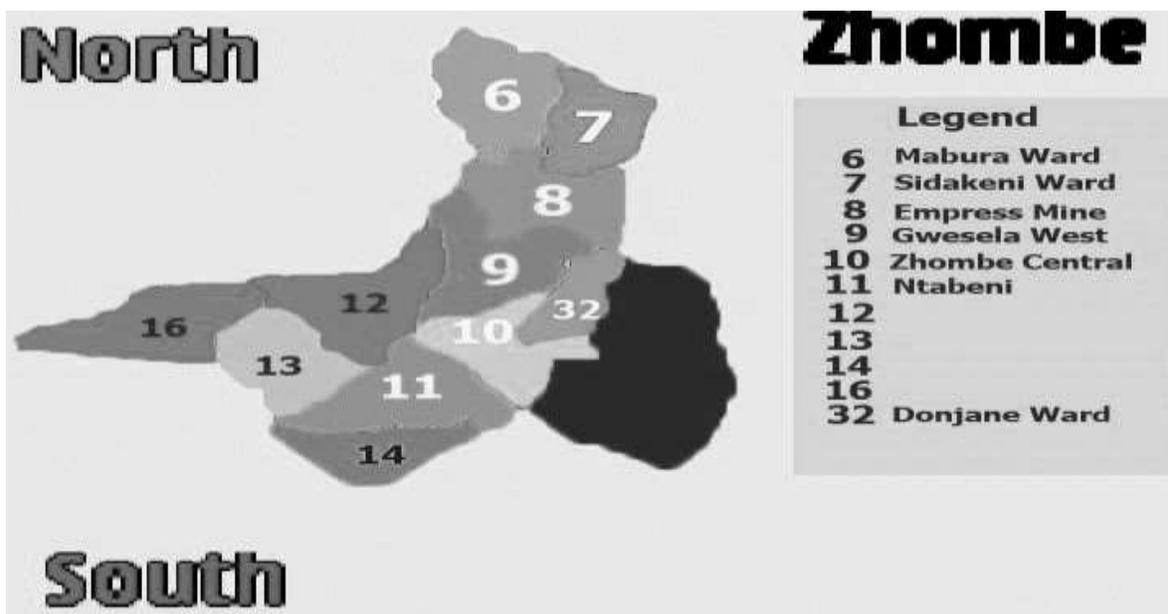


Figure 2. Zhombe North Rural District map.  
Source: Google Maps.

characterized by a beta distribution (Otchia, 2014). The model has unimodal and bimodal densities with varying skewness severity

(beta distribution). This gives the zero-inflated beta regression model credible flexibility in modeling dependent variables for which

**Table 1.** Variables expected to influence household agricultural commercialization.

Description of variable	Measurement	Expected relationship
Household head age	Number of years	+
Household size	Number of people	+
Labour commercialization	Working days engaged hired labor over the total number of days utilized from planting and weeding to the harvesting of all the field crops	+
Land size	Hectares	+
Distance from market	Kilometers	-
Fertilizer use per hectare	Kilograms	+
Food crops hectarage	Hectares	+/-
Livestock units	Livestock units are computed using standard livestock unit values for different types of livestock	+
Household head gender	1=Male, 0=Female	+
Education	1=Education level above primary, 0=Otherwise	+
Off-farm employment	1=Regular employment outside farming, 0=Otherwise	-
Use of credit	1=Used credit in farming, 0=Otherwise	+
Agricultural training	1=Received training on farming, 0=Otherwise	+
Farming implements index	An index computed using Principal Components Analysis in STATA	+
Certified seed use	Weight in kilograms of purchased seed over the total weight of seed utilized on a farm	+

Source: Madududu P.

normalizing transformations are impossible. There are improvements in the theoretical work on beta regression, enabling the regression to incorporate a mixture model to estimate observation at either zero or one (Ospina and Ferrari, 2010). Zero-inflated beta regression assumes the dependent variable can follow a beta distribution with two given parameters  $\mu$  and  $\theta$ .

$$f(y; \mu, \theta) = \frac{\Gamma(\theta)}{(\Gamma(\mu\theta)\Gamma((1-\mu)\theta))} y^{\mu\theta-1}(1-y)^{(1-\mu)(\theta-1)} \quad (1)$$

Where,  $\mu$  is  $E(y)$ ,  $\theta$  is the precision parameter,  $\Gamma$  is the gamma function,  $0 \leq \mu \leq 1, \theta > 0$ ,

The formula for the gamma function is:

$$\int_0^\infty t^{x-1} e^{-t} dt \quad x > 0 \quad (2)$$

This parameterization dictates that  $E(y) = \mu$  and  $Var(y) = \mu \frac{1-\mu}{\theta+1}$ . The variance of the dependent variable is a function of the distribution mean  $\mu$  and the precision parameter  $\theta$ . Extending the GLM theory then accommodates this distribution. The parameter estimates in the beta regression associate the changes in the dependent variable mean and precision as a  $\Gamma$  function of explanatory variables. The zero-inflated model shows the results of the logistic regression model that uses the zeros data since zero-inflated beta regression is a mixture of beta regression and logistic regression (Otchia, 2014). Inflated beta distribution incorporates degenerate probability statements producing a mixture density. For the zero-inflated model, a new parameter  $\pi_0$  is added to account for the probability of the observations at zero. The mixture density is:

$$f(y; \pi_0, \mu, \theta) = \begin{cases} \pi_0 & \text{if } y=0, \\ (1-\pi_0)f(y; \mu, \theta) & \text{if } 0 < y < 1, \end{cases} \quad (3)$$

Where,  $0 < y < 1, y \sim f(y; \mu, \theta)$ .

The zero-inflated beta regression model is:

$$Y_i = \beta_0 + \beta X_i + \varepsilon_i \quad (4)$$

Where:  $Y_i$  is the dependent variable comprised of proportions that are less than one and many zeros,  $\beta$ : is a vector of parameters to be estimated,  $X_i$ : is a set of explanatory variables, and  $\varepsilon_i$ : is the disturbance term.

Following the discussions given in the prior sections on the estimation of critical drivers of agricultural commercialization and the list of variables in Table 1, the empirical model for the zero-inflated beta regression was specified as:

**Table 2.** Sampled households grouped by agricultural commercialization.

Commercialized	Non-commercialized
52	113

Source: Madududu P.

$$\begin{aligned}
 COMPS = & \beta_0 + \beta_1 Age + \beta_2 Household\ size + \beta_3 Labour\ commercialisation + \\
 & \beta_4 Land\ size - \beta_5 Distance\ from\ the\ market + \beta_6 Fertiliser\ use\ per\ hectare - \\
 & \beta_7 Food\ cropping\ hectarage + \beta_8 Livestock\ units + \beta_9 Household\ head\ gender + \\
 & \beta_{10} Education\ level - \beta_{11} Off - farm\ employment + \beta_{12} Use\ of\ credit + \\
 & \beta_{13} Agricultural\ training + \beta_{14} Farming\ implements\ index + \beta_{15} Certified\ seed\ use
 \end{aligned}$$

(5)

The researcher collected data from respondents by administering a pre-tested structured questionnaire in a cross-sectional survey design. A structured questionnaire captured all the information needed. The questionnaire was divided into four sections capturing the general information, household socioeconomic and demographic data, and farming data. The data collected was published in Mendeley's data (Sekyi et al., 2020).

#### Ethics and consent

The researcher requested permission to conduct a study in the area through the University of Zimbabwe, which requires students to ask for research permissions from the Ministry of Agriculture and traditional rural leaders before embarking on data collection for academic purposes. The researcher asked for permission from the Chief, who is the traditional leader in the area in which the research was conducted, and also asked for permission from the Ministry of Lands, Agriculture, Water, Fisheries, and Rural Development through the AGRITEX Department, which leads agricultural research and extension in the country. The University of Zimbabwe approved the study since it is part of its scholarly work. There were no issues involving human or animal rights violations in the research, and no clinical aspects were involved. Participants gave oral consent, and after agreeing to be interviewed, the researcher would question the respondents. The researcher did not coerce anyone to participate unwillingly in the survey and gave complete information concerning the reasons for data collection and the intentions of the study. The researcher kept the collected information confidential and maintained anonymity in the questionnaires to avoid compromising the privacy of the data. The study was also presented to stakeholders (farmers, development partners, extension workers, and policymakers) at a dissemination conference coordinated by the African Economic Research Consortium, which funded the study on November 11, 2021.

## RESULTS

Preliminary data analysis procedures explored the general characteristics (such as participant households' ward location, household head gender, and household head education levels) for all the agricultural commercialization participants in the survey.

#### Total sample agricultural commercialization statistics

The researcher grouped the households that participated in the survey using their level of commercialization to come up with commercialized and non-commercialized households. The researcher's rationale for grouping the households followed the literature in that most African households, on average, sell less than half of their farm produce (Tijani, 2018; Hailua et al., 2015). As a result, farmers selling more than 40% of what they produce were therefore regarded as commercialized households by the researcher, while households selling less than 40% of their products were non-commercialized households. Table 2 indicates that 68% of the households were non-commercialized, with an average COMPS value of 0.11, while 32% of households were commercialized, indicating a low level of commercialization in the study area.

#### Agricultural commercialization distribution by ward locations

Table 3 shows the number of households that participated in the survey grouped by their ward number locations. The most significant proportion of households who participated in the survey was from ward 7 with 41%, followed by ward 8 with 33%, and lastly, wards six, which contributed 26%. The average COMPS values for the smallholder farmers in wards 6, 7, and 8 were 0.36, 0.37, and 0.31, respectively.

#### Agricultural commercialization by household head gender

Table 4 shows that most Zhombe North Rural District households were male-headed (79%), while few were female-headed (21%). The COMPS value for the female-

**Table 3.** Sampled households by ward number.

Mabura (Ward 6)	Sidakeni (Ward 7)	Empress Mine (Ward 8)
43	67	55

Source: Madududu P.

headed households was 0.23, while the COMPS value for the male-headed households was 0.31. T-test analysis showed no significant difference in the COMPS values between male-headed and female-headed households.

### Agricultural commercialization by education level

Table 5 indicates that most household heads who participated in the survey had an education level above primary (75%), while only 25% had an education level equivalent to or below the primary level. This indicates a generally high level of education in the Zhombe North Rural District household heads. The COMPS value for the primary level or below was 0.29, while the COMPS value for the above primary level was 0.3. The t-tests show that the difference in the COMPS values was not significant.

After installing all the relevant commands, the zero-inflated beta regression model was estimated in Stata 14 scientific package. The Chi-square probability measure of the model at a 1% level of significance was the first necessary indicator of model fitness (Uronu and Ndiege, 2018). However, this was not enough to determine model fitness. A link test tested model fitness. The hat-squared variable of the test was not significant hence; the null hypothesis stating that the model was misspecified was rejected, implying the correct specification of the model. Another post-estimation test used for the model fitness was the Akaike Information Criterion (AIC) (Williams and Dame, 2013). The model with the lowest AIC value was better than the models with higher AIC values. Many models were estimated until the model with the lowest AIC value was obtained. The coefficients on the predictors and marginal effects were recorded. The results of the zero-inflated beta regression model for the key drivers of agricultural commercialization are summarized in Table 6. The zero-inflated beta regression model produces results for the proportion (beta) model ( $0 < y < 1$ ) and the zero-inflated model ( $y = 0$ ). The table shows that land size, the proportion for certified use, use of credit, fertilizer use per hectare, and the constant had a significant positive influence on agricultural commercialization. On the other hand, household head age, food cropping hectareage, and off-farm employment negatively influenced agricultural commercialization. The results produced by the zero-

inflated beta regression model are of no difference from other previous agricultural commercialization study results from other scholars that used other models such as probit and Tobit models.

### DISCUSSION

The land size positively influenced agricultural commercialization at a 1% significance level ( $p > 0.01$ ). An increase in the land size by 1 hectare, holding all other factors constant, would immediately increase the COMPS value by 0.26. Other scholars also found this result that revealed the positive influence of land size on agricultural commercialization (Noort et al., 2022). The scholars highlighted that land proves to be a valuable asset to achieve commercialization as it enables households to shift from subsistence farming toward commercial farming by producing more surplus that can be channeled to markets. Again, households with larger land portions realize the economies of scale and become more profitable than households with small land portions (Williams et al., 2018).

The proportion of certified use positively influenced agricultural commercialization at a 10% significance level ( $p < 0.1$ ). An increased proportion of accredited seeds would lead to an instantaneous increase in the COMPS value by 0.069. Improved seeds play an essential role in farming as these seeds are hybrids and are also treated against pest and disease infections. There are limited studies that look at the effect of improved seeds on agricultural commercialization. This result adds to the current literature on the factors affecting agricultural commercialization.

Credit enhances the chance of farmers to use improved inputs that raise agricultural productivity. The survey results show that, of the 165 interviewed households, 44 of them used farm credit. Farming credit positively influenced agricultural commercialization at a 5% significance level ( $p < 0.05$ ). Changing from non-use of farm credit to farming credit would increase the COMPS value by 0.19. The result concurs with other previous studies' findings that confirm the importance of agricultural farming credit in the commercialization of households (Hailua et al., 2015).

Fertilizer increases crop productivity, creating an opportunity to produce a surplus to sell. Fertilizer use positively affected agricultural commercialization at a

**Table 4.** Sampled households grouped by household head gender and commercialization status.

Household commercialization status	Male	Female
Commercialized	45	7
Non-Commercialized	85	28

Source: Madududu P.

**Table 5.** Sampled household heads grouped by education level.

Above primary level	Primary level and below
124	41

Source: Madududu P.

10% significance level ( $p < 0.1$ ). Increasing fertilizer use by 1 kg would result in an instantaneous increase of COMPS value by 0.00063. The literature shows that Africa still experiences meager rates of fertilizer use compared to other regions in the world (ZimVAC, 2018). Other researchers have indicated the importance of fertilizer in promoting agricultural commercialization and household food security (Linderhof et al., 2019). Other scholars believe that agricultural commercialization leads to higher usage of fertilizer through increased farm income that can make the households afford fertilizer that can increase the productivity of food crops, promoting food security.

Household head age negatively affected agricultural commercialization at a 5% significance level ( $p < 0.05$ ). An increase in the age of the household head by one year would result in an instantaneous decline of the COMPS value by 0.0038. This may be because younger household heads are still energetic and have higher labor productivity than older households, which translates into more output surplus sold on the market. Given that cotton, the highly commercialized crop in Zhombe North, is labor-intensive in weeding, spraying, and harvesting, younger household heads have more energy to grow the labor-intensive crop. Younger household heads also have more cash requirements for school fees and other demands such as asset accumulation; hence they become engaged in agricultural commercialization than older household heads to increase their income. Other researchers revealed the same negative effect of household head age on agricultural commercialization (Mutami, 2015).

Food cropping hectareage negatively influenced agricultural commercialization at a 1% significance level ( $p < 0.01$ ). Increasing the land allocated to food crops by 1-hectare while holding all other factors constant would instantly decline the COMPS value by 0.31. This result may look awkward, but this can be expected given the

climatic conditions in the study area in the natural farming region 3. The three natural farming region experiences excessive and frequent dry spells that drastically affect the production of food crops like maize production. The statistics in the study area show that all the households grow maize. Still, when there is a severe dry spell, the yields may be rendered to 100% crop failure, significantly when the crop is affected at its critical stages of growth, such as the tasseling and the grain filling stage. Crops like cotton are drought resistant and can perform better under the conditions that prevail in natural farming region 3. This would explain the negative relationship of food cropland allocation to agricultural commercialization in the Zhombe North Rural District. It would also be essential to note that drought-resistant crops like sorghum and millet may perform better in the region but are less preferred in the study area. This may be due to these small grains' tastes, preferences, and labour intensiveness.

Off-farm employment negatively affected agricultural commercialization at a 10% significance level ( $p < 0.1$ ). A change in a household from the lack of off-farm work to off-farm employment would, on average, result in a decline in the COMPS value by 0.062. This may be because household heads with other permanent employment engagements outside farming will have limited time to commit themselves to farm; hence, their farming activities will be more subsistence than commercial. These farmers also have other reliable sources of income to meet other cash demands for the family. Thus, they participate less in the crop output markets. Again, household heads without other forms of employment regard farming as their source of livelihood. Therefore, they commit to producing a marketed surplus to get income for their cash and food requirements. The same result was also revealed by other researchers who explained the issues of time commitments to farming and lower-income needs from the farming sector if one has different forms of employment (Dzanku, 2019).

### Policy implications

This study has significant policy implications for rural Zimbabwe, particularly given that agriculture is the backbone of the Zimbabwean economy and a substantial source of rural people's livelihoods. Results from the study cannot be generalized to the whole country of Zimbabwe since factors may differ as to the agro-ecological zones, farmer characteristics, cash crops, and other regional factors. The first policy implication that could be drawn from the study concerns the issue of land size in the rural communal farmers, which had a positive influence on agricultural commercialization. The government needs to reconsider its communal land policy to ensure that farming households have access to

**Table 6.** Estimation results of the drivers of agricultural commercialization (n=165).

Variable	Proportion model			Zero-inflated model	
	Coef.	z-stat.	Marg. effects (dy dx)	Coef.	z-stat.
Household head age	-0.021*	-1.75	-0.0038**	0.04	1.48
Household size	0.029	1.01	0.0063	-0.08	-0.48
Labour market participation	1.01	0.96	0.063	1.09	0.2
Land size in hectares	0.256**	1.94	0.26***	-6.2***	-5.03
Distance from market	0.047	0.41	0.018	-0.34	-1.03
Fertilizer use per hectare	0.0002	-0.11	0.00063*	-0.02**	-2.29
Food cropping hectarage	-1.12***	-4.44	-0.308***	4.97***	3.69
Livestock units	-0.007	-0.18	-0.0024	0.04	0.36
Household head gender	-0.06	-0.24	-0.07	1.62	1.17
Education	-0.35	-1.47	-0.04	0.31	0.29
Off-farm employment	-0.32**	-1.76	-0.067*	0.88	1.04
Use of credit	0.48	1.57	0.194**	-2.64**	-2.09
Agricultural training	0.14	0.43	0.017	-0.04	-0.06
Farming implements index	0.031	0.37	-0.0029	0.16	0.31
The proportion of certified seed use	0.95*	1.74	0.069	0.76	0.85
Constant	1.389*	1.63	-	2.2	0.85
Wald Chi <sup>2</sup> (12)			67.8		
Prob>Chi <sup>2</sup>			0.000		
AIC			30.8		

Source: Madududu P.

considerably larger land to produce enough to feed their families and have excess to sell or consider a shift to high-value crops productions which can raise farm profits even under small land sizes. Other factors identified include fertilizer and certified seed use, which positively influenced agricultural commercialization in the study area. Policymakers need to put appropriate measures in place to ensure the availability and easy access of inputs such as fertilizer and certified seeds in the Zhombe North rural community. This can increase the commercialization of agriculture in the area. Access to farming credit and rural agricultural finance measures is needed so that this can, in turn, increase access to improved inputs for the farmers.

More than two-thirds of the Zimbabwean population is below the age of 25. There is much room for the Zimbabwean economy to improve by supporting the youth in agriculture. Furthermore, young smallholder farmers need support as they have plenty of energy to perform farming activities and have higher income demands for their growing families. This can also ease the ever-increasing concerns of youth unemployment in Zimbabwe.

## Conclusion

The study revealed that land size, fertilizer use, use of

credit, and proportion of certified seed use had a significant positive effect on agricultural commercialization. In contrast, household head age, food cropping land size, and off-farm employment significantly influenced. The conclusion is that farming characteristics dominate the factors affecting agricultural commercialization. Without a conducive farming environment, it will be challenging to achieve higher levels of agricultural commercialization. The results from this study were also similar to the findings of other researchers who used the Tobit model. Further study is needed to show if the results can be different when using large-scale data or when conducting country analysis.

## FUNDING

This work was supported by the African Economic Research Consortium (AERC)

## CONFLICT OF INTERESTS

The authors have not declared any conflicts of interests.

## REFERENCES

Abdullah RF, Ahamad R, Ali S, Chandio AA, Ahmad W, Ilyas A, Din IU

- (2019). Determinants of commercialization and its impact on the welfare of smallholder rice farmers by using Heckman's two-stage approach. *Journal of the Saudi Society of Agricultural Sciences* 18(2):224-233.
- Adong A, Muhumuza T, Mbowe S (2014). Smallholder food crop commercialization in Uganda: panel survey evidence from Uganda. *Research Series No. 116*.
- Alberto O, Junior G, Guedes TA, Orbolato AM, Mario W, Nunes DC (2017). Zero-inflated beta regression model for leaf citrus canker incidence in orange genotypes grafted onto different rootstocks. *Acta Scientiarum* 1(4):161-171.
- Alexander K, Case P, Jones M, Connell J (2017). Commercialising smallholder agricultural production in Lao People's Democratic Republic. *Development in Practice* 27(7):965-980.
- Aryemo IP, Akite I, Kule EK, Kugonza DR, Okot MW, Mugonola B (2019). Drivers of commercialization: A case of indigenous chicken production in northern Uganda. *African Journal of Science, Technology, Innovation and Development* 11(6):1-10.
- Bekele A, Alemu D (2015). Farm-level determinants of output commercialization: In haricot bean based farming systems. *Ethiopian Journal of Agricultural Sciences* 25(1):61-69.
- Carletto C, Corral P, Guelfi A (2017). Agricultural commercialization and nutrition revisited: Empirical evidence from three African countries. *Food Policy* 67:106-118.
- Dyke T, Mathew TH, Agnes RS (2020). Rural community perceptions on the impact of climate change on subsistence farming: Mutoko community in Zimbabwe. *e-BANGI* 17(7):89-104.
- Dzanku FM (2019). Food security in rural sub-Saharan Africa: Exploring the nexus between gender, geography and off-farm employment. *World Development* 113:26-43.
- FAO, IFAD, UNICEF, WFP W (2018). The state of Food Security and Nutrition in the World 2018. Building climate resilience for food security and nutrition. *FAO: Rome*.
- Gani O, Hossain E (2015). Market participation decision of smallholder farmers and its determinants in Bangladesh. *Economics of Agriculture* 62(1):163-179.
- Government of Zimbabwe (2018). National agriculture policy framework (2018-2030): First Draft. *GoZ: Harare*
- Hailua G, Manjireb K, Aymutic KM (2015). Crop commercialization and smallholder farmers' livelihood in Tigray region, Ethiopia. *Journal of Development and Agricultural Economics* 7(9):314-322.
- Ingabire C, Mshenga MP, Langat K, Bigler C, Musoni A, Butare L, Birachi E (2017). Towards commercial agriculture in Rwanda: Understanding the determinants of market participation among smallholder bean farmers. *African Journal of Food, Agriculture, Nutrition and Development* 17(4):12492-12508.
- Janssen V, Linderhof V (2018). The effect of agricultural commercialization on food security: The case of crop producing households in post-reform Vietnam. *Wageningen UR, Wageningen* retrieved from <https://edepot.wur.nl/443236>.
- Linderhof V, Janssen V, Achterbosch T (2019). Does Agricultural Commercialization Affect Food Security: The Case of Crop-Producing Households in the Regions of Post-Reform Vietnam? *Sustainability* 11(5):1263.
- Madududu P (2019). Agricultural commercialization and household food security survey data. *Mendeley Data*. Published: 3 December 2019 Version 1, DOI:10.17632/9tfd8rckxw.1
- Mapfumo A (2015). An Econometric Analysis of the Relationship between Agricultural Production and Economic Growth in Zimbabwe. *Russian Journal of Agricultural and Socio-Economical Sciences* 11(23):11-15.
- Mchugh ML (2013). The Chi-square test of independence Lessons in biostatistics. *Biochemia Medica* 23(2):143-149.
- Melo J De, Tsikata Y (2014). Regional integration in Africa challenges and prospects. (WIDER Working Paper No. 2014/037).
- Mutami C (2015). Smallholder Agriculture Production in Zimbabwe: A Survey. *Consilience* 14(1):140-157.
- Noort MWJ, Renzetti S, Linderhof V, du Rand GE, Marx-Pienaar NJMM, de Kock HL, Magano N, Taylor JRN (2022). Towards Sustainable Shifts to Healthy Diets and Food Security in Sub-Saharan Africa with Climate-Resilient Crops in Bread-Type Products: A Food System Analysis. *Foods* 11(2):135.
- Ochieng J, Knerr B, Owuor G, Ouma E (2016). Commercialisation of Food Crops and Farm Productivity: Evidence from Smallholders in Central Africa. *Agrekon* 55(4):458-482.
- Olumeh DE, Rahma A, Otiemo DJ, Oluoch-kosura W (2018). Characterizing Smallholder Maize Farmers' Marketing in Kenya: An Insight into the Intra-Household Gender, Wealth-Status, Educational and Credit Access Dimensions. *Journal of Marketing and Consumer Research* 48(1):1-11.
- Ospina R, Ferrari SLP (2010). Inflated Beta Distributions. *Statistical Papers* 51(1):111-126.
- Ospina R, Ferrari SLP (2012). A general class of zero-or-one inflated beta regression models. *Computational Statistics and Data Analysis* 56(6):1609-1623.
- Otchia CS (2014). Agricultural Modernization, Structural Change and Pro-poor Growth: Policy Options for the Democratic Republic of Congo. *Journal of Economic Structures* 3(1):1-43.
- Rubhara T, Mudhara M (2019). Commercialization and its determinants among smallholder farmers in Zimbabwe. A case of Shamva District, Mashonaland Central Province. *African Journal of Science, Technology, Innovation and Development* 11(6):1-8.
- Sekyi S, Abu BM, Nkegbe PK (2020). Effects of farm credit access on agricultural commercialization in Ghana: Empirical evidence from the northern Savannah ecological zone. *African Development Review* 32(2):150-162.
- Tijani SA (2018). Determinants of Market Participation among Small Scale Shea Butter Processors in Kwara State, Nigeria. *Tanzania Journal of Agricultural Sciences* 17(1).
- Uronu A, Ndiege BO (2018). Rural Financial Inclusion: Prospects and Challenges of Collective Action in Extending Financial Services among Rural Smallholders Farmers in Tanzania. *International Journal of Agricultural Economics* 3(2):23-30.
- Williams R, Dame N (2013). Scalar Measures of Fit: Pseudo R<sup>2</sup> and Information Measures. *Stata Journal* 2(1):1-16.
- Williams R, Papke LE, Wooldridge JM (2018). *Stata Tip 63: Modeling Proportions* &quot; Kit Baum. *Journal of Applied Econometrics* 11(6):299-303.
- ZimVAC (2018). Households and community survey. *Food and Nutrition Council Publications: Harare*.