A Double Hurdle Approach on Factors Influencing Market Participation and Intensity of Participation Among Small-Scale Indigenous Chicken Farmers in Botswana

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Abstract
Indigenous chicken farming is a crucial agricultural activity for small-scale farmers in rural areas as it provides high-quality protein from meat and eggs, create employment and income for the family. This helps to alleviate poverty in developing countries of Africa. Market participation and intensity of participation are critical determinants of income generation and economic sustainability for small-scale indigenous chicken farmers in Botswana. However, indigenous chicken farmers' market participation is still minimal and has received little attention from policymakers. This paper seeks to analyze factors influencing market participation and intensity of participation among small-scale indigenous chicken farmers. The paper is based on the data collected in the Kweneng East district in Botswana. A multi-stage sampling technique was used to select 276 respondents, and a semi-structured questionnaire was used to collect primary data. Data was analyzed using STATA and a double hurdle model was used to analyze the data. The findings revealed that the Tropical Livestock Unit, market access, leadership position of a friend/relative, trust in indigenous chicken traders, distance to main road, land size, marital status, trade experience and vaccination of chickens influence the farmers decision to participate in the market. Intensity of participation was influenced by the number of schooling years, dependency ratio, TLU, extension services, market access, support from friends/family and number of years stayed in a village. The paper proposes the posting by the government of extension officers in the villages for easier access to small-scale farmers.
Keywords: Market participation, intensity of participation, small-scale farmers, indigenous chicken, double hurdle.
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1. Introduction

Small-scale indigenous chicken farming plays a critical role in rural livelihoods, serving as a source of food security, income generation, and cultural value in developing countries of Africa. The indigenous birds are an essential livestock asset of many households in developing nations as a source of livelihood in less favoured areas of Africa and disadvantaged groups (Gueye, 2007). Furthermore, the indigenous chickens are valued for their adaptability, hardiness, resilience to harsh climatic conditions and ability to provide food and income for rural communities (Manyelo *et al*., 2020; Singh *et al*., 2023).

In Africa, farmers do not produce indigenous chickens on a scale that can be considered commercial, as with hybrid chickens (Ouma, 2011). This is mainly due to a weak production node of the chain, which is characterized by small flock sizes reared in a low-input free-range production system (Mathenge *et al*., 2010). In Botswana, farmers rear indigenous chickens on a low-input and low-output system, Moreki (2000). This contributes to low market participation because most indigenous chicken farmers let the chickens free range and scavenge for themselves during the day and confine them in temporary shelters at night without proper food provision. In some cases, the farmers supplement their diet with cereal grains and occasionally leftover food from the household. Apart from these feed supplements, little or no input, such as vaccines and antibiotics, is used, leading to low animal protein and egg output because of illness and malnutrition (Nguyen, 2011; Toomer *et al*., 2019).

Despite the significance of indigenous chickens, the market participation of small-scale indigenous chicken often varies widely due to numerous influencing factors. Market participation is the ability of an individual farmer to participate efficiently and effectively in a market and the intensity of participation measures the extent or scale of involvement in the market (Andareige *et al*., 2021). These aspects are crucial in determining the economic benefits derived from indigenous chicken farming. Smallholder farmers in rural areas rely heavily on household market participation, resulting in restricted market involvement and low economic rewards, hence persistent poverty (Niankara & Traoret, 2019). Markets are critical as they define farmers' channels to sell their surplus (Ngwako *et al*., 2021). Thus, the recognition of the potential of markets to unlock economic growth and agricultural development gave rise to a market-led rural development paradigm during the 1980s (Readon & Timmer, 2007). Additionally, Pacillo (2016) notes that farmers' shift from subsistence farming to commercial agriculture through market participation is believed to be effective in enhancing agricultural development and reducing poverty as this

has the potential to raise income, improve household welfare, food security and nutritional status (Babu *et al*., 2014). Understanding the drivers of market participation and intensity of participation of indigenous chickens is essential for designing policies and interventions that enhance the economic outcomes for small-scale indigenous chicken farmers. Therefore, this paper seeks to explore these factors, examining their impact on market participation and providing insights into strategies to improve participation and income generation in the agricultural sector.

2. Materials and methods

This paper is based on the data collected from the Kweneng East district, the biggest sub-district in the Kweneng district of Botswana. A multistage sampling procedure was employed to select a sample size of **276** respondents. In the first stage, the Kweneng district was purposefully selected because it is well known for its agricultural potential. In the second stage, the Kweneng East sub-district was purposively selected because it is the largest sub-district dominated by small-scale farmers and has the highest population of chickens. In the third stage, 8 villages across the district were randomly selected. The study chose these villages randomly to represent farmers with a small number of chickens, a large number of chickens, farmers from remote areas, and farmers closer to the capital city to avoid bias.

2.1 Model specification

The paper adopted a double hurdle model by Cragg (1971) to analyze the factors influencing market participation (See Achandi & Mujawamariya, 2016; Ingabire *et al*., 2017; Reyes *et al*., 2012; Zondi *et al*., 2022). The DH model consists of two stages: In the first stage the farmer decides whether to participate in the market or not to participate. If the farmer's decision is to participate, the second stage is to determine how much output should be sold to the markets (intensity of participation). The DH model estimation involves a Probit regression to identify factors affecting the decision to participate in markets by using all sample households in the first stage. The model takes values of 1 and 0 that are assigned to represent the choice of whether a producer decides to participate or not. The standard Probit model that assesses the household participation decision is described in Eq (1):

$D_i = \alpha Z_i, k + \varepsilon_i$……………(1)

$D_i = 1$ if $D^*_i > 0$ $D_i = 0$, if $D^*_i \leq 0$

Where D_i is a dummy variable that takes the value 1 if the producer participates in marketing the output and 0 otherwise, Z_i is a vector of independent variables hypothesized to influence participation decisions, k is the regressor, α is a vector of parameters to be estimated and ε_i is the error term.

In the second stage, truncated regression that excludes part of the sampled observation based on the value of the dependent variable is used (Wooldridge, 2010). The regression considers the observations that take 1 for participation decision. Therefore, the second hurdle represents the actual intensity of participation, expressed by the volume of supply. The truncated regression model with the lower left truncation equal to 0 is used to determine factors affecting the intensity of participation. The truncated regression model for factors affecting the intensity of participation is described as:

$y_i = \beta_i \chi_i + i + \varepsilon_i$

$y^*_i = \beta_i \chi_i + \nu$…………….. (2)

$y_i = \{y^*_i$ if $y^*_i > 0$ and $D_i = 1$; 0 otherwise$\}$

where y^*_i and y_i are latent and the observed intensity of participation, respectively, x_i is a vector of variables influencing the intensity of participation, β is a vector of parameters to be estimated.

The error terms are assumed to be independently and normally distributed as both decisions made by the individual producer independently which are as $u_i \sim N(0, 1)$ and $v_i \sim N(0, \sigma^2)$.

The log-likelihood function for the double-hurdle model that nests the Probit model and a truncated regression model is given following (Christoph *et al*., 2014):

$\log L = \ln 1 - \Phi Z'_i \alpha (x_i \beta')] + + \ln [\Phi(z_i' \alpha) 1 \Phi(y_i - x_i')]$…………………. (3)

Where Φ and φ refer to the standard normal probability and density functions, respectively, Z_i and X_i represent independent variables for the Probit model and the Truncated model, respectively, α, σ, and β are parameters to be estimated for each model as presented in Table 1.

Table 1: Variables included in the Double Hurdle regression model

Variables	Variable Description and Measurement	Exp Sign
Dependent		
Mkt participation	The decision of a farmer to participate (1=Yes 0=No) Dummy	
Intensity of participation	Quantity of indigenous chickens sold (Continuous)	
Independent		
Gender	Gender of the household head (Dummy) 1=Male 2=Female	+/-
Schooling years	Number of schooling years of the household head (Continuous)	+
Dependency ratio	Ratio of the non-working household members compared with working group (continuous)	+
TLU	Tropical Livestock Unit of the farmer's other livestock in units (continuous)	+
Extension services	Access to extension services (dummy) 1=Yes, 0=No	+/-
Market access	Access to a reliable market by farmers (Dummy) 1=Yes 0=No	+/-
Leadership position	Having a friend or relative in leadership position (Dummy) 1=Yes, 0=No	+
Trust in indigenous chicken traders	Farmers having trust on indigenous chicken traders (Dummy)1=Yes,0=No	+/-
Distance	Distance of the farm to the market (Continuous) Kilometers	-
Land size	Land size allocated for indigenous chicken farming (Continuous)	
Marital status	Marital status of the household head (Dummy) 1=married, 2=single	+/-
Rely on support	Relying on family, friends and relatives support in production (dummy) 1= Yes, 0=No	+/-
Trade experience	Number of years in indigenous chicken trading (continuous)	+/-
Vaccination	Vaccination of indigenous chickens by farmers (Dummy) 1=Yes 0=No	+/-
Years stayed in a village	Number of years stayed in a village by indigenous chicken farmers (continuous)	+
Type of main road	Type of main road used by the farmer (gravel, tarred road) (continuous)	+

3. Results

Prior to running the regression, econometric tests were done to test the validity and reliability of the double hurdle model. A likelihood test was done to check whether the double-hurdle model was the best alternative to the Tobit model. The Wald chi-square value of 70.45 was observed for indigenous chicken market participation, and the null hypothesis was rejected in favour of the double hurdle as the appropriate model. A Wald chi-square statistic of the model was used to test if the specified independent variables have an effect compared to the intercept. The Chi-square value was significant at the 1% level, indicating that at least one coefficient of the independent variables differs from zero, as presented in Table 2.

3.1 Market participation results

Table 2 presents the first hurdle probit model results on the determinants of household decisions to participate in the market.

Table 2: The probit model regression results

Variables	First Hurdle Market participation (0=No 1=Yes)		
	Coefficient	Std Error	P-value
Gender (0=Female 1=Male)	0.131	0.205	0.525
Years of schooling	-0.015	0.021	0.475
Dependency Ratio	-0.006	0.111	0.958
TLU	**-0.022***	0.013	**0.090**
Receive Extension (0=No 1=Yes)	-0.194	0.269	0.471
Market Access (0=No 1=Yes)	**1.062***	0.281	**0.000**
Leadership Position (0=No 1=Yes)	**0.452***	0.232	**0.051**
Trust chicken Trader (0=No 1=Yes)	**0.333***	0.190	**0.079**
Main Road Km	**-0.075***	0.044	**0.088**
Ln Land size	**-0.332****	0.150	**0.026**
Marital Status (1=Married 0=Single)	**0.453****	0.184	0.014
Rely Support (0=No 1=Yes)	0.210	0.194	0.278
Trade Experience years	**0.075***	0.017	**0.000**
Vaccination (0=No 1=Yes)	**0.667****	0.267	**0.012**
Years of staying in the village	-0.003	0.005	0.527
Type of Main Road	0.327	0.227	0.150
Constant	**-1.877***	0.678	**0.006**

Wald chi2(16) = 70.45 & Prob > chi2=0.000

The variable TLU negatively and significantly influences the indigenous chicken farmer's decision to participate in the market at a 10% level. A one percent increase in the units of other livestock owned leads to a

decrease in the farmer's decision to participate in the market by 2.2%. This is because farmers who own other livestock are more likely to concentrate on other animals with higher TLU and are less likely to participate in the local chicken market. This is due to the fact that animals provide the household with food, manure, revenue, and productive assets. They are also a symbol of prosperity and status. These results are in line with those of Rahut *et al*. (2015), who noted that households with greater livestock assets can employ them as draught animals, boost productivity through the use of manure, and make money from the sale of animal products.

Market access positively and significantly influences the farmer's decision to participate in the indigenous chicken market at a 1% level. The positive coefficient shows that once a farmer has access to a reliable market, the likelihood of participation in indigenous chicken markets increases by 106.2%. One reasonable argument is that having access to a stable market increases market participation by giving local chicken farmers better pricing, steady demand, and less uncertainty, all of which are important for investment and planning. Furthermore, when farmers have a dependable market, they may overcome the limitations of market participation since they have a guaranteed and timely purchase. The findings are corroborated by Nanyonjo *et al*. (2020), who clarified that access to trustworthy markets and involvement in agricultural marketing are critical for both male and female producers as they aid in social network building and revenue generation.

The leadership position of the farmer's relatives or friends positively influences the farmer's decision to participate in the market at a 10% level. The positive coefficient shows that when a farmer has friends or relatives in leadership positions, he/she is more likely to participate in the indigenous chicken market by 45.2%. The leadership position of a friend or relative acts as a catalyst in the farmer's decision to participate in the market as they help with access to resources, reliable market and market information. These results align with Akidi (2016), who stated that friends or relatives in leadership positions may enable farmers to secure better prices or market opportunities through their established networks and influence within community structures.

The results show that indigenous farmers' trust in indigenous chicken traders positively and significantly influences farmers' decision to participate in the market at a 10% significance level. The positive signs imply that when indigenous chicken farmers trust indigenous chicken traders, they increase their likelihood of participating in the market by 33%. One reasonable argument is that trust contributes to developing a mutually beneficial and long-lasting connection between a buyer and a seller. Years of dealing with a specific trader may lead to this since it fosters a good rapport and trust. The findings are consistent with those of Zanello *et al*. (2012), who noted that farmers have a far higher level of trust in trading with a farm gate buyer if they have a strong relationship with them.

The distance to the main road negatively and significantly influences the farmer's decision to participate in the indigenous chicken market at a 10% level. A unit increase in the farmer's distance from the main road to the chicken market will decrease the farmer's decision to participate in the market by 7.5%. This is explained by the fact that longer distances are associated with higher transportation costs, hence reducing the farmer's likelihood of participating in the market. The results are consistent with the findings of Onoja *et al*. (2012), who confirmed that households closer to market outlets are more likely to sell their fish than those living further away.

The land size used for indigenous chicken farming measured in square meters negatively and significantly influences the farmer's decision to participate in the market at a 5% level. The negative sign implies that an increase in the farmer's land size decreases the likelihood of a farmer participating in the market by 33.2%. One explanation for this could be that farmers with greater land areas tend to concentrate on raising crops or other livestock, which demand a lot of land, taking resources and attention away from raising chickens locally. These findings are in contradiction to those of Raghbendra *et al*. (2005), who found that in smallholder agriculture, land size and output level are positively correlated, potentially increasing market participation.

Marital status positively and significantly affects the farmer's decision to participate in the indigenous chicken market at a 5% level. An indigenous chicken farmer's marital status increases the farmer's likelihood of participating in the market by 45.3%. This could be the fact that married indigenous chicken farmers are more likely to participate in indigenous chicken farming because of the need to increase family income. Additionally, married household heads tend to consult their partners before deciding in order to get their full support and family labour in production. These results are consistent with the findings of (Onya *et al*. 2016), who found that marital status was positive and significant for participation in the cassava market and garri market.

A farmer's years of experience in indigenous chicken trading positively and significantly influence the farmer's decision to participate in the market at a 1% level. The results indicate that a one-year increase in indigenous chicken trading experience enhanced the likelihood of a farmer's participation in the market by 7.5%. This is most likely a result of farmers learning more about the local chicken industry through years of trading. Farmers also make important contacts in the market, which increases their selling chances. The findings of Mailu *et al*. (2012), who discovered that farmers with more trading expertise were better able to negotiate favorable terms and hence participate more actively in the market, are consistent with these findings.

Farmers' vaccination of chickens positively and significantly influences market participation at a 5% level. The results indicate that an increase in the vaccination rate of chickens increased the likelihood of farmers'

participation in the market. This is explained by the fact that when chickens are vaccinated against parasites and diseases, they become more resilient to diseases. As such, farmers would not incur losses due to high flock mortality, which increases productivity and market participation. The results are consistent with the findings of Otiang *et al.* (2012), who stated that regular vaccination is associated with significant increases in flock sizes. Reducing disease incidence allows farmers to sell healthier birds at potentially higher prices, mitigating the low farm gate prices often experienced when selling through middlemen (Mathiu, 2021).

3.2 Factors that influence the intensity of participation

A truncated regression model that excludes non-market participators from the sampled observation was used to determine the factors influencing the intensity of participation in indigenous chicken farming. The intensity of participation is expressed by the quantity sold in the market. The second hurdle model results are presented in Table 3.

	Second Hurdle Ln Number of chickens sold		
	Table 3: Truncated model regression results		
Variables	Coefficient	Std Error	P-value
Gender (1=Female 2=Male)	0.086	0.135	0.524
Years of schooling	**0.039****	0.016	**0.013**
Dependency Ratio	**0.212****	0.093	**0.022**
TLU	**0.016****	0.007	**0.030**
Receive Extension (0=No 1=Yes)	**0.344***	0.190	**0.070**
Market Access (0=No 1=Yes)	**0.290****	0.145	**0.046**
Leadership Position (0=No 1=Yes)	0.036	0.121	0.764
Trust Chicken Trader (0=No 1=Yes)	-0.087	0.123	0.478
Main Road Km	0.048	0.033	0.142
Ln Land size	-0.221	0.176	0.209
Marital Status (1=Married 2=Single)	0.049	0.128	0.702
Rely Support (0=No 1=Yes)	**-0.286****	0.130	**0.027**
Trade Experience years	0.000	0.007	0.986
Vaccination (0=No 1=Yes)	0.169	0.167	0.311
Years of stayed in the village	**0.006***	0.003	**0.062**
Type of Main Road	0.206	0.150	0.169
Constant	0.910	0.428	0.034
Wald chi2(16) = 70.45 & Prob > chi2=0.000			

The number of schooling years positively and significantly influences the intensity of participation at a 5% level. An increase in a year of schooling increased the likelihood of the indigenous chicken farmer's intensity of participation in the markets by 3.9%. This can be attributed to the fact that education enhances farmers' understanding of the importance of market participation. This helps farmers to grasp new information and knowledge regarding production, marketing and make informed decisions regarding their production. The findings are consistent with those of Barrett (2008), who concluded that education enhances managerial competencies and the successful implementation of improved production, marketing and processing activities. This makes it possible for farmers to venture into new agricultural innovations. Enete & Igbokwe (2009) and Randela *et al*. (2008) argued that education would endow the household with better production and managerial skills, which could lead to increased participation in the market.

The dependency ratio positively and significantly influences the intensity of participation at the 5% level. A dependency ratio is the number of dependents (children 0-14 years and elderly above 65 years) relative to the working-age population. The results indicate that a one percent increase in the dependency ratio increases the likelihood of increased intensity of participation in the market by 21.2%. Due to rising consumption and financial demands, households with increasing dependency ratios frequently feel pressured to support non-working members. Because it is accessible and takes little capital commitment to meet the demands of the dependents, this can encourage indigenous chicken farmers to participate more actively in income-generating activities like indigenous chicken farming. These results are consistent with the findings of Simon *et al.* (2015), who stated that poultry farming provides a quick turnover through the sale of eggs and live birds, which can help meet household

needs.

Tropical Livestock Units positively and significantly influence the indigenous chicken farmers' intensity of participation at a 5% level. A one percent increase in the units of other livestock owned by a farmer led to an increase in the farmer's intensity of participation in the market by 1.6%. Farmers who own other livestock are more likely to participate in the indigenous chicken market and increase their intensity of participation. This is because these farmers often have access to more resources, such as manure and additional land use, which can indirectly support indigenous chicken farming. These results align with the findings of Singh *et al.* (2023), who concluded that these resources enhance production capacity, enabling farmers to increase the scale of their operations and participate more actively in markets. Talihun *et al.* (2023) concluded that TLU indicated a significant association between participation status and livestock holding.

Access to extension services positively and significantly influences the indigenous chicken farmers' intensity of participation at a 10% level. A unit increase in the farmer's access to extension services increases the likelihood of intensity of farmers' participation in the market by 34.4%. This is explained by the fact that farmers with frequent contact with extension officers are more likely to acquire knowledge about production, market information, input and output prices, and veterinary services. This information is helpful to farmers as it raises awareness of the need to take necessary precautions, reduce mortality rates, and maintain their chickens' good health. Therefore, this would increase their productivity and intensity of participation in indigenous chicken markets. These results are supported by (Tarekegn & Yosefe, 2017), who explained that the utilization of extension service helps improve the household's technical capacity.

Market information access positively and significantly influences indigenous chicken farmers' intensity of participation at a 5% level. The positive coefficients show that once a farmer has access to market information, the participation intensity in indigenous chicken markets increases by 29.0%. This can be explained by the fact that indigenous farmers who have access to accurate and timely market information are empowered with knowledge of prevailing prices and demand trends. In addition, farmers can avoid unnecessary travel and reduce costs associated with seeking buyers or transportation. These results are supported by Nwafor *et al.* (2020), who highlighted that market information enables them to negotiate better prices and make informed decisions about where and when to sell their products, ultimately increasing their market participation intensity.

Support from friends and family members to the indigenous chicken farmer negatively and significantly influences the intensity of participation in indigenous chicken market at a 5% level. Indigenous chicken farmers who depended on support from both family members and friends had a probability of decreasing their intensity of participation by 28.6%. The results suggest that support from friends or relatives can replace the need to sell indigenous chickens during critical times, reducing market participation. In addition, assistance from friends or relatives provides a buffer that enables indigenous chicken farmers to meet their consumption needs without increasing their sales in the market. These results align with the findings of Dercon & Krishnan (2000), who noted that income transfers between relatives helped households in Ethiopia smooth consumption, reducing the need for intensified market activity during adverse conditions.

The number of years a farmer has lived in a village positively and significantly influences the intensity of participation at a 10% level. A unit increase in the number of years a farmer lived in a village increases the intensity of participation by 0.6%. A plausible explanation is that indigenous chicken farmers who have stayed in a village for a long time tend to understand the market dynamics, pricing, demand, and consumer preferences better than their counterparts. In addition, they develop social networks with other farmers, traders, and community members, facilitating access to vital market information, resources, and collective marketing opportunities. These factors enhance farmers' effective participation in the markets. These results are consistent with those of Alene *et al.* (2008), who found that farmers with longer ties to a community were more likely to use local resources effectively to increase their marketable surplus.

4. Conclusion and recommendations

This paper sought to determine the factors influencing market participation and the intensity of participation among small-scale indigenous chicken farmers using the double hurdle model. The results show that the TLU, distance to the main road(km) and the land size allocated for Indigenous chicken farming negatively and significantly influence the small-scale farmer's decision to participate in the market. Additionally, access to reliable markets, leadership position of the farmers' friends/relatives, trust in indigenous chicken traders, marital status of the indigenous chicken farmer, trade experience in indigenous chicken farming and vaccination of indigenous chickens positively and significantly influence the farmers' decision to participate in the market. The number of schooling years, dependency ratio, TLU, access to extension services, access to reliable markets and the number of years stayed by the farmer in a village positively and significantly influence the intensity of participation in indigenous chicken market. Support from friends and family was found to negatively and significantly influence the intensity of participation in indigenous chicken markets. Based on these results, the paper proposes the need for the government to allocate agricultural extension officers to all villages across the country to help reach farmers

in remote areas and educate them on market requirements, quality standards and value-addition techniques. The role of non-governmental organizations in supporting farmers' participation in the market cannot be ignored.

5. Acknowledgemets

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