Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.15, No.1, 2025

Determinants of Choice of Market Outlets among Smallholder Vanilla Farmers in Antalaha District, Madagascar

Georgia Rahelison * George Owuor and Hillary Kiplangat Bett

Department of Agricultural Economics and Agribusiness Management, Egerton University, P.O Box 536-20115, Egerton-Njoro, Kenya

* E-mail: georgiarahelison1@gmail.com

Abstract

This paper examines the factors that influence the choice of vanilla market outlets among smallholder farmers in the Antalaha district, Madagascar. A cross-sectional survey of 384 vanilla farmers was conducted in Antalaha district, Madagascar. Data was collected using a semi-structured questionnaire and personal interviews. For data analysis, descriptive statistics and a multivariate probit model were used. The data was analyzed using SPSS and STATA software. Multivariate probit model results show that gender, education level, off-farm income, land ownership, group membership, vanilla yield, dry vanilla, and green vanilla significantly influence the choice of market outlets among smallholder vanilla farmers. This study recommends the need to enhance educational initiatives, improve market access, provide agricultural training, and develop infrastructure to help smallholder vanilla farmers overcome market limitations and optimize their choice of profitable market outlets.

Keywords: Vanilla, Choice of market outlets, Smallholder farmers, Green and dry vanilla

DOI: 10.7176/JBAH/15-1-06
Publication date: February 28th 2025

1. Introduction

Madagascar is the leading producer of vanilla beans, accounting for over 80% of the world's production (Randriambololona *et al.* (2023). It is also the largest exporter of vanilla in the world, with exports worth US$619 million in 2021 (OEC, 2023). In addition, in 2020, vanilla represented 10% of Madagascar's total GDP (Yoon e*t al.*, 2020). The largest vanilla production region is north-east region of SAVA (Sambava, Antalaha, Vohémar, and Andapa) with more than 25,000 hectares of land under vanilla cultivation (Yoon *et al.*, 2020). Within the SAVA region, Antalaha district produces the most vanilla.

The vanilla bean is one of the most popular and frequently used food flavourings in the world. In addition, vanilla is used in foods, fragrances and medications, and it can also be applied to complementary medicinal uses such as to relieve fever, spasms, and gastrointestinal irritations (Singletary, 2020). About 40% of vanilla is sold for food purposes, whereas the rest is used for cosmetic and industrial purposes. The main channels of final consumption of Madagascar vanilla are international food and cosmetic companies (Yoon *et al.*, 2020).

The vanilla sector in Madagascar has grown significantly over the last decade, contributing to economic development and employment opportunities, particularly in the SAVA region (Andriamahery & Zhou, 2018). Furthermore, vanilla is essential to Madagascar as there are few economic opportunities as profitable as vanilla, and it also supports the local Malagasy population through the income generation. The cultivation of high-value agricultural products, such as vanilla, is considered by government bodies and development organisations as a crucial approach for improving food security in rural and urban areas (Andriamparany *et al.*, 2021). Vanilla market contributes to farmers' livelihoods, which enables them to invest in farmland, build houses, afford quality education and acquire material possessions (Osterhoudt, 2020).

The vanilla sector faces several challenges including lack of monitoring and control, lack of road infrastructure, low and volatile prices, theft of vanilla and lack of information and support (Fairfood & CNV international, 2016). Other challenges that affect vanilla production include weather variations, climate disasters such as cyclones, and changes in energy prices(Jones & Murphy, 2009). In addition, Government intervention in the vanilla market is also one of the most challenging problems in the marketing of vanilla (Cadot *et al.*, 2006). Market risks relating to uncertainty about prices, costs, and market access affect profitability of smallholder farmers (Wulandari, 2021). These challenges affect farmers' livelihoods along the value chain and restrict their access to the vanilla market.

Marketing of agricultural produce in Africa is achieved through various outlets depending on the produce and country. The major outlets used include farm gate, local market and urban market, cooperatives, brokers, retailers, wholesalers, assemblers, and final consumers (Arumugam *et al.*, 2022; Dessie *et al.*, 2018; Melese *et al.*, 2018; Kuma *et al.*, 2013; Sigei *et al.*, 2015; Tarekegn *et al.*, 2017). In Madagascar and indeed Antalaha district vanilla is commonly sold to local markets, urban markets and cooperatives. The different outlets that exist possess different challenges as well as opportunities. The revenue accrued from the different outlets needs to be explored for a better understanding of the most effective, productive, and profitable option.

There is a dearth of scientific research on the choice of market outlets for smallholder vanilla farmers in Madagascar, particularly in the Antalaha district. This paper therefore seeks to fill this information gap. It is expected that the findings of this paper will provide policy direction to the farmers, government and policy makers so as to unlock the potential of vanilla production and marketing.

2. Data and Methods

2.1 Study Area

The study was carried out in the Antalaha district, which is one of the hundred and nineteen districts in the Republic of Madagascar. It is located in the north-east of Madagascar and spans an area of 6,795 km² (INSTAT, 2020). It is one of the four districts of the SAVA Region. Others include Sambava, Andapa, and Vohémar. There are 282,158 people living in the district, which corresponds to a population density of 41.52 persons per km (INSTAT, 2020). The annual temperature in the district is 27.15ºC (80.87ºF), which is 3.27% higher than the average for Madagascar. Antalaha receives 146.44 days of rain (40.12% of the total) and 131.93 millimeters (5.19 inches) of rainfall per year. Antalaha experiences two distinct seasons: the rainy season, which runs from November to April, and the dry season, which runs from May to October. February is the wettest month, with an average of 10.6 inches of rain. The latitude of Antalaha is 14º 90` south, and the longitude is 50º 28` east. Agriculture is a dominant economic activity in the Antalaha district supporting 89.7% of households (ILO, 2020). The food crops grown include rice, cassava, potatoes, maize and beans while cash crops include vanilla, coffee, cloves and pepper. Vanilla is the main cash crop in the district, and around 87.2% of smallholder farmers in the region grow this crop (ILO, 2020). Poverty levels in the region are high at approximately 75% (ILO, 2020).

The Antalaha district was chosen principally because vanilla cultivation is the major occupation of the people in this district, and this crop is also the main economic cash crop. In addition, Antalaha is part of the tropical and humid zone with a high potential for vanilla production. Moreover, poverty levels in the district have increased, which is why intervention measures need to be implemented to solve the problem. The Antalaha district was considered for this study due to its predominance in vanilla cultivation. The study area is shown by the map in the figure below:

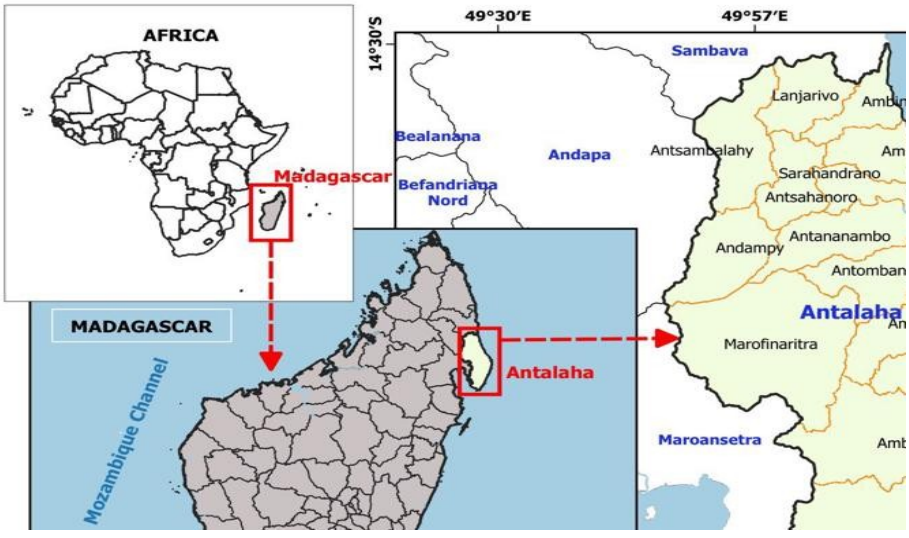

Figure 1. A map of Antalaha district

Source: Egerton University, department of Geography, 2023

2.2 Research Design and Sampling Technique

This study used a survey design to determine smallholder vanilla farmer's participation in different market outlets in Antalaha District. The survey was based on cross section data with a one year recall period. Smallholder vanilla farmers were selected as respondents using a multistage sampling method. In the first stage, the researcher employed the purposive sampling procedure to select the Antalaha district among the four districts in the SAVA region due to the majority of vanilla production. In the second stage, the municipalities of Ampohibe and Ambalabe were purposively selected from the eighteen municipalities in this district. These two municipalities were selected due to the large number of small-scale vanilla farmers. The third and final stage was used snowball sampling to select 384 respondents, because the sample frame and the size of the subpopulation of vanilla farmers in each municipality were not known.

Table 1. Sample size distribution of the respondents in the study area

Municipalities	**Number of households**	**Proportion**	**Sample size**
Ampohibe	4,093	45.49%	175
Ambalabe	4,905	54.51%	209
Total	**8,998**	**100%**	**384**

Source: INSTAT- CCER, 2018

2.3 Sample Size Selection

The proportional-to-size sampling technique was used to determine the desired sample size. This method was used because the exact size of the target population in the study area is unknown. According to Kothari (2004) and Cochran (1963), the following formula was used to determine the required sample size

$$n = \frac{z^2 pq}{e^2} \qquad (1)$$

where n = sample size, z refers to a z-value of 1.96 on the confidence level of 95% (α = 0.05), p represents the proportion of smallholder vanilla farmers in the population which is equal to 0.5 statistically suitable and reliable size of sample when the population cannot be specified, q indicates the proportion of the target population estimated not to have the characteristics measured (proportion of non-smallholder vanilla farmers) and which is calculated as 1-p (1-0.5=0.5), and e represents the 5% acceptable error. The following calculation is used to determine the sample size:

$$n = \frac{1.96 \times 1.96 \times 0.5 \times 0.5}{0.05 \times 0.05} = 384$$

384 respondents were used as the sample size for the vanilla smallholder farmers.

2.4 Data Collection and Analysis

Primary data was collected by interviewing respondents and personally administering questionnaires to small-scale vanilla farmers, using a semi-structured questionnaire comprising both open and closed questions. To test the validity and reliability of the questionnaire, a pilot study was carried out before the actual data collection. The questionnaire was pre-tested among 40 smallholder vanilla farmers outside the two municipalities targeted for the study. A multivariate probit model was used to analyze the data in order to determine the factors affecting the market outlet choices among vanilla smallholder farmers in the Antalaha district of Madagascar. Data management and analysis were conducted using SPSS and STATA software.

2.5 Analytical Framework: Multivariate Probit Model

A multivariate Probit (MVP) model was used to determine factors affecting vanilla smallholder farmers' choices among different market outlets in the Antalaha district, Madagascar. Additionally, the multinomial logit (MNL) model and the ordered logit model are also suitable for this research, as the dependent variables have more than two outcomes. The MNL model is suitable when the decision-maker selects one option among a set of different

choices (Arumugam *et al.*, 2022; Tse, 1987). It is also employed when farmers are required to choose between several mutually exclusive market outlet options (Arumugam *et al.*, 2019; Rossini *et al.*, 2014; Tse, 1987). This model is used when the nominal outcome variable to be predicted is unordered. The MNL model can be applied to any number of continuous or categorical independent variables. However, the MNL model cannot be applied in this study since smallholder farmers can select more than two outcomes from the various market outlets, and their choices are not mutually exclusive. Further, the assumption of independence of irrelevant alternatives (IIA) is also a weakness associated with the use of the MNL model, as this assumption implies that one particular choice option does not affect the relative selection probabilities of the other options (Vijverberg, 2011). Further, the ordered logit model is similar to the MNL model, except that it is a regression model for an ordinal response variable. In contrast, the ordered logit model cannot be used in this research, as small-scale farmers cannot choose ordered outlet markets as a response variable.

The MVP model was used to analyze the selection of several channels simultaneously and took account of independence and correlation when the farmer chose a marketing channel. (Arinloye *et al.*, 2015; Ngenoh *et al.*, 2020). In this research, the choice of market outlets for small-scale farmers represents a multiple response that is not mutually exclusive. This implies that the MVP model was applied in this study, as smallholder farmers can choose to sell their vanilla simultaneously on the local markets, on the urban markets, and on cooperatives.

The econometric model of this study is characterised by a set of dependent variables Y_{it}. The MVP model's functional form is described as follows:

$$Y_{it}^{*} = \beta_{it} X_{it} + \varepsilon_{it} \quad \text{with } (t=1, 2, 3) \qquad (2)$$

where (t=1,2,3) represents the choice of the vanilla market outlets including local market, urban market and cooperative, X_{it} represents a 1 × k vector of all factors that influence market outlet selection, β_{it} represents a k × 1 vector of the parameter to be predicted, i^{th} farmer is given i (1,2,....,n) to choose a market outlet, and ε_{it} (t= 1,….,m) represents error terms.

The observed outcome for choosing the vanilla market outlet was modelled as follows,

Y_{it} [$\begin{matrix} 1 \; if \; Y_{it}^{*} > 0 \\ 0 \; otherwise \end{matrix}$ t= 1, 2, 3; 0= otherwise

In this research, small-scale farmers choose market outlets based on their profits. Whereas, the decision of market outlet implies a multiple choice such as local market, urban market, and cooperatives. Consequently, the system of equations for each market outlet becomes:

$$Y_{1i}^{*} = \beta_1 X_1 + \varepsilon_{1i} \qquad (3)$$

$$Y_{2i}^{*} = \beta_2 X_2 + \varepsilon_{2i} \qquad (4)$$

$$Y_{3i}^{*} = \beta_3 X_3 + \varepsilon_{3i} \qquad (5)$$

where, Y_1^{*} =local market, Y_2^{*}= urban market, and Y_3^{*}= cooperatives.

The simulated maximum likelihood is used to estimate the unknown parameters of equation (2). Consequently, the implicit functional form will be estimated to determine the factors affecting vanilla smallholder farmers' choice of market outlets, as shown below:

$$Y_i = \beta_0 + \beta_1 \text{Sex} + \beta_2 \text{Educ} + \beta_3 \text{Hhsize} + \beta_4 \text{Offinc} + \beta_5 \text{Lsize} + \beta_6 \text{LOwn} + \beta_7 \text{FarmExp} + \beta_8 \text{Group} + \beta_9 \text{VanYie} + \beta_{10} \text{Dry} + \beta_{11} \text{Green} + \beta_{12} \text{Dist} + \varepsilon_i \qquad (6)$$

where, Y_i represents the market outlet that smallholder farmers choose.

The constant is β_0, the coefficients are β_1 to β_{15}, and the error term is ε_i.

3. Results and Discussion

3.1 Socio-demographic and Economic characteristics of Vanilla Farmers in Antalaha district, Madagascar

Results in Table 2 show socio-demographic factors of vanilla farmers in Antalaha district of Madagascar. The average age of respondents was around 45 years. This productive age means that they are in an active and productive phase, enabling them to manage their farms effectively and implement modern farming techniques. On average, the majority of respondents had around 6 years of formal education, which indicates a low level of literacy among vanilla farmers. This can limit their ability to access, understand and implement modern farming practices, which impacts negatively on production efficiency and yields. Smallholder vanilla farmers had a mean

of 14 years' experience of vanilla farming, indicating a substantial level of practical knowledge and expertise in the field. This extensive experience likely enhances their ability to navigate the challenges of vanilla farming and make informed decisions about farming practices. Household size averaged 4 members per household, which is very essential for offering farm labour. This suggests that having several family members available can help solve labour challenges in farming activities, potentially improving productivity and efficiency in farming operations.

Table 2. Socio-demographic attributes among vanilla farmers in Antalaha district

Variables	**Mean (N=384)**	**Std. Dev.**
Age (years)	44.76	14.53
Education (schooling years)	6.02	3.63
Farming experience (Years)	13.66	11.16
Household size	4.30	1.86

The economic factors of vanilla farmers in Antalaha district of Madagascar are presented in Table 3. The respondents had an average land size around 1 hectare. The study by Hänke (2020) found that the main farmland in Madagascar's SAVA region is occupied by vanilla agroforestry systems, with an average farm size of 0.9 ha, which is followed by rice (0.6 ha), coffee (0.1 ha), cocoa (0.1 ha), and cloves (0.1 ha). This indicates that vanilla is an important crop in the SAVA region, particularly in Antalaha, playing a major role in the livelihoods of numerous farmers. In terms of yield, the results show that mean yield is 46 kg per hectare. This low yield is attributed to the prevalence of vanilla diseases (*Bekorontsana*), sub-optimal farming practices and insufficient access to high-quality inputs, which negatively affect crop productivity. Additionally, limited extension services, unpredictable weather and market constraints are exacerbated by other factors that hamper farmer productivity and sustainable yields.

Table 3. Economic factors of vanilla farmers in Antalaha district, Madagascar

Variables	**Mean (N=384)**	**Std. Dev.**
Land size (hectares)	1.38	1.17
Vanilla yield (Kg)	46.27	64.71

Table 4 presents the results for sex, land ownership, agricultural training, and group membership among vanilla farmers. The majority of vanilla farmers are male (93%) compared to female (7%). This is attributed to males having greater access to productive resources, information, and financial capital compared to females, enabling them to engage more effectively in vanilla cultivation. Land ownership shows that a majority (72%) of vanilla farmers own titles to their land, reflecting a strong level of land ownership. This can increase their security and stability, enabling them to invest in farming practices and develop long-term plans for their farms. Group membership data shows that only 20% of farmers are members of community institutions, indicating a low level of collaboration among vanilla farmers. This low level of group membership can limit access to shared resources, knowledge, and support, which impacts overall productivity and resilience in the agricultural sector. In terms of agricultural training, the results show that 16% of farmers have received adequate training. This indicates that only farmers belonging to groups can easily access training compared to those operating individually.

Table 4. Distribution of sex, land ownership, agricultural training, and group membership, among vanilla farmers

Variables		Percentage (%)
Sex	Male	93.2
	Female	6.8
Landownership	Yes	72.4
	No	27.6
Training	Yes	16.2
	No	83.8
Group membership	Yes	20.3
	No	79.7

Table 5 reveals that the majority of farmers (80%) sold their vanilla on the local markets, followed by cooperatives (21%), and the urban markets (5%) respectively. Although the local market offers relatively low prices, it remains the preferred choice for 80% of vanilla farmers because of its proximity to their farms and the facility it offers for quick and accessible sales. These findings are consistent with those of Adugna *et al.* (2019) and Olufadewa & Obi-Egbedi (2018) who found that the majority of smallholder farmers opt to sell their produce on the local market.

Table 5. Market outlet choices among vanilla farmers

Market outlets	Frequency	Percentage (%)
Local markets	307	80
Urban markets	18	4.7
Cooperatives	81	21.1

3.2 Factors Influencing Choice of Market Outlets among Smallholder Vanilla Farmers

Table 6 presents the results of the multivariate probit model analysing the factors influencing vanilla farmers' choice of market outlets. The results show the Wald test (Wald chi2 (36) = 576.93, p<000) and the likelihood ratio test (LR Chi2 (3) = 100.935, p<0.000). The covariance matrix, designated rho21=rho31=rho=32=0, indicates that the rho values are statistically significant at the 95% level of confidence. This implies rejection of the null hypothesis, which supposes that all values of rho are jointly equal to zero. This indicates that the multivariate probit model had strong explanatory power and was well fitted.

Results in Table 6 show that sex, education, off-farm income, land ownership, group membership, vanilla yield, dry vanilla and green vanilla significantly affect the market outlet choices. For the local markets, group membership was significant at 1% level, and green vanilla was significant at the 5% level. Sex, and dry vanilla were significant at the 1% level, vanilla yield and receive off-income were significant at the 5% level, and land ownership was significant at the 10% level in the urban markets. For the cooperatives, group membership was significant at the 1% level, education was significant at the 5% level, and vanilla yield and dry vanilla were significant at the 10% level.

Table 6: Multivariate probit results for factors affecting the choice of market outlets among smallholder vanilla farmers

Variables	Local markets	Urban markets	Cooperatives
	Coef. (RSE)	Coef.	Coef.
Sex (1=Male,0=Female)	-0.051 (0.434)	3.599*** (0.730)	0.160 (0.437)
Education (schooling years)	-0.041 (0.027)	0.051 (0.046)	0.053** (0.024)
Household Size (Number)	-0.005 (0.046)	0.106 (0.087)	0.032 (0.044)
Off- farm income (Yes, No)	-0.030 (0.203)	0.963**(0.435)	0.107 (0.176)
Land size (hectares)	-0.045 (0.081)	-0.004 (0.132)	0.029 (0.090)
Land ownership (Yes, No)	0.124 (0.191)	-0.630* (0.379)	-0.043 (0.237)
Farming experience (Years)	0.009 (0.010)	0.009 (0.014)	0.001 (0.009)
Group membership (Yes, No)	-1.99*** (0.231)	0.166 (0.312)	1.833***(0.231)
Log vanilla yield (Kg)	-0.127 (0.091)	0.444** (0.175)	0.148* (0.084)
Distance to the market (Km)	0.013 (0.009)	-0.019 (0.015)	-0.011 (0.010)
Dry vanilla	0.229 (0.263)	4.740*** (0.437)	0.386 (0.273)
Green vanilla	0.596** (0.296)	-0.231 (0.317)	0.534* (0.299)
Constant	1.178 (0.655)	-12.004 (1.480)	-2.833 (0.655)

Number of observations = 384, Wald chi2 (36) = 576.93, Log pseudo-likelihood = -222.203, Prob > chi2 =0.0000, rho21 = rho31 = rho32 = 0.

The asterisks ***, **, and * indicate significance levels of 1%, 5%, and 10%, respectively.

Note: RSE: Robust Standard Errors in the parentheses.

The positive and significant influence of sex indicates that male head of households had high likelihood of choosing the urban markets at 1% level. The findings show that men are 360% more likely to choose urban markets compared to women. This is because urban markets offer the highest prices for vanilla compared to local markets and cooperatives. Additionally, males have better access to transport resources that aid ferrying of vanilla to urban markets compared to women. The study by Hänke *et al.* (2018) found that female-headed households are less integrated into the vanilla value chain, while male-headed households are more integrated due to higher sales and higher contract completion rates in Madagascar. Similar results were found by Endris *et al.* (2020), indicating that male farmers in Ethiopia were more likely to sell onions to collectors than female-headed households. The findings are in line with those of Ngeno *et al.* (2024), who reported that male farmers were more likely to sell carrots on the local market than women to sell carrots on the local market than women.

The results for education show a positive effect on cooperatives at 5% significance level, indicating that a higher level of formal education increases the probability of choosing cooperative outlets by 5.3%. This indicates that educated farmers are better able to understand the benefits of cooperatives, including fair prices, market access, and support services, which can improve performance in a volatile market. According to Amato (2018), vanilla farmers choose cooperatives because of the numerous benefits, such as access to zero-interest loans, collective price negotiation, higher prices for their products, and greater security against crop theft. Further, the study by Hänke *et al.* (2018) found that better-educated households have more vanilla cultivation experience, and larger fields are likely to produce larger vanilla harvests, which improves their ability to access urban markets. These results are in agreement with those of Degefa *et al.* (2022), who found that farmers' level of education was positively and significantly related to the likelihood of choosing cooperative market outlets in Ethiopia. In addition, Chekol & Mazengia (2022) confirmed that farmers with a high education level improve their choice of market outlets by considering trade margins and marketing costs.

Off-farm income positively affects the probability of farmers accessing the urban market at 5% significance level. This shows that farmers engaged in non-farm or off-farm activities are more likely to sell their products on the urban market (96.3%) than those with no off-farm income. This is because farmers with non-agricultural income are more likely to be able to afford transportation costs and have more time and resources to travel to the urban market, enabling them to sell their products and search for the best prices. Moreover, off-farm income provides farmers with an extra source of revenue, enabling them to produce more products to offer on the urban markets.

The results contradict those of Gachoka *et al.* (2023), Ng'ang'a *et al.* (2022), and Ermias & Yildiz (2021) who revealed that off-farm income negatively influenced the likelihood of a farmer selecting a broker or producer group, wholesaler market, and retail markets respectively. These results are inconsistent because the farmers in this study sell vanilla, whereas the farmers in the other studies focus on crops such as mangoes and beans, which have different market options and price structures. Additionally, products like mangoes are perishable and can spoil easily, which is why farmers often prefer to sell to brokers or wholesalers rather than directly to the urban market.

Land ownership negatively and significantly affects selling in the urban market at 10% significance level. The fact that vanilla farmers have land ownership reduces the likelihood of selling in urban markets by 63%. Most of the landowners diversify and produce other crops that act as a fallback position in case of shocks unlike those who rely on family/communal land. Thus, they are not compelled to engage in urban markets that are far away even though they offer better prices because they have other livelihood options. Additionally, land ownership increases farmers' production capacity, leading to higher agricultural productivity, as it guarantees security of rights and access to the necessary resources (Mdoda & Gidi (2023). The results are inconsistent with Momanyi (2016), who found that land ownership positively impacted the probability of farmers accessing in market at 5% significance level. The inconsistency is because the results of Momanyi (2016) focus on vegetable farmers, who may experience different market dynamics compared to vanilla farmers. Additionally, vegetable production often requires quick sales due to the perishability of the crops, leading farmers to prioritize immediate market access.

Group membership has a negative and positive significant impact on the decision to choose the local markets and cooperative markets at 1% level respectively. Being a member of a cooperative or farmers' group reduces the chances of selling on the local market and increases the choice of selling to cooperatives. The reason for this could be that the cooperative offers technical support and training to its members and distributes an annual bonus. The results align with those of Tarekegn *et al.* (2017), who found that cooperative membership had a positive and significant impact on the probability of selecting a cooperative outlets. They also revealed a negative and significant impact of choosing collectors outlet at 5% level. Further, the research by Chelang'a *et al.* (2023) revealed that membership in a farm group negatively influenced the choice of middlemen and spot combinations.

The vanilla yield produced (quantity of vanilla produced) significantly and positively influences the choice of the urban market at the 5% level. Further, vanilla yield positively affects the probability of selling on the cooperative market outlets at the 10% significance level. The positive correlation suggests that farmers producing a high volume of vanilla favour the urban markets and cooperatives than local markets, implying that the urban market and cooperatives have a greater capacity to absorb large quantities of vanilla. The results are consistent with the findings of Kotey *et al.* (2021), which revealed that the volume of cowpea sold positively impacts the likelihood of selecting the wholesale market at 1% significance level. Additionally, the results are in accordance with the results of Ermias & Yildiz (2021), where the likelihood of choosing wholesalers and collectors was positively influenced at the 1% and 10% significance levels.

Dry vanilla positively and significantly influences the probability of choosing urban markets at 1%. The positive correlation suggests that farmers who have dry vanilla prefer the urban market rather than cooperative and local markets. Farmers with dry vanilla are more likely to target urban markets because of the longer shelf life, ease of transport, and higher prices. Further, dry vanilla beans have a higher market price than fresh/green vanilla, meaning they are more profitable for farmers. The findings align with those of Peña-Barrientos *et al.* (2023) who found that dried vanilla beans achieved higher prices due to their improved flavour profile, which makes them more desirable in international markets.

Green vanilla positively and significantly influences the possibility of choosing local markets and cooperatives at 5% and 10% significant levels respectively. The positive coefficient indicates that farmers who have green vanilla prefer the local markets and cooperatives rather than urban markets. This is possible because local markets and cooperatives often offer direct access to buyers, reducing transportation time and costs. Additionally, local markets and cooperatives may offer better prices for green vanilla due to the direct interaction between farmers and buyers, as well as the potential bargaining power of cooperatives. The findings are in line with those of Watteyn *et al.* (2022) who found that many farmers choose to sell green vanilla beans instead of dried vanilla because of lower processing costs and faster profits.

4. Conclusions and recommendations

MVP results showed that the sex, education level, off-farm income, land ownership, group membership, vanilla yield, dry vanilla, and green vanilla were the major factors that significantly affected the likelihood of choosing various market outlets among vanilla smallholder farmers in the Antalaha district of Madagascar.

This study suggests that the government should focus on enhancing educational initiatives, market access, access to agricultural training, and improving infrastructure to help smallholder vanilla farmers overcome market limitations and optimize their choice of profitable market outlets. Additionally, policy makers should stabilise prices, improve the transparency of market operations, and support cooperative programs to ensure that smallholder farmers have sustainable and profitable ways of selling their produce.

5. Acknowledgements

My sincere appreciation extends out to the African Economic Research Consortium (AERC) for the generous financial assistance.

6. Author Contributions

Georgia Rahelison: Conceptualisation and design of the research, analysis and interpretation of the results, drafting of the article, review and editing of the intellectual content, and preparation of the final version for publication.

George Owuor: Supervision, verification, and manuscript review and editing.

Hillary Kiplangat Bett: Supervision, verification, and manuscript review and editing.

7. Conflict of Interest

There are no conflicts of interest, according to the authors.

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