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Article

An analysis of the smallholder farmers' cassava (*Manihot esculenta* Crantz) value chain through a gender perspective: the case of Dak Lak province, Vietnam

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GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE

An analysis of the smallholder farmers' cassava (*Manihot esculenta Crantz*) value chain through a gender perspective: the case of Dak Lak province, Vietnam

Xuan Hoa Ao^{1,2}, Trinh Vuong Vu², Khac Dong Le¹, Sopin Jirakiattikul³ and Kuaanan Techato^{1*}

Abstract: Many rural women, who are faced with the challenges of low rural incomes and gender inequality, improve their role in the farming system based on participation in the agricultural value chain thus enhancing agricultural productivity, household income and sustainable development. This study investigates the factors which affect participation in the production of cassava in Dak Lak Province and decisions in relation to the cassava value chain from a gender perspective. Data were obtained through a questionnaire-based survey of 300 household farmers, in-depth interviews with key informants, and focus group discussions. Probit and ordinary least squares regression models in a two-stage Heckman model were adopted to determine the factors affecting females' decisions to participate in cassava cultivation, their level of participation and their participation in other stages of the cassava value chain. The survey results show that men are prominent in all stages of cassava production but there is a more equal gender dynamic in both cassava production participation decisions and decisions relating to the quantity of cassava to be supplied for commercial purposes.

ABOUT THE AUTHORS



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PUBLIC INTEREST STATEMENT

For the past decade, gender issues and their relations to the cassava value chain have been generating serious concern in Vietnam. However, there is no study that has yet evaluated the cassava value chain and the role of gender. Therefore, this present study has focused on analyzing the cassava value chain via a gender perspective in Dak Lak Province, Vietnam. Surprisingly, this study reveals that males play a dominant role in the cassava value chain compared to their female counterparts, which is not consistent with previous studies' findings in various other locations around the world. The baseline information from this research will be useful to policymakers in formulating plausible and sustainable policies and will enhance the cassava value chain in Vietnam.

This article draws attention to the continuing role challenges of female smallholder farmers, but also shows how women's empowerment is contingent on equity dynamics in the household as well as social norms in the community and wider society.

Subjects: Gender & Development; Sustainable Development; Rural Development; Economics and Development; Economics

Keywords: cassava value chain; female; gender equality; male; smallholder farmer

1. Introduction

Agriculture is an important component of a national economy (Singh-Peterson & Iranacolaivalu, 2018) including the Vietnamese economy, contributing to the latter approximately 18% of the gross domestic product (GDP) and 47% of total employment (Ho, Nguyen, Adhikari, Miles, & Bonney, 2017). Women play an undeniably important role in the agriculture sector (Sell & Minot, 2018), and constitute 43% of the agricultural labour force in developing countries (FAO, 2011). In the case of Vietnam, farming and other agricultural activities constitute the principal sustainable livelihood of most Vietnamese people (Kerkvliet & Porter, 1995). Among the cash crops important in Vietnamese agriculture, cassava (*Manihot esculenta* Crantz) production plays an important role in ensuring poor people's livelihood (Ho et al., 2017). The whole country has an area of approximately 535 thousand hectares planted to cassava (GSO, 2018a), with cassava yield growing by 9.94 million tonnes in 2018 (GSO, 2018b). Some recent studies have suggested that there are differences in male and female perceptions relating to many issues in society worldwide. Men are prominent in relation to both basic human rights and strength of voice in their households and communities (World Bank, 2012). Hence, men have more opportunity to access knowledge as well as markets and have an advantage over women who are generally more vulnerable. As a result, men are more involved in cash-crop activities, which gives them the advantage of higher income (Sell & Minot, 2018). However, evidence from studies shows that the role of women who attend to the welfare of the household can be improved by both men and women making decisions (Sell & Minot, 2018) rather than just the men. Thus, the value chain approach to agricultural products can be applied to deal with intra-household gender inequality (Masamha, Thebe, & Uzokwe, 2018a). Additionally, many studies that have considered gender have focused exclusively on modern value chains because they examined agriculture value chains in high-value cash crops, for example, tomatoes, cashew nuts, cocoa and avocado (Jeckoniah, Mdoe, & Nombo, 2013; Oduol et al., 2013). Therefore, there has been little analysis of the effect of the traditional roles of genders such as the relationship between male and female roles in the cassava chain at the household level (Masamha et al., 2018a). Both McNulty and Oparinde (2015) and Olukunle (2013) asserted that farmers receive fewer profits than other actors in the cassava chain. Moreover, Dolan (2001) found that there was discrimination against female farmers in contract farming patterns compared to men in the gardening export sector in Kenya and exploitation of female farm workers in African horticulture was also reported by (Barrientos, Dolan, & Tallontire, 2003, 2001). However, Maertens and Swinnen (2009) reported that women in Senegal have substantial influence and play an important role in modern supply value chains. Agricultural economists in both developed and developing countries have been concerned about resources in agricultural supply chains for a long time (Goetz, 1992). Gender inequality in agriculture reflects a complex set of problems relating to control over resources, control over decision making, labour, and support from kin (Kerr, 2005). A previous study found that 53% of the labour force in the agricultural sector of developing countries is made up of women, who play an indispensable role in agricultural production (Apata, 2013). Therefore, the gender gap is closing and this may be because women's participation in economic activities is more active than before. Furthermore, Sarkar, Sahoo, and Klasen (2019) suggested that for a woman to decide whether or not to work is a complex issue that involves social norms, educational attainment, and responsibilities to care for dependents such as children and the elderly. However, Garikipati (2009) argued that women seem to be involved in agriculture whenever possible. In a project in Southeast Asia, conducted by the Netherlands Development Organisation in 2015 to promote inclusive business for the sustainable growth of cassava by smallholders, the gender-related aspects of the cassava value chain were examined in order to propose plausible strategies in Cambodia (SNV Cambodia, 2015).

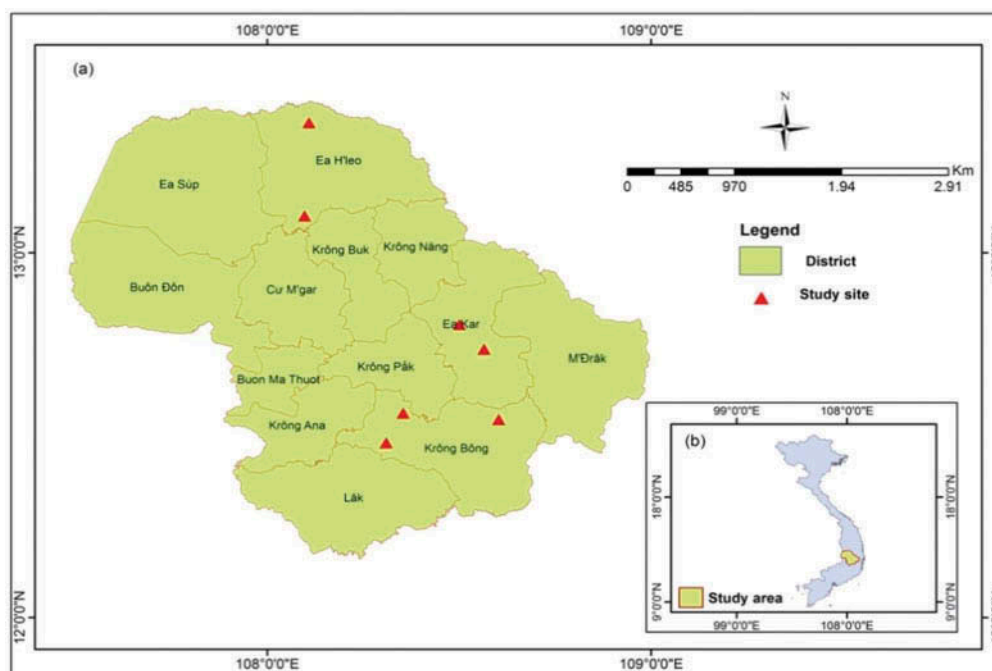
As yet, there has been no empirical research analyzing the role of gender in the cassava value chain in Vietnam. Most studies of the cassava value chain have focused on the cost and benefit dimensions of cassava (Son, Lam, Fahrney, Thi, & Thuy, 2016). Other research has examined the relationship between cassava production and consumption as well as the relationships among the actors in the cassava value chain, in which middlemen play a vital role (Viet, Quoc, Gia, Van, & Van, 2013). Moreover, Son et al. (2016) noted that the incomes of rural households that are derived from cassava plays a vital role in the livelihood of the farmer. However, the findings reported in the present paper are fundamentally different from those of previous related studies since they highlight the contribution of rural women to food security and natural resource management in spite of inequality and discrimination (Doss, Meinzen-dick, Quisumbing, & Theis, 2018). The present study contributes to the existing literature in a number of ways and shows that many factors are involved in determining the dynamics of the participation of women in the labour force. The main aim of the study is to assess the factors which affect women's decisions to participate in cassava cultivation and the level of that participation. In addition, this study seeks to determine what factors influence the participation of farmers in the market and the level of their participation in the cassava value chain. This paper will contribute important information for implementing well-informed policies relating to the cultivation of cassava in Vietnam as well as in relation to the role of gender in sustainable farming systems in rural areas.

2. Materials and methods

2.1. Study area and data collection

The study described in this paper was conducted in Dak Lak Province (Figure 1), which is situated in the Central Highlands of Vietnam, and has an area of over 13,125 square kilometers. The area's climate can be separated into two sub-regions. The climate in the south-east is cool and pleasant but in the north-west, the climate is quite hot and dry. The region grows various crops but the climate is not suitable for high-value crops and many solutions have been put forward to overcome this problem. Cassava cultivation has been found to be one of the best choices. The study was conducted in three districts, Krong Bong, Ea H'leo and Ea Kar, where cassava production is dominant compared to other crops. Cassava is the main source of income of the local households.

Figure 1. The location of the study area.



Data collection was conducted using structured questionnaires. Data relating to the characteristics of individual households were obtained through a survey of households. In order to meet the research objectives, suitable measures were designed based on a cross-sectional methodology (Kothari, 2004; Masamha, Uzokwe, Ntagwabira, Gabagambi, & Mario, 2017). Key informants' in-depth interviews were held with local authorities and extension officers. Moreover, focus group discussions (FGDs) with heads of household of cassava farmers were conducted in each commune. All in all, we conducted 7 FGDs with a total of 70 farmers who were randomly selected from the list of households. Through FGDs the vital information was elicited to assist in identifying major cassava production, processing, and marketing issues within each area under study. Moreover, 14 participants including local authority as leader of village, extension officers and commune officer also attended these discussions. The three districts selected for the study, Krong Bong, Ea Kar and Ea H'leo, were surveyed based on a multi-stage sampling method. In each district, communes were selected randomly based on the aims of the study. A total of seven communes were thus selected in each commune; a survey was conducted based on household visits using the structured questionnaire, in order to collect pertinent data. The total sample size was 300 households, all of whom were engaged in the cultivation of cassava.

2.2. Analytical methods

Quantitative data were analyzed using the IBM SPSS Statistics 20.0 software package using probit and ordinary least squares (OLS) regression models (Arega et al., 2007; Masamha, Thebe, & Uzokwe, 2018b; Sebatla, Mugisha, Katungi, Kashaaru, & Kyomugisha, 2014). A two-stage Heckman model was adopted as an appropriate model to test decision-making associated with the cassava value chain and was used to determine the factors affecting females' decisions to participate (Sebatla et al., 2014) and their level of participation in cassava production and the cassava market (Masamha et al., 2018b). The model employed a two-step process consisting of analyzing: (1) woman's decisions about whether or not to participate in cassava cultivation and the cassava market; (2) The level of farmers' participation in cassava farming and the cassava market (Zamasiya, Nelson, Kefasi, & Shephard, 2014). In the Heckman model, the first stage equation of the model adopted a probit model to estimate the effect of the factors influencing the decision about whether or not to participate, as well as the extent of market participation (Masamha et al., 2018b; Sebatla et al., 2014; Zamasiya et al., 2014). The female farmers' participation in both production and marketing were adopted as the dependent variables based on a dichotomous measure of 1 if a woman was willing to engage in cassava cultivation; and 0 otherwise. The equation used for the probit model was proposed by (Masamha et al., 2018b), as follows.

$$Y^* = \beta_0 + \beta_i X_i + \mu \quad (1)$$

Following Sebatla et al. (2014), the Heckman model was calculated as:

$$\begin{aligned} y_{1i} &= 0 \text{ if } Q_i \leq 0 \\ y_{1i} &= 1 \text{ if } Q_i \geq 0 \end{aligned} \quad (2)$$

where y_1 is the binary response and Q_i is the quantity of cassava cultivated by a woman.

The participation equation was then rewritten in the following form:

$$Y_1^* = \beta_{1i} X_{1i} + \varepsilon_{1i} \quad (3)$$

where Y_1^* is a latent variable, which is the utility a farmer gets from participating in the market.

The dichotomous model was stated as:

$$Y = \begin{cases} 1, & \text{if farmer sell any cassava} \\ 0, & \text{otherwise} \end{cases} \quad (4)$$

In the case of the probit model in the first step, the estimation was conducted as follows:

$$\Pr(Y_1) = f(x_1, x_2, x_3 \dots e) \quad (5)$$

where $\Pr(Y_1)$ is the probability of a farmer making a decision to sell cassava into a market or not; x_i etc. are the variables; and e the normally distributed error term. In the second stage Heckman model, the levels of participation were calculated using OLS and estimated to test the effect of the hypothesized factors based on the amount of cassava cultivated or harvested. The theoretical model can be presented as:

$$Q_i = f(y_1, y_2, y_3, \dots, y_n) \quad (6)$$

where Q_i is the volume of cassava produced; y_n denotes independent variables. The variance inflation factor (VIF) indicator was calculated to check for multicollinearity between the independent variables in the empirical estimation procedure and the Breusch-Pagan/Cook-Weisberg method was used to test the heteroscedasticity of the model (Greene, 2002).

3. Results

3.1. The production stage of the cassava value Chain

3.1.1. Factors affecting women's decisions to participate in the production stage of the cassava value Chain

Table 1 shows the results of the probit model analysis of the factors affecting women's decisions to participate in the cassava value chain. The goodness of fit of the model was assessed using McFadden pseudo R^2 , which was 0.515. As can be seen, the head of household had the responsibility for making the decision relating to cassava cultivation. Moreover, various factors were found to significantly affect the head of household's decisions relating to cassava cultivation, these consisting of the level of education of the farmer (EDU) and the education squared (EDU_Sq), the area of residential land squared (LAN_Sq), and the inverse of the square root of the farmers' loans (1/LOA_Sqrt) ($p < 0.05$). The results of the probit

Table 1. Probit model estimates for women's decisions to participate in the production stage of the cassava value chain

Variables	Coefficient	S.E.
COM	0.328 (1.04)	0.204
AGE	0.024 (0.36)	0.07
U18	1.446 (5.24)	1.028
M.HH	0.058 (1.82)	0.356
MAL	-0.762 (2.64)	0.518
LAN	4.443 (26.04)	5.106
CAS.QUA	0.104* (0.32)	0.062
SEL.PRI	0.001 (0.01)	0.001
EXP.CUL	0.138* (0.40)	0.079
VAR	-0.672 (2.74)	0.537
LOA	-0.009 (0.04)	0.007
HOU.ARE	0.005 (0.03)	0.005
INT	0.569 (4.01)	0.787
LO.TRA	-0.45 (6.80)	1.334
U18_Sq	-0.478* (1.29)	0.252
1/LOA_Sqrt	-30.940** (76.96)	15.09
EDU_Sq	2.290** (5.57)	1.093
LAN_Sq	-3.937** (8.17)	1.602

-2 Log Likelihood = 33.6

McFadden pseudo R^2 = 0.515; Cox and Snell R^2 = 0.510 and Nagelkerke pseudo R^2 = 0.680

* $P < 0.10$; ** $P < 0.05$; *** $P < 0.01$; Values in parentheses show SD.

regression model presented in Table 1 were not according to initial expectations, since the land area squared variable (LAN_Sq) and the 1/LOA_Sqrt variable were found to have the highest negative effect based on significance coefficients of both $p < 0.05$, whereas the original expectation was that the area of residential land (LAN) and the farmers' loans (LOA) would be positively related to decisions to cultivate cassava. The effect of these variables was therefore apparently influenced by the decision of women to participate in the cassava value chain. However, there is a contradiction, which is that the original variables such as the area of land (LAN) had positively related to deciding the cassava production of women. This is due to the farmer having various options and cassava cultivation not being a priority when they had a large area of their own land. Hence, the women's decision is negative in such a case. Furthermore, both the quantity of cassava (CAS.QUA) and the farmer's experience in cassava farming (EXP.CUL) variables were found to positively affect the participation of women in cassava cultivation and were significant at the $p < 0.10$ level.

3.1.2. The level of women's and men's participation in the production stage of the cassava value Chain

The quantity of cassava produced was the dependent variable in the ordinary least squares (OLS) regression models for men and women, and was logarithm transformed (Table 2). Similarly, for women, the independent variables of people under 18 years old in household (U18), total members in household (M.HH), total males in household (MAL), and the area of cassava cultivation (CAS.ARE), were also logarithm transformed.

The cassava farming experience (EXP.CUL) variable was square-root transformed and for men the independent variables of age of household head (AGE), U18, MAL, LAN and the household area (HOU.ARE) were logarithm transformed. In both the female and male cases, the backward selection method was applied in order to eliminate unwanted variables from the OLS model at each successive stage (Masamha et al., 2018b). After the OLS regression was conducted, the best fitting models were chosen. For women, these indicated goodness of fit coefficient R^2 of 0.55, indicating that 55% of the variance in the quantity of

Table 2. Ordinary least square estimate for the quantity of cassava produced by women and men in Dak Lak province (the level of women's participation in production)

Model	Variable	Coefficients	S.E.
Model 1	(Constant)	2.668*** (4.73)	0.376
Female	INT	-0.086 (1.32)	0.105
$R^2 = 0.55$	LO.TRA	-0.076 (1.03)	0.082
N = 158	Ln_U18	0.095 (0.96)	0.076
	Ln_M.HH	0.169 (2.45)	0.195
	Ln_MAL	-0.117 (1.92)	0.153
	Ln_CAS.ARE	1.017*** (0.98)	0.078
	SEL.PRI	-0.0002** (0.00)	0.000
	Sqrt_EXP.CUL	0.122*** (0.59)	0.047
Model 2	(Constant)	1.689** (9.76)	0.822
Male	MBIKE	-0.147 (1.21)	0.102
$R^2 = 0.67$	LO.TRA	-0.126 (1.01)	0.085
N = 141	Ln_AGE	0.431** (2.01)	0.169
	Ln_U18	0.159** (0.85)	0.072
	Ln_MAL	-0.283** (1.28)	0.108
	Ln_LAN	1.160*** (0.91)	0.077
	SEL.PRI	0.0002 (0.00)	0.000
	Ln_HOU.ARE	-0.136 (1.01)	0.085

* $P < 0.10$; ** $P < 0.05$; *** $P < 0.01$; Values in parentheses show SD

cassava harvested could be explained by the model. For men, the R^2 was 0.67, indicating that 67% of the variance in the amount of cassava harvested could be explained by the model. The natural log transformation of the area under cassava cultivation (\ln_CAS_ARE) was a significant ($p < 0.001$) positive predictor at the 99% confidence level affecting the volume of cassava that was cultivated by women. This shows that the area of cassava strongly affects the level of women's participation in the market. This situation can be explained by the fact that arable land is available, not only for the cultivation of cassava but also for many other crops. In addition, cassava is often a marginal crop and there is no priority to grow it. Therefore, farmers, particularly women may decide to cultivate cassava if the household owns more land. (Household group discussion, in Cukty commune, 2018).

3.2. The supply to market stage of the cassava value Chain

3.2.1. The main factors affecting the quantity of cassava sold on the market by the farmers

Table 3 shows that the area of residential land of the household (LAN) and the years of cassava cultivation experience of the farmer (EXP.CUL) were positively and significantly affected by the decision to participate in the cassava market ($p < 0.001$ and $p < 0.05$) respectively. It also shows that the availability of the internet to the farmer (INT) was negatively and moderately strongly associated with their decision to participate in the cassava market as suppliers ($p < 0.10$). The models' goodness of fit coefficients were judged to be adequate based on McFadden, Nagelkerke and Cox, and Snell pseudo R^2 values of 0.406; 0.464 and 0.174 respectively.

The farmers will shift from cassava to other crops if they have better information about the cassava market as well as the prevalence of cassava-specific diseases in a particular year, rather than engaging in continuous cassava cultivation. If the price of cassava is low that would affect the farmers' income derived from the cultivation of cassava. These findings were borne out by the group discussions with farmers (household group discussion in Ea Sar commune, 2018). The variables LAN, EXP.CUL and farmer has access to internet or not (INT) were found to be significant factors at the 90 to 99% levels in the probit linear regression model. Most farmers participated in the cassava market based on local markets, as well as through farm-gate sales. Other variables had either positive or negative effects on the farmers' market decisions, although their effects were not found to be significant in the regression model. For instance, the total female in household (FEM), farmer owns local transport or not (LO.TRA) and farmer owns motorbike or not (MBIKE) variables were positive but not significant. On the other hand, AGE and SEL.PRI had negative but not significant effects on the farmers' decisions about whether or not to participate in the market. Overall, the pattern of influence could be explained by the farmers not being able to control the price of cassava since it is dependent on the relationship between supply and demand

Table 3. Probit model estimates for farmer's decision to participate in the market

Variables	Coefficient	S.E.
AGE	-0.024 (0.26)	0.015
SEL.PRI	-0.001 (0.00)	0.000
EXP.CUL	0.064** (0.47)	0.027
LAN	3.227*** (10.86)	0.627
MAL	-0.152 (3.00)	0.173
FEM	0.001 (2.53)	0.146
LO.TRA	0.222 (5.68)	0.328
MBIKE	0.221 (6.60)	0.381
INT	-0.689* (6.39)	0.369
EDU	-0.24 (3.67)	0.212

-2 Log Likelihood = 84.126

McFadden pseudo R^2 = 0.406; Cox and Snell R^2 = 0.174 and Nagelkerke pseudo R^2 = 0.464

* $P < 0.10$; ** $P < 0.05$; *** $P < 0.01$; Values in parentheses show SD

in the market. However, farmers can change their cultivation behaviour once the cassava price has fluctuated dramatically although only in succeeding years after a price change becomes apparent.

3.2.2. The main factors affecting the level of market participation of farmers

The results shown in Table 4 indicate the level of participation of farmers as defined by the volume supplied to the market. The OLS regression model results indicate that the variable natural log transformation of the area of cassava cultivation (Ln_CAS.ARE) was found to be a positive and strongly significant influence on the level of farmers' market participation ($p < 0.01$). This is because farmers with more land will have a greater option to plant not only cassava but also other crops and will thus tend to dedicate more arable land to the cultivation of cassava. Both the variables natural log transformation of people under 18 years old (Ln_U18) and the quadratic variable (Ln_AGE_Sq) had a positive and significant ($p < 0.05$) effect on the quantity of cassava sold by the farmers. Thus, the number of people less than 18 years old in the household, as expected, encouraged participation in cassava production, as did the age of the household head. This is because the age of the household head bears a strong correlation with the farming experience of that person. The level of the farmer's market participation is dependent on the farmer's age, therefore influenced not only by his or her age, but also by their experience in cassava cultivation. The farmer's experience can give him or her an advantage in accessing and interpreting market information as well as sharing experience (Sebatta et al., 2014).

In contrast, the natural log transformation of the squared male variable (Ln_MAL_Sq) had a negative and significant effect on market participation ($p < 0.05$) indicating a decreasing marginal effect on cassava market participation as a supplier, based on the number of males in a household.

3.3. The role of women and men as growers in the cassava value Chain

In this study, the cultivation of cassava tubers includes land preparation, planting, fertilizing and spraying pesticide, harvesting and carrying the end product to the residence. Table 5 shows that men dominate all the processes in the production stages—especially those of carrying the harvested cassava to the home, spraying pesticide and land preparation. These are all predominantly male responsibilities, with men accounting for 91.33%, 88.33% and 78.01% respectively of all processes. This is the case because those processes not only require physical strength but also farming experience and thus favour performance by men.

On the other hand, for some processes in cassava cultivation, the percentage participation was similar between men and women; for instance, men were responsible for around 58% of the fertilizing of cassava compared to approximately 42% of the fertilization performed by women.

Table 4. OLS estimates for the quantity of cassava sold by farmers in Dak Lak Province (level of market participation of farmers)

Variable	Coefficients	S.E.
(Constant)	1.928*** (8.89)	0.513
MBIKE	−0.112 (1.21)	0.07
LO.TRA	−0.082 (1.04)	0.06
Ln_AGE_Sq	0.156** (1.13)	0.065
Ln_U18	0.132** (0.90)	0.052
Ln_MAL_Sq	−0.091** (0.71)	0.041
Ln_CAS.ARE	1.049*** (0.95)	0.055
SEL.PRI	0.0002 (0.00)	0.000
Sqrt_EXP.CUL	0.051 (0.59)	0.034
VAR	−0.03 (0.40)	0.023

* $P < 0.10$; ** $P < 0.05$; *** $P < 0.01$, $R^2 = 0.585$; Values in parentheses show SD

Table 5. The percentage of male and female participation in cassava cultivation

Processing	Mean (%)	S.E (%)	Median (%)
LAN_PRE_M	78.01	1.31	90.00
LAN_PRE_F	21.99	1.31	10.00
PLANT_M	61.13	0.77	60.00
PLANT_F	38.73	0.81	40.00
FER_M	57.96	1.28	60.00
FER_F	41.89	1.27	40.00
PES_M	88.33	0.82	90.00
PES_F	11.67	0.81	10.00
HARV_M	67.11	0.78	68.00
HARV_F	32.90	0.78	32.00
CARRY_M	91.33	0.63	95.00
CARRY_F	8.52	0.57	5.00

However, in general, due to the limitations of their individual characteristics, low-skill level and lower levels of knowledge, women play a less important role in the cassava value chain than men. Nevertheless, women are involved to some degree at all stages of the cassava cultivation process from land preparation to finally carrying the fresh cassava to their home as well as to the market.

4. Discussion

The findings support those of previous studies (Apata, 2013; Butterworth, Abdulsalam-saghir, & Martin, 2008; Coles & Mitchell, 2010; Masamha et al., 2018a) which concluded that there are different economic values and benefits to be gained from the participation of males and females, based, for instance on access to assets and education level, in terms of sources of household income through farming activities. The results reported herein agree with the findings of Masamha et al. (2018a) in relation to the cassava food value chain, which found that women were prominent in the processing stage of the cassava value chain at the household level. The results of the study are consistent with the findings of Coles and Mitchell (2010): that gender inequality is a significant obstacle to female participation in the production stages of cassava. However, this is a reasonable situation since many of these stages require physical strength, so men are likely to be predominant in the cassava value chain, whilst women can share the burden to a moderate degree.

4.1. The factors influencing the decision of women to participate in cassava cultivation

The findings in this study are in line with those of (Masamha et al., 2018b) in that the variable based on the LAN_Sq was negatively and significantly associated with women's decision to participate in cassava cultivation ($p < 0.05$) (Table 6). This negative effect was consistent with the outcome of previous research relating to the size of farm such as Heltberg's (1998) study of the distortion of rural

Table 6. Probit model's significant variables estimates for production participation decisions of women

Variables	Coefficient	S.E.
CAS.QUA	0.104* (0.32)	0.062
EXP.CUL	0.138* (0.40)	0.079
U18_Sq	-0.478* (1.29)	0.252
1/LOA_Sqrt	-30.940** (76.96)	15.09
EDU_Sq	2.290** (5.57)	1.093
LAN_Sq	-3.937** (8.17)	1.602

* $P < 0.10$; ** $P < 0.05$; Values in parentheses show SD

markets. The negative impact of land area square is also consistent with the results of Saenz and Thompson (2017), who investigated the role of gender and policy in farm households. Similarly, the number of people under 18 years old squared variable had a negative and significant effect ($p < 0.1$) on women's decisions to engage in cassava cultivation. However, the results of this study were in contrast to those of Masamha et al. (2018b) in relation to the EDU variable in its transformed squared form. In the present study, this variable had positive and significant effects ($p < 0.05$), while in the study of Masamha et al. (2018b) the coefficient was negative, although not significant. In particular, it was revealed in this study that the 1/LOA_Sqrt variable influenced women's decisions to engage in cassava farming. The wider study also discovered that rural credit is very difficult to access through the formal credit market in rural areas. In this case, this variable had a negative and significant effect ($p < 0.05$) on the decision of women to participate in cassava cultivation. This can be explained by the fact that if the farmers could access formal credit more easily, they would grow another high value crop instead of cassava. Only a small number of previous studies have identified and estimated the effect of the availability of credit on the cassava value chain. Our result shows that access to credit through, for instance, loan programs and other forms of assistance encourage female leadership roles in households and this supports the findings of Arega et al. (2007) and of Saenz and Thompson (2017). Additionally, it was found that the ownership of local transport (LO.TRA) had a negative and insignificant effect on women's participation in this study. This finding is similar to those of Jagwe, Ouma, and Machethe (2010) and of Masamha et al. (2018a) relating to the cultivation of bananas in Africa and the analysis of the cassava value chain with respect to gender in Tanzania, respectively. The result of our study reflects a difference from initial expectations. This can be explained by the fact that most fresh cassava is bought at the farm gate by middlemen. Therefore, farmers may not need to transport their product to the market. Hence, this variable had a negative effect although this was not-significant.

In reviewing the role of gender in the value chain, most previous scholars have considered employment, working situations, salary and age as well as the marital status of women (Flores & Bastiaensen, 2017). The selling price of cassava had a positive effect on female's decisions to participate in cassava cultivation but the effect was not significant. This finding is similar to that reported by Arega et al. (2007) who assessed the effects of transactions and cost mitigation on maize producers. There are numerous infrastructural and physical challenges inhibiting the participation of female farmers in cassava cultivation as reported by Singh-Peterson and Iranacolaivalu (2018). Furthermore, this finding is in line with that of Tran et al. (2018) who found that the education level, number of dependents and access to credit of rice farmers influenced women's participation decisions.

4.2. The level of participation by women in the production stage of the cassava value Chain

In regard to the level of participation in the production stage of the cassava value chain by women and men, the finding of the present study is quite different from that of Masamha et al. (2018b) with the R^2 coefficients for women and men being quite similar at 0.55 and 0.67 respectively (Table 7),

Table 7. Significant variables estimate for the level of participation of women in cultivation stage

Model	Variable	Coefficients	S.E.
	(Constant)	2.668*** (4.73)	0.376
Female	Ln_CAS.ARE	1.017*** (0.98)	0.078
$R^2 = 0.55$	SEL.PRI	-0.0002** (0.00)	0.000
N = 158	Sqrt_EXP.CUL	0.122*** (0.59)	0.047
Male	(Constant)	1.689** (9.76)	0.822
$R^2 = 0.67$	Ln_AGE	0.431** (2.01)	0.169
N = 141	Ln_U18	0.159** (0.85)	0.072
	Ln_MAL	-0.283** (1.28)	0.108
	Ln_LAN	1.160*** (0.91)	0.077

* $P < 0.10$; ** $P < 0.05$; Values in parentheses show SD

while Masamha et al. found that the R^2 value for females was approximately double that for males (0.447 and 0.26, respectively). This means that the total variation explained by the model for men is less than that for women. Based on previous research, excluding variables such as marital status, region and age may have affected the significance of the results from the OLS model. However, variables added in the regression model for females, such as Ln_CAS.ARE, selling price of cassava (SEL.PRI) and the square root of cassava farming experience (Sqrt_EXP.CUL) had both negative and positive effects that were significant ($p < 0.05$). Further, in the model for males, the finding relating to the age of the household head concurs with that of Ayamga, Sarpong, and Asuming-Brempong (2006) and of Masamha et al. (2018b) and was also statistically significant. This finding is also in line with that of Masamha et al. (2018b) that accessibility to information technology negatively affected the participation of women in cassava production. However, this finding seems to contrast with the findings in relation to the cereal market (Siziba & Bulte, 2012). In addition, the burden of caring for children and elderly relatives in the household represents a barrier impeding women from participation in cassava cultivation (Singh-Peterson & Iranocolaivalu, 2018).

4.3. Factors influencing the farmer's decision to participate in the market

The study found that women play an important role in making decisions relating to participation in the cassava value chain and this finding is different from that of some previous studies. For instance, it contrasts with that of Sebatta et al. (2014) relating to the potato market in Uganda that in most cases men make the final decision on whether to supply products or not, as well as where and in what quantity. The study's finding also contrasts with that of Hill and Vigneri (2011) relating to female farmers selling coffee in Uganda but is in agreement with that of Doss (2001) who found that female farmers dominate subsistence crop cultivation. This result is not surprising since in Vietnam the role of women in rural areas has been enhanced because of women's empowerment and their access to markets, both of which have enhanced their power to make decisions within households (Morrison, Raju, & Sinha, 2007).

Further, this finding is similar to that of Siziba and Bulte (2012) that the area of residential land (LAN) may influence farmers' decisions relating to market participation. However, the finding in this study is positive and significant, with ($p < 0.01$) (Table 8); while for the previous study, the effect was not significant. Moreover, this study is also contrary relation to the experience of the farmer (EXP.CUL), which was found to have a positive and significant effect in the present study but was not found to be a significant factor by Jagwe et al. (2010). However, this study's finding is consistent with that of Tran et al. (2018) in relation to the production of rice in Vietnam, with both studies finding positive and significant effects from the cultivated land area variable as well as from the women's age variable on the men's decisions to participate in cultivation. Additionally, the findings of this study are consistent with those of Jagwe et al. (2010) in that selling price and the gender of the household head all have an effect on decision making, although this was not statistically significant. Moreover, the latter found that the variable concerning the farmer having access to the internet or not (INT) had a negative and significant effect, which is consistent with the result of Masamha et al. (2018b) regarding participation in the cassava value chain in Tanzania. It is plausible that the internet be used for collecting marketing information that relates to high-value crops and it can useful for farmers who own communication assets.

Table 8. Significant variables estimate the factors influencing the decision of farmers market participation in the cassava value chain

Variables	Coefficient	S.E.
EXP.CUL	0.064** (0.47)	0.027
LAN	3.227*** (10.86)	0.627
INT	-0.689* (6.39)	0.369

* $P < 0.10$; ** $P < 0.05$; *** $P < 0.01$; Values in parenthesis show SD.

4.4. The level of market participation by farmers in the cassava value Chain

In terms of the level of market participation, the gender of the farmer being male had a negative and significant ($p < 0.05$) effect on the quantity of cassava sold in the market. This finding contrasts with the result reported by (Sebatta et al., 2014). Moreover, based on the farmers' group discussion, the farmers tend to think that cassava is the women's crop. This supports the positive impact of women's participation in cassava farming and decisions as to when, where and what quantity of cassava to sell. (Krong Bong, Farmers' group discussion, 2018).

Men have more opportunity than women to engage in non-farm activities in order to earn money either as casual laborers or by working for private companies, and this finding supports those of Barrett (2008), Reardon, Timmer, Barrett, and Berdegue (2003) and Sebatta et al. (2014). In this study, the women's role was equivalent to that of men and they were often responsible for contact with middlemen when selling their produce either at the farm gate or at markets although this depended on individual households. Similar results were reported in relation to farmers' participation in the banana market by Jagwe et al. (2010), where the number of children under 18 years old had a positive and significant effect on the level of market participation. Moreover, both studies found that the farmer's experience had no statistically significant effect on market participation. In contrast, however, Jagwe et al. (2010) found that the transportation variable had a positive and significant effect which contrasted with the findings in this study. Furthermore, our finding is similar to finding of studies by Masamha et al. (2018b): that the Ln_AGE_Sq variable influences the decision of farmers to participate in markets; the effect is positive and significant, with $p < 0.05$ (Table 9).

4.5. The roles of men and women in the cassava cultivation process

In terms of the role of gender in the cultivation stage of the cassava value chain, the study's findings are similar to those of Radel (2011) in his study of the cultivation of chilli in Calakmul, Mexico. The male household heads controlled the agricultural processes such as weeding, and harvesting and were responsible for the entire production process including when, where and what to grow. In this case, women participated in work activities in the role of helper. The result of this study also supported that of Radel (2011) in that women had little participation in spraying pesticides and preparing the land using tractors. A plausible explanation for this is women's physical characteristics, their low educational levels and also their lack of technical skills, which may result in women making less use of farm machinery than men (Fischer et al., 2018). Additionally, this finding is consistent with that of Masamha et al. (2018a), who investigated intra-household gender dynamics in the cassava value chain and found that in most cases, men and women were jointly responsible for harvesting although the task was predominantly performed by men. What emerged from this study was that women's participation in the processes of planting, weeding and harvesting was different from their role in African countries where they were involved not only planting, weeding and harvesting but also in fertilizing crops and spraying pesticide in cassava cultivation (Coulibaly, Arinloye, Faye, & Abdoulaye, 2014; Masamha et al., 2018a).

Table 9. Significant variables estimate the level of market participation by farmers in the cassava value chain

Variable	Coefficients	S.E.
(Constant)	1.928*** (8.89)	0.51
Ln_AGE_Sq	0.156** (1.13)	0.07
Ln_U18	0.132** (0.90)	0.05
Ln_MAL_Sq	-0.091** (0.71)	0.04
Ln_CAS.ARE	1.049*** (0.95)	0.06

* $P < 0.10$; ** $P < 0.05$; *** $P < 0.01$; Values in parentheses show SD

5. Conclusion

In conclusion, cassava cultivation entails labour intensive activities including land clearing, tillage, planting, weeding, harvesting and processing for consumption. In common with previous research, this study's findings shed light on the key issue of female participation in the cassava value chain and finds that their role is not as extensive as that of men. This finding is, however, limited to rural females in remote areas and contrasts with the emerging role of females in other economic activities. This study not only sheds light on the issue of gender, but also explores how factors related to socio-economic and individual household characteristics affect both actual participation and the level of participation in the cassava value chain of smallholder farmers, especially the role of females throughout the cassava production and supply to the market. The gender equality issue needs to be concerned with the smallholder farmer in the cassava value chain. Thus, it is highly recommended that a further study be undertaken relating to the development of sustainable livelihoods for smallholder farmers through advancing the cassava value chain for both farmer and other stakeholders. Such a study should also help in the development of a plausible policy by the local authority.

Based on the findings of this study, some policy changes are suggested to reduce the gender gap and advance women's welfare and empowerment in cassava cropping and agriculture generally in Dak Lak Province. An agricultural training short-course should be provided for farmers so they can learn to better use farming resources. The local government should create equal opportunity access to credit institutions as well as public services such as an extension service. The government should promote and communicate the role of gender in order to improve the perceptions of farmers regarding the gender issue and providing projects as a priority for women in rural area. It is one of the most effective strategies for closing the gender gap, improving the added value of agriculture and contributing to sustainable rural development.

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Conflicts of Interest

The authors declare that there are no conflicts of interest related to the content of this article.

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