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Determinant Factors of Lao Farmers' Engagement to Agricultural Value Chains: A Case Study of Cassava

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ABSTRACT

Over seventy-two percent of the Laos population is engaged in agriculture. Since the introduction of the New Economic Mechanism (NEM) strategic framework in 1986, agriculture has been acknowledged as the foundation of economic development in Laos. The Ministry of Agriculture and Forestry has designated rice, bananas, maize, coffee, cassava, and sugarcane as cash crops with high export potential. Cassava plantations cover more than 100,000 hectares and are steadily expanding. They generate more than US$225 million in 2020 for smallholder farmers. This study aims to investigate the factors that influence Lao farmers' participation in the cassava value chain. It also explores economic advantages of participating in the cassava value chain for Laos farmers. Based on the study's findings, this research provides recommendations to improve the cassava supply chains and their impact on increasing farmer welfare, reducing production costs, and enhancing the economic benefit of Lao cassava producers.

This study purposively selected cassava production sites in 5 provinces namely: Champasak, Borikhamxay, Saravan, Vientiane, and Xayaboury. In the data collection process, the data collection team was able to retrieve information from 138 households. Information retrieved from the field survey has been analyzed using descriptive and inferential statistics. The study outcome shows that several socio-demographic characteristics play an important role in Lao cassava value chain engagement, predominantly age, income level, level of education, and geographical location. Additionally, most households that participated in the cassava value chain stated that they received both direct and indirect economic benefits after entering the value chain, which can be seen through the improvement of household income, overall living conditions, educational opportunities, and other factors. In order to improve the overall social welfare and economic benefits for Lao cassava farmers, several policy recommendations have been developed for multiple timeframes. The policy recommendations cover training farmers to enhance productivity, favorable price policies, infrastructure improvements, and government intervention in the cassava supply chain to enhance the participation of farmers in the cassava supply chains.

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ACRONYMS AND ABBREVIATIONS

Acronym	Definition
CI	Confidence Interval
CMD	Cassava Mosaic Disease
CWBD	Cassava Witches Broom Disease
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
LAK	Lao kip
Lao PDR	Lao People's Democratic Republic
MAF	Ministry of Agriculture and Forestry
MOIC	Ministry of Industry and Commerce
MPI	Ministry of Planning and Investment
NEM	New Economic Mechanism
SEA	Southeast Asia
SOE	State Owned Enterprise
THB	Thai baht
USD	United States Dollars

INTRODUCTION

Currently, the global and regional economies are facing an economic recession from the impact of the COVID-19 pandemic since 2019. The global GDP growth is at 3.6% in 2022, declining from 6.1% in 2021, along with the conflicts of Russia's special military operation in Ukraine and the economic sanctions from several countries to Russia. These shocks increase pressures on the energy and food supply chains, causing upward influences on prices, especially for food and agricultural products.

In Lao PDR, agriculture is the main sector supporting livelihoods and well-being of the majority of the population. Over 72% of the population has been involved in the agricultural sector.[1]. Agriculture has been recognized as the foundation for the economic development of Laos since the New Economic Mechanism strategic framework was introduced in 1986. In a period of nine months in 2022, the economic growth had slightly increased, as indicated by a GDP growth of 4.2% (Compared to a GDP growth of 3.5% in the same period of 2021). The agricultural sector has grown by 2.9%, covering 17.5% of GDP[2]. The main factor for the growth of the agricultural sector is the expansion of plantations.

The Ministry of Agriculture and Forestry (MAF) has designated six cash crops with high export potential: rice, bananas, maize, coffee, cassava, and sugarcane. Cassava is regarded as one of Southeast Asia's (SEA) most important cash crops, with more than two million households in this region engaged in its production value chain. In Lao PDR, cassava plantations cover more than 194,900 hectares (and growing steadily), bringing in more than US$328 million for smallholders in 2022 alone. Cassava is one of the country's most important exports, ranking after only gold, copper, and bananas in overall national export values. The increase in Lao cassava exports grew from 83 million USD in 2019, to 193 million USD in 2020, to 265 million USD in 2021, and 328 million USD in 2022[3]. Furthermore, it has also been observed that, since 2016, cassava production has become one of the main agricultural products for export from Laos.

Cassava is one of the principal commercial crops grown by farmers in the central and southern regions and is sold to traders and industries for both internal and international markets. Laos' cassava exports mainly rely on a few nations in the SEA region, particularly Vietnam, Thailand, and China. Cassava starch and dried chips are two of the primary items exported to neighboring nations' value chains. However, because it shares a border with nations with significant fertile grounds for growing cassava, Laos is a minor source of cassava output in the region.

Starch processing factories are directly and indirectly engaged in promoting cassava production. The cultivation and trade of cassava mostly operates under informal contracts, and cross-border trade mainly occurs in the districts near neighboring countries' borders (Manivong et al., 2018). According to the global scenario, Thailand ranks 3rd among cassava producing countries, followed by Nigeria and Brazil consecutively. Cassava starch is primarily used for consumption as an ingredient in processed food products, for which Laos generally supplies the raw materials. Investors from Vietnam also have come to Laos to establish processing plants in the central and southern provinces to produce cassava products using local raw materials and export them to a third country. In recent years, China has been regarded as a major market for cassava utilization

[1] Laos Expenditure and Consumption Survey 2018/2019.
[2] Ministry of Planning and Investment (MPI), Dec 2022.
[3] Ministry of Industry and Commerce (MOIC), Jan 2023.

in food processing for industrially processed products, particularly driven by the growing local population's demand for processed food and the increase in export opportunities. Laos also benefits as a source of cassava flour supply due to China's limited domestic land area for cassava production.

Cassava has become an important crop in Laos, with cultivation expanding in response to an increase of regional and global demand for starch-based products, animal feeds and ethanol. In particular, cassava crops are grown in close proximity to factories that process them, allowing for direct marketing and supply through such factories. Cassava production in Laos is driven by small landowners who seek extra revenue from participating in the cassava value chain. Engagement of those smallholders in cassava plantations provides a significant share of their income after rice production. Thus, cassava production is an important cash income source for smallholder farmers, which produces high returns to both land and labor by enhancing livelihoods.

The Lao government has prioritized cassava as one of its cash crops in an effort to encourage rural development and the eradication of poverty. As small-scale landowners, these farmers face substantial opportunity costs as they consider alternative cash crops that could be grown on the same land. The economic benefit of producing cassava could be an important factor for smallholders participating in the cassava value chain. Yet, little is known about factors influencing cassava growers in the value chain. While broad information on the costs and benefits of cassava growing is available, there is a limited analytical framework on determinant factors that influence small landowners engaging in cassava cultivation, and landowner bargaining power in the cassava value chain (Cárcamo, 2020; Thipphavong, Manolom, Soukhaseum, Southammavong, & Bodhisane, 2022; World Bank, 2018b).

There is no specific policy for cassava production and marketing that assigns solid responsibilities to various departments and institutions in Laos. There has been limited planning and promotion to develop a sustainable cassava value chain in Laos. Thus, a study on determinant factors that influence small landowners engaging in the cassava plantation and their bargaining power in the cassava value chain is needed. This paper will this evidence gap and addresses the following key questions:

(1) What determinant factors influence Lao smallholders in their engagement in cassava value chains?

(2) To what extent can Lao smallholders benefit from participating in the cassava value chains?

(3) What are the implications of the global supply constraints on farmers' welfare and production costs in the cassava value chain? and

(4) What policy implications can increase the benefits of farmers in the cassava value chain?

LITERATURE REVIEW

In general, Laos' cassava plantations are linked to regional value chains. Commercial farming has been vigorously pushed and promoted in Laos since the government introduced a policy focused on the market economy in 1986. The expansion of foreign investment in the Lao agricultural sector marks a significant turning point in the growth of commercial farming. Raw or processed bananas, rubber, maize, sugarcane, and cassava planted in Laos are among the agricultural commodities with the highest regional demand. Approximately $3.09 billion in investments were made in the agricultural sector over the past 30 years (1989-2019), with FDI accounting for 89% of the total amount[4].

An important driver in the influx of FDI into the Lao agricultural sector is the regional demand. Three key countries serve as major markets for Lao agricultural products: China, Vietnam, and Thailand. It's possible that the changed market demands in those nations will have an impact on Laos' agricultural outputs. Using cassava as an example, it was forecasted that China will be the main source of cassava starch imports in 2021 (R. Howeler, 2020; ITC, 2023). Thus, any changes in consumption quantity in China will cause an effect on the general quantity of regional supply to rise as well, and Laos is not an exception. Laos is ranked number four as a major supplier of cassava starch to China and is a leading supplier for the markets in Thailand and Vietnam. Almost all of Laos' dried chips and cassava starch are sold to those three nations in the region. Therefore, the shift of cassava consumption in countries in the region will impact the trade and cultivation of cassava in Laos.

Many smallholder farmers rely on selling their cassava produce to starch mills and traders as a significant source of supplementary revenue. One may argue that cassava is a traditional crop in Laos and has been grown for many years as a supplement to staple foods, especially for those who live in mountainous areas (R. H. Howeler, 2004; Souvannavong, 2021). Technically, cassava is easy to cultivate and care for, as it can grow in many varieties of soils (Becerra-Lopez Lavalle et al., 2021). Although there were some disruptions from COVID-19, the expenses associated with cassava crops would be typically offset by anticipated benefits, which are driven by rising market demand from China (Manivong et al., 2018). A study by Cock and Connor (2021) showed that if there is still a continuous demand from the major importing countries, developing countries will benefit from an increase in income from cultivating cassava. An increase in farmers' cassava plantations for extra income is predominant in many provinces in Laos where starch factories and traders' facilities are located nearby. According to a report on agricultural statistics in Laos, the country's cassava planting areas had expanded by more than 50% between 2015 and 2021, showing a positive trend when compared to other cash crops like maize and sugarcane during the same time-period. Because of this, many smallholder farmers who participate in the cassava value chain now focus on cassava plantations as an additional source of income.

Cassava prices in Laos are highly dependent on international market prices, which fluctuate according to the relative prices of other supplementary commodities and regional demand. As a supplement of inputs for the manufacturing of ethanol, the price of cassava has been fluctuating in recent years due to variations in the relative prices of maize and sugarcane. For instance, when the Chinese government announced policies in 2014 and 2018 to boost renewable bioenergy, the regional prices of energy crops, including cassava, maize, and sugarcane, increased in response

[4] Authors calculated from a statistical report on investments, Lao Ministry of Planning and Investment.

(Koizumi & Ohga, 2007; Singvejsakul, Chaovanapoonphol, & Limnirankul, 2021). Some companies and traders in Laos end-fixed purchase prices in contract farming, due to the variability in cassava prices as a result of the global economic slowdown, and switched to buying the farmers' cassava outputs at spot prices instead (Manivong et al., 2018).

The cassava disease outbreak and other external factors can cause production losses and disrupt the income of Lao farmers involved in the cassava value chain. The prevalence of cassava diseases like the Cassava Witches Broom Disease (CWBD) and the Cassava Mosaic Disease (CMD) – which have been found in numerous cassava plantations in Laos – has alarmed cassava farmers. When CWBD or CMD outbreaks occur in the planting areas, this can reduce the yields of cassava per hectare (NAFRI, 2020) which could reduce the farmers' anticipated income from selling cassava (Souvannavong, 2021).

A considerable amount of research is focused on analyzing the impact of the cassava value chain on farmers' incomes, as well as conducting cost-benefit analyses. The studies on cassava value chain cover a range of crops in various developing countries; however, their primary goal aims to determine the benefits to farmers participating in the cassava value chain. (Arthey, Srisompun, & Zimmer, 2018; Newby, Smith, Cramb, Delaquis, & Yadav, 2019; Onphanhdala; Smith, Newby, & Cramb, 2018; World Bank, 2018a). The studies on cassava value chain cost-benefit analysis mainly use qualitative research to illustrate how different actors are related to input supply, production, and marketing (Manivong et al., 2018; Sarka, Woldeyohannes, & Woldesilasie, 2017; Smith et al., 2018; Souvannavong, 2021; World Bank, 2018a). In the case of Laos, most studies apply a qualitative approach by using data from field surveys and focus group discussions (Manivong et al., 2018; Smith et al., 2018; Souvannavong, 2021).

Research using a quantitative approach to factor analysis investigates the correlation between related variables empirically. Although the study objectives for empirical applications are very diverse, the binary logistic regression model is typically used for examining the correlation of variables (i.e., analyzing the relationship between factors in the model) (Awotide, Abdoulaye, Alene, & Manyong, 2019; Chancharoenchai & Saraithong, 2022; Dadzie, Ndebugri, Inkoom, & Akuamoah-Boateng, 2022). Awotide et al. (2019) used the Tobit model to measure the factors affecting cassava farmers' access to financing and found that increasing outputs, diversifying sources of income, and accumulating assets are all statistically significant factors that have a positive impact on farmers' access to large amounts of credit. The influence factors on the model can be identified using the Probit model, another type of binary regression. In Northern Thailand, a study on the supply chains for cassava chips indicated that generation and occupation are significant factors influencing people's decisions to move from potato to cassava chips (Chancharoenchai & Saraithong, 2022). Additionally, Dadzie et al. (2022) employed the Probit model and discovered that in Ghana, social contacts, a high degree of trust, age, the frequency of extension services, access to financing, and revenue influenced cassava farmers' risk aversion and decision to adopt new farming techniques. Since there have not been any prior studies of this kind in Laos, the empirical study on identifying factors that influence farmers' decisions to join the cassava value chains will be a new area of study. As a result, this study will make use of binary regression to ascertain the variables that have an impact on the Lao farmers that participate in the cassava value chain investigations. This effort will greatly progress following research.

The binary logistic regression model is used when measuring the relationship of factors that has a dichotomous (binary) variable as a dependent variable, for instance, examining the relationship between "unemployed" or "not" (take a dummy value 1 or 0) and social characteristic variables

(sex, age and ethnicity) (Tranmer & Elliot, 2008). Awotide et al. (2019) tested the statistical significance of the relationship between smallholder cassava farmers' access to credit and socioeconomic characteristics using the binary logistic regression model, and they found that more than half of the analyzed parameters had statistical significance, including household size, the number of animals in the household, the amount of cassava produced, and the monetary value of the household's productive assets. The studies by Chancharoenchai and Saraithong (2022) and Dadzie et al. (2022) also demonstrate the statistical analysis of factors correlation in the cassava value chain by testing a binary dependent variable in the context of smallholder cassava farmers' risk attitude in relation to social networking, as well as customers' preferences and impact factors, such as price, personal characteristics, perception and understanding. The binary logistic regression model will be used in this study to investigate the factors that influence farmers' decisions to participate in the cassava value chain. Previous studies on the cassava value chain in Laos primarily used qualitative analysis techniques to assess the economic and social benefits of involvement (Manivong et al., 2018; Newby et al., 2019; Smith et al., 2018; Souvannavong, 2021). This empirical study will demonstrate statistical evidence from a binary logistic model by using income from cassava growing of households as a dependent dummy variable while independent variables consist of economic and social welfare from participating in the cassava value chain. The empirical findings are crucial for the latter section of determining the most probable drivers of farmer participation in the cassava value chain as well as for the study's policy recommendations. The analytical processes are demonstrated in the following section.

METHODOLOGY AND DATA COLLECTION

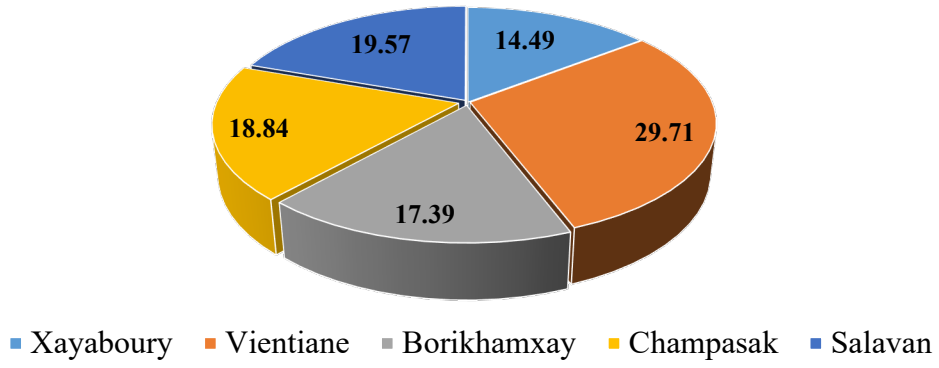
Methods

To determine the factors influencing Lao farmers in cassava value chain engagement, this study applies a cross-sectional study design. The cross-sectional study is an observational study design. In a cross-sectional study, the researchers simultaneously measure the outcomes and exposures of the participants. Participants in a cross-sectional study are simply picked according to the inclusion and exclusion criteria established for the study. Once participants have been selected for the study, the researchers monitor the study to evaluate the participants' exposure and the outcomes (Setia, 2016).

Data Collection

The data collection period was from mid-October to mid-November 2022, in which the data collection team was divided into Southern and Northern teams to effectively collect data on time. The Southern data collection team is responsible for Champasak, Borikhamxay, and Saravan, whereas the Northern team gathered data from Vientiane and Xayaboury provinces. The inclusion criteria include cassava farmers in the selected provinces. The inclusion criteria of this study refer to small-scale cassava production (family size) who participated in the cassava production value chain. In contrast, the exclusion criteria are cassava growers who have just started growing cassava within one year. Throughout the data collection period, the data collection teams were able to survey 138 farm households. The sample size was based on the convenience sampling technique. It is a non-probability sampling technique in which units are selected for the sample based on their accessibility to the researchers. This could be due to geographical proximity, availability at a given time, or a willingness to participate in the study (Scribbr, 2023). Figure 1 summarizes the proportion of samples from five provinces, where the Vientiane and Salavan provinces are two large sample sizes of data collection, accounting for 29.71% and 19.57% respectively, or almost half of the samples, where the other half of samples are from Champasak, Borikhamxay and Xayaboury provinces.

Figure 1. The Proportion of Samples from Five Provinces (%)



Source: Authors' compilation from field survey - October to November 2022

Selected Summary Statistics of the Sample Households

The respondents are largely males, with approximately 70% out of total. The farmers' average age is 46 years old, with the minimum and maximum ages being 18 and 77, respectively. Primary school accounts for 41% of most of the samples' highest education, whereas secondary and high school education make up 33% and 15%, respectively. Only 8.69% of respondents, however, have diplomas or higher degrees. Average household size in the samples consisted of six people and approximately four of those people work as laborers on activities related to cassava farming. Out of a total sample, around 65.22% of farmers indicated that their primary source of income comes from cassava plantations; in the absence of this, their household revenue comes from other agricultural crops and livestock, such as rice, coffee, bananas, poultry, cattle, and so on. The farmers have at least two years of experience growing cassava, with the maximum levels of experience being about 15 years. It took the farmers an estimated average of seven years to begin growing cassava. For about 80% of samples, the distance between the cassava farms and their residence is less than five kilometers. The majority of respondents, accounting for 91% and 83% of the total, are farmers who own their land and use their own tools for cultivating cassava.

In Laos, those involved in the cassava value chain rarely make use of contract farming. Fewer than three percent of surveys mention contract farming. It suggests that farmers are self-sufficient and currently have a wide range of options for selling their crops. Almost 40% of sampled individuals had land extension to boost production yields, while 53.62% of the sampled group did not expand their cassava field. High returns, high demand, and free markets for cassava are the main rationale for land expansion. About 65.22% of the total sample showed that earlier sources of family income had been replaced by sales of cassava products after starting a cassava plantation.

The minimal production cost per hectare is 700,000 kip, however, the average cost per hectare for the entire portion is roughly 4,000,000 kip. Soil preparation costs are the most expensive part of the total cost of production and are paid by the farmers. It has been noted that the production costs in Vientiane province are between 10% and 15% lower than those in the other provinces. Farmers employ local labor only for one or two days during planting and harvesting seasons, with facts suggesting that about 84.33% of all farmers are self-employed. The general rise in input prices as a result of high inflation and exchange rate fluctuations in Laos has increased the production costs of cassava plantations. The majority of the expenses were incurred in the plowing processes, followed by the cost of hiring laborers for planting and harvesting as well as purchasing herbicides and insecticides.

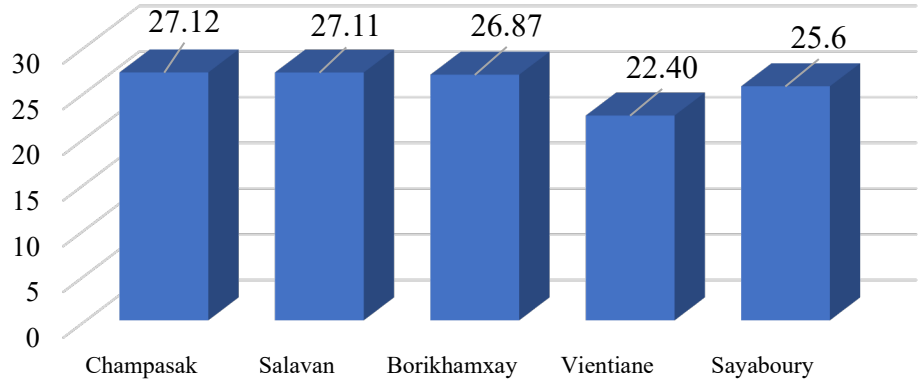
According to observations, the southern provinces of Laos produce more cassava than the central provinces, particularly Sayaboury and Vientiane provinces. As shown in Figure 2, certain regions can harvest cassava at a maximum yield of about 50 tons per hectare. Sixty percent of respondents claim their total sales from cassava have increased since 2019, while only about 25% of respondents experienced total sales that have not changed, and the rest of them have experienced reduced total sales. According to Figure 3, 52% of all cassava farmers' annual sales are for sums between 30 and 99 million kip, and only 20% are greater than 100 million. It can be noted that the income from cassava is clearly higher than other sources of household income earning.

The benefit that local farmers receive from cassava plantations is better illustrated in Figure 3. Additionally, there are a number of indicators that show the farmer's benefit from cassava cultivation when comparing before and after farmer engagement. For instance, household income

has increased significantly, accounting for 57.25% of the total sum, followed by an increase in 36.96%, which is shown in Table 1. With regard to the data from the survey, farmers participating in cassava value chains have better chances to consume more foods and are able to buy new household appliances as well as vehicles for their family. Furthermore, according to the data, more than 90% of respondents claimed that their family members (children) can enroll in schools and pursue further education. In conclusion, a comparison of the farmers' general living conditions before and after participating in the cassava value chains shows that their standards of living have improved. The benefit that local people receive from cassava investment is better illustrated in Table 1.

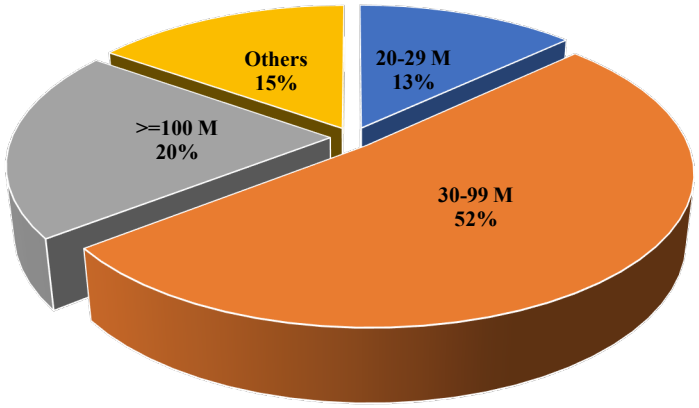
However, it is observed that cassava harvest output has decreased after the first or second harvesting seasons. Farmers have suggested that pesticides and herbicides might have damaged the soils. This consequence requires technical assistance from government agencies to provide guidance for farmers on how to improve the quality of soils and increase yields. One of the most crucial factors in increasing productivity – training – is an essential component, however, only 29% of cassava farmers reported receiving training from businesses and government organizations. Out of that amount, 84.12% are related to technical cultivation, and 13.16% are related to fostering. About 80% of training programs are supported by the district offices of agriculture and forestry and followed by local businesses.

Figure 2. The Yield of Cassava (tons per hectare) by province



Source: Authors' compilation from field survey - October to November 2022

Figure 3. Annual Total Sales of Farmers



Source: Authors' compilation from field survey - October to November 2022

Approximately 56.52% of respondents sell raw cassava while 21.01% sell dried chips. The remaining 22.47% of farmers sell their products as both raw and dried chips. The market channels mostly rely on selling through the middlemen, which accounts for about 47.83% of sales, followed by selling directly to manufacturers, which accounts for 35.51% of sales, and items sold by both middlemen and factories, which accounts for about 16.67% of sales. The majority of cassava products are sold in local markets, where farmers can freely negotiate prices.

According to the field surveys the two biggest obstacles for farmers in recent years have been increases in petrol prices and crop destruction by pests. Farmers also stated one of the top five difficulties they encounter is related to cassava cultivation techniques. Although understanding how to cultivate cassava is a key component in why farmers choose to plant it (as seen in Table 2), farmers also state that sophisticated techniques are still needed to boost outputs. In addition, the sale prices also fluctuate unpredictably over time, destabilizing farmer's income.

Table 1. Qualitative comparison Before and After Growing Cassava

No	Contents	Condition (Percentage %)					
		Increased significantly	Increased	Neutral	Declined	Declined significantly	Not sure
1	Household income	57.25	36.96	3.62	2.17	0.00	0.00
2	Nutrition	42.03	55.07	2.90	0.00	0.00	0.00
3	Household appliances	42.75	53.62	3.62	0.00	0.00	0.00
4	Vehicles	44.20	43.48	10.87	0.72	0.00	0.72
5	Opportunity for family members' education	47.10	43.48	7.25	0.72	0.00	1.45
6	Overall living conditions	51.45	40.58	5.80	0.00	0.00	0.72

Source: Authors' calculation based on field survey - October to November 2022.

Table 2. The Current Obstacles Faced by Farmers in Engaging in Cassava Value chains?

No.	The items	Number of answers
1	Petrol price	79
2	Pests	65
3	Low technical plantation	58
4	Price fluctuation	56
5	Arid soil/ poor quality of soil	48
6	Others (Cost, soil deterioration, rotten product…)	39
7	Natural disaster	38
8	Lack of maintenance techniques	34
9	High labor wage	30
10	The difficult expansion of new planting areas	28
11	Lacking sophisticated equipment	26
12	Lack of labor	26
13	High fertilizer price	22
14	Not suitable variety	14
15	Exchange rage	12
16	Difficult-to-find varieties	5
17	Low skill of tools application	5
18	Far from the sale place	3

Source: Authors' calculation based on field survey - October to November 2022.

With regard to respondents' perspectives, 37.68% of respondents surveyed say the governmental sector has not provided any support for their efforts to develop cassava value chains. According to Table 3, 18.12% of those who do receive support have neutral sentiments toward their performance, and 13.77% say they are unsatisfied with the support they have received from the public sector. The survey data also shows that farmers who grow cassava have less motivation to work under contract with their business partners (e.g., manufacturers and middlemen). As a result, more than 60% of the sampled respondents were uncertain about the contract farming platform. Additionally, their needs in terms of planting expansion and financial support are not being met. Farmers, however, are satisfied with regard to market access and trade facilitation. This circumstance clearly demonstrates that cassava farmers possess substantial access to market information, and they actively engage in sharing it with one another.

Table 3. The Respondents' Perspectives on Business Environment

No.	Contents	Level of willingness (%)					
		Most willing	Willing	Neutral	Not much wiliness	Not willing at all	Not sure
1	Assistance from the public sectors	5.80	22.46	18.12	13.77	2.17	37.68
2	Assistance from the contracting parties	0.72	10.14	13.77	12.32	2.90	60.14
3	Assistance from groups of producers	2.21	16.91	18.38	6.62	2.94	52.94
4	Assistance from local authorities	12.06	22.70	28.37	7.80	0.00	29.08
5	Infrastructure (Communications, Transportation)	15.11	33.81	23.74	10.07	2.88	14.39
6	Access to finance	9.29	12.86	21.43	8.57	9.29	38.57
7	Expansion of new planting fields	8.70	15.94	24.64	11.59	6.52	32.61
8	Market Access	39.42	26.28	21.90	5.84	1.46	5.11
9	Trade facilitation	35.71	25.71	25.00	6.43	2.14	5.00
10	Mechanisms of price taken in the market	22.06	19.85	32.35	16.18	5.15	4.41

Source: Authors' calculation based on field survey - October to November 2022.

Empirical Analysis

Growing cassava as a major source of income for households has been used as a proxy to determine the factors influencing Lao farmers in cassava value chain engagement. The research team applies both descriptive and inferential statistics to understand the association between socioeconomic variables and growing cassava as a major source of income.

The binary Logistic Regression Model has been used to assess the factors influencing Lao farmers in entering the cassava production value chain. The dependent variable is growing cassava as a major source of income for households. In other words, the dependent variable is whether a household is accessing the cassava production value chain as the household's major source of revenue. On the other side, the independent variables come from respondents and their households' socio-economic characteristics (Awotide et al., 2019). Specifically, the independent variables are gender, age, level of education, location by province, income level (from other sources), distance to farmland, size of property, training session, source of labor, contract situation, renting additional property, hiring tractor services (as a proxy to the availability of materials), household size (including both labor and non-labor forces), and years of experience as a cassava farmer.

FINDINGS

This section shows the result of the accessibility to cassava farming business as a household's major source of income. Table 4 shows the cross-tabulation analysis of socio-demographic characteristics and growing cassava as the major source of income. The socio-demographic characteristics of respondents and their households, which covers gender, age, level of education, location by province, income level (from other sources), distance to farmland, size of property (size of farming area), trading session, source of labor, contract situation, renting additional property, hiring tractor services, household size (labor and non-labor forces), and years of experience as a cassava farmer. As previously mentioned, this study retrieves information from 138 households from four provinces. In particular, under the predisposing characteristics, respondents from Vientiane Province shared the highest portion of 29.7% (41 households), whereas the least sample was taken from Xayaboury Province in the northern part of Laos (20 households or 14.5%). Most of the farmlands deploy a household-based labor force, of which approximately 105 out of 138 (76.1%) households use more than 50% of the household-based labor force. The data also reveals that most of the households do not have any contract with middle parties or buyers; only a marginal number of 4 households (2.9%) have made a contract with third parties. Under need-based characteristics, more than 65% of farmers stated that growing cassava is their major source of income.

The descriptive statistical analysis also found four variables to be statistically significant a 90% Confidence Interval (CI), namely: age, level of education, income level (from other sources), and renting additional properties, of which age is statistically significant at 99% CI. The Pearson χ^2 p-values indicate that the relationship between these variables and growing cassava as the major source of income is not independent.

It should be recalled that the binary logistic regression model was used to predict the accessibility to cassava farming business as a household's major source of income. As shown in Table 5, the R^2 is equal to 0.440, indicating that independent variables together account for 44% of the reasons for entering the cassava production industry for more than five years. According to the statistical estimation, three independent variables were statistically significant at 95% CI, namely – age, level of income (from other sources), and hiring tractor services.

Significantly, at 99% CI, households' heads with ages between 36-49 years old are 10 times more likely to grow cassava as major source of income in comparison to other age groups. Additionally, at 95% CI, owning machinery such as a tractor is also an important factor associated with the cassava production value chain as a major source of revenue for households. It can be said that most Lao cassava producers/farmers are small holders; even though growing cassava is the households' major source of revenue, these households are not able to purchase essential machinery such as a tractor.

Table 4. Socio-demographic Characteristics and Growing Cassava as a Major Source of Income

Socio-demographic characteristics	Major source of income		Total	Pearson X^2 P-value
	No	Yes		
Gender				
▪ Male	35 (72.9%)	66 (73.3%)	101 (73.2%)	0.958
▪ Female	13 (27.1%)	24 (26.7%)	37 (26.8%)	
Age				
▪ 18 to 35 years old	12 (25.0%)	12 (13.3%)	24 (17.4%)	0.002***
▪ 36 to 49 years old	11(22.9%)	49 (54.4%)	60 (43.5%)	
▪ 50 years old and above	25 (52.1%)	29 (34.2%)	54 (39.1%)	
Level of education				
▪ Primary school (grades 1 – 5)	18 (37.5%)	35 (36.4%)	53 (38.4%)	0.055
▪ Middle school (grades 6 – 9)	19 (39.6%)	37 (41.6%)	56 (40.6%)	
▪ High school (grades 10 – 12)	3 (6.3%)	14 (15.6%)	17 (12.3%)	
▪ Vocational school or university degree	8 (16.7%)	4 (4.4 %)	12 (8.7%)	
Location by province				
▪ Champasack	13 (27.1%)	13 (14.4%)	26 (18.8%)	0.114**
▪ Borikhamxay	5 (10.4%)	17 (18.9%)	22 (15.9%)	
▪ Saravan	13 (27.1%)	16 (17.8%)	29 (21.0%)	
▪ Vientiane	13 (27.1%)	28 (31.1%)	41 (29.7%)	
▪ Xayaboury	4 (8.3%)	16 (17,8%)	20 (14.5%)	
Income level (from other sources)				
▪ Less than 1m LAK	5 (10.4%)	33 (36.7%)	38 (27.5%)	0.010***
▪ 1m to less than 2.5m LAK	28 (58.3%)	40 (44.4%)	68 (49.3%)	
▪ More than or 2.5m to less than 5m LAK	9 (18.8%)	9 (10.0%)	18 (13%)	
▪ 5m LAK or above	6 (12.5%)	8 (8.9%)	14 (10.1%)	
Distance to farmland				
▪ Less than 5km	39 (81.3%)	73 (81.1%)	112 (81.2%)	0.984
▪ 5km and above	9 (18.8%)	17 (18.9%)	26 (18.8%)	
Size of property				
▪ Less than 2ha	18 (37.5%)	22 (24.4%)	40 (29%)	0.246*
▪ 2ha to less than 5ha	23 (47.9%)	49 (54.4%)	72 (52.2%)	
▪ 5ha and above	7 (14.6%)	19 (21.1%)	26 (18.8%)	
Training session				
▪ No	33 (68.8%)	65 (72.2%)	98 (71%)	0.669
▪ Yes	15 (31.3%)	25 (27.8%)	40 (29%)	
Source of Labor				
▪ Less than 50% from household	12 (25%)	21 (23.3%)	33 (23.9%)	0.843
▪ 50% and above	36 (75%)	69 (76.7%)	105 (76.1%)	
Contract situation				
▪ Contract	1 (2.1%)	3 (3.3%)	4 (2.9%)	0.677
▪ Independent	47 (97.9%)	87 (96.7%)	134 (97.1%)	
Renting additional properties				
▪ No	43 (89.6%)	80 (88.9%)	123 (89.1%)	0.901
▪ Yes	5 (10.4%)	10 (11.1%)	15 (10.9%)	
Hiring tractor services				
▪ No	34 (70.8%)	49 (54.4%)	83 (60.1%)	0.061**
▪ Yes	14 (29.2%)	41(45.6%)	55 (39.9%)	
Household size				
▪ 1 to 4 members	14 (29.2%)	19 (21.1%)	33 (23.9%)	0.291
▪ 5 and above	34 (70.8%)	71 (78.9%)	105 (76.1%)	
Experience as a cassava farmer				
▪ Less than 5 years	23 (47.9%)	38 (42.2%)	61 (44.2%)	0.521
▪ More than or equal too 5 years	25 (52.1%)	52 (57.8%)	77 (55.8%)	
Total	48	90	138	

*** 99%, **95%, *90% Confidence interval (CI);

Table 5. Association between Socio-economic Characteristics and Cassava as a Household's Major Source of Income.

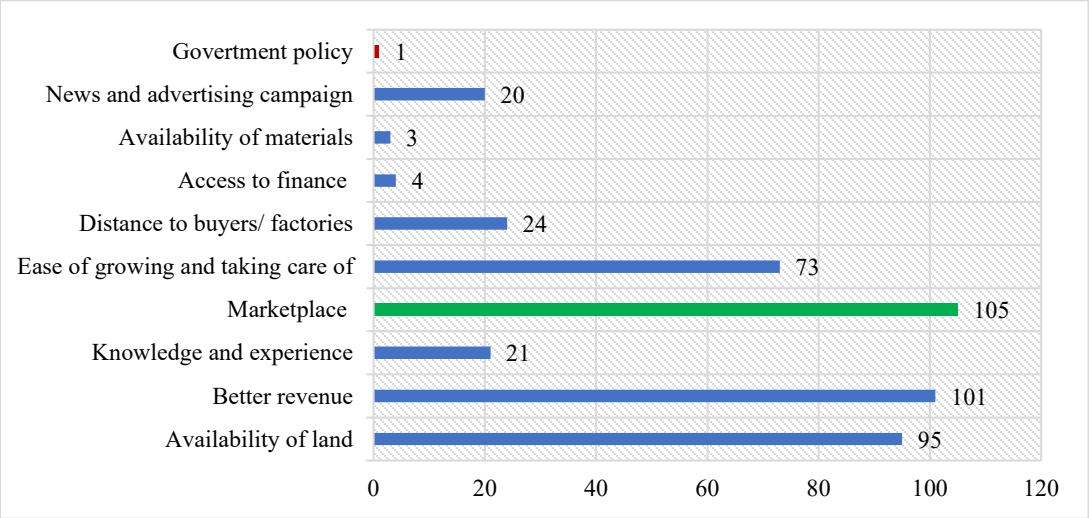
Independent variable	OR	P-Value
	R^2 = 0.440	
Gender		
▪ Male		
▪ Female	1.159	0.815
Age		
▪ 18 to 35 years old		
▪ 36 to 49 years old	10.277	0.003***
▪ 50 years old and above	1.348	0.694
Level of education		
▪ Primary school (grades 1 – 5)		
▪ Middle school (grades 6 – 9)	0.712	0.535
▪ High school (grades 10 – 12)	4.970	0.077*
▪ Vocational school or university degree	0.468	0.468
Location by province		
▪ Champasack		
▪ Borikhamxay	1.178	0.854
▪ Saravan	0.400	0.239
▪ Vientiane	2.822	0.154
▪ Xayaboury	2.595	0.295
Income level (from other sources)		
▪ Less than 1m LAK		
▪ 1m to less than 2.5m LAK	0.096	0.03**
▪ More than or 2.5m to less than 5m LAK	0.025	0.01**
▪ 5m LAK or above	0.083	0.016**
Distance to farmland		
▪ Less than 5km		
▪ 5km and above	0.763	0.833
Size of property		
▪ Less than 2ha		
▪ 2ha to less than 5ha	2.575	0.111
▪ 5ha and above	2.305	0.288
Training session		
▪ No		
▪ Yes	0.876	0.825
Source of Labor		
▪ Less than 50% from household		
▪ 50% and above	0.829	0.746
Contract situation		
▪ Contract		
▪ Independent	5.096	0.253
Renting additional properties		
▪ No		
▪ Yes	1.615	0.527
Hiring tractor services		
▪ No		
▪ Yes	3.475	0.024**
Household size		
▪ 1 to 4 members		
▪ 5 and above	1.702	0.368
Experience as a cassava farmer		
▪ Less than 5 years		
▪ More than or equal too 5 years	1.846	0.288

*** 99%, **95%, *90% Confidence interval (CI);

Most farmers choose to rent rather than buy tractors for longer-term use and economies of scale purposes. In addition, households' income from other sources is regarded as an important factor; the regression model shows that lowest income households with other source of revenue less than 1 million LAK (approximately US$60) are more likely to enter the cassava value chain as major source of income when compared to wealthier income groups.

Despite not statistically significant at 90% CI, the analysis shows that households participating in the cassava farming industry as their main source of income are 5 time more likely to have heads who have a high school degree (10-12 years of schooling), 2.822 times more likely to engage in farming in the Vientiane Province, and are 2.575 times more likely to possess plantation areas ranging from 2 hectares to less than 5 hectares.

Figure 4. Factors Associated with Cassava Production Value Chain



Source: Authors' compilation from field survey - October to November 2022

During the interview sessions, respondents were asked to select three out of the ten most influential factors (Figure 4) associated with the decision to enter the cassava production value chain. Those ten factors include government policy, news and advertising campaign, availability of materials, access to finance, distance to buyers/factories, ease of growing and taking care of cassava, availability of marketplace, knowledge and experience, better revenue, and the availability of land. The result of the interview shows that the availability of the marketplace is the most important factor, with 105 counts, followed by better revenue (101 counts), availability of land (95 counts), ease of growing and caretaking (73 counts), and so forth. In contrast, only one respondent stated that government policy is an important factor that leads them into the cassava production value chain.

Discussion and Policy Recommendations

Regardless of not being statistically significant at 90% CI, the study outcomes found some important association with cassava value chain engagement. A household that owns the size of property or land between 2 hectares to less than 5 hectares has the highest probability of entering the cassava value chain in Laos as the household's major source of income. The plantation areas are slightly larger than average size compared to other developing countries. In Africa, small scale

farmers are unable to gain access to finance and other extension services (Dogba, Oluoch-Kosura, & Chumo, 2022). Farm size matters in decisions to engage in value chains such as cassava. Contrary to most developed countries, where agricultural products are produced on large farms under contract farming with the clients, (Laos' neighboring country such as Thailand also has a huge number of small-scale cassava farms), the vast majority of Lao farmers do not engage in contract farming (OAE, 2010). For the developing country's context, implementing small-scale farming has several advantages. Firstly, Small-scale agricultural practices typically emphasize sustainable land use, including crop rotation, composting, and natural insect control methods. Small-scale farming maintains soil fertility, preventing soil erosion and reducing the need for chemical fertilizers and pesticides. Fresh, organic produce without hazardous chemicals and pesticides is frequently grown on small farms. Both farmers and consumers may benefit from better health outcomes due to the implementation process.

The model shows that respondents with high school degrees are more likely to participate in the production value chain. The supporting reason is that most of the farmers that participate in the cassava value chain in Laos are between the ages of 36-49 years old. These groups of people are able to access secondary school more, in comparison to older generations (Global Economy, 2023). This level of education allows them to understand basic profit calculations in entering the value chain. However, the descriptive statistics found that minimal households participated in the cassava farming session hosted by cassava processing counterparts. Processing firms organized these training sessions with the goal of enhancing the efficiency and productivity of cassava production.

A recent study on the relationship between demographic and socio-economic characteristics of cassava farmers and production output in northern Ghana done by Awotide et al. (2019) that focused on the relationship between demographic and socio-economic characteristics of cassava farmers and production output, found that the educational variable was estimated to have a positive value that was statistically significant at 1%, which suggests that higher levels of education lead to increased output from farmers. In this regard, education is an important factor that increases the efficiency of cassava production. It would seem that educated farmers can better assimilate knowledge about new and improved farming methods quickly (Abdul-kareem & Sahinli, 2017).

Most cassava producers are smallholders living within a perimeter of 5 km, and some live on their farmland. In this circumstance, it could be very easy to access farmland on a daily basis; however, some farmlands are located far away from the main road, which proportionally increases transportation expenditure and reduces the incentive to join the production value chain. The likelihood of growing land holding size was decreased by 8.5% as the households' distance from main roadways rose. Due to the perishability of cassava tubers, increased distance to a road from farm sites affects access to markets-(Jerumeh & Omonona, 2010).

Once again, according to the descriptive and inferential statistical analysis, the results show that regardless of whether the cassava value chain is the majority of households' revenue, most of the farms still must rent tractor services for farmland preparations. Renting costs and land preparation costs take up a large portion of the total cassava production costs. Hence, it is not easy to afford or own tractors for long-term cassava cultivation. This is similar to South African cassava production, where farmers who struggle to acquire timely access to machinery during the production process may consider employing a contractor instead of purchasing their own equipment. The current surge in machinery prices may be primarily caused by increased

importation costs, high transportation expenses, and perpetually rising interest rates (Marais, 2022).

The statistical data from the descriptive analysis (Table 5) shows that most cassava farming families are contract-free. The crops are therefore sold at the going rate on the market (spot market), which may be greater or lower than in prior years. The farmers have the option of selling their harvests to processing plants or third parties (traders/collectors) directly. Farmers are sometimes unwilling to sell their crops to factories because the factories prefer to give them coupons instead of cash. For payment, in this instance, the farmer must make another trip to the factory. Some farmers choose to sell their coupons or cassava to third parties in order to receive cash as quickly as possible, even if the price is lower than the market price. It should be recalled that the fuel prices in Laos have reached a new high in 2022. Another important reason that deters the direct transaction between farmers and cassava processing factories is increasing fuel prices, which simultaneously increase transportation costs from farming locations. In this regard, most cassava growers also end up selling to third parties at relatively lower prices.

Due to Russia's invasion of Ukraine in the spring of 2022 – the world's largest exporter of fertilizer valued at over US$ 7.6 billion in 2020 – fertilizer prices reached an unprecedented high. This substantial increase in prices has directly impacted farmers, resulting in a proportional rise in their costs. The Russia-Ukraine war exacerbated an already tight global supply situation that began in 2020 with COVID-19 related worker shortages and factory shutdowns, being the first of several disruptions that triggered market volatility in the fertilizer industry (Jenkins, 2022). For cassava cultivation in Laos, there is a limited external effect from the increase in fertilizer price escalation. This is because cassava production processes in Laos do not rely on any kind of fertilizer to promote cassava growth. However, the depreciation of LAK rates at the rate of 32.9% directly affects the cost of herbicide by more than 40%. Without increasing cassava prices, the costs of pesticides will cut into farmers' revenue. Similar to other industries, the fuel price shock also creates significant impacts on the cassava supply chain. The significant surge in fuel prices has led producers to make the decision to sell cassava to third parties at reduced prices instead of selling to factories, in order to avoid the burden of high transportation costs.

With respect to the study's findings, several policy suggestions for various parties and policymakers can be made. Firstly, education is crucial for cassava production value chain participation. Cassava farmers' education background positively relates to success in the cassava production value chain. It is highly recommended that the government organize training campaigns for cassava farmers on pertinent information such as production techniques and contract farming policies. The Lao government should also offer a short training program on small-scale cassava farming management for Lao farmers to enhance their capability and productivity.

Secondly, the government may provide subsidies or incentives for machinery rental providers. This policy can be put into practice on a local, state, or federal level and might be directed at particular farming practices or pieces of equipment. The government may also impose price controls or monetary limits on the agricultural equipment rental market. This would be done to ensure that farmers have reasonable access to the necessary equipment. The government could establish agricultural equipment rental services that offer farmers lower rates than private rental companies or offer rental companies tax incentives for providing farmers with affordable rental rates. These policy options could encourage more businesses to enter the market and provide competitive pricing. Government intervention to lower the cost of renting agricultural machinery

could support small farmers and advance sustainable agriculture. Farmers can maintain their operations and contribute to the nation's food security if they have access to affordable equipment.

Thirdly, encouraging young people to engage in rental services may be a viable solution to inadequate credit facilities for purchasing tractors. This strategy can assist young people to overcome financial obstacles that may prevent them from purchasing tractors. It could also enable young entrepreneurs to launch their own rental services, thereby contributing to job creation and economic expansion. To assist this process, the government could offer tax breaks, subsidies, or other forms of financial support to those who launch tractor rental businesses. The government could also provide training and technical assistance to assist young people in acquiring the skills needed to operate a successful rental business.

Additional ways to increase the competitiveness of smallholders in the cassava value chain include a number of approaches, such as investing in research and development to improve cassava varieties and production techniques. This could increase yields, decrease production costs, and enhance the quality of cassava products, thereby increasing their market competitiveness. Another option could be to improve infrastructure such as roads, storage facilities, and processing facilities which could reduce post-harvest losses and enhance the quality of cassava products. This would increase the profitability and competitiveness of smallholder farmers by granting them access to larger and further-flung markets. Another consideration is that most of the farmers do not have bank accounts with financial institutions. These farmers must wait and travel to the town many times to get payment from factories. It is also necessary for government sectors to encourage and educate them about the benefit of having bank accounts.

Another consideration is that one of the most important inputs for cassava farming is herbicide. Due to the depreciation of LAK against THB, the price of herbicide dramatically increased during the last two quarters of 2022. As such, the government could play an important role in importing and distributing herbicides and other important farming inputs to control the escalation of production costs as much as possible.

Finally, households that rely on entering the cassava production value chain for their primary income have the lowest income level from other sources. Apart from growing cassava, these households are engaging in small trade, animal raising, and other odd jobs. On the other hand, those categorized in higher income quantiles are also relying on rice farming, large-scale livestock production, and trade. For the households whose revenue comes primarily from cassava production, government sectors need to be involved in setting a minimum price for cassava. Alternatively, the government could consider developing a State-Owned Enterprise (SOE) that focuses on cassava production. The existence of SOE could play an essential role in creating price competition in the cassava production value chain.

CONCLUSION

Smallholder farmers in Laos have increased their cassava crop production recently, due to the increasing regional market demand for the crop. In many regions in the country, especially in the provinces near starch plants and factories that process cassava from neighboring countries, cassava is a significant cash crop for farmers. However, because Laos' smallholder farmers heavily rely on international markets to sell their cassava products and import the necessary farming supplies, they are more vulnerable to external shocks like market disruption from COVID-19 and an increase in fuel costs brought on by the war between Russia and Ukraine. China continues to be a significant influencer in terms of market size and demand, even though Vietnam and Thailand are the two countries that import the most cassava from Laos. Thus, a rise in the demand for cassava in the Chinese market will have a big impact on the cassava value chain in Laos, where starch factories and traders/collectors are essential in promoting and consuming the outputs of smallholder farmers in Laos, whether they are fresh roots or dried chips.

In order to examine the engagement of smallholder cassava farmers as a household's major source of income, the binary logistic regression model is applied in the study. According to the statistical estimation, age, degree of income (from other sources), and hiring tractor services are the three determinant factors that have significant impact on smallholder farmers' decision to join the cassava value chain. On the other hand, it can also determine that property size, location within a province, and educational attainment are all statistically significant at 85% confidence intervals. The results show that, at the 95% confidence interval, household heads who are 36 to 49 years old had a higher likelihood than other age groups of cultivating cassava as their primary source of income. As the major source of income for households, entering the cassava production value chain also requires possession of a material like a tractor. The regression model demonstrates that lower income households with other sources of income of less than 1 million LAK (approximately US$60) are more likely to enter the cassava value chain as a major source of income. This is in contrast to higher income groups.

This study offers multiple policy suggestions for different stakeholders and policymakers. In order to effectively lower prices and increase economies of scale, the government should first take action to promote contract farming, offer technical training for farmers, and give farmers access to financing for specific types of machinery (tractors). The government should also play an important role in importing and distributing herbicides and other crucial farming inputs to control the escalation of production costs as much as possible. The government could also encourage and educate farmers about the benefits of having bank accounts for reducing travelling cost to the town to get payment from starch factories. Additionally, the government's policy to promote alternate revenues can help smallholder farmers in reducing the impact of any external shock on their income. Last but not least, the government may encourage the establishment of a State-Owned Enterprise (SOE) that focuses on cassava production. This is essential to creating price competition throughout the cassava value chain.

As cassava production is relatively new in Laos, it is necessary to conduct further studies focusing on the cassava production value chain. There are still several gaps that need to be addressed. Laos requires additional research on cassava production and productivity. This includes research on the use of improved cassava varieties, best practices for land preparation and planting, pest and disease control, and the efficient application of fertilizers. Cassava post-harvest losses and post-

harvest processing research are still inadequate. Ways to lessen losses during harvesting, transport, and storage could also be the subject of research.

Another necessary area of study would be on cassava processing technologies that can add value to cassava products and increase their marketability. There is limited research on cassava products' market access and competitiveness. The competitiveness of cassava products may be affected by factors such as quality standards, costs, and market information. In addition, there is a need to examine market links between smallholder farmers and buyers, as well as ways to strengthen them. Insufficient research has been conducted on the environmental sustainability of cassava cultivation and processing. The effect of cassava production on soil health, water resources, and biodiversity could be investigated, as well as strategies for promoting sustainable practices. Changes in climate can also have significant effects on cassava production. Cassava is a staple food crop grown in tropical and subtropical regions, and it is especially susceptible to changes in temperature, rainfall patterns, and extreme weather conditions. Hence, it is necessary to find out the impact of climate change on the cassava production value chain and access to international markets in future studies.

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