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Factors influencing the practice of commercial rice production for food security in Vientiane capital, Laos

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ABSTRACT
Rice is viewed as an indicator of food security and poverty reduction, but many rural areas of Laos still face rice insufficiency. Dealing with the problem requires transitioning from traditional farming to commercial production using modern techniques. This study aimed to investigate the factors influencing the adoption of commercial rice production for local food security and poverty reduction. The survey included 70 samples in the Namxouang irrigation development area of Vientiane Capital, Laos, using a questionnaire for secondary and primary data collection. Both descriptive and inferential statistics were employed to describe the collected data and analyze factors influencing commercial rice production. The findings revealed that 65.7%, 18.6%, and 15.7% of the respondents engaged in commercial, semi-commercial, and subsistence rice production, respectively. In addition, it also found that land size, labor costs, and machinery costs each had a significant positive relationship with the practice of commercial rice production at a statistical significance level of 0.01. At the same time, household size, media perception, and annual income had significant negative relationships with the practice of commercial rice production at significance levels of 0.01 and 0.05. Therefore, high-quality rice varieties, new rice production techniques, and rice production groups are needed to support farmers using the same technical practices to obtain similar yields. Moreover, regulations are required to control chemical use and manage paddy land. These changes would help achieve the government policy to promote smart farming and good agricultural practice for food security and poverty reduction.

Contribution/Originality: This is the first study to discover factors influencing the practice of rice production in irrigated areas. The result can guide local governments and stakeholders to help farmers increase their rice yields and improve their quality for regional food security and export.

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1. INTRODUCTION

In recent years, Laos has focused on achieving the sustainable development goals to graduate from Least Development Country (LDC) status by 2026. Promoting sustainable agriculture for food security and poverty reduction is a priority in the national socio-economic development plan (Ministry of Planning and Investment (MPI), 2016, 2021) to address food insecurity, which remains a pressing problem among low-income households. The incidence of poverty is higher among agricultural households (LSB & WB, 2020), so food and nutrition insecurity are closely associated with poverty and vulnerability. Still, more is needed to understand why food insecurity remains problematic in some areas of rural Laos despite the general improvement in living standards across the country (Santos et al., 2022; WFP, 2017). Food security continues to be focused on rice – its production, marketing, and consumption – as rice contains a significant number of calories and a wide variety of essential vitamins, minerals, and other nutritional values (Mohidem, Hashim, Shamsudin, & Man, 2022; Timmer, 2010). Rice production is thus viewed as an indicator of food security and poverty reduction. Many areas of Laos still face chronic rice deficits, even though rice self-sufficiency has reportedly been achieved at the national level. In dealing with the problem of rice insufficiency, efforts need to shift from traditional farming practices to production groups or a new cooperative production model, both using modern technology (smart farming), improving the efficiency of agricultural production using modern tools and new techniques, promoting good agriculture practices (GAP) and organic farming for domestic consumption and tourist attraction, improving the profitability of rice production, and investing in market infrastructure (Ministry of Planning and Investment (MPI), 2021; Newby, Manivong, & Cramb, 2013).

To achieve food security and poverty reduction, the Ministry of Agriculture and Forestry projects the need to produce at least 3.7 million tons of rice annually for food security and export, based on the priority and potentiality of the northern, central, and southern regions (MAF, 2022). However, the promotion of rice production for food security and export in Laos continues to face many problems. Production has been insufficient to meet the demand of domestic consumers due to problems associated with climatic change, with annual losses of 10% of harvested rice, as well as poor transport facilities to move rice from surplus to deficit areas. Moreover, factors such as drought and post-harvest failures are essential determinants of food insecurity at the household level, and the transition to sustainable commercial production still presents the following challenges: minimal infrastructure, limited technical knowledge, and lack of sufficient extension support (FAO, European Union, & CIRAD, 2022; Sacklokham, 2014; Santos et al., 2022). In addition, food security needs still struggle to be met due to land degradation, land use issues, and several large-scale investment projects affecting production areas. Moreover, production has been unstable and unable to meet export demand and quality due to low productivity, limited investment budgets and technology capacity, and the impacts of natural disasters (Ministry of Planning and Investment (MPI), 2021).

Although farmers are intensely encouraged by the Lao Government to practice commercial rice production for local consumption and to obtain surpluses for export, many still practice traditional rice production techniques, produce rice for subsistence, and apply low-quality management at the farm and post-harvest levels. Different rice seed varieties often get mixed at older rice mills, reflecting a fragmented milling sector dominated by small operators with outdated and inefficient technology (Liese et al., 2014; WB, 2018). The objective of commercialized agriculture is production with the intent to sell; thus, when crops are grown as an economic activity, it is called commercial agriculture (Grant, Guilleminault, & Sarma, 2017; Rath, 2021). On the other hand, households with access to irrigation currently cultivate other crops in their paddy fields in the dry season as an alternative to producing a second crop of rice, with some of them converting their land to fish ponds. In addition, the irrigation systems need to meet certain standards to support food security and commercial production; irrigation systems have limited access to water in the dry season (ADB, 2018; MAF, 2022; Sourideth, Ouanesamone, & Newby, 2011). This factor makes farmers uninterested in production, though the local government encourages it. However, previous studies have found that socio-economic and environmental factors and household income significantly impact the adoption of agricultural conservation innovations. Still, education level, social networks, and labor do not affect farmers' choice to adopt agriculture innovations (Vuntade & Mzuza, 2022).

In contrast, Ayenew and Tilahun (2022) revealed that education, household size, income, climate change perception, and farmland size all had statistically significant effects on farmers' adoption of climate-smart agriculture. Similarly, Abubakar, Garba, Gana, and Jocob (2019) suggested that farmer training, expansion contracts, household size, land ownership, and farming experience were significant factors influencing the adoption of rice production methods. Moreover, Rapankum et al. (2022) and Ntshangase, Muroyiwa, and Sibanda (2018) confirmed that experience on dairy farms, labor type, farm size, and amount of raw milk produced significantly affected farmers' acceptance of the dairy farming standard. Also, an increase in extension visits, age, education, and farmers' positive perceptions significantly increased the likelihood of a farmer adopting no-till conservation agriculture. On the other hand, the study found that land size and technology were positively correlated with rice production levels. While labor availability and the demand for rice had strong relationships with the volume of rice produced, seed, fertilizer, herbicide, family size, and off-farm income were significant and major determinants of wet season paddy output (Jamaludin, Amer, & Hasan, 2010; Sary, Wen, Darith, & Chand, 2020). At the same time, education levels, farming experience, soil quality, market information, farm machinery ownership, and contracts with extension agents significantly and positively influenced the adoption of improved rice varieties. In contrast, age had a very negative effect on the adoption of improved rice varieties. Furthermore, credit is an important factor in the farming sector and is linked to increased farm productivity and improved livelihoods of rural households (Chandio & Yuansheng, 2018).

At the same time, a small number of farmers in the Namxouang irrigation area in Vientiane Capital continue to practice subsistence agriculture. They prefer to cultivate only in the wet or dry seasons and only an amount sufficient for household consumption. They are not interested in growing rice in both seasons even though they are in an

irrigated area and encouraged by the government, so they sometimes lease their paddy fields to other farmers or leave their land fallow. This study aimed to explore the main factors influencing commercial rice production in support of local food security and generating additional income for poverty reduction. The results can be used as a guide for consideration by the government or key development partners to promote commercial rice production in irrigated areas throughout Laos.

2. METHODOLOGY

The study applied both qualitative and quantitative approaches to data collection. The population included 2,189 rice farming households from 10 villages in Naxaythong District, Vientiane Capital province. The sample size of 70 households was determined using Arkin (1974); samples were selected through the multi-stage sampling method, including purposive and snowball sampling techniques. The questionnaire was developed based on the research objectives and was used for secondary and primary data collection. It included questions on personal and socio-economic background, agricultural activities, and farming systems currently practiced. Before collecting the data, three experts in the field of agriculture checked the validity of the questionnaire. It was then tested with 30 rice farmers to obtain the reliability index. The reliability of the questionnaire was obtained by using the Kuder and Richardson (1937) reliability coefficient, which resulted in a reliability of 0.84. Descriptive and inferential statistics were applied to analyze the collected data using SPSS software version 20. Descriptive statistics were used to examine the frequency, percentage, arithmetic means, standard deviation, minimum, and maximum, while inferential statistical analysis was applied to analyze the correlation relationships between the dependent and independent variables.

3. RESULTS AND DISCUSSION

3.1. Background of the Respondents

The analysis found that most respondents were male, accounting for 72.9% of the sample, and the rest were female, 27.1%. The average age was 51.53 years old, with a range from 24 to 75 years old, and most respondents were married, accounting for 95.7%. The remaining 2.9% and 1.45% were windowed and single, respectively. The average household size was 5.47 people per household and ranged from two to 11 people, while the average number of laborers in each household was 3.1 and ranged from one person to six people. Among those interviewed, 98.6% had an education level ranging from primary school to university; the remaining 1.4% were illiterate. Their rice farming experience averaged 29.84 years, ranging from five to 55 years. Moreover, decision-making on agricultural activities in the household was equal between husband and wife in 60% of households. Among the remaining 40%, decisions were made only by the husband, wife, parents, son, or daughter.

The data also revealed that 62.9% of the respondents were rice farmers, and the remaining 37.1% were government officials, weavers, traders, businesspeople, and construction workers. In comparison, 34.3% had a single occupation, and 47.1% and 18.6% had two or three occupations, respectively, of which one was their major occupation. Among the respondents, 92.9% received information on agricultural production via radio, television, workshops, or training. All respondents were members of a water user group, while 77% and 27% participated in their village development fund or a rice production group, respectively. Concerning land tenure status, 55.7% owned land and neither rented from nor rented out land to other farmers. The remaining 15.7%, 22.9%, and 5.7% leased land only, owned and rented additional land, and owned and rented land, respectively. Among the respondents, the average paddy land holding size was 1.45 hectares per household, ranging from 0.32 to 7.20 hectares. The average annual income reported was US$8,715, ranging from US$1,729 to US$33,600 per household. Of the respondents, 25.7% accessed credit for agricultural production activities, while the remaining 74.3% never accessed any credit.

3.2. The Practice of Commercial Rice Production

The study found that most respondents in the study area had not fully engaged in commercial rice production. However, their land is irrigated, and government extension agents have promoted commercial production. Table 1 shows that 65.7% of the respondents produced rice primarily for selling to local markets to support food security in the Vientiane Capital area. These farmers tended to have large paddy fields. Some of them not only produced rice on their own land, but they also rented more paddy land for rice cultivation; and hired more labor and machines during land preparation, transplanting, harvesting, and threshing, because these required more work.

On the one hand, some owned machines such as tractors and threshing machines to practice rice production in large areas during both the wet and dry seasons for commercialization. They immediately sold the harvested rice to middlemen and rice mill owners for income generation. As such, it can be asserted that they were fully engaged in commercial rice production consistent with the Lao Government's policy to achieve food security in the community. On the other hand, 18.6% of the respondents undertook semi-commercial rice production since they prioritized food security at the household level. They would keep harvested rice at home and sell it when they needed money for an emergency, or they would wait until the rice cultivated in the next season was growing well, without the threat of flood, drought, and pests, to ensure a good yield for food security. After that, they sold their surplus to middlemen who came to purchase agricultural products in the village to supplement their household income.

In contrast, some farmers in this group had medium to large areas of paddy land, sufficient to perform commercial rice production, particularly if they practiced in the rainy and dry seasons, leased land to other farmers, especially relatives or friends, and charged a fee in rice to support household food security. However, 15.7% of the producers had never sold rice and only produced a rice crop in the wet season sufficient for household consumption. They neither rented more land nor cultivated rice for commercialization during the dry season. It has been

established that Laos households mainly produce sticky rice for self-consumption rather than sale (Sengsourivong & Ichihashi, 2019). This group of farmers may have small plots of paddy land because some of them are young and new households who had just separated from their parents' families, so they had a small area of paddy land given to them by their parents. At the same time, they also had other occupations, particularly government officials and construction workers, so they lacked the time and labor for rice cultivation. However, they still engaged in subsistence rice production; sometimes they had insufficient rice for year-round consumption and needed to purchase additional rice from the local market for food security in the household.

Table 1. The pattern of rice production in the study area.

Pattern of rice production	Number of households	Percentage
Subsistence production	11	15.7
Semi-commercialized production	13	18.6
Commercialized production	46	65.7
Total	70	100.0

3.3. The Key Factors Influencing the Practice of Commercial Rice Production

Multiple linear regression was applied to find the factors influencing the practice of commercial rice production in the study area. A multiple linear regression model measured the relationship between independent and dependent variables. The measured form of the equation was specified as in Equation 1:

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots\ldots\ldots + \beta_{15} x_{15} \quad (1)$$

Y is the dependent variable (Commercial rice production). X_1, X_2, X_3,….. X_{15} are independent variables (age, education, household size, number of occupations, farming experience, media perception, group participation, land size, household labor, annual income, amount of credit, fertilizer, pesticide, labor, and machinery costs). β_0, β_1, β_2,……. β_{15} are unknown parameters (constant to be estimated from the data).

The analysis of the multiple linear regression shown in Table 2 found that land size, labor costs, and machinery costs had significant positive relationships with the practice of commercial rice production at a statistical significance level of 0.01, while household size, media perception, and annual income had a significant negative relationship with the practice of commercial rice production at a statistical significance level of 0.01 and 0.05; therefore, the findings can be presented as follows:

$$\text{Commercial rice production (Y)} = -0.028 - 0.362(\text{Household size}) - 0.725(\text{Media perception}) - 0.172(\text{Income}) + 1.091(\text{Land size}) + 0.458(\text{Labor cost}) + 0.462(\text{Machinery cost}) \quad (2)$$

In accordance with the analysis in Equation 2, if the household size was reduced by one person, there was a greater chance that rice was produced commercially. This may relate to food security at the household level because households prefer to keep sufficient rice for household consumption for the whole year. Thus, the larger the household, the more rice was required for consumption. Mullis and Prasertsri (2020) and Sacklokham (2014) emphasized that the average rice consumption in Laos was the highest in the world; it was 216 kg of milled rice or almost 450 kg of paddy rice per capita per year in 2000. More recently, it has declined, especially in urban areas, to about 206 kg per capita per year in 2020; each household thus needs to keep at least 2.4 tons of paddy rice for consumption, so they have less surplus rice for selling.

The results also revealed that if farmers perceived they had less information related to agricultural production, they engaged more in commercial rice production. As a result, the agricultural information they received through television, training courses, workshops, advertisements, and other means may be related to other agricultural activities. At the same time, they also were encouraged to practice those commercialization activities that could provide them with a better income. Some farmers used their paddy fields to undertake other agriculture activities, namely pig or chicken raising, fishponds, or cultivating other crops such as beans, sawah lettuce, cucumbers, vegetables, and others. Abubakar et al. (2019) suggested that farmer training significantly influenced the adoption of the rice production practice.

On the other hand, MRC (2019) claimed that the agricultural land in Lower Mekong Basin had changed due to expanding agricultural areas, changing crop cultivation and patterns, and shifts from agriculture to other land uses depending on social-economic development. ADB (2018) confirmed that the improvement of the irrigation system was the fastest way to increase rice crop production and enable farmers to diversify into high-value crops demanded by the market. Similarly, if annual household income from agriculture declined or the household generated less income overall, the cultivation of commercial rice crops would increase. Farmers may thus undertake several occupations simultaneously, including business, trading, and working as government officials and construction workers to generate income. As a result, however, they were always busy and had little or no time for commercial rice production. Instead, they applied easy techniques in some seasons, changing from rice transplanting to a dry sowing technique, and they used herbicides and pesticides to control weeds and snails, even though this resulted in lower yields. Some rented their paddy land out to other farmers to obtain fees or rice; they charged about 360 kg of paddy rice per hectare of cultivated rice during one wet or dry season because they lacked sufficient time and labor to grow rice themselves. In this way, sufficient rice was obtained for household consumption. However, if the land size for rice production increased, farmers were more likely to engage in commercial rice cultivation. Although some farmers would like to produce rice commercially, they have limited paddy land, thus limiting their production to rice for household consumption. At the same time, finding and hiring additional paddy land for rice production was challenging because farmers preferred to rent it out exclusively to friends or relatives from inside or outside the

community. Ayenew and Tilahun (2022) confirmed that household size, income, and farmland size all had statistically significant effects on farmers' adoption of climate-smart agriculture.

Finally, the results showed that if labor and machinery costs for rice cultivation increased, the number of farmers cultivating rice commercially would also increase. This meant that farmers had large paddy land and could fully adopt rice production on a commercial scale because they hired more labor and machinery. Specifically, they hired more labor during rice transplanting and harvesting and paid machinery costs for land preparation, threshing, and loading rice.

In summary, the analysis indicated that the combination of reduced household size, media perceptions, annual income, and increased land size, labor, and machinery costs resulted in farmers engaging in more commercial rice production in the irrigated area. At the same time, the other factors that were not significant and were not included in the equation, such as age, education, number of occupations, farming experience, group participation, household labor, amount of credit, fertilizer cost, and pesticide cost, may also play a role by combining at a minimal percentage or being an existing factor. Factors that are needed to support farmers who cultivate rice commercially in both the wet and dry seasons in irrigated areas and for local food security purposes include providing more information on the importance of rice production and identifying appropriate zones for rice cultivation. This is needed to reduce the replacement of other crops by a second crop of rice in the dry season. The limited paddy land of some households was problematic, given the expanding population growth. Therefore, it is necessary to encourage farmers to apply new production techniques and use improved varieties, fertilizer packages, and other inputs to increase the yield for commercialization. Because the practice of the rice GAP method could increase and improve the tillers, panicle, yield, and quality, it could provide potential benefits and increase the production and price of both sticky and non-glutinous rice compared to non-GAP rice (FAO, European Union, & CIRAD, 2022; Huyly, Soytong, Makhonpas, & Adthajadee, 2011; MI, 2017; Senthilkumar, Tesha, Mghase, & Rodenburg, 2018). In addition, farmers need to form commercial rice production groups. This would help them access information on rice production together and cultivate using the same techniques based on group requirements, even though they may have different social and economic circumstances in the community. It would not only support them in reducing the dry sowing technique, but it would also help increase yield and reduce chemical application, directly impacting the rice field's living conditions.

Table 2. Factors influencing the practice of commercialization.

Factors	The practice of commercialization		
	Coefficient	Std.	P-value
Personal background factors			
(Constant)	-0.028	0.918	0.976
Age	0.015	0.181	0.934
Education	0.111	0.114	0.336
Household size	-0.362**	0.099	0.001
Number of occupations	0.382	0.254	0.138
Social factors			
Farming experience	-0.003	0.171	0.988
Media perception	-0.725*	0.327	0.031
Group participation	-0.159	0.327	0.628
Economic factors			
Land size	1.091**	0.218	0.000
Household labor	0.250	0.155	0.114
Annual income	-0.172*	0.065	0.011
Amount of credit	0.180	0.102	0.083
Agricultural input factors			
Fertilizer cost	0.184	0.207	0.378
Pesticide cost	-0.040	0.198	0.840
Labor cost	0.458**	0.131	0.001
Machinery cost	0.462**	0.174	0.010
R-squared			0.899

Note: * < 0.05 and ** < 0.01.

4. CONCLUSION

Based on the analysis, it can be concluded that farmers in the study area engaged in subsistence agriculture, semi-commercial, and full commercial rice production for food security based on their household capacity and socio-economic conditions. Households with many family members, yet that controlled limited paddy land, emphasized producing sufficient rice for household consumption. Some of these households rented additional land for semi-commercial rice farming. At the same time, households with more paddy land but less labor or fewer available family members sometimes rented out their land or merely produced sufficient rice for household consumption. Most farmers in the study area practiced rice production in both wet and dry seasons for food security and to generate their primary income through selling, even though some lacked paddy land and sufficient labor. Instead, they rented additional paddy land and hired more labor and machinery. This confirms that commercial rice production can provide farmers with a profitable income. Therefore, the following aspects need to be addressed to encourage more

farmers to engage in commercial rice production in irrigated areas. Firstly, concerned organizations need to conduct additional research to produce suitable quality rice varieties that are tolerant of floods, drought, pests, and diseases, and that are high yielding. These varieties should be available at a reasonable price, enabling farmers to access and purchase suitable varieties. This would help farmers with sufficient family members but limited paddy land to produce rice for food security and sale. Some farmers continue to use the same rice seed variety for many seasons, which yields only 3.6 tons per hectare on average, ranging from 2.2 tons to 4.6 tons per hectare. Secondly, concerned organizations, especially district agricultural officials, should have strict rules for the management and control of chemical applications; they should identify and continuously check with distributors or chemical shops which type of chemicals should be permitted to be used in the area, keeping in mind that some chemicals are prohibited in neighboring countries. At the same time, they need to encourage farmers to practice the transplanting technique, or rice GAP, to help reduce chemical applications, as it would benefit producers, consumers, and biodiversity in the rice field. Thirdly, rice production groups must be organized in each village. Each group should adopt a practical and concrete model, not an abstract model, in terms of regulations, information dissemination, production techniques, credit guarantee, water use management, and other practices. This would enable farmers to receive similar information about rice production and employ the same rice production techniques based on group requirements and regulations. The outcome should ensure that the average rice yield among group members does not differ widely.

On the other hand, farmers who have income from several sources should also follow the group requirements, applying the same methods and changing from dry sowing to transplanting techniques, thus helping to increase rice yields and reducing herbicide use in the study area. Finally, the government or concerned organizations need to strictly manage and zone agricultural land in irrigated areas, designating areas for cultivating rice and other crops for food security. This will prevent paddy fields from being sold and converted to residential land or other agricultural activities that may cause food insecurity in the community and cause rice production to be insufficient for local consumption and export in the future. The improvement of these four dimensions would help achieve the government policy of shifting from traditional to commercial agriculture using modern technology to increase rice production volume and quality to ensure food security in Vientiane Capital.

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