



The Factors Affecting Orchard Fruit Farming in Hau Giang Province, Vietnam

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ABSTRACT

Background: Currently, the production and consumption of fruit products in Hau Giang Province face numerous challenges. These include low-lying soil and the use of disease-infected cultivars. Moreover, farmers in the region rarely utilize organic fertilizers or implement soil improvement techniques, resulting in a gradual decline in soil fertility. Additionally, orchard fruit farmers' investment and care practices are primarily based on traditional methods and customs rather than following recommended technical processes. As a result, this study aims to examine the factors that can impact the farming activities of orchard fruits in Hau Giang Province, Vietnam.

Methods: Using stratification and random sampling, the study was conducted in four districts and one city in Hau Giang from January 2020 to March 2022. The survey included 150 orchards, with five different fruit varieties represented in the four districts and the city. Each area had a sub-sample of 30 orchards, including Sanh orange, Xoan orange, sugar mandarin, green peel pomelo and Cat Hoa Loc mango. Data was collected through direct interviews with farmers using prepared questionnaires. The data was then analyzed using descriptive statistics, analysis of variance (ANOVA) and regression analysis.

Result: The management labor, farming experience, fruit yield and product selling price can predict statistically significant income. In the farmer's opinion, product consumption was an important issue that farmers considered. With the desire to find a stable market for orchard fruit products, farmers want to change their trees. One crucial issue that requires attention is the structuring of orchard fruit production with connections between farmers and enterprises to stabilize the income in fruit farming.

Key words: Eco-social, Hau giang, Income, Orchard fruits, Regression.

INTRODUCTION

Agribusiness, especially managing orchards, is challenging in today's modernized and globalized world. The demand for high-quality products is strong (Brewer *et al.*, 2020), making it crucial to capture the behavioral responses of farmers, the primary agribusiness industry agents. This understanding is essential for developing the orchard-based fruit industry (Rezaei *et al.*, 2020; Sottile *et al.*, 2020). For small-scale growers in underdeveloped nations, fruit production offers substantial marketing and revenue prospects (Dagar *et al.*, 2020; Damme, 2018; Jamnadass *et al.*, 2011; Kehlenbeck *et al.*, 2013). Fruit trees are essential for tackling climate change, reducing the danger of land degradation and providing household income (Elagib and Al-Saidi, 2020; Leakey, 2018).

In Hau Giang Province, there are approximately 134,000 hectares of agricultural land. Of this, 41,568 hectares are dedicated to orchard fruits, with citrus trees covering 14,431 hectares. Mangoes cover 3,520 hectares, longan covers 784 hectares, jackfruit covers 6,562 hectares, custard apples cover 762 hectares, pineapples cover 2,744 hectares and the remaining orchard fruits cover 12,765 hectares (Tam, 2020). The average yield for all orchard fruit varieties in Hau Giang is 13 tons per hectare, resulting in an annual output of over 358,000 tons (KV, 2019).

Currently, the production and consumption of fruit products in Hau Giang province face difficulties, such as using infected cultivars. The low-lying soil and the

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susceptibility of orchard fruits to flooding during the rainy season contribute to the appearance of dangerous diseases, such as root rot and greening in citrus trees. Farmers rarely used organic fertilizers or improved the soil, resulting in gradual soil degradation and decreased fertility. Fruit production was mainly driven by market demand for expensive fruit goods and was frequently done haphazardly on a small scale without adhering to local planning. Furthermore, farmers rely on their experience and customs rather than following recommended technical processes when investing in and caring for their orchard fruits. These factors can negatively impact the profitability

of orchard fruit farming. However, the influence of socio-economic factors on this issue has not been thoroughly explored. Therefore, this study aimed to identify the socio-economic factors that may affect the income of orchard fruit farmers to improve the economic efficiency of orchard fruit farming in Hau Giang Province.

MATERIALS AND METHODS

Study location and data collection

Hau Giang is a province located in the central region of the Mekong Delta. The province covers a total land area of 160,245 hectares and is divided into eight administrative units consisting of two cities, one town and five districts. The study was conducted from January 2020 to March 2022, utilizing stratification and random sampling methods. A sample size of 150 orchards representing five different fruit varieties was used in four districts and one city in Hau Giang. Each area had a sub-sample of 30 orchards (Hogg *et al.*, 2015). The specific fruit varieties included Sanh orange (*Citrus nobilis*) in Nga Bay city, Xoan orange (*Citrus sinensis*) in Phung Hiep district, sugar mandarin (*Citrus reticulata*) in Long My district, green peel pomelo (*Citrus maxima*) in Chau Thanh district and Cat Hoa Loc mango (*Mangifera indica*) in Chau Thanh A district. The data was collected through direct interviews with farmers using prepared questionnaires.

The farmer characteristics were collected, such as the gender of household head (HH), HH age, HH education, HH size and farming experience of the farmers. The farming factors were recorded, such as orchard area, tree age, nitrogen fertilizer application, management labor (labor of caring and managing the orchard), labor days (performing activities such as soil bed covering, fertilization, weeding, irrigation, pruning, flowering control, pest control, harvest) and fruit yield.

The selling price, revenue (derived by multiplying the selling price by the fruit yield), variable costs (such as fertilizer, agricultural chemicals, labor costs and gas) and orchard income (derived by deducting the variable costs from the revenue) were the economic factors that were gathered. The farmers' perspectives on orchard fruit farming were recorded, including the selling price, product consumption, production capital, extension support and locality concerns. All monetary values were recorded in Vietnamese currency (VND).

Data analysis

Descriptive statistics were employed for the data on frequencies and percentages and One-way analysis of variance (ANOVA) was utilized to identify any differences between fruit yields and economic efficiency. A multiple regression analysis was conducted to investigate the factors that influenced the income of orchard fruits. The regression model was expressed as follows:

$$\hat{Y} = f(X_i)$$

Where,

$\hat{Y}$: Income from orchard fruit products.

X_i ranged from X_1 to X_{12} , with 12 variables including the gender, age and education of the household head (in years), household size (number of members), orchard area (in hectares), tree age (in years), management labor (number of workers), farming experience (in years), labor days (days per hectare), nitrogen fertilizer (in kilograms per hectare), fruit yield (in tons per hectare) and selling price (in VND per kilogram), respectively.

The Chi-square and Cramer's V tests were utilized to assess the characteristics of farmers, farming factors, their attitudes towards orchard fruit farming and their willingness to switch to different varieties. A significance level of $p < 0.05$ was established. The data was analyzed using IBM SPSS 23 (Mallery and Paul, 2016).

RESULTS AND DISCUSSION

Farmer characteristics and farming factors of orchard fruits

All of the Chi-square tests in Table 1 were statistically significant. Men led the majority of households (HH) in fruit-growing areas. Male-headed households have the advantage of being able to communicate and learn farming techniques from other experienced farmers. The average age of HH was relatively high at 51.7 years old, possibly due to the long-term residence of these households in the area. Most HH had 6-9 years of schooling (47.3%), equivalent to a secondary school education. This level of education can be sufficient for farmers to absorb information related to their farming processes. According to the study results, the average number of family members per household was 3-4 persons (51.3%), consistent with the national census data. The farmers had 6-10 years of farming experience (43.3%), which was strongly correlated ($r = 0.46^{**}$) with the age of the trees (Table 2). It suggests that the longer a tree has been planted, the more farming experience the farmer has gained.

All of the Chi-square tests in Table 2 were statistically significant. Most orchard areas were between 0.2 and 0.5 hectares, accounting for 48.0%. It is significantly lower than the average land area per household in the entire country, which is 0.66 hectares and in the Mekong River Delta, which is 0.8 hectares (Chung and Ha, 2017). The small land size was dispersed among individual households, making it difficult for farmers to produce enough fruit for export requirements.

The average age of the trees in the orchard was between 4 and 10 years, accounting for 74% of the total (Table 2). It suggests that the orchard has not been in cultivation for a long time. It could be attributed to farmers changing their crop structure in response to fluctuations in market prices and consumer demand. Additionally, replanting of trees damaged by insects, diseases and

flooding in the lowlands of the Mekong Delta may have contributed to the relatively young age of the trees. There was a positive correlation between tree age and income ($r=0.2^*$), indicating that the more mature the orchard fruits are, the more profitable they will be. The average amount of nitrogen fertilizer applied to the orchard was 281 kg/ha, which was within the recommended range (Table 2), according to Ve and Phong (2011).

According to Table 2, an average of 4.7 persons per hectare was required for management labor. However, with an average household size of 4 (Table 1), it was evident that the household's labor may not be enough to manage 1 hectare of orchard, leading to the need for hired labor. Furthermore, the small amount of orchard land farmers own (Table 2) indicated that there had not been a significant accumulation of land for fruit farming in Hau Giang. In comparison to the labor required for rice cultivation (106 days per hectare for three rice crops) (Phuong and Xe, 2011), the labor day used for orchard fruit farming (54.8 days per hectare per year) (83.3%) was lower due to

the infrequent care needed for orchard fruits throughout the year.

The results of the statistical analysis showed that the yield of Sanh orange (17,555 tons/ha) and Sugar mandarin (14,324 tons/ha) were the highest among the five fruit varieties (Fig 1). This difference was found to be statistically significant ($P<0.05$) when compared to the yields of Cat Hoa Loc mango (8,803 tons/ha), Xoan orange (8,200 tons/ha) and green peel pomelo (7,390 tons/ha). The average fruit yield of the five varieties was 11.3 tons/ha, which differed from the Hau Giang province survey data (13 tons/ha) (KV, 2019). This difference could be attributed to the fact that this study only investigated five fruit varieties.

Economic efficiency of orchard fruit farming

The results of the ANOVA analysis indicated that there was a significant difference in the selling price (in VND) among different fruit varieties ($p<0.05$). Specifically, the selling price of Cat Hoa Loc mangoes (38,317 VND/kg) and green peel pomelo (36,000 VND/kg) was found to

Table 1: Characteristics of orchard fruit farmers in hau giang province.

Farmer characteristics	Farmers	Percentages	Chi-square	Sig.
Gender of HH			105.84	0.000
Female	12	8.0		
Male	138	92.0		
Age of HH (years)			50.20	0.000
20-30	3	2.0		
31-40	20	13.3		
41-50	42	28.0		
51-60	53	35.3		
<20 and >60	32	21.3		
Average		51.7±9.9*		
Education of HH (years)			21.64	0.000
1-5 (Primary school)	54	36.0		
6-9 (Secondary school)	71	47.3		
10-12 (High school)	25	16.7		
Average		7.0±2.8*		
Household size (number)			71.81	0.000
1-2	24	16.0		
3-4	77	51.3		
5-6	42	28.0		
>6	7	4.7		
Average		4.0±1.5*		
Farming experience (years)			54.13	0.000
0-5	28	18.7		
6-10	65	43.3		
11-15	23	15.3		
16-20	19	12.7		
>20	15	10.0		
Average		11.5±6.6*		

Source: Survey data processed in 2022.

*± Sd (Standard deviation).

be higher compared to Xoan orange (23,333VND/kg), sugar mandarin (17,950 VND/kg) and Sanh orange (11,283 VND/kg). It is worth noting that Hau Giang fruit products are

primarily consumed domestically and the selling price is a significant concern for farmers due to its instability. During the primary harvest season, the selling price

Table 2: Orchard fruit farming factors in hau giang province.

Farming factors	Farmers	Percentages	Chi-square	Sig.
Orchard area (ha)			121.07	0.000
0.2-0.5	72	48.0		
0.6-1.0	51	34.0		
1.1-1.5	15	10.0		
1.6-2.0	1	0.7		
<0.2 and >2.0	11	7.3		
Average		0.6±0.2*		
Tree age (years)			194.16	0.000
4-10	111	74.0		
11-15	18	12.0		
16-20	6	4.0		
>20	15	10.0		
Average		8.7±4.0*		
Nitrogen fertilizer (kg/ha)			52.40	0.000
0-100	1	7.0		
101-200	52	34.7		
201-300	39	26.0		
>300	58	38.7		
Average		281.0±64.0*		
Management labor (number)			160.13	0.000
0-2	11	7.3		
3-5	102	68.0		
6-10	33	22.0		
>10	4	2.7		
Average		4.7±2.1*		
Labor day (days/ha)			169.96	0.000
10-30	7	4.7		
31-50	18	12.0		
>50	125	83.3		
Average		54.8±16.4*		

Source: Survey data processed in 2022.

*± Sd (Standard deviation).

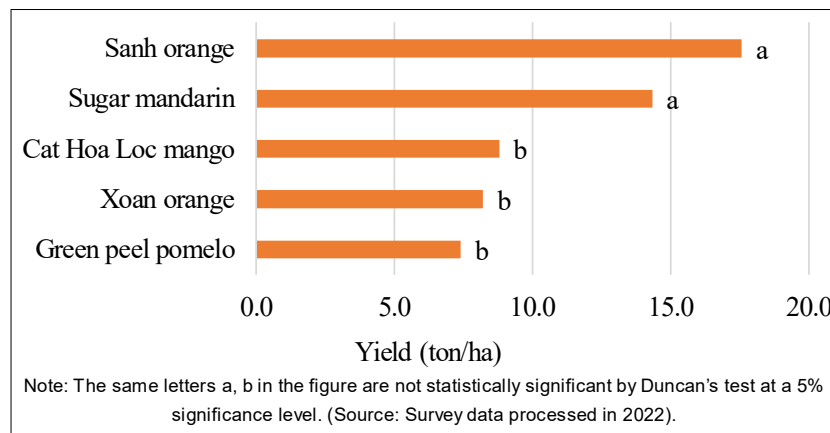


Fig 1: Fruit yield of five fruit tree varieties.

decreases when products are abundant. Farmers may try controlling flowering to produce off-season fruits to obtain higher prices. This highlights the need for the involvement of enterprises in fruit storage, processing and export to minimize fluctuations in product sales.

The results of the ANOVA in Fig 2 showed statistically significant differences in revenue, variable cost and income among different fruit varieties ($p < 0.05$). The variable cost for Sanh oranges was significantly higher (96.5 million VND/ha) than other fruit varieties, while Xoan oranges had a relatively low variable cost (57.3 million VND/ha). The average revenue for green peel pomelos (253.8 million VND/ha), sugar mandarins (258.5 million VND/ha) and Cat Hoa Loc mangoes (335.7 million VND/ha) were significantly different ($p < 0.05$) from Xoan (185 million VND/ha) and Sanh (205.1 million VND/ha) oranges. These results suggested a strong positive correlation between fruit yield ($r = 0.655^{**}$, $p = 0.01$) and product selling price ($r = 0.229^{**}$, $p = 0.01$) with revenue, indicating that higher fruit yield and selling price can positively impact revenue. Due to its high selling price, revenue and relatively low variable cost, Cat Hoa Loc mango had the highest income value (269 million VND/ha), significantly different from other varieties. Citrus trees are commonly grown in Hau Giang province (Tam, 2020). Still, there is a problem of product stagnation during the primary harvest season, making it difficult to sell in the market and resulting in lower revenue. Additionally, root rot disease often affects citrus trees (Jaouad *et al.*, 2020), leading to increased costs for disease treatment and care, especially during the flooding season. Overall, the income from the five fruit varieties was relatively high compared to rice farming (40 million VND/ha) (Phuc and Phong, 2022). Hau Giang Province has no coordination between farmers and other

sectors in the production-consumption chain. It has led to low production of fruit products that meet quality standards, making it difficult for them to be exported and significantly impacting the profits of local farmers.

Regression analysis

The regression model for revenue, which was predicted by several farming parameters and farmer characteristics, is shown in Table 3. With an R^2 value of 0.768, the results showed that the independent variables can account for 76.8% of the variation in income, which was statistically significant ($p < 0.001$). An excellent match for the model was indicated by the F count 37.9, which was also significant at $p < 0.05$. The t-test revealed that the regression coefficients for four indicators-management labor, farming experience, fruit yield and selling price-are significantly different from zero, confirming the validity of the regression model. All tolerance and Variance Inflation Factors (VIF) values, which measure the collinearity, are less than 1 and 10, respectively, indicating no collinearity between the independent variables (Mallery and Paul, 2016). Therefore, the regression equation can be established as follows:

$$\hat{Y} = -158.049 - 16.612X_1 + 2.546X_2 + 17.307X_3 + 0.010X_4$$

Where,

$\hat{Y}$: Income.

X_1 : Management labor.

X_2 : Farming experience.

X_3 : Fruit yield.

X_4 : Selling price.

Management labor had a significant negative impact on income, with a p-value of less than 0.001. The regression coefficient of -16.612 indicates that increasing the labor involved in managing the orchard (*i.e.*, labor cost) can lead to decreased income. On the other hand, farming

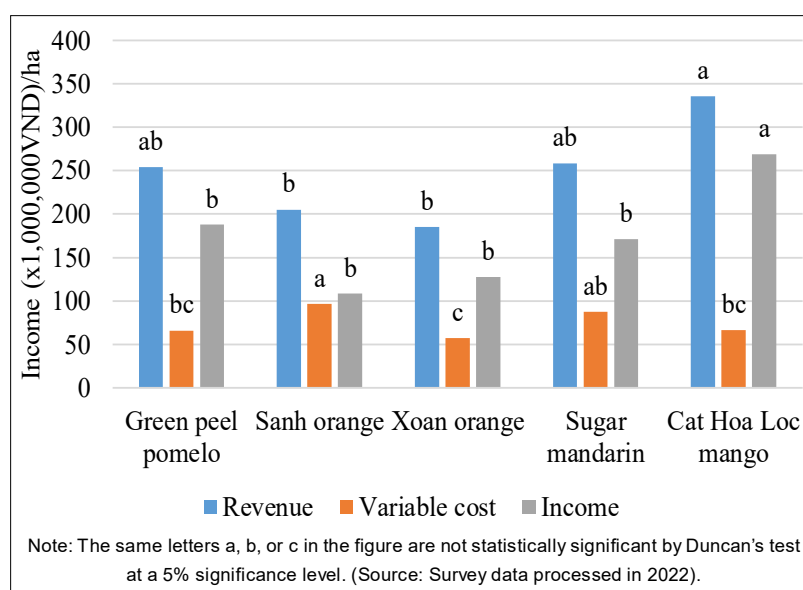


Fig 2: Economic efficiency of five fruit tree varieties.

experience positively influences income, with a significance level of $p < 0.05$ and a regression coefficient of 2.546. It suggests that the more experience a farmer has, the higher their income potential. This is likely because long farming experience allows farmers to accumulate knowledge, make informed decisions and mitigate risks in farming.

The farming experience was a significant factor in the soybean farming model and the cultivation of other crops in Nigeria (Mustapha *et al.*, 2012; Osuji *et al.*, 2013). The study also showed that fruit yield significantly impacts income, with a significant level of $p < 0.001$ and a positive regression coefficient of 17.307, indicating that higher fruit

Table 3: Regression coefficient values of farmer characteristics and farming factors on the income of orchard fruit farming.

Indicator	Regression coefficients	Standardized coefficients	t value	Sig.	Tolerance	VIF
(Constant)	-158.049		-2.585	0.011*		
Age of HH (year)	-0.139	-0.009	-0.199	0.843	0.844	1.185
Gender	-35.918	-0.063	-1.493	0.138	0.952	1.050
Family size (number)	3.892	0.036	0.818	0.415	0.858	1.166
Education of HH (years)	-1.114	-0.020	-0.438	0.662	0.827	1.209
Orchard area (ha)	-15.976	-0.062	-1.444	0.151	0.918	1.089
Tree age (years)	-0.537	-0.021	-0.407	0.685	0.649	1.542
Nitrogen fertilizer (kg/ha)	-0.014	-0.011	-0.252	0.801	0.840	1.191
Management labor (number)	-16.612	-0.222	-4.618	0.000**	0.729	1.372
Farming experience (years)	2.546	0.108	2.231	0.027*	0.723	1.383
Labor day (days/ha)	-0.316	-0.033	-0.776	0.439	0.915	1.092
Fruit yield (tons/ha)	17.307	0.899	18.179	0.000**	0.691	1.448
Selling price (VND/kg)	0.010	0.782	13.852	0.000**	0.531	1.883
R ²						0.768
F count						37.9
Sig.						0.000

Source: Survey data processed in 2022.

Note: *Significance at level = 0.05; **Significance at level = 0.001.

Table 4: Evaluation of farmers in orchard fruit farming.

Indicator	Frequency	Percentage	Chi-square	Sig.
Selling price			39.64	0.000
Bad	24	16.0		
Average	85	56.7		
Good	41	27.3		
Product consumption			99.84	0.000
No stable	106	70.7		
Stable	34	22.7		
Very stable	10	6.7		
Production capital			103.08	0.000
Bad	7	4.7		
Average	37	24.7		
Good	106	70.7		
Extension support			6.04	0.049
Bad	36	24.0		
Average	59	39.3		
Good	55	36.7		
Locality' concern			6.76	0.034
Bad	35	23.3		
Average	57	38.0		
Good	58	38.7		

Source: Survey data processed in 2022.

yield could lead to increased income. Additionally, the selling price was found to have a significant effect on income, with a significance level of $p < 0.001$ and a positive regression coefficient of 0.010, indicating that a higher selling price could result in more significant income. The standardized coefficients, which indicated the relative influence of each factor, showed that fruit yield had the most significant impact on income (0.899), followed by selling price (0.782), farming experience (0.108) and management labor (-0.222). Overall, it can be stated that to achieve a high income from orchard fruit farming and one must focus on increasing farming experience and fruit yield, obtaining a reasonable price for products in the consumer market and reducing management labor.

Farmer evaluation and desire to change fruit tree varieties

The findings of the Chi-square test indicated that there was a statistically significant correlation between the views of farmers about local government issues, production capital, product consumption and selling prices (Table 4). The findings revealed that the average selling price of the product (56.7%) and the unstable consumption of products (70.7%) indicated that the domestic fruit consumption market had not supported orchard fruit farming. It highlights the need for enterprises and relevant state management agencies to focus on exporting fruits. On the other hand, fruit farmers have earned higher incomes than those who grow rice and other upland crops, allowing them to accumulate good capital (70.7%) for investing in fruit farming. Additionally, farmers highly

Table 5: The desire of farmers to change new orchard fruit varieties.

Planting variety	Expect to change (%)				
	Green peel pomelo	Durian	Jack fruit	Sugar mandarin	Cat Hoa Loc mango
Green peel pomelo	66.7	33.3	0.0	0.0	0.0
Sanh orange	6.7	73.3	0.0	0.0	20.0
Xoan orange	0.0	46.7	20.0	0.0	33.3
Sugar mandarin	0.0	30.0	0.0	60.0	10.0
Cat Hoa Loc mango	0.0	13.3	0.0	0.0	86.7
χ^2					227.81
df					16
Sig.					0.000

Source: Survey data processed in 2022.

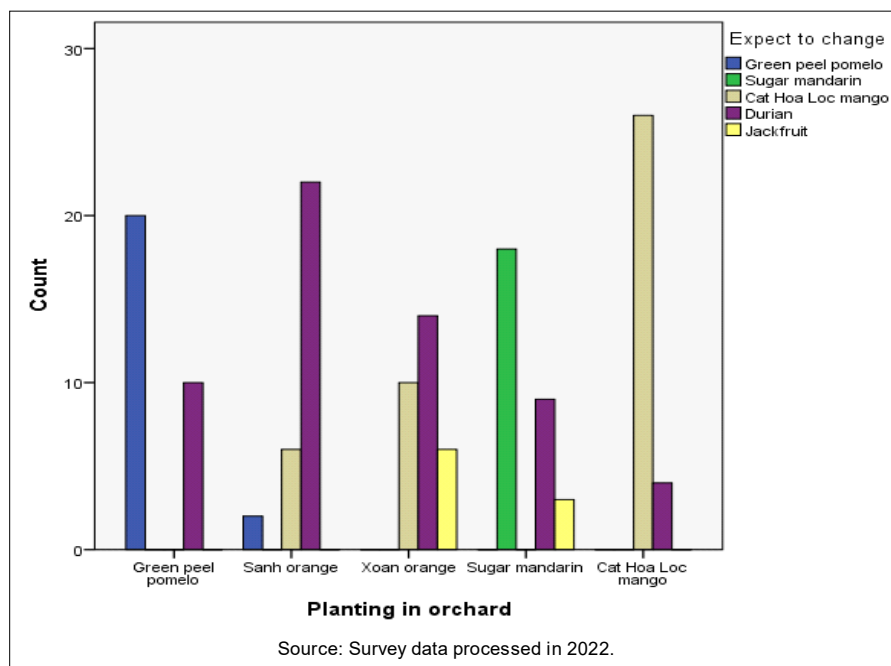


Fig 3: Frequencies of expectation of changing fruit tree varieties.

appreciated the support provided by agricultural extensions, such as training on variety selection, cultivation techniques and pest control (36.7-39.3%). This support has enabled them to take a more proactive approach to managing their orchards. In Hau Giang province, many farmers have converted their rice fields into orchards for higher income. As a result, local authorities (38.0-38.7%) had taken an interest in utilizing these lands owned by farmers.

The results of the Chi-square test (Table 5) indicated that there was a statistically significant desire among farmers to change their orchard fruit varieties ($\chi^2 = 227.81$, $df = 16$, $p < 0.001$). The Cramer's V value of 0.616 ($p < 0.001$) suggested this desire was quite strong, with 61.6% of farmers wanting to change. The information in Table 5 and Fig 3, which demonstrated that farmers tried to replace their durian orchards with other kinds, further supports it. Market demand and consumption requirements often influence the decision to plant certain orchard fruit varieties. For example, China imports a significant amount of durian from Southeast Asian countries (Hogg *et al.*, 2015), making it a potential partner for exporting durian from countries like Vietnam. As a result, many farmers choose to grow durian trees to increase their income. The unstable domestic fruit market (Table 4) is also a factor driving farmers to seek more stable consumption markets for their orchard fruits.

CONCLUSION

The ANOVA model revealed a significant difference in yield, product selling price and economic efficiency among five varieties of orchard fruits in Hau Giang Province. Additionally, the regression model demonstrated that factors such as management labor, farming experience, fruit yield and product selling price directly impact increasing income in fruit farming. It is worth noting that product consumption is a crucial consideration for farmers. To achieve a higher income, farmers are interested in transitioning their orchard fruits, particularly durian, to focus on exporting. However, there are several key issues that must be addressed to support fruit consumption and ultimately increase the farmers' income. Establishing fruit production areas through farmer-business cooperation with a stable consumption market is essential. Furthermore, investing in research and technology transfer for orchard fruit farming is essential to ensure high yields and quality. Local authorities, scientists and institutes/universities should also provide training for farmers on good agricultural practice (GAP), utilizing biological methods, ecological technology and eco-friendly probiotics to produce safe and high-quality fruit products for export.

Declaration ethical approval

Authors declare this manuscript does not include any studies using animal and human beings.

Consent to publication

All authors read and approved the final manuscript.

Conflict of interest

The authors declare no conflict of interest.

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