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Households' livelihood diversification and its influencing factors in the Vietnam's smallholder mixed farming systems

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ABSTRACT
This study aims to measure the extent of household livelihood diversification, identify its effect on household income, and determine key factors that influence households' livelihood diversification. A total of 426 smallholders were randomly selected for a survey in Hue City, Vietnam, conducted from December 2024 to April 2025. The Simpson Index of Diversity (SID) was used to quantify the extent of livelihood diversification, and a Tobit regression model was applied to determine the determinants of households' livelihood diversification. The findings revealed a moderate level of livelihood diversification (mean SID=0.303), with smallholders engaging in a combination of on-farm, off-farm, and non-farm livelihood strategies. Livelihood diversification was found to have a positive impact on household income. Six factors including age, education level, number of family laborers, number of skilled laborers, participation in credit schemes, and technology adoption were positively and significantly associated with livelihood diversification levels. These results underscore the importance of promoting diversified livelihoods to enhance income and resilience among small-scale households. The study suggests that rural development policies should prioritize human capital development, strengthen access to appropriate technologies, and expand credit opportunities to foster inclusive and sustainable livelihood diversification of smallholders in developing countries.

Contribution/Originality: This study contributes to existing literature by providing a more systemic view of the determinants of livelihood diversification by smallholders and highlighting areas that need to be considered when designing policies to support smallholders in diversifying their livelihoods in developing countries.

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1. INTRODUCTION

Smallholder farmers play an important role in agricultural production in developing and emerging countries; they account for about 80% of the global farm population and produce more than 30% of the world's food (FAO, 2021). They contribute significantly to global food security, nutrition, and sustainable development (Fan & Rue, 2020; Nwanze & Fan, 2016). However, smallholders face multiple challenges that constrain their profitability and overall success, including limited access to resources, agricultural market volatility, and the negative impacts of climate variability and change. Diversifying livelihood activities is widely recognized as an important pathway to improve household well-being and ensure food security in developing nations (Brugère, Holvoet, & Allison, 2008; Hengsdijk et al., 2007; Israr, Khan, Jan, & Ahmad, 2014). Livelihood diversification generally involves engaging in a range of income-generating activities beyond traditional farming, such as wage employment, small-scale businesses, and the use of forest or aquatic resources. Empirical evidence shows that livelihood diversification positively influences household income, economic resilience, poverty reduction, and overall welfare (Abebe, Chalchisa, & Eneyew, 2021; Adepoju Abimbola & Obayelu Oluwakemi, 2013; Alobo Loison, 2016; Habib, Ariyawardana, & Aziz, 2023; Oyinbo & Olaleye, 2016; Peng et al., 2022; Samuel & Joe, 2025). In the context of climate change, urbanization, and increasing pressures on natural resources, livelihood diversification is increasingly seen as a key mechanism for strengthening the sustainability and adaptive capacity of rural households (Beltrán-Tolosa, Cruz-Garcia, Ocampo, Pradhan, & Quintero, 2022; Chuong, Ngoc, Dat, & Yen, 2021; Habib et al., 2023; Khan et al., 2024). Several studies have examined livelihood diversification in developing countries, including Vietnam. However, most focus on specific household types, such as cassava-growing households (Nguyen Hac et al., 2024) households migrating to the Central Highlands (Hương, Lan, Ngọc, & Đình, 2023) or ethnic minority group as the Dao (Nguyen et al., 2020). Some studies used census data from general households to assess livelihood diversity (Chuong et al., 2021; Diep & Vien, 2017; Nga, Trang, Mai, & Hường, 2022; Trang, 2023). Yet, there remains limited research on livelihood diversification in the context of mixed farming systems. To date, no formal study has measured the extent of livelihood diversification, assessed its impact on household income, and identified its determinants within Vietnam's smallholder mixed farming systems.

Vietnam is an agriculture-based developing nation, with more than 61% of its population living in rural areas. Most rural households operate on small landholdings, often less than 0.5 hectares, and rely heavily on agriculture as their main livelihood source (GSO, 2024). Smallholders play a vital role in Vietnam's agricultural transformation and export performance, but they face major challenges related to mechanization, sustainability, limited land for production, capital access, and climate vulnerability (Dao & Pham, 2022; Marks, 2018). Strengthening the resilience and commercial viability of smallholders, especially women and youth, is critical for advancing national development and climate change goals (Nwanze & Fan, 2016). Structural constraints, such as limited land, insufficient capital, and restricted access to markets and technologies, continue to hinder livelihood diversification and income security, leaving smallholders particularly susceptible to shocks and external risks. To design effective policies and interventions that support sustainable livelihoods for smallholders and rural communities, it is essential to better understand the factors influencing livelihood diversification strategies. Therefore, the main objectives of this study are: (1) to measure the extent of livelihood diversification and its impact on household income; and (2) to identify the key determinants of livelihood diversification among smallholder households engaged in mixed farming systems in Vietnam.

Previous discussions have highlighted that livelihood diversification among smallholder farmers is influenced by a range of demographic, socio-economic, situational, and institutional factors. Existing literature suggests that the extent of diversification varies across producers (Abebe et al., 2021; Adepoju Abimbola & Obayelu Oluwakemi, 2013; Alobo Loison, 2016; Gwandi, Adewuyi, & Dia, 2024; Habib et al., 2023; Oyinbo & Olaleye, 2016; Peng et al., 2022; Samuel & Joe, 2025). As illustrated in Figure 1, the relationship between the dependent variable livelihood diversification and various independent variables is depicted using directional arrows, indicating the influence of the latter on the former. Demographic characteristics such as age, gender, and education are considered key determinants. Similarly, socio-economic characteristics like farm size, labor, and situational factors (e.g., credit, technology) are presumed to impact livelihood diversification. In addition, institutional aspects, including market opportunities and policy support, are also expected to play a significant role.

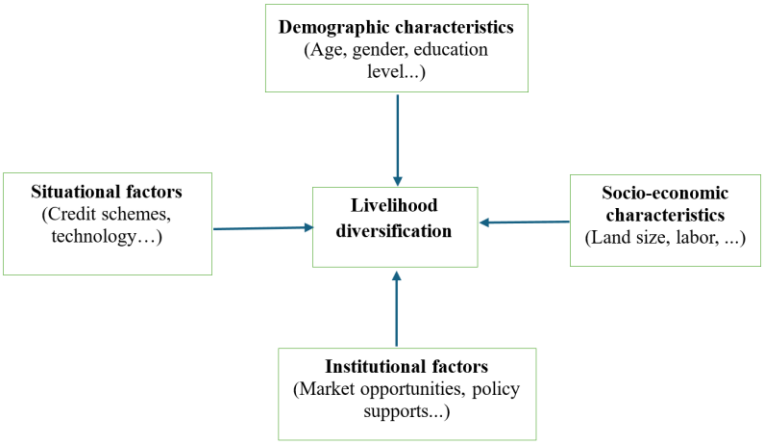

Figure 1. Conceptual framework of this study.

2. METHODOLOGY

2.1. A Brief Description of the Study Region

This study was conducted in Thua Thien Hue province (officially restructured as Hue city from July 1, 2025), focusing on three rural areas (upland, plain, and coastal areas) within the province, which is located in Central Vietnam (Figure 1). The province comprises 4,947.11 km² and its total population was 1,166,500 people in 2024, of whom about 70% reside in rural areas and rely primarily on agriculture and farming-related activities for their livelihoods (Thua Thien Hue Statistical Office, 2025). Rural household livelihoods in the province are traditionally based on small-scale crop cultivation, animal husbandry, and forest resource use. In recent years, the province has promoted livelihood diversification as a key strategy to improve rural incomes and enhance climate resilience, with a focus on integrated farming, community-based tourism, medicinal plant cultivation, and forest-based livelihoods. These efforts align with broader national policies aiming to foster sustainable rural development and reduce poverty in mountainous and ethnic minority areas. Figure 2 illustrates the study location

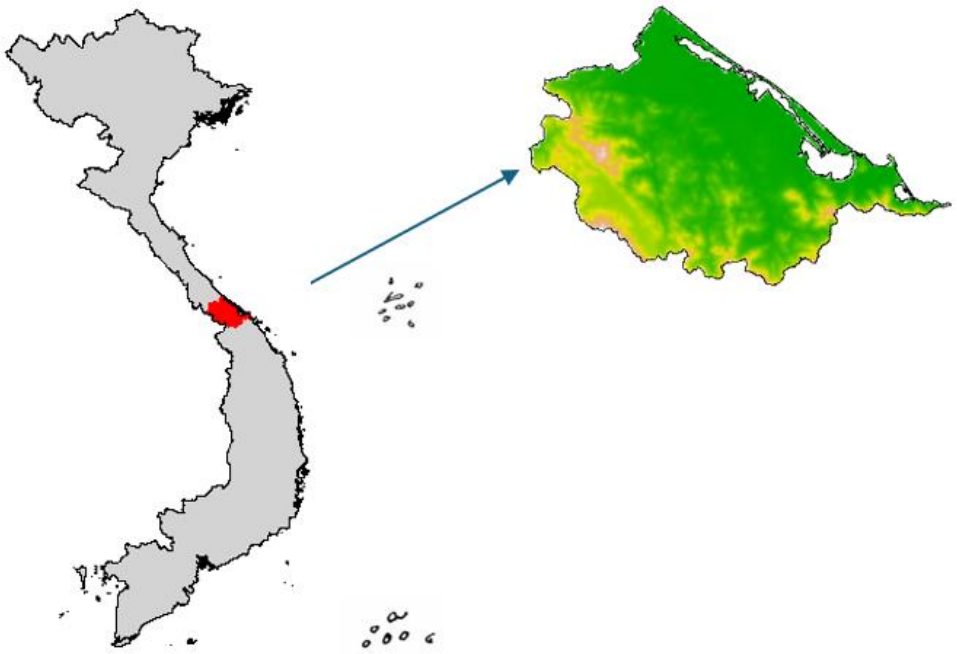

Figure 2. The study location.

2.2. Sampling Strategy

A random sampling strategy is planned to select participants for this cross-sectional survey. The survey sample size was determined using Yamane's formula (Yamane, 1967).

$$n = N / (1 + N \times e^2) \quad (1)$$

Where n is the sample size.

N is the total population (4,706 smallholder households).

e is the level of precision (5%).

With a 5% margin of error, the required sample size was 369 smallholder households. To ensure representativeness and compensate for possible non-response, the final sample size was increased to 426 households.

2.3. Data Collection and Data Analysis

A semi-structured questionnaire was developed to collect data. The questionnaire was administered through face-to-face interviews at the respondents' houses during their leisure time, and the survey was conducted from December 2024 to April 2025.

Households' livelihood diversification is measured by the Simpson Index of Diversity (SID) (Simpson, 1949), which is a popular index to measure the level of livelihood diversity of farm households (Alemu, 2023; Challa, Mamo, Tibeso, & Dawud, 2019; Dympep, Singh, Singh, & Chiphang, 2018; Iraoya & Isinika, 2020; Musyoka & Onjala, 2023). SID index is expressed according to the following formula.

$$SID = 1 - \sum_{i=1}^{n} (Pi)^2 \quad (2)$$

Where:

Pi: Ratio of income generated by livelihood number i compared to total income from all livelihood activities of rural smallholders.

n: Total livelihood sources of rural smallholders include on-farm activities, forestation and non-timber forest product exploitation, off-farm activities, non-farm activities, and other activities.

The SID index of households has a maximum value of 1. The SID index value depends on the number of income sources and the household's income structure. The more sources of income a household has, the greater its potential SID value. However, the greater the difference in proportion between income sources of household livelihoods, the smaller the SID index value will be. For households dependent on only one source of income, the SID has a value of 0. According to Sarker, Wu, Alam, and Shouse (2020), the level of household livelihood diversity is divided into five levels, from no livelihood diversity to very high livelihood diversification, as below.

SID ≤ 0.01 = No livelihood diversity.
SID= (0.01 ≤ 0.25): Low livelihood diversity.
SID= (0.26 ≤ 0.50): Medium livelihood diversity.
SID= (0.51 ≤ 0.75): High livelihood diversity.
SID= (0.76 ≤ 1): Very high livelihood diversity.

Data was processed and analyzed using Stata version 17. Several statistical parameters, such as mean, percentage, and One-Way ANOVA, were used to describe research results. To examine the determinants of households' livelihood diversification, this study applied the Tobit regression model (Greene, 2012; Tobin, 1958; Wooldridge, 2010), which is appropriate when the dependent variable is censored or limited within a specific range. In this case, the SID index, which measures the extent of livelihood diversification, ranges from 0 to 1. Smallholder households with a SID value of 0 engage in only one type of livelihood activity, while those approaching 1 are highly diversified.

The Tobit regression model used in this study is specified as follows:

$$SIDi^* = \beta_0 + \sum_{j=1}^{n} \beta jXij + \varepsilon i \quad (3)$$

Where:

SIDi* is a latent (unobserved) variable representing the potential level of livelihood diversification for household *i*. This value is censored between 0 and 1, with values close to 0 indicating low diversification and values close to 1 indicating high diversification.

β_0 is Intercept term.

X_j Coefficients associated with explanatory variables.

βj are slopes of the equation in the model.

ε_i is random error term.

The explanatory variables were carefully chosen from the mainstream literature (Bayata & Nega, 2020; Glory & Nsikak-Abasi, 2018; Hassan, Khan, & Mehmood, 2024; Hương et al., 2023; Kalinga, Kangalawe, & Lyimo, 2019; Khan et al., 2024; Musumba, Palm, Komarek, Mutuo, & Kaya, 2022; Tefera, Gecho, & Wallole, 2021; Tyenjana & Taruvinga, 2019; Yussuf & Mohamed, 2022) and derived from the key profiles of households in the research area. Explanatory variables are described in Table 1.

Table 1. Description of hypothesized variables affecting SID.

Variable name	Description	Variable type	Measurement
X1	Smallholders' gender	Dummy	1 = Male; 0 = Female
X2	Smallholders' age	Continuous	Years
X3	Smallholders' education levels	Continuous	Years
X4	Number of family laborers	Continuous	Numeric
X5	Number of skilled family laborers	Continuous	Numeric
X6	Farmland size	Continuous	Hectare
X7	Distance from home to the capital of the city	Continuous	Kilometers
X8	Smallholders' participation in credit schemes	Dummy	1 = Yes; 0 = No
X9	Smallholders' communications with extension officers	Dummy	1 = Yes; 0 = No
X10	Internet access and usage	Dummy	1 = Yes; 0 = No
X11	Smallholders' participation in CBOs	Dummy	1 = Yes; 0 = No
X12	Access to support policies from government	Dummy	1 = Yes; 0 = No
X13	Having market linkage with value chain actors	Dummy	1 = Yes; 0 = No
X14	Having access to input services for farming	Dummy	1 = Yes; 0 = No
X15	Having knowledge/information about climate change	Dummy	1 = Yes; 0 = No
X16	Adoption of new technologies	Dummy	1 = Yes; 0 = No

3. RESULTS AND DISCUSSION

3.1. Socio-Economic Characteristics of Smallholders in the Study Area

Our analysis shows that participants in this study were mainly middle-aged. The age distribution of the participants is shown in Figure 3. Respondents were classified into five age groups (20–30, 31–40, 41–50, 51–60, and >61 years). The 41–50 age group had the highest proportion (31.5%), followed by the 51–60 years age group (27.5%), while the 20–30 age group had the lowest proportion (6.5%). Men account for 68.3%, reflecting the dominant role of men in agricultural production. The educational level of participants was generally low. The distribution of education levels among participants is shown in Figure 4. Education levels were classified into four groups: no formal education, primary, secondary, and high school. Most respondents had completed secondary school (37.3%), followed by high school (24.9%), while 16.2% had no formal education (never attended formal schooling). Each household had an average of 0.6 skilled or trained laborers, indicating limited technical human resources. The average cultivated land size was

0.4 ha, reflecting a common small-scale agricultural production model. Regarding access to resources and information, about 54% of households had contact with agricultural extension services, approximately 68% had access to credit schemes, while 94.6% used the internet and 89.7% received information about climate change. Notably, 75.4% of households applied new technology in production, indicating a positive trend in adaptive production. However, access to government support (24.1%) and participation in community organizations (27%) remained limited. Additionally, only 47.7% of households had access to favorable production inputs, and 48.4% had links with other value chain actors.

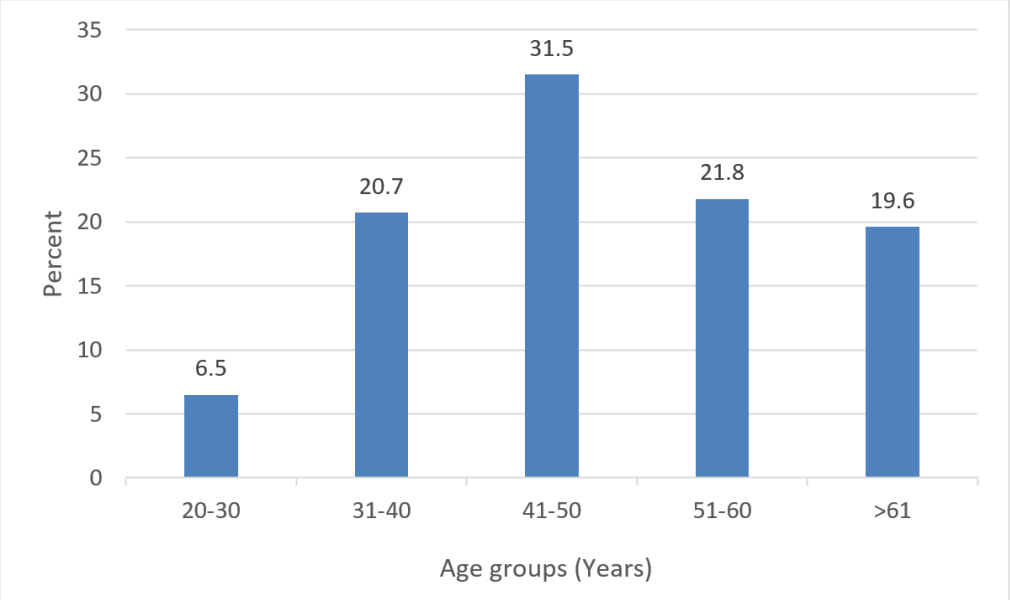

Figure 3. Age distribution of participants in the study area (N=426).

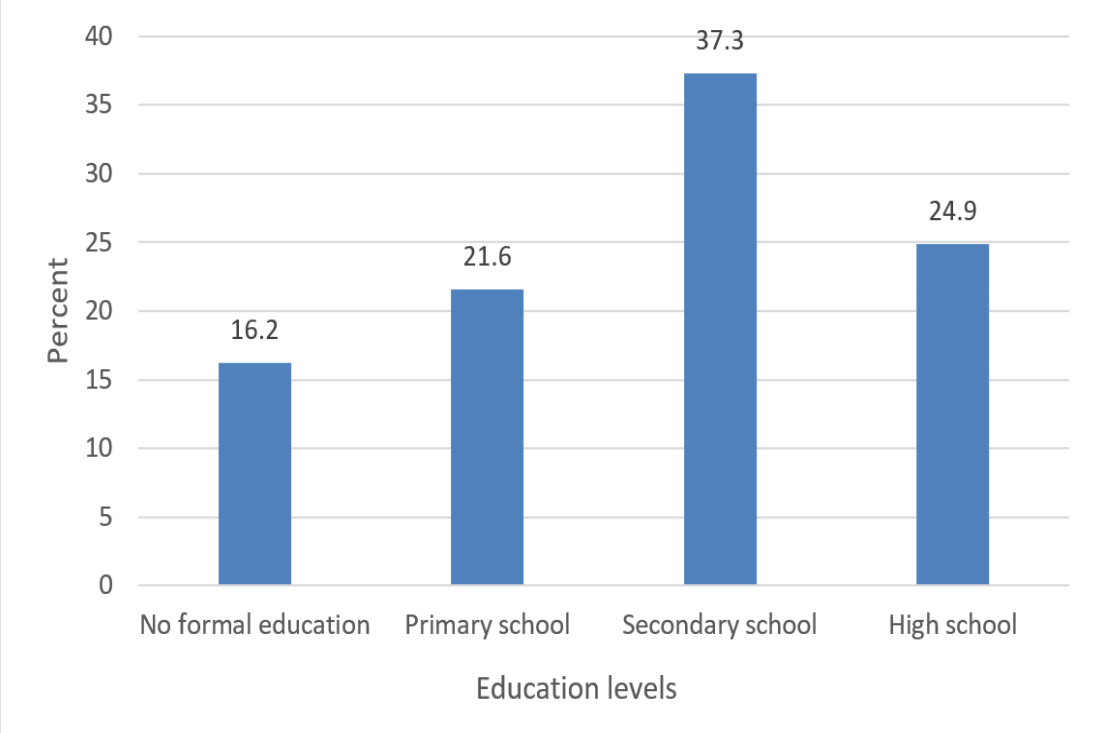

Figure 4. Distribution of participants' education levels in the study area (N=426).

3.2. The Livelihood Activities of Smallholders

The results in Table 2 indicated a wide range of livelihood activities among households in the study area, categorized into on-farm, off-farm, and non-farm activities. On-farm livelihood activities dominated the livelihood portfolio, with food crop production being the most prevalent (69.2%), followed by livestock production (41.5%), plantation forestry (27.5%), and fruit crop production (30.3%). Although vegetable production, industrial crops, and

aquaculture were present, their participation rates remained relatively low, highlighting the limited diversification within this category.

Off-farm livelihood activities were less common but still contributed significantly, with agricultural wage labor (21.1%) and fishing (16.0%) being the most practiced. Activities such as forest protection management and collection of non-timber forest products accounted for a small proportion, indicating underutilization of forest-related opportunities.

Non-farm livelihood activities showed notable engagement, particularly in factory or industrial labor (36.4%) and non-agricultural wage labor such as construction and domestic work (23.0%). Small trading and retail services also played a significant role (19.7%), reflecting the increasing integration of rural households into market-oriented and service-based economies. Remittances and government support (10.6%) served as a safety net for some households, underscoring the role of external income in rural livelihoods.

The results of this research suggest that while on-farm activities remain central to rural livelihoods, non-farm income sources are becoming increasingly important, especially amid declining land productivity and climate uncertainties. Although there are several studies (Abebe et al., 2021; Adepoju Abimbola & Obayelu Oluwakemi, 2013; Alobo Loison, 2016; Gwandi, Adewuyi, & Dia, 2024; Habib et al., 2023; Oyinbo & Olaleye, 2016; Peng et al., 2022; Samuel & Joe, 2025), findings from this study have not been reported in any prior research. This research shows that there is limited engagement in forest-based and aquaculture activities, which may reflect barriers such as access to resources, knowledge, or market connections. Therefore, policies aiming to support livelihood diversification should focus not only on enhancing productivity within traditional agriculture but also on enabling access to non-farm employment opportunities and sustainable natural resource use.

Table 2. Distribution of Smallholder Households' Livelihood Activities (N=426)

Categorisation	Name of livelihood activities	Percent (%)
On-farm	Food crop production	69.2
	Fruit crop production	30.3
	Vegetable production	13.6
	Industrial crops production	11.3
	Plantation forestry	27.5
	Livestock production	41.5
	Poultry production	30.5
	Aquaculture production	9.9
	Others (medicinal plants, beekeeping)	1.0
Off-farm	Agricultural wage labor	21.1
	Collection of non-timber forest products	1.9
	Forest protection management	9.6
	Fishing	16.0
	Primary processing of agricultural products	1.2
Non-farm	Non-agricultural wage labor (e.g., construction, transport services, domestic work)	23.0
	Small trading, food vending, and retail services	19.7
	Factory or industrial labor	36.4
	Others (remittances from family members or government support)	10.6

Figure 5 illustrates the distribution of livelihood strategies among households in the study area indicates diverse approaches to income generation. The majority of smallholders (46.5%) adopted a mixed strategy combining both on-farm and non-farm activities. Additionally, 19.5% engaged in all three types on-farm, off-farm, and non-farm highlighting a significant trend toward livelihood diversification. A smaller proportion of households relied exclusively on a single source: 7.0% on on-farm activities, 10.1% off-farm, and 3.3% on non-farm. The relatively low share of households depending solely on agriculture reflects the declining role of pure farming in the local livelihood structure. The results of some previous studies (Bayata & Nega, 2020; Khai, Kinghan, Newman, & Talbot, 2013; Pimhidzai et al., 2020; Tefera et al., 2021) suggested that livelihood strategies that combine multiple income sources are becoming increasingly important in rural areas, which is corroborated by the results of this study. However, the transition to off-farm and non-farm livelihoods remains constrained by limited access to vocational skills, finance, and market information. Therefore, policies aiming to support sustainable livelihood development should prioritize skills training, technology transfer, and improved access to markets, especially in remote and resource-poor communities.

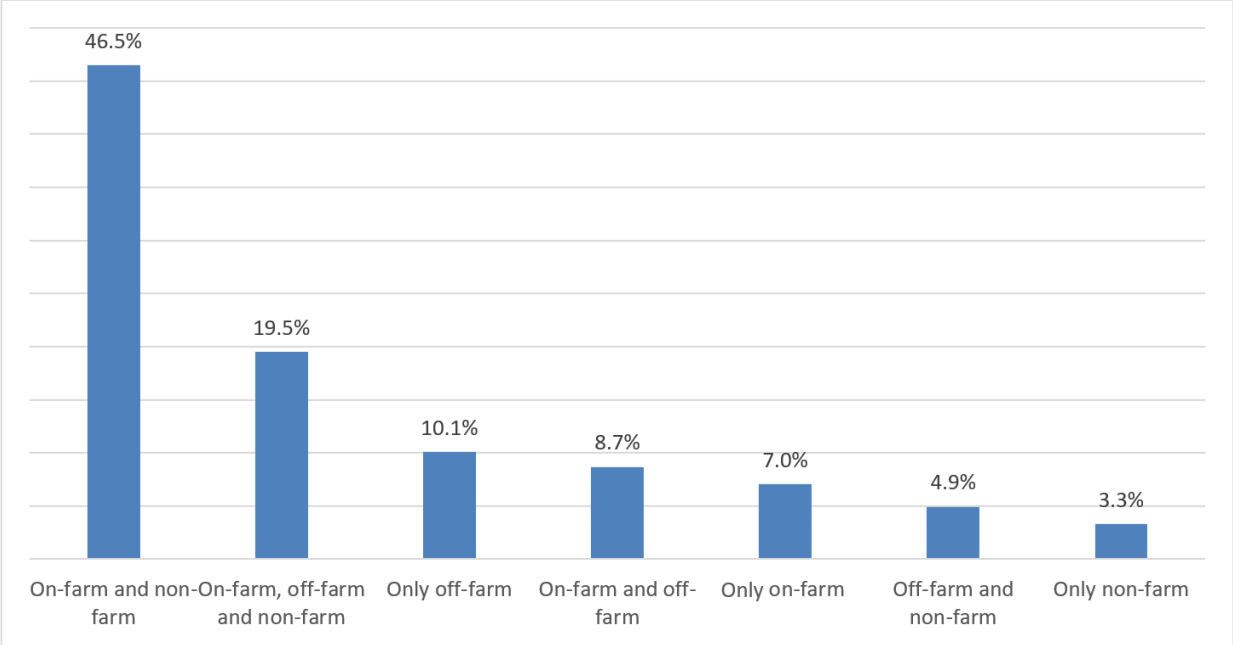

Figure 5. Distribution of rural households following type livelihood strategies (N=426).

3.3. The Extent of Livelihood Diversification Among Smallholders

The extent of livelihood diversification among smallholders in the study region was assessed using the SID index. The SID value for each household depends on both the number of livelihood activities and the relative contribution of each activity to total household income. A higher number of livelihood activities generally results in a higher SID value; however, if there is a large disparity in income shares among those activities, the SID value will be lower. As shown in Table 3, the average SID among rural smallholders in the study area was 0.303, indicating a relatively low level of livelihood diversification. This low SID value reflects significant fluctuations in income derived from different livelihood sources. Although a high proportion of households (79.6%) engaged in mixed livelihood strategies, the uneven distribution of income among these activities resulted in a lower overall diversification index.

Table 3. Level of SID of rural smallholders (N=426).

Level of livelihood diversification	Frequency (N=426)	Percent (%)	SID mean
No livelihood diversification (SID <0.01)	106	24.8	0
Low level of livelihood diversification (SID=0.01 ≤ 0.25)	45	10.6	0.158
Medium level of livelihood diversification (SID= 0.25 ≤ 0.51)	245	57.5	0.424
High level of livelihood diversity (SID = 0.51 ≤ 0.75)	30	7.0	0.598
Very high level of livelihood diversity (SID = 0.76 ≤ 1)	0	0	-
Total respondents	**426**	**100**	**0.303**

The results indicated that the rate of households with undiversified livelihoods (24.8%) and households with low levels of diversification (10.6%) shows that a significant number of rural households have not yet implemented or do not have enough capacity to implement diversified livelihood strategies, making them vulnerable to fluctuations in markets, weather, diseases, etc.

The findings indicated that about 57.5% of smallholder households had a moderate level of livelihood diversification, indicating that the potential for household livelihood diversification exists but they still face barriers in accessing knowledge, techniques, and capital. Research by Nam and Dung (2024) also showed that the lack of effective agricultural extension programs, lack of opportunities for learning, and technology transfer are the main barriers to livelihood diversification. Notably, the fact that no household achieved a very high level of livelihood diversity (SID ≥ 0.76) indicates a limitation in the ability to integrate multiple livelihood activities simultaneously, which is often only achieved by households with high levels of management skills, strong capital, and good access to development resources. This indicates that although the level of livelihood diversity of rural smallholder households in this study has changed, there are still many challenges. This requires more comprehensive support policies on training, access to credit, markets, and agricultural extension to improve adaptive capacity and sustainable poverty reduction.

3.4. The Impact of Livelihood Diversification on Household Income

The analysis results presented in Table 4 show that there was a clear positive relationship between the level of livelihood diversity and the average household income. When households were grouped into four levels of livelihood diversity based on the SID index, the average annual income of the groups tended to increase with the level of livelihood

diversification. Specifically, the group of households that did not diversify their livelihood activities (SID < 0.01) had the lowest income, averaging VND 99.6 million per year. Meanwhile, the group of households with the highest level of livelihood diversity (SID > 0.51) had an average income of VND 179.4 million per year nearly twice as high as the group without diversification. The remaining two groups, with low (SID = 0.165) and medium (SID = 0.395) levels of diversity, recorded incomes of 153.7 and 160.3 million VND per year, respectively. The results of the one-way ANOVA test showed that there was a statistically significant difference in average income between groups of households with different levels of livelihood diversity ($F = 6.681$, $p = 0.000$). This indicated that the income of the group of households with high levels of livelihood diversity (SID ≥ 0.51) was significantly higher than that of the group with no diversity (SID < 0.01). This result revealed that the level of livelihood diversification positively affects the annual income of rural smallholders. Combining multiple livelihood activities has contributed to improving rural household income generation capacity, while strengthening the role of livelihood diversification as an effective strategy in household livelihood development. The results of some previous investigations (Agbola et al., 2008; Alemu, 2023; Dympep et al., 2018; Gebreyesus, 2016; Phung Duc & Waibel, 2009; Sharma, 2016; Tran, An-Vo, Cockfield, & Mushtaq, 2021; Zerai & Gebreegziabher, 2011) suggests that greater livelihood diversification was positively associated with increased household income, which is supported by the findings of this research. This research also shows that livelihood diversification plays an important role in improving household income. Expanding and combining multiple livelihood activities helps not only households reduce risks but also optimize resources and profit opportunities in the rural context. Therefore, improving the diversity of household livelihoods not only enhances household income but also strengthens households' ability to adapt to possible risks.

Table 4. Average household income according to SID index (N=426).

Level of livelihood diversification	SID mean	Mean household income (Million VND/Year)	Standard deviation
No livelihood diversification (SID <0.01)	0	99.6	93.1
Low level of livelihood diversification (SID=0.01 ≤ 0.25)	0.165	153.7	154.3
Medium level of livelihood diversification (SID= 0.25 ≤ 0.51)	0.395	160.3	130.6
High level of livelihood diversity (SID = 0.51 ≤ 0.75)	0.606	179.4	138.1
Total respondents	0.303	146.0	128.3
F= 6.681, P=0.000			

3.5. Factors Affecting Smallholder Livelihood Diversification

Table 5 presents the results of the Tobit regression analysis examining factors influencing smallholder livelihood diversification in the study area. The regression model was statistically significant, with a likelihood ratio chi-square (LR $chi^2(16)$) of 75.10, $p < 0.01$, and a Pseudo R^2 coefficient of 0.255, indicating a moderate fit and suggesting that the model reasonably explains the variation in the livelihood diversity index (SID). This implies that the selected independent variables significantly contribute to explaining differences in livelihood diversity among rural smallholders. Out of the 16 independent variables included in the model, six showed statistically significant regression coefficients. Notably, livelihood diversification was significantly associated with education level, the number of skilled laborers (≤ 99%), age of the household head, adoption of new technology (≤ 95%), number of family laborers, and participation in credit schemes (≤ 90%).

Table 5. Results of Tobit regression model of factors affecting SID (N=426).

Independent variables	Coefficient	Std. err	T	P-value
X1_Gender	0.050	0.051	0.97	0.331
X2_Age	0.003	0.001	2.13	0.034**
X3_Education level	0.053	0.015	3.50	0.001***
X4_The number of family laborers	0.022	0.012	1.79	0.074*
X5_The number of skilled laborers	0.055	0.017	3.12	0.002***
X6_ Farmland size	-0.000	0.001	-0.35	0.724
X7_Distance from the capital of the city	0.001	0.001	0.72	0.471
X8_Smallholders' participation in credit schemes	0.051	0.027	1.89	0.059*
X9_Smallholders' communications with extension officers	0.020	0.030	0.68	0.497
X10_Internet access and usage	-0.004	0.059	-0.08	0.939
X11_Smallholders' participation in CBOs	0.004	0.037	0.12	0.907
X12_Access to support policies from grovement	0.049	0.032	1.52	0.130
X13_Having market linkage with value chain actors	-.0528	0.036	-1.43	0.153
X14_Having access to input services for farming	-0.041	0.041	-1.00	0.287
X15_Having knowledge/Information about climate change	0.041	0.044	0.93	0.353
X16_Adoption of new technologies	0.113	0.046	2.46	0.014**
_cons	**-0.143**	**0.115**	**-1.25**	**0.212**
LR $chi^2(16) = 75.10$; $p < 0.01$; Pseudo $R^2 = 0.2550$				

Note: *: indicates significant at ≤ 90% level; **: indicate significant at ≤ 95%; ***: indicate significant at ≤ 99%.

This study found that small-scale households' livelihood diversification was statistically associated with their adoption of new technologies (β=0.113, p=0.014). This indicates that small-scale households who adopt new technologies or innovations are better positioned to diversify their livelihood activities. The findings from this study have not been reported in any prior literature. However, a study by Musyoki, Busienei, Gathiaka, and Karuku (2022), which examined farmer livelihood diversification and the adoption of climate-smart farming technologies in Kenya, found that the adoption of climate-smart farming technologies was associated with Kenyan farmer livelihood diversification, but it was not statistically significant, supporting the results of this study. FAO (2021) indicates that access to and application of technical advances from energy-saving irrigation systems and drought-tolerant crop varieties to digital production management technology play an essential role in improving production efficiency, reducing risks, and promoting sustainable livelihoods for farmers. Findings from this research emphasize the importance of promoting the transfer of technologies tailored to local ecological and economic conditions. Prioritizing context-specific solutions, combined with technical training integrated into practical, community-based livelihood models, can enhance the feasibility, adoption, and long-term sustainability of livelihood diversification, especially as smallholders face increasing vulnerability to climate change and resource limitations.

It has been found that smallholder livelihood diversification was statistically connected to the number of skilled laborers in households (β=0.055, p=0.002), which suggests that the more skilled laborers a household has, the more livelihood diversification activities it undertakes. Although a body of research (Abebe et al., 2021; Adepoju Abimbola & Obayelu Oluwakemi, 2013; Alobo Loison, 2016; Habib et al., 2023; Oyinbo & Olaleye, 2016; Peng et al., 2022; Samuel & Joe, 2025) has been conducted to investigate livelihood diversification in several contexts, findings from this investigation have not been reported in any previous literature. However, Pour, Barati, Azadi, and Scheffran (2018) examined the role of livelihood assets in livelihood strategies in Iran and found that households with members who had vocational training or professional skills were more proactive in adjusting their livelihood strategies to cope with environmental and market fluctuations, which is partially supported by the result of this research. Some important policy implications can be drawn to improve the quality of labor in rural areas to promote livelihood diversification, focusing on organizing short-term vocational training courses suitable to the needs and capacities of rural workers, supporting access to training for disadvantaged groups (women, youth, ethnic minority workers).

The education level of the household head had a positive and statistically significant impact on the SID index (β=0.053, p=0.001). This suggests that households with a higher education head tend to engage in more types of livelihoods, due to better access to information, higher labor skills, and more effective risk coping. This finding is consistent with studies in Nepal, Rwanda, and Nigeria, where education level was identified as a factor that promotes livelihood diversification, especially through participation in non-farm activities (Oladapo et al., 2025; Rahut, Ali, Kassie, Marenya, & Basnet, 2014). In the context of Vietnam, Tran, Tran, Pham, and Nguyen (2023) also confirmed the positive role of education on agricultural household income, emphasizing that education not only improves production efficiency but also expands non-agricultural livelihood opportunities. However, the impact of education also depends on local institutional conditions and economic opportunities. In areas lacking labor markets or supporting infrastructure, the role of education may not be fully realized. Therefore, along with investment in education, there is a need for synchronous support policies to facilitate the process of livelihood diversification in rural areas.

The age of the household head had a positive impact on SID (β = 0.003, p = 0.034), suggesting that life and production experience can positively contribute to the choice of appropriate livelihood strategies. This result is similar to the study results of Chuong et al. (2021); Khatun and Roy (2012); Nasa'i, Atala, Akpoko, and Kudi (2010), and Oladapo et al. (2025), in which older household heads tend to be more conservative but more cautious in managing livelihood risks and often choose diversification to ensure income stability. The findings of this study contribute to clarifying the role of human resources, environmental awareness, and technological capacity in promoting sustainable livelihoods in rural areas. This suggests that policies to support vocational skills improvement, enhance communication on climate change, and promote technical innovation should be given more attention in current rural development programs.

4. CONCLUSIONS AND RECOMMENDATIONS

This study provides empirical evidence that smallholders in the study area do not operate their farms and households with one or some livelihood activities, but use a wide range of diversified livelihood activities, spanning on-farm, off-farm, and non-farm sectors. The average livelihood diversification index (SID = 0.303) reflects a moderate level of diversification. Importantly, the findings reveal that livelihood diversification has a positive impact on household income, confirming that combining multiple sources of livelihoods is an effective strategy to enhance income and reduce vulnerability.

The results identified key determinants of livelihood diversification, including age, education level, number of family laborers, number of skilled laborers, participation in credit schemes, and adoption of new technology. Rural smallholder households with more skilled labor, better education, and greater access to information and technology tend to have higher levels of diversification. The results of this study underscore the importance of both resource endowments and informational access in shaping diversification decisions and improving household adaptability and resilience. The study results suggest that social and economic development priorities for small-scale farmers in developing and emerging nations should be given to rural development policies that enhance the capacity and skills of rural workers, improving access to technical and technological information.

This study acknowledges several limitations. While it offers valuable insights into the factors influencing small-scale farmers' livelihood diversification, the research was limited to mixed farming systems in Hue city. As such, the

findings may not be generalizable to other regions or farming contexts. Future studies should expand the geographical scope and include diverse agricultural systems to enhance the applicability of the results. Moreover, the cross-sectional design of this research captures farmer perceptions at only one point in time, which may not reflect evolving views as farmers gain more experience. Longitudinal studies would be beneficial to better understand how these perceptions change over time and their impact on livelihood diversification. Further research is also recommended to validate these findings in other settings and to explore the determinants of livelihood diversification among smallholder farmers engaged in different farming systems. Broader contextual analyses could provide a more comprehensive understanding of the dynamics involved.

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Institutional Review Board Statement: The study involved minimal risk and followed ethical guidelines for social science fieldwork. Formal approval from an Institutional Review Board was not required under the policies of Hue University of Agricultue and Forestry, VietNam. Informed verbal consent was obtained from all participants, and all data were anonymized to protect participant confidentiality.
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
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