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HOUSEHOLD FOOD SECURITY AND LIVELIHOOD STRATEGIES IN PROTECTED AREAS: A CASE STUDY IN TAY YEN TU NATURE RESERVE, SON DONG DISTRICT, BAC GIANG PROVINCE

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ABSTRACT

The main objective of this study was to quantify food security at the household level in Tay Yen Tu Nature Reserve, Son Dong district, Bac Giang province. The Household Food Insecurity Access Scale (HFIAS) was used to obtain food insecurity statuses. Households in Tay Yen Tu Nature Reserve were classified into four categories including food security, mild food insecurity, moderate food insecurity, and severe food insecurity with prevalences of 25.28%, 20.8%, 32.5%, and 20.8%, respectively. The relationship between livelihood strategies and household food security (HFS) revealed that diversifying products and sales tended to improve the food security status. Furthermore, using Principal Component Analysis (PCA) and Cluster Analysis (CA), the research found that the livelihood strategies of the food security category were based on agricultural and natural forest activities, while those of the food insecurity categories related to commercial forest, off-farm, and other activities. Finally, this research suggested that policy makers should focus on promoting agricultural models in paddy rice, maize, peanut, and livestock production; provide support for poor households cultivating plants that consume less water such as soybean, maize, and peanut; shift traditional cultivation from “cereal-livestock mix” to a model of cash income diversification; and invest in and implement intensive horticultural production and infrastructure development including transportation development, irrigation systems, electricity, and market development.

Keywords: Food security, livelihood strategies, protected area

An ninh lương thực cấp hộ và chiến lược sinh kế ở các khu bảo tồn: trường hợp nghiên cứu tại khu bảo tồn thiên nhiên Tây Yên Tử, huyện Sơn Động, tỉnh Bắc Giang

TÓM TẮT

Mục tiêu chính của nghiên cứu là đo lường an ninh lương thực cấp hộ ở khu bảo tồn thiên nhiên Tây Yên Tử, huyện Sơn Động, tỉnh Bắc Giang dựa trên thang đo tiếp cận mất an ninh lương thực cấp hộ (HFIAS).Các hộ nghèo điều tra ở Khu bảo tồn được phân loại thành 4 cấp độ bao gồm: an ninh lương thực, không đảm bảo an ninh lương thực ở mức độ nhẹ, mức độ trung bình và mức độ trầm trọng, với tỉ lệ lần lượt là 25,28%, 20,80%, 32,50% và 20,8%. Xem xét mối quan hệ giữa an ninh lương thực cấp hộ và chiến lược sinh kế, nghiên cứu phát hiện ra rằng việc đa dạng hóa sản phẩm và nơi bán giúp cho hộ cải thiện tình trạng an ninh lương thực. Bên cạnh đó, sử dụng phương pháp phân tích thành phần chính (PCA) và phân tích cụm (CA), nghiên cứu chỉ ra rằng chiến lược sinh kế của các hộ an ninhlương thực thường sử dụng là dựa vào các hoạt động nông nghiệp và rừng tự nhiên. Trong khi đó, các hộ mất an ninh lương thực thì dựa vào thu nhập từ rừng sản xuất và thu nhập phi nông nghiệp. Từ đó, nghiên cứu đề xuất khuyến nghị chính sách như: hỗ trợ phát triển các mô hình trình diễn trong nông nghiệp; hỗ trợ cho hộ nghèo canh tác cây trồng sử dụng ít nước như ngô và cây trồng họ đậu; chuyển đổi sản xuất từ kết hợp cây ngũ cốc - chăn nuôi sang mô hình đa dạng hóa thu nhập; cải tạo vườn tạp và phát triển hạ tầng bao gồm: giao thông, thủy lợi, điện và phát triển thị trường.

Từ khóa: An ninh lương thực, chiến lược sinh kế, khu bảo tồn.

1. INTRODUCTION

Food security has been a global issue attracting much attention in many countries around the world. Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO, 1996). According to FAO, Vietnam has been food-secure at a national level since 1990 but in fact, 9.9 million people still remained undernourished in 2015 in Vietnam, occupying 11 percent of Vietnam's population. Thus, food security at an individual and household level continues to be a problem in Vietnam, especially in the remote areas of this country (WorldBank, 2015).

Tay Yen Tu Nature Reserve is located in Northeast Vietnam. It was established by the Decision No. 117/QD-UB of Bac Giang Provincial People's Committee on July 22, 2002. Tay Yen Tu Nature Reserve is considered to be a high biodiversity area in Northeast Vietnam. About 45% of its population living in or around the nature reserve was poor and highly dependent on forests (Forest Protection Department of Bac Giang Province, 2016). Thus, starvation and poverty have led to the conversion of forest to agricultural land, soil erosion, illegal logging, and environment degradation. Through the years, these phenomenon have led to the decreases in the quantity and quality of the ecosystem. Degradation of the environment, biodiversity loss, poverty, and food insecurity have become the big issues that are challenging policy decision-making. With all the reasons mentioned above, finding out the relationship between household food security and livelihood strategies is expected to contribute to solving the trade-off between conservation and food security in protected areas in Vietnam.

2. METHODOLOGIES

2.1. Study Site Selection

Tay Yen Tu Nature Reserve is located in four communes: Thanh Son, Thanh Luan, Tuan Mau, and An Lac of Son Dong district and Luc Son commune of Luc Nam district, Bac Giang province. The nature reserve is included on a list of special-use forests of Vietnam. This nature reserve consists of two sections: Tay Yen Tu and Khe Ro, with a total forest area of 13,022 ha, comprised of a 6,022 ha core zone and a 7,000 ha ecological rehabilitation zone.

Tuan Mau, Thanh Son, and An Lac were the 3 sampled communes. These communes were selected as the research sites because of the following reasons: i) these communes were located in both inside and outside the nature reserve, ii) the three communes showed the highest poverty proportion in the area at 34.65%, 44.62%, and 53.56%, respectively, in 2015 (Commune People's Commitee of Son Dong District, 2016); and iii) the livelihoods of the households living in those communes strongly depended on natural resources of the nature reserve. In terms of section, the nature reserve had two sections: Thanh Luc Son and Khe Ro. The proportion of poverty in the Thanh Luc Son section was lower than that of the Khe Ro section.

2.2. Data Collection

Both primary and secondary data were used in the study. The secondary data was collected from government offices at the commune, district, and national levels. Copying and taking photographs helped to collect most documents concerning food security in protected areas. The Participatory Rural Appraisal (PRA) tools and a household survey were used to collect the primary data. As for sampling design, the targeted sample was poor households in The Tay Yen Tu Nature Reserve. The population was the 1,007 households below the poverty line. According to the sample size determination by Krejcie & Morgan (1970), at a 5% level of significance and a t-value of 1.96 derived from a population size of 1000 of continuous data (cited by Bartlett *et al.*, 2001), the sample size households in each commune of this study is given in Table 1. Simple random sampling was used to select the households in the three communes.

Table 1. Sample size

The Nature Reserve Section	Commune	Total households	Households below the poverty line	Sample Size (Households)
Thanh Luc Son	Thanh Son	520	284	25
	Tuan Mau	785	272	35
Khe Ro	An Lac	842	451	60
Total		2,147	1,107	120

Source: Author's own elaboration, 2015

2.3. Data Analysis

2.3.1. Measuring Household Food Security

The household food insecurity access scale (HFIAS), a nine-item food insecurity scale that was developed by USAID, was employed to assess household food security status in this study. The questions follow a progression, starting with anxiety about food supply, followed by questions concerning the quality of food, then questions on the quantity of food consumed, and then asking about the number of days households experienced hunger in the hunger period (60 days) during 2015[1](Deitchler *et al.*, 2010). The HFIAS indicator categorizes respondents into four levels of household food security: secure, and mildly, moderately, and severely insecure. Food security was identified if the household head said "no" to the all questions or said yes but rarely to question 1. Mild food insecurity was mentioned if the respondent said "yes, sometimes" to question 1, was not able to meet the kind of food he/she preferred, ate a limited variety of food 1 to 2 times, or just only ate some food with a frequency of rarely. Moderate food insecurity was calculated when a household said "yes, sometimes or often" to questions 3 and 4, and answered questions 5 and 6 with less than 10 times in the hunger period. Severe food insecurity occurred when a household affirmed they often have to eat a smaller meal or eat fewer meals in a day. These categories are shown in detail in Table 2, 3. Identifying the relationship between food security and livelihood strategies

Principal Component Analysis (PCA)

According to Jolliffe (2014), PCA is a variable reduction procedure that transforms a number of correlated variables into a smaller number of uncorrelated variables called principal components. In this study, PCA was conducted with six variables of income sources including crop, livestock, natural forest, commercial forest, off-farm, and other income sources. The result of the PCA revealed the components representing the features of livelihood strategies based on income sources.

Cluster Analysis (CA)

CA is a tool used to identify homogenous groups of cases, such as observations and respondents, in which the same response will be allocated in a group that has the same particular features. CA is usually used based on PCA results. In this study, CA with the component scores (from PCA) was used to classify subjects into groups.

3. RESULTS AND DISCUSSIONS

3.1. Descriptive Statistics of Characteristics of Poor Households

The household's socioeconomic characteristics are shown in Table 3. Out of 120 sampled households, there were 53% households living inside in the nature reserve. These households were in four villages including Dong Thong, Dong Ri, Tan Lap, and Na Trang. Other households, accounting for 47%, belonged to Neo, Na O, and Thac villages. Male household heads accounted for 82.5% of the respondents.

[1]The hunger period was determined based on results of group discussions with leaders of villages and households to identify what time of the year the community/household is not able to get enough food for meals.

Table 2. Categories of food insecurity

Ques. No.	Content	Frequency		
		Rarely (1-2 times)	Sometimes (3-10 times)	Often (>= 10 times)
1	How often did you worry that your household would not have enough food?			
2	How often did you or any household member not able to eat the *kinds of foods you preferred*[2] because of a *lack of resources*[3]?			
3	How often did you or any household member have to eat *a limited variety of foods*[4] due to a lack of resources?			
4	How often did you or any household member have to eat some foods *(sweet potato, rice porridge, cassava root, broken rice)* because of a lack of money to obtain other types of food?			
5	How often did you or any household member have to eat a smaller meal (major eating occasions) than you felt you needed because there was not enough food?			
6	How often did you or any other household member have to eat fewer meals in a day because there was not enough food?			
7	How often did your household food stores ever completely empty and there was no way of getting more?			
8	How often did you or any household member go to sleep at night hungry because there was not enough food?			
9	How often did you or any household member go whole day and night without eating anything because of not enough food?			

Note: : Food secure; : Mildly food insecure; : Moderately food insecure; : Severely food insecure

Source: Adapted from Deitchler et al., 2010

Table 3. Household distribution by socioeconomic characteristics

Household Characteristics		Frequency	Percentage
Zonation	Outside	56	46.67
	Inside	64	53.33
Gender of household head	Female	21	17.50
	Male	99	82.50
Ethnicity	Minorities people	84	70.00
	Kinh people	36	30.00
Housing type	Semi-firm	75	62.50
	Cottage	41	34.17
	Permanent	4	3.33
Number of main assets	1-3 assets	62	51.67
	More than 4 assets	58	48.33

Source: Author's survey, 2015

[2] Mean number of foods that food secure people eat that food insecure people cannot afford to eat.

[3] Mean number of people not having money or the ability to grow or trade for food.

[4] Mean of an undesired monotonous diet

Table 4. Descriptive statistics of socioeconomic characteristics

Indicator	Unit	Mean	SD	Maximum	Minimum
Age of household head	Year	43.12	13.39	83	23
Education of head household	Year	4.67	2.93	12	0
Household size	Person	3.93	1.20	7	1
Dependent ratio	%	60.12	49.11	200	0
Distance to market	km	6.25	1.67	9.3	2.3
Cropping intensity	Times	1.66	.33	2.50	1.00
Forest land size	ha	1.89	1.72	6.0	360
Cropland size	m^2/household	2,620.76	1,554.80	7,920.0	0.00
Total income	(mil. VND)	19.19	13.63	67.78	1.11

Source: Author's survey, 2015

In terms of ethnicity, five ethnic groups are living together in the nature reserve involving Kinh, Dao, Tay, Nung, and San Chi. The Kinh group is the majority ethnic group and the others are all minority ethnic groups. The minority ethinic households occupied about 70% together, while the Kinh households held 30% because the Kinh people are immigrants to this area. The Kinh people entered into this area within the four last decades, following the policies of building new economic zones in mountainous areas. Three housing types were popular in this area: semi-firm, cottages, and permanent houses with percentages of 62.5%, 34.0% and 3.5% of sampled households, respectively.

The age of household heads ranged from 23 to 83 years, 43.12 years on average, indicating that age is advantagous for economic development (Table 4). Meanwhile, schooling years of the household heads was 4.67 years on average. Most household heads stopped at primary school, and more importantly, there were 17 illeterrate household heads. Household size on average was 3.93 persons. More over, the high ratio of dependents in the households accounted for the burden on the households' labors and directly influenced food security.

The descriptive statistics of sample size showed that the mean distance to market was 6.25 km (distance from house to center market of the region) meaning that a lot of communities are living far from the commune's center. The cropping intensity was an important indicator to evaluate rotation avalability of agricultural land. This indicator depend on irragation avalability as well as crop rotation of households. In the sample size, the average cropping intensity reached 1.6 times. This could be explained by the limitation of irrigation systems, leading to housholds only able to cultivate during one season.

In terms of land size, cropland was fragmented and there currently is not a comprehensive strategy for land consolidation in local areas. According to the leader of An Lac commune, each household owned 6-7 pieces of land. The land fragmentation issue was popular in all communes, leading to many challengers in terms of machine application as well as production commercialization. The average crop land size per capita was very low (2,620 m^2/household). The backward irrigation system also leads to low productivity.

In general, the total annual income of poor households in the nature reserve reached 19.19 milllion VND per household. This number was slightly lower than the poverty standard of the whole nation (less than 0.4 million VND/capita/month).

3.2. Household Food Insecurity Status

As shown in Figure 1, the affirmative responses of household experiences were

grouped into four categories of food security. The results illustrate that the prevalence of food security, mild insecurity, moderate insecurity, and severe insecurity were 25.8%, 20.8%, 32.5% and 20.8%, respectively. The data also shows that the proportion of food insecurity of households was very high (approximately 75%) compared to the food security scale.

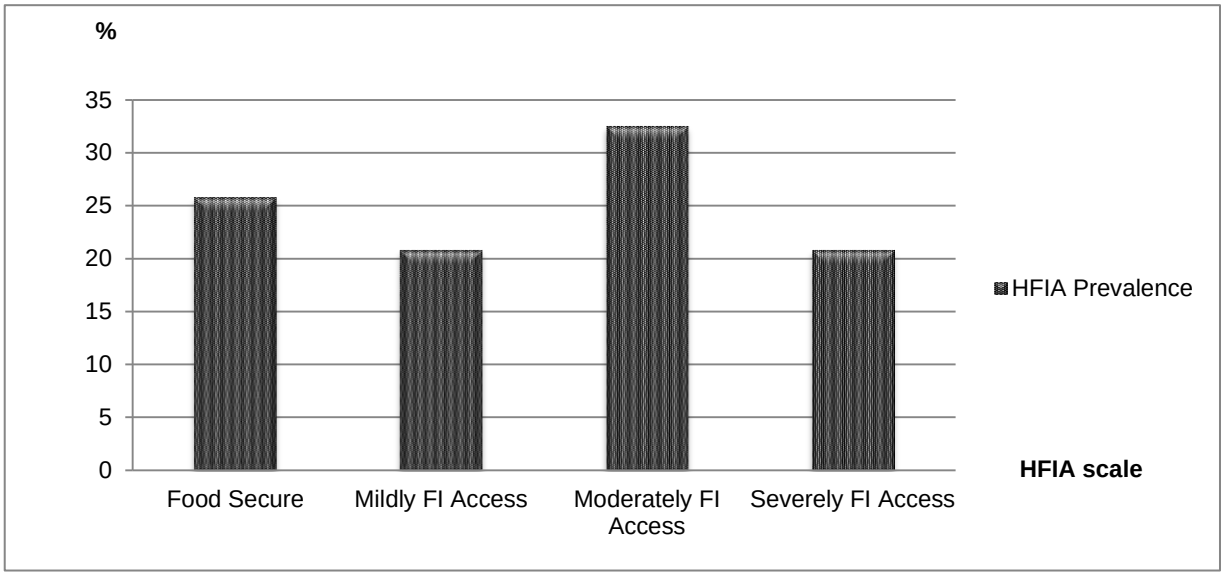

Figure 1. Household food security status

Note: FI: Food Insecurity
Source: Author's survey, 2015

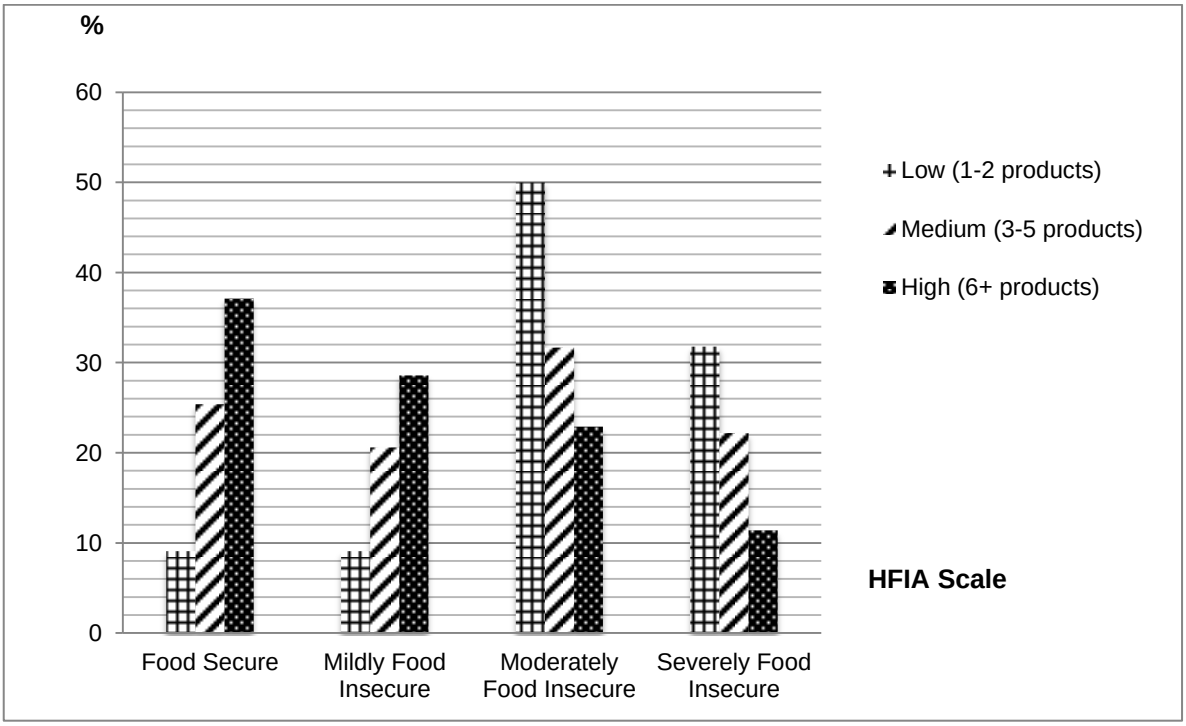

Figure 2. Production Diversification and Food Security

Source: Author's survey, 2015

3.3. Livelihood Strategies and Food Security

3.3.1. Production Diversification Strategies and Food Security

The indicators of diversity of agricultural production were derived from the number of agricultural products being produced on-farm (Barahona *et al.*, 2011). The households producing 1 to 2 product types were classified as *low production diversification*, those producing 3 to 5 product types were classified as *medium production diversification*, and the households producing 6 or more product types were considered as *high production diversification*.

In the study area, there were a total of eight major productive activities that contributed to total income of households, including paddy rice, maize, peanut, cassava, acacia, pig, poultry, and buffalo production. Of 120 households, only 8.3% of those had more than 7 product types. Most households produced from 2 to 6 product types.

After the relationship between the diversification in agricultural production activities and the level of food security was explored, we found a strong association (X^2 = 12.49, d_f = 6, $p < 0.05$). The more that households diversified their products, the less food insecure those households had. The reverse was true for the less product-diversified households (Figure 2). A higher percentage of food secure households had highly diversified agricultural strategies. One-third of extremely severely food insecure households were involved in very few agriculture-related activities. Figure 2 also suggests that there may be some causes for concern over the fact that more than one-half of the households that had moderate food insecurity, fall into the 'low' diversification category.

3.3.2. Sale Diversification Strategies and Food Security

The indicators of sales activities were also derived from the number of products sold by the households. The households selling no products were classified as *subsistence,* one to two products as *low market orientation*, and three or more as *high market orientation*.

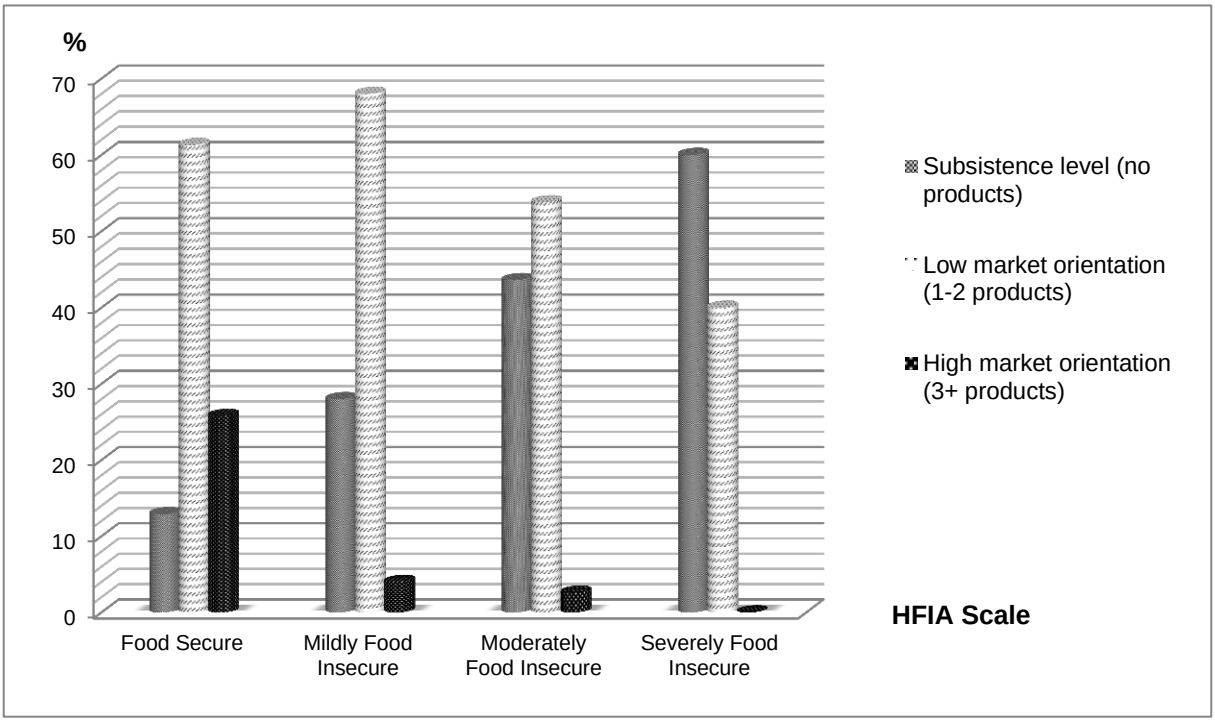

Figure 3. Sales Diversification/Market Orientations and Food Security

Source: Author's survey, 2015

Indeed, we confirmed there was a strong association between the market orientation of a household and the level of hunger reported (X^2 = 27.24, d_f = 6, p < 0.001). The households selling a greater range of products reported a greater food security level; and the reverse was true for households selling fewer products. Out of 25 households that reported severe food insecurity, 60% reported that they sold no products (see Figure 3). A further 40% only sold one or two different product types.

3.3.3. Income Source-Based Strategy and Food Security

The study tried to evaluate livelihood strategies through the income sources of household, of which six income sources were determined including: *i) Crop income* was calculated from the total gross crop income minus the total cost of inputs of all crops. Total gross income was identified by value of all crop products over the year, based on local market prices at the survey time. Total cost of crop inputs was the sum of seeds, fertilizers, pesticides, plough services, etc.; *ii) Livestock income* was the total value of gross income of livestock after deducting total costs. Livestock income was formed from three main sources: livestock sales, livestock for subsistence, and livestock services (ploughing). Annual cost of livestock consisted of feeds, breeding, and veterinary services. The value of gross income and costs was also based on local market at the survey time; *iii) Natural forest income* was determined from the value of natural forest products such as fuel wood charcoal, construction wood for houses, and non-timber forest products (honey, medicinal plants, resin, tree roots, mushrooms, etc.); *iv) Commercial forest income* was from forest harvesting that households earned by casual hired labor; *v) Off-farm income* was from wages that households got through masonry, carpentry, brick making, and other rural services; and *vi) Other income* was from remittances, pensions, and subsides from poverty reduction policies for poor households.

The first step, Principal Component Analysis (PCA), was used to explore the main components from the six income sources. The results from PCA with the Varimax rotational method revealed three components with Eigen values greater than 1 (1.38, 1.24, and 1.11) which could explain 62.59% of the variance. It can be easily seen that the difference among components loading allocation in each component (Table 5 and Table 6).

Table 5. KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.478
Bartlett's Test of Sphericity	Approx. Chi-Square	27.582
	df	15
	Significant	0.024

Source: Author's survey, 2015

Table 6. Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.389	23.157	23.157	1.389	23.157	23.157	1.357	22.619	22.619
2	1.247	20.787	43.944	1.247	20.787	43.944	1.200	20.000	42.619
3	1.119	18.647	62.591	1.119	18.647	62.591	1.198	19.972	62.591
4	0.847	14.113	76.704						
5	0.789	13.144	89.849						
6	0.609	10.151	100.000						

Note: Extraction Method: Principal Component Analysis
Source: Author's survey, 2015

Table 7. Rotated Component Matrix[a]

Income source	The most important component loading (In bold)		
	1	2	3
Crop income	0.62	-0.08	0.28
Livestock income	0.79	-0.05	-0.10
Natural forest income	-0.02	-0.29	0.76
Commercial forestry income	-0.10	-0.45	-0.69
Off-farm income	0.51	0.61	-0.22
Others income	-0.23	0.73	0.02

Note: Extraction Method: Principal Component Analysis; Rotation Method: Varimax with Kaiser Normalization; a. Rotation converged in 5 iterations
Source: Author's survey, 2015

Table 8. Distribution of income sources among clusters

Income source	Mean income per capita (Mil.VND)		F (T-test)	Sig.
	Cluster 1 (N = 49)	Cluster 2 (N = 67)		
Crop	0.2	0.7	11.7	0.001
Livestock	0.3	0.8	14.3	0.000
Natural forest	0.1	1.4	37.7	0.000
Commercial	1.0	0.1	40.9	0.000
Off-farm	2.4	0.7	22.9	0.000
Others	1.1	0.6	11.7	0.001

Source: Author's survey, 2015

The components loading from PCA were rotated using the rotated component matrix. The result reveals three important components (Table 7). The first component had a positive significant loading related to crop income and livestock income. The second component had a positive loading in terms of off-farm income and others income. The last component showed a positive loading on natural forest income and negative loading on commercial forest income. Consequently, component 1 could be described as the "*Agricultural dependency*"; component 2 named "*Off-farm and others source dependency*" and component 3 is related to "*Forest dependency*".

The second step, the hierarchical cluster analysis using Ward's method with inputs as component scores by PCA results was used. The criteria to decide the number of clusters was based on: (i) scree plot that was made from plotting the coefficients and number of clusters, (ii) dendrogram data (Mooi & Sarstedt, 2011), and (iii) the distribution among cluster performances (Patrício *et al.*, 2013)

Cluster analysis revealed three distinct clusters. However, one cluster only had four respondents. Thus, it was excluded from the analysis. Hence, crosstabulation was conducted among the income variables and household food security statuses, and revealed two livelihood strategy groups as indicated in Table 8.

Cluster 1 represented households that had a low income from agricultural sources (crop and livestock) and natural forest sources but they earned a high commercial forest income, off-farm income, and other income. Thus, we could conclude that cluster 1 reflected the household group with commercial forest - based income, off-farm income, and other income strategies.

Table 9. Relationship between Food Security and Income Source-Based Strategy

HFIA Scale	Strategy based on commercial forest, off-farm and other activities (N = 49)		Strategies based on Agriculture, natural forest activities (N = 67)	
	Count	%	Count	%
Food Secure	7	14.3	22	32.8
Mildly Food Insecure	10	20.4	15	22.4
Moderately Food Insecure	21	42.9	16	23.9
Severely Food Insecure	11	22.4	14	20.9

*Note: * Pearson Chi-square test (Significant at p-value <0.05)*
Source: Author's survey, 2015

Conversely, cluster 2 consisted of households having a higher income from agriculture and natural forest sources. They earned less income from commercial forests, off-farm activities, and other income activities, compared to cluster 1. Hence, households in cluster 2 had agriculture-based income and natural forest-based income strategies.

The response of households regarding the household food insecurity scale (HFIA scale) to provide the relationship between livelihood strategies and food security is indicated in Table 9. The higher the proportion of households who were living on commercial forests, off-farm activities, and others activities, the more the households faced food insecurity. Particularly, more than 84% households depended on these livelihood strategies were facing food insecurity at a mild or more serious level. On the other hand, households with agricultural and natural forest strategies tended to have a higher food security status. Only one-fifth of households fell into the severe food insecurity category while approximately one-third of households ensured food security over time.

4. CONCLUSIONS

The issue of household food security and its relationship with livelihood strategies are the main concerns in Tay Yen Tu Nature Reserve. Based on the household food insecurity access scale, four categories were clarified as: food security, mildly food insecure, moderately food insecure, and severely food insecure with the prevalence of, respectively, 25.28%, 20.8%, 32.5%, and 20.8%. The results reveal that there are strong relationships between livelihood strategies and household food security. Poor households selected production diversification as the adaptive strategy as well as risk reduction strategy to ensure food security. Based on the diversification of products, households could reduce food shortage situations and mono-food intake. In addition, the research also illustrates that sale diversification contributed to ensuring food security. High proportions of respondents in the severely food insecure category depended on subsistence production while the food security group produced both subsistence and market products. Moreover, agricultural income and natural forest income were the main income sources of the food security group, while off-farm, commercial forest, and other income activities were the main income sources of the food insecurity group. The findings demonstrate that commercial forest as well as off-farm income are only temporary solutions to solve food shortage immediately. Unstable employment of off-farm jobs and low income of forest plantation are causes leading to low total income that directly affects food security. It is not in doubt that agriculture and natural forest resource still play the most important roles for food security.

Consequently, the research suggested that policy makers should build and promote the demonstration models in paddy rice, maize,

peanut, and livestock production. The efficiency of the models helps poor households be more confident to replicate. Additionally, the local government should support households cultivating plants that consume less water such as soybean, maize, and peanut. These plants not only help to diversify products but also to improve land quality. Moreover, agricultural policy should shift from a traditional cultivation of "cereal-livestock mix" to the model of cash income diversification. For example, in Son Dong district, off-farm businesses, honey production, poultry, and horticulture should be promoted widely to enhance total income as well as ensure environmental objectives. On the other hand, intensive horticultural production is not the only possible way to solve food insecurity in long-term. Some agro- forestry that should be promoted include a combination of litchi and honey production or livestock mixed production forest. Finally, policies on infrastructure including transportation development, irrigation systems, electricity, and market development should be invested and implemented.

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