MINISTRY OF INDUSTRY AND TRADE

INDUSTRIAL UNIVERSITY OF HO CHI MINH CITY



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RESEARCH AND DEVELOP SUSTAINABLE LIVELIHOOD MODELS BASED ON AGRICULTURAL CULTIVATION OF PEOPLE IN THE BUFFER ZONE OF TA DUNG NATIONAL PARK

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LIST OF PUBLISHED PROJECTS

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INTRODUCTION

1. Rtionale

Ta Dung National Park is located adjacent to the Dak Nong Plateau and the Di Linh Plateau, which is considered the "green lungs" in the Central Highlands. It is a forest consisting of many mountain ranges with an average altitude of 1.200 – 1.500m, with Ta Dung peak 1.982m high, the lowest altitude is the southern land of the National Park with an altitude of 600m, located in the middle of the highland. Dak Nong plateau and Nguyen Di plateau Linh belongs to the South- Central biogeographic Zone, this is the geographical and biological intersection between the Southern Central Highlands and the Southeast Zone.

Ta Dung National Park plays an important role in preserving watershed forests and is the source of two large rivers (Krong No - Serepok in the North and Dong Nai in the South) providing drinking water for industrial production. and agriculture.... for the southern key economic Zone. In addition, hydroelectric plants have created an elevated lake with an area of about 3.632 hectares of water surface and formed 47 large and small islands, including some islands of the Conservation Area with large, convenient areas. beneficial for ecotourism development on the island.

It is expected that in the long term, Ta Dung National Park will be invested and planned into an eco-tourism area, sports tourism, source tourism, sightseeing and relaxation with diverse tourism product chains, featured. Despite the above advantages, Ta Dung National Park is also under great pressure from the buffer zone communities through invasive farming activities, exploitation of timber and non-timber forest products, and hunting of wild animals. The above problems stem from the livelihoods of people in the buffer zone, so the management and protection of Ta Dung National Park requires many measures, including solving non-forest-based livelihoods.

Through preliminary surveys, ensuring sustainable livelihoods from agricultural farming models for households in the buffer zone of Ta Dung National Park will

contribute to improving the lives of the community and reducing the impact on the National Park. From the above perception, the topic "Research and development of sustainable livelihood models based on agricultural cultivation of people in the buffer zone of Ta Dung National Park " was chosen to be implemented as a doctoral thesis of the research lifesaving.

2. Objectives

2.1 General goals

Evaluate the current state of land use along with economic, social and environmental efficiency and the suitability of agricultural cultivation models in the buffer zone of Ta Dung National Park to propose a number of farming models and solutions to support sustainable livelihood development to minimize impacts on forest resources.

2.2 Specific goals

- Assess the current state of land use and livelihood activities and analyze existing agricultural models of people in the buffer zone of Ta Dung National Park to identify factors affecting economic efficiency, economic, social and environmental from production activities.

- Agro-ecological zoning and land adaptation assessment in the study area.

- Evaluate the economic, social and environmental effectiveness of proposed farming models and select sustainable agricultural farming models.

- Select models and propose solutions to develop sustainable livelihood models based on agricultural cultivation of people in the buffer zone of Ta Dung National Park.

3. Subject and scope of research

- Research object: Livelihood models from agricultural cultivation (crop farming and animal husbandry) of ethnic minority households (Ma, K'ho, H'Mong, Dao and other ethnic.

- Scope of research: The research area is the buffer zone of Ta Dung National Park, including 3 communes: Dak Som (in Dak G'Long district, Dak Nong province), Phi Lieng commune and K'Nàng (in Dam Rong district, Lam Dong province). The total area and scope of the study area is 14.571,54 ha.

4. Scientific and practical significance

4.1 *Scientific significance*

The research topic has supplemented the scientific and theoretical basis for sustainable livelihood farming models, based on assessing the advantages and disadvantages of existing agricultural farming models combined with natural conditions, sustainability criteria and evaluation indicators, the thesis has selected and proposed sustainable livelihood models based on agricultural cultivation for people in the buffer zone of Ta Dung National Park. This result is the scientific basis for establishing a sustainable community-based farming model as well as contributing to protecting the buffer zone as well as the core zone of the National Park.

4.2 Practical significance

The research results of the thesis can provide local environmental and management agencies with data on land use models that can be applied to the fields of agriculture, natural resource and environmental protection school to ensure sustainable livelihoods for the buffer zone community in general and Ta Dung National Park in particular.

The application of the thesis's research results will contribute to proposing models and solutions to raise awareness of people and local officials in ensuring sustainable livelihoods and conservation.

5. Newness of the thesis

Domestic and foreign research on soil quality and soil potential is mostly concerned with soil research activities and issues. Aims at four main directions: (1) Investigating and mapping land resources; (2) Land evaluation; (3) Research on land potential performance; (4) Use management land management and protection. The thesis approaches specific livelihood activities in the research area, analyzing existing agricultural models of people in the buffer zone of Ta Dung National Park. To identify factors affecting economic, social and environmental efficiency from production activities. From there, select and propose the development of sustainable livelihood models based on agricultural cultivation of people in the buffer zone of Ta Dung National Park.

CHAPTER 1 OVERVIEW OF THE RESEARCH

1.1 Overview of research on sustainable livelihoods

There are many different approaches and definitions of livelihood, however there is agreement that the concept of livelihood includes many factors that affect the life activities of each individual or household. Basically, livelihood activities are decided by each individual or farming household based on their capacity and ability. At the same time, it is influenced by institutions, policies and social relationships that individuals or households have established in the community.

Sustainable livelihoods is a multi-method approach that emphasizes people's participation, viewing poverty reduction as the main outcome. Covers a range of levels and measures for improving livelihoods from local-scale projects to

international campaigns for policy changes. “Sustainable livelihoods” is a term used by DFID since the 1990s in poverty reduction and sustainable development programs.

Thus, sustainable livelihoods must meet the following principles: People-centered; accessible; with people's participation; building on human strengths and dealing with vulnerabilities; overall; implemented at many levels, in relationships with partners, sustainably and dynamically.

Based on the results of research on assessment criteria for livelihoods and sustainable livelihoods, the authors generally approach them from four aspects: economic, social, environmental and institutional. A livelihood is considered economically sustainable when it achieves and maintains a basic level of economic well-being, which can vary across Zones.

1.2 Overview of research on farming models related to buffer zones

The study reviewed about 37 studies in several countries on farming models related to buffer zones. In general, the approach to farming models related to buffer zones includes: the ability to effectively use available capital; living context including economic, technological, demographic and seasonal trends; human perceived priorities; choice strategies for pursuing priorities; the institutions, policies and organizations that access different types of assets or opportunities and the results they achieve; Their approaches to five types of capital (financial, physical, human, social and natural), the main analytical method here is to put people at the center of development. In particular, research on developing farming models related to buffer zones based on research methods on buffer zone livelihoods and sustainable land adaptation assessment zoning is still limited.

1.3 Characteristics of the study area

Ta Dung National Park has an area of 19.935,3 hectares and is divided into 3 subdivisions. The main task of this subdivision is to protect landscape and forest resources; restore forest ecosystems, restore biodiversity and other values of the forest; experiments, research on silviculture, fauna, flora and hydrogeology; develop

ecotourism. The main task of this subdivision is to ensure administrative management activities, build working houses, guest houses, nurseries, and research facilities on forest flora and fauna; Organize facilities serving scientific research, sightseeing, and tourism services.

Ta Dung National Park is located in an important location in terms of economy, environment and national security and defense. It is also a place to protect and maintain ecological balance for the entire Zone, absorb and store carbon, reduce gas emissions, etc. However, Ta Dung National Park is also under great pressure from the buffer zone community due to encroachment activities, exploitation of timber and non-timber forest products, illegal hunting of wild animals...The above problems stem from the livelihoods of people in the buffer zone, so management is difficult. Protecting Ta Dung National Park requires many measures, including addressing non-forest-based livelihoods.

1.4 Existing problems and proposed research directions

The above overview shows that the research aims to build a model Sustainable livelihoods based on agricultural cultivation of people in the buffer zone have not been paid attention to and fully implemented solutions to improve the lives of the community and reduce the impact on Ta Dung National Park.

Thesis topic "Research and development of sustainable livelihood models based on agricultural cultivation of people in the buffer zone of Ta Dung National Park" aims to create a scientific basis for establishing sustainable farming models as well as contributing to protecting the buffer zone as well as the core zone of the National Park.

To choose a sustainable livelihood model for this area, the main implementation contents include:

- Assessing the current state of land use and environment at Ta Dung National Park;

- Assess the impacts of livelihoods on forest resources and the environment of Ta Dung National Park;

- Ecological zoning and land adaptation assessment for sustainable farming;

- Analyze model selection and propose solutions to support sustainable livelihood development.

CHAPTER 2 RESEARCH CONTENT AND METHODOLOGY

2.1 Research content

(i) Assess the current state of land use and environment in Ta Dung National Park. (ii) Investigate the current situation of livelihoods and evaluate the impact of existing livelihood activities from agricultural cultivation models in the study area. (iii) Agro-ecological zoning and land adaptation assessment in the study area. (iv) Evaluate the economic, environmental and social effectiveness of proposed farming models and select sustainable agricultural farming models. (v) Orientation for developing sustainable agricultural models and solutions to support sustainable livelihood development.

2.2 Research methods

2.2.1 Methodology diagram



Figure 2.1 Diagram of research implementation steps

The study investigated the current status of land use, livelihood resources, livelihood activities and pressures on forest resources and environment of Ta Dung National Park. Thereby, evaluating the trend of the VCI and TCI indexes shows that outside the special-use forest area, the condition of land cover has degraded in the remaining areas. At the same time, evaluate the economic, social and environmental effectiveness and suitability of agricultural farming models in the buffer zone of Ta Dung National Park to propose sustainable farming models and minimize impacts on forest resources, through the application of integrated models of GIS and MCA (with AHP - GDM techniques) in the process of assessing sustainable land adaptation. From there, propose land use types and sustainable agricultural cultivation models in the buffer zone of Ta Dung National Park..

2.2.2 Data collection method through survey questionnaire

To ensure scientificity, research needs to meet the minimum observation sample size requirement (household units). According to mathematical statistics literature, this sample size (n) depends on the variance (or variability) of the sample (S^2) and the desired level of confidence (d). In the case of a finite sampling population (determined n), the sample capacity is also proportional to the population size, according to a value t^2 (the square of the value of the Student t distribution):

$$n = \frac{N.t.S}{Nd^2+t^2S^2} \quad (2.1)$$

In there:

- N: Total number of households (number of households in 3 communes);
- n: Number of households to be investigated;
- t: Value of the Student t distribution (when taking the degree of freedom as ∞ and the significance level α = 0,05, t = 1,64);
- d: Desired error (5%);
- S^2: Sample variance (0,25).

Applying the above formula, the results of calculating the number of households to be surveyed in the 3 buffer zone communes are as follows:

$$n = \frac{4.740 * 1,64 * 0,5}{4.740 * 0,1^2 + 1,64^2 * 0,25} \sim 120 \text{ (households)} \quad (2.2)$$

2.2.3 Methods of soil sample collection and analysis

Take soil samples for analysis according to TCVN 4046:1985 on cropland - sampling method. After taking the sample, preserve the soil sample in a specialized sample container or in a clean plastic bag; Sample labels must be kept in plastic bags to ensure they are not blurred by water; fixed with sturdy wire and placed in a sample container for transport to the environmental monitoring room.

Analyze indicators: pH, H_2O, pH KCl, hydrolytic acidity, exchangeable acidity, total organic carbon, total nitrogen (N), total phosphorus (P_2O_5%), total potassium

(K_2O%), digestible phosphorus (P_2O_5), digestible potassium (K_2O), Ca^{2+}, Mg^{2+}, K^+, Na^+, CEC, mechanical composition, density..

2.2.4 Method of analyzing land cover trends and identifying related factors

The trend of land cover determined through vegetation indicators (Vegetation Indices - VIs) from remote sensing is VCI and TCI. The formula for calculating TCI and VCI was built by Kogan as follows:

$$VCI = 100\frac{NDVI_{i-}NDVI_{min}}{NDVI_{max-}NDVI_{min}} \quad (2.3)$$

$$TCI = 100\frac{LST_{max-}LST}{LST_{max-}LST_{min}} \quad (2.4)$$

The degree of influence of factors affecting the coverage coin is determined by the logic recovery method and decomposition method.

2.2.5 Method of agro -ecological zoning

This study selects criteria for shallow ecological zoning from ecological conditions of soil - water - climate and altitude. Based on topographic maps, soil maps and land use maps, ecological zones in the province have been divided and their properties surveyed. From there, proceed to digitize, overlap and partition the agricultural ecological map. Each ecological Zone has different characteristics in terms of soil, water, terrain, altitude and specialized types of farming.

2.2.6 Methods of land adaptation assessment

Applying FAO (2007) land adaptation assessment method, which is a sustainable land adaptation assessment method, and building a land resources database on GIS; Applying the integrated model of GIS and multi-criteria analysis (MCA) with AHP-GDM technique to the land assessment process in the study area as shown in Figure 2.2.

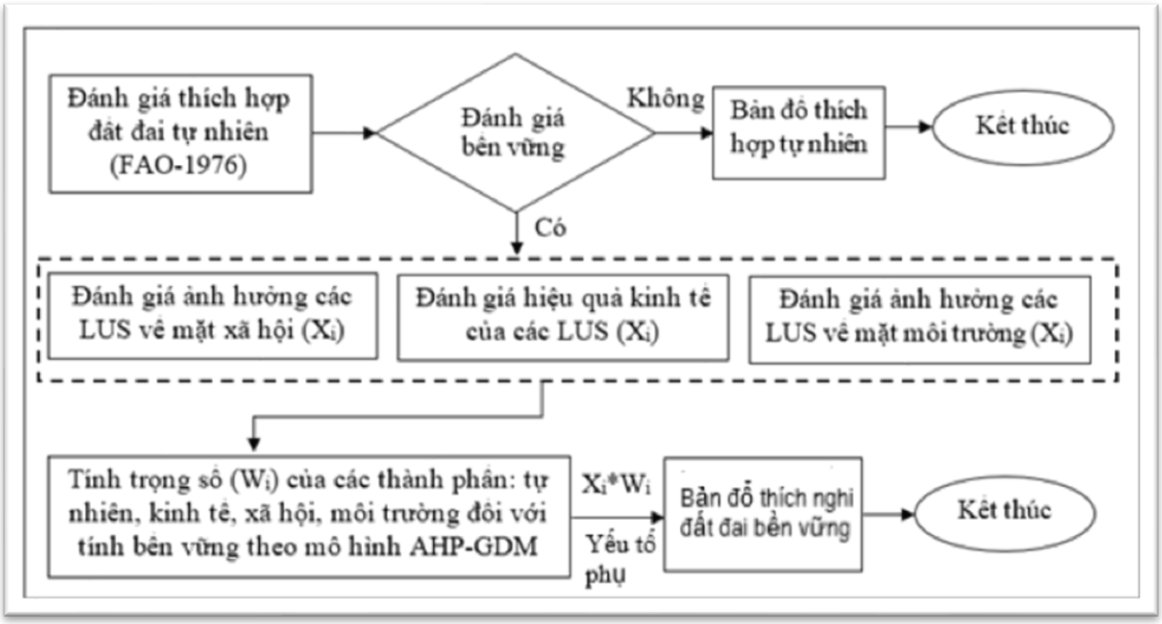


Figure 2.2 GIS and MCA models in sustainable land assessment

This method, based on combining the results of natural adaptation, economic adaptation, sustainable adaptation and secondary factors to increase the detail of LMU, determines the level of land adaptation. sustainable for prospective models.

2.3.7 Data processing method

Information and data after being collected will be screened, coded and analyzed by the author, with the aim of evaluating sources of livelihood capital and the impact of livelihoods on the environment and resources. forests, income levels and efficiency from existing agricultural farming activities using Excel 2010 and JMP application software.

In addition, the study analyzes the economic efficiency of different types of land use based on the following criteria: production costs, net profit and profit margin as a basis for evaluating and comparing the economic efficiency of land use types of land use.

CHAPTER 3 RESEARCH RESULTS AND DISCUSSION

3.1 Assess the current state of land use and environment in Ta Dung National Park

3.1.1 Assess the current status of agricultural land use

According to the 2019 land inventory report in the study area, there are two main types of agricultural production: perennial crops (coffee, macadamia,...) and other annual crops (noodles, corn, beans,...). In particular, the current status of perennial crops has the highest agricultural production area of 12.467,45 hectares (Dak Som commune has the highest perennial crop area of 5.208,29 hectares, accounting for 35,74% of the investigated area), other annual crops (HNK) has an area of 2.104,09 hectares (in Dak Som commune, the HNK area is 2.104,09 hectares, accounting for 14,44% of the investigated area), some main types of agricultural cultivation in 03 communes.

Table 3.1 Current status of agricultural land use

Conscious	District	Commune	Current Status	Area (ha)	Structure (%)
Dak Nong	Dak Glong	Dak Som	CLN	5.208,29	35,74
			HNK	2.104,09	14,44
Lam Dong	Dam Rong	Da K'Nang	CLN	3.400,01	23,33
		Phi Lieng	CLN	3.859,15	26,48
Investigated area to build soil quality map (ha)				14,571,54	
Area not investigated (ha)				31,982,69	

3.1.2 Current environmental status of Ta Dung National Park

Currently, the area and quality of the National Park's forests are still declining. Precious timber species with high use value and other non-timber forest products are

still regularly exploited. Besides, forest land encroachment still occurs. In particular, programs to conserve, plant and develop rare tree species to preserve and protect species that do not yet exist are also the cause of the decline. Along with the decline in forest area and quality, there is a decline in the economic and environmental value of the forest ecosystem, especially the value of non-timber forest products and the ability to protect, preserve land and water of the forest has been greatly reduced. Recent observations show that there are many dry and flooded areas, many floods, flash floods, and post-rainfall floods occurring right in and around the National Park that did not exist before.

3.2 Trend of land cover in the National Park area and related causes

The analysis was performed for each grid cell and the results are presented in Figure 3.1. In these figures, except for the yellow boxes (corresponding to values from -0,5% per year to 0,5% per year), the remaining boxes all have a clear trend with a significance level of 0,01.

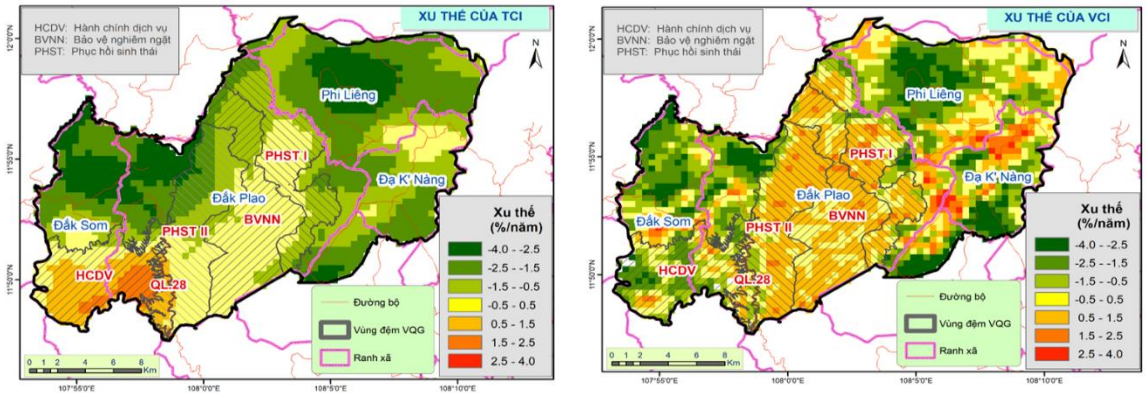


Figure 3.1 Trends of TCI, VCI and in the national park area and buffer zone

Statistics on trends of VCI and TCI by administrative units. These tables and figures show that except for the core areas of the national park, in the perennial crop and other agricultural areas of the communes, the trends of VCI and TCI clearly decrease. This shows the degradation of crops in this area, affecting the sustainability of agricultural-based livelihood activities and the need for a detailed land adaptation assessment for this area.

The clear decrease in TCI corresponding to the increase in temperature as shown in Figure 3.1 also shows that the amount of surface evaporation has increased compared to the beginning of the period, or the amount of water for irrigation has increased and will increase in the future. The decrease in VCI is also related to evaporation, which requires agricultural land use planning to be closely linked to water resources. Comparing between communes, the average value of VCI is the lowest in Phi Lieng and Dak Som communes, or the plant health status here has clearly deteriorated compared to before. Except for the administrative and service area (HCDV), VCI increased in the core area of the National Park, showing the effectiveness of moving from the base of Ta Dung Nature Reserve to Ta Dung National Park and the current forest management work is Very good.

The results of determining the coefficients of the logistic regression equation simulating the trends of VCI and TCI according to land use types, the level of influence of land use types on the trends of VCI and TCI is gradually increasing. From negative to positive, it will be from production forests, other agriculture, perennial trees and then special-use forests.

3.3 Assessment of livelihood activities and pressures on forest resources and environment of Ta Dung National Park

People in the buffer zone in the communes are mostly ethnic minorities, the majority of whom cultivate coffee trees as their main source of income. In addition, some households in Phi Lieng and Da K'nang communes, due to the “Kinh” ethnic group living there, have learned experience in growing crops as well as intercropping food crops, so the majority of households in these two communes The commune grows food such as corn and wet rice, and there are also a number of markets and small businesses buying and selling services.

Overall, the two communes Phi Lieng and Da K'nang are much more economically stable than Dak Som commune. However, most households borrow capital from the state to cultivate. Most households receive training in tree planting techniques from

state-owned enterprises such as: planting, care, and harvesting techniques, seed treatment,...

Preliminary research shows that residential activities and tourism development in the National Park buffer zone have changed the land use structure and the land fund for conservation has gradually narrowed. In addition, in recent years, tourism activities in this area have developed strongly, also contributing to the amount of waste, emissions and wastewater causing environmental pollution.

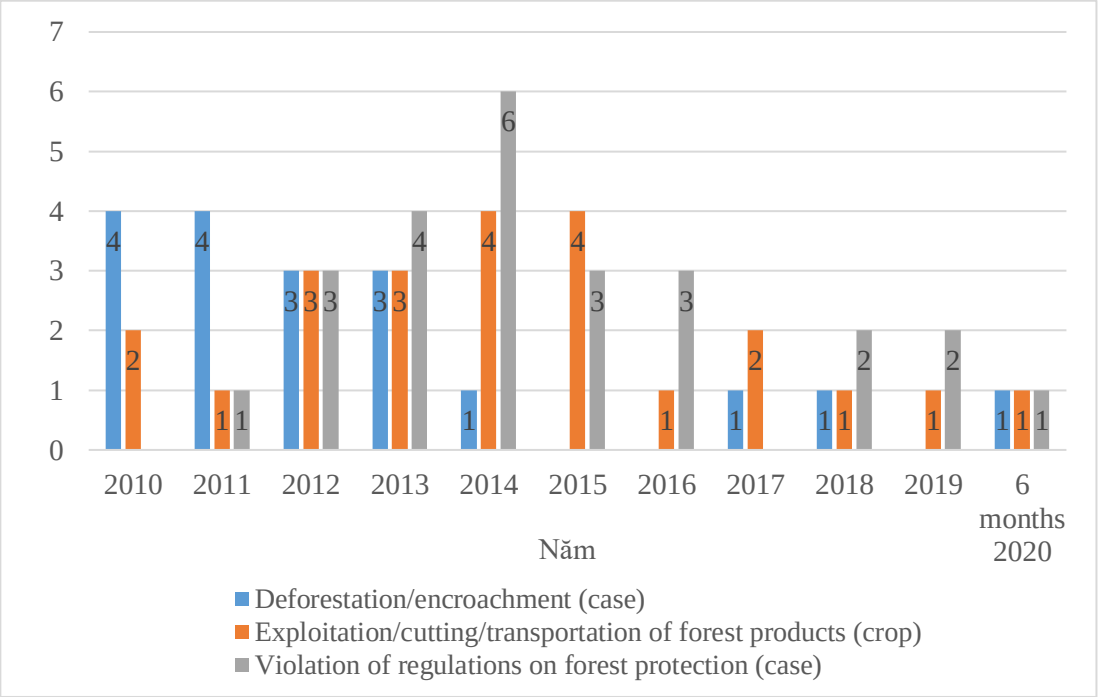


Figure 3.2 Number of forest law violations at Ta Dung National Park in the period 2010 - 2020

To ensure their lives, especially during lean months, people go to the forest to hunt, trap wild animals, and harvest wood and other forest products. In addition, the increasing market demand for forest products has put pressure on people to exploit and deplete forest resources.

3.4 Ecological zoning and land adaptation assessment for sustainable farming

3.4.1 Agro-ecological zoning

Research and use GIS software (geographic information system) to digitize, update information, overlap, delineate, and build agro-ecological zoning maps based on the current state of agricultural production, along with Secondary factors such as terrain slope, soil and climate (average temperature and rainfall). Each agro-ecological Zone has different characteristics of agricultural landscapes and characteristics of terrain, soil and climate that create specialized types of farming.

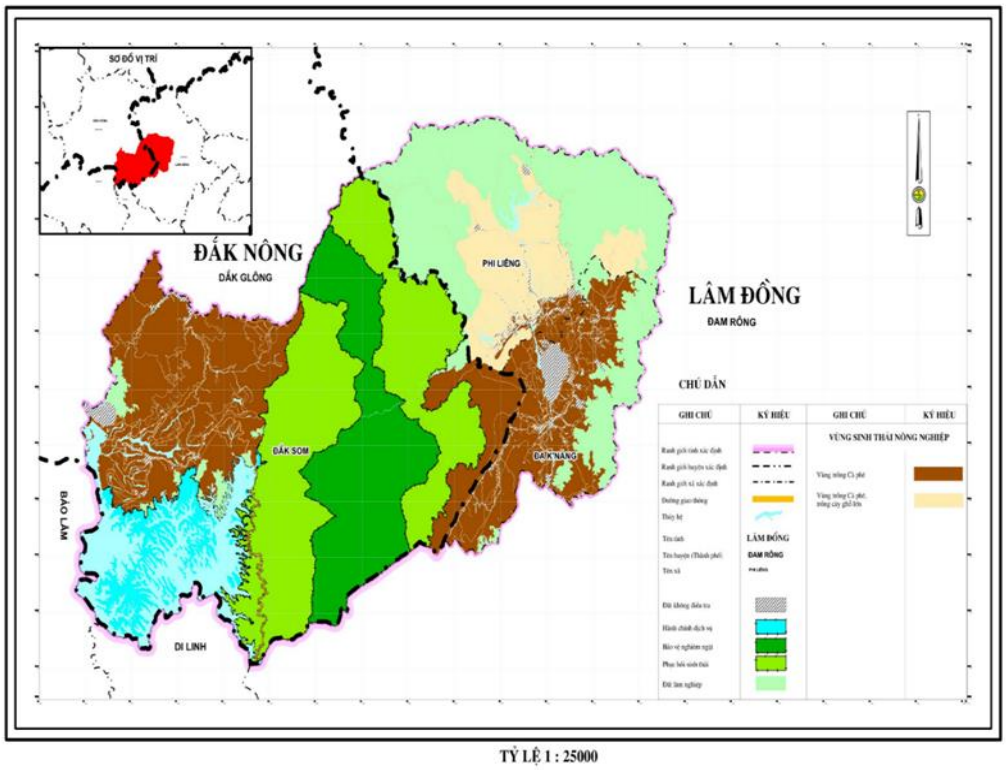


Figure 3.3 Map of agro-ecological zones in the study area

- Dak Som Coffee Growing Area (Region 1): Coffee cultivation area in Dak Som commune, occupying an area of 7,312.38 hectares, accounting for 50.18% of the surveyed area, including the entire agricultural production land in Dak Som commune. The current crop status in this area is mainly perennial crops with an area of 5,208.29 hectares, The typical soil is red-yellow soil on clay rocks (Fs) of

5,618.20 hectares, the area has a night temperature of <13°C or >20°C, the average annual rainfall is about 1500 mm to 2000 mm, and the common slope is greater than 15° to 25°.

- Central Coffee Growing Area (Region 2): This is a high-yield coffee growing area in the research area of 02 communes of Phi Lieng and Da K'Nang, accounting for an area of 3,792.33 hectares, accounting for 26.03% of the survey area. The current status of perennial crops occupies the entire agricultural production area in 02 communes, the typical soil is 1,589.00 hectares of red-yellow soil on clay (Fq), the area has a common night temperature of 13-<15°C and 18-20°C, the average annual rainfall is from 1500-2000 mm, The common slope is greater than 15°-25°, and gradually decreases towards the center.
- The Northeast-North coffee and large timber planting area (Region 3), Dak Som commun, occupies an area of 3,466.83 hectares, accounting for 23.79% of the survey area in the East and North regions, forming an arc in the study area. The current status of crops on agricultural production land is perennials, the typical soil is red-yellow soil on clay (Fs) 3,323.73 hectares, the area has a night temperature of <13°C or >20°C, the average annual rainfall is more than 2,000 mm, common slopes greater than 15° to 25°.

3.4.2 Land adaptation assessment

The study conducts an assessment of land adaptation and potential of two types of land use, Coffee and Macadamia, based on simultaneously considering the sustainability of natural, economic, social and environmental aspects; As well as taking advantage of the knowledge sources of experts, managers, and producers in the research area, the author uses multi-criteria analysis method (MCA), group AHP technique (AHP – GDM) combined criteria and hierarchy for assessing land use potential.

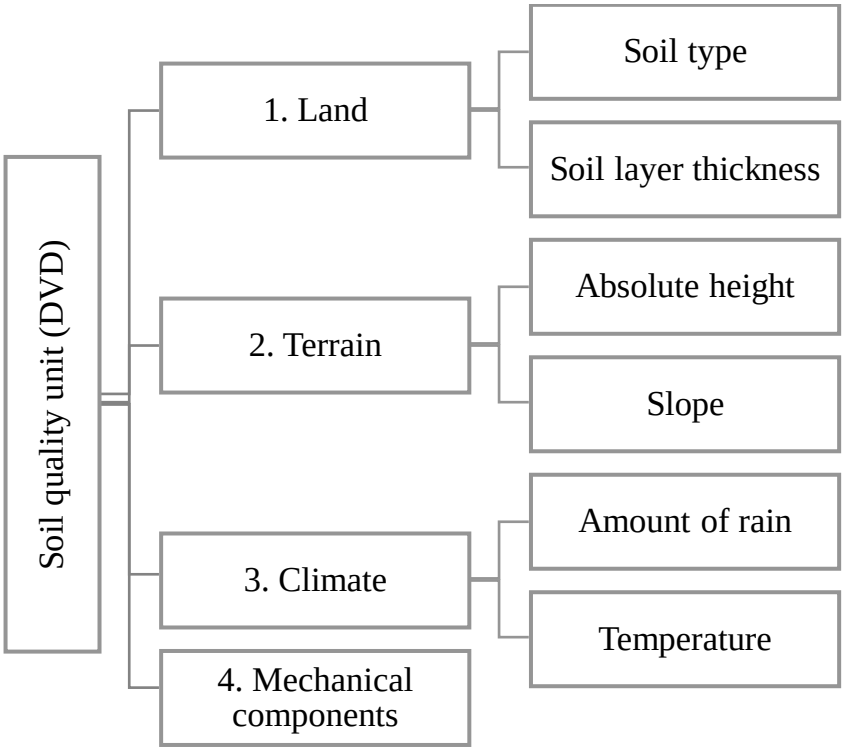


Figure 3.4 Diagram of elements establishing soil quality units

❖ Develop land unit maps

Simple map built on Mapinfo software, resulting in 06 thematic maps, including information layers: Soil, terrain, climate, fertility (in case only mechanical components are evaluated). The thematic maps are stacked on top of each other to form a land unit map, serving the next step of classifying the land suitability level of LUTs and proposing potential LUT models in the study area. The results show that the study area has a total of 28 land plots with 24 land units from 14.571,54 hectares of investigation area.

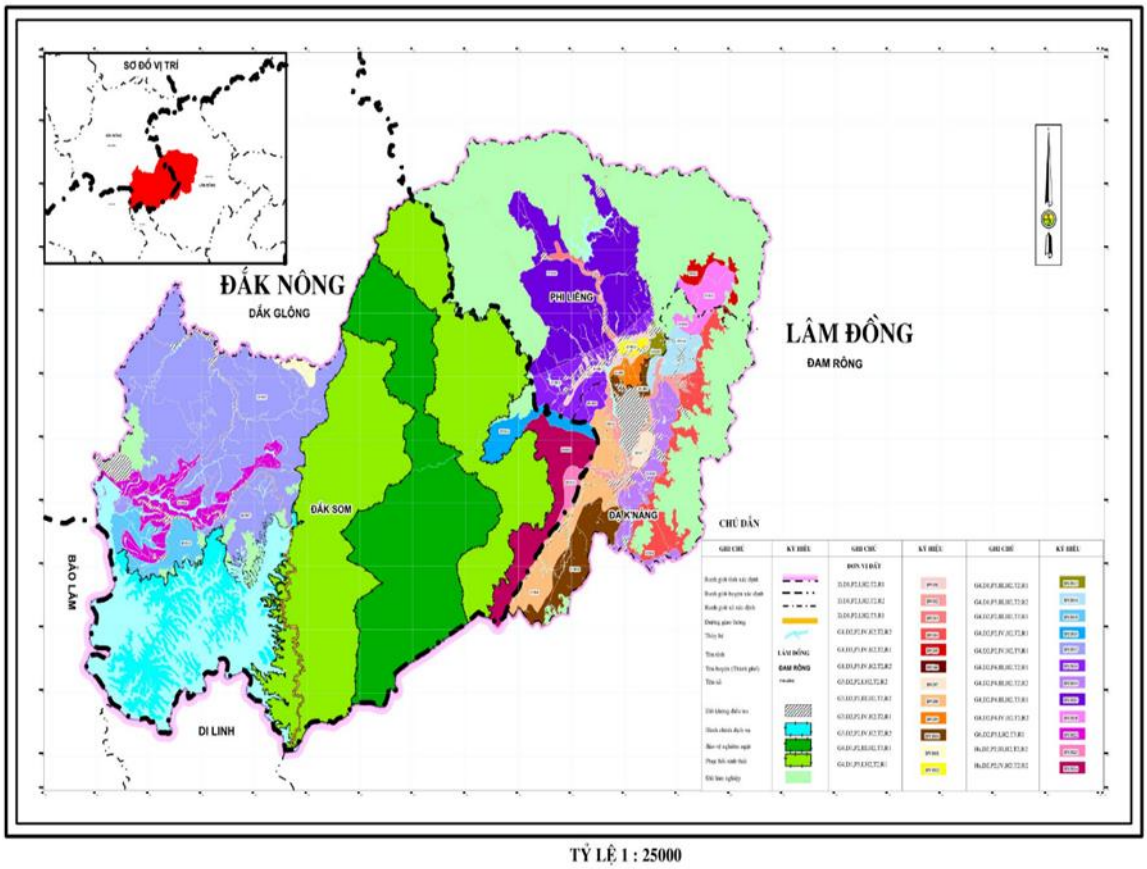


Figure 3.5 Land unit map

❖ Assess natural land adaptability

To classify the level of land adaptation to coffee and macadamia trees, the study compared and contrasted the LUR of the LUT with the characteristics of each land unit (LMU), these data were connected by Geographic information system and ALES software.

Table 3.2 Area divided by level of natural adaptation

Conscious	District	Commune	Agro-ecological zone	Coffee adaptation	Macadamia adaptation	Area (ha)	Structure (%)
Dak Nong	Dak Glong	Dak Som	Dak Som Coffee growing area (Zone 1)	N	N	1.040,46	7,14
				S1	S1	653,72	4,49
				S2	S1	5.000,01	34,31
					S2	618,19	4,24
Lam Dong	Dam Rong	Da K'Nang	Central Coffee growing area (Zone 2)	N	N	300,00	2,06
					S3	13,00	0,09
				S1	S2	97,01	0,67
				S2	S1	1.760,00	12,08
					S2	530,00	3,64
				S3	S3	700,00	4,80
		Phi Lieng	Central Coffee growing area (Zone 2)	N	N	137,07	0,94
				S2	S1	255,25	1,75
			Coffee growing area, large wood growing area in the North-East (Zone)	N	N	120,55	0,83
					S3	148,80	1,02
				S1	S1	2.647,48	18,17
				S2	S2	550,00	3,77
Investigated area to build soil quality map (ha)						**14.571,54**	**100%**
Area not investigated (ha)							**31.982,69**
Total natural area (ha)							**46.554,23**

In general, the natural adaptation ability of the two selected models (coffee and maca), has a large unsuitable area, and an unsuitable area larger than 10% of the investigated area. In addition, analysis of the suitability level according to agro-ecological zones in the central coffee growing area (Zone 2) in Phi Lieng commune and Da K'Nang commune shows that some zones are not naturally suitable for

cultivating trees Coffee in the area. This is the potential to develop and expand the area of macadamia trees in the future.

❖ Assess economic adaptability and identify potential LUTs

Economic adaptation assessment is only conducted for LUSs with natural adaptation levels of S3 or higher (S1, S2, S3). Economic adaptation is evaluated according to each specific economic indicator, including 3 indicators: (1) Total income (B), (2) Net profit (GM) and (3) Benefit-cost ratio (B/C). Through consultation with experts and actual investigation in the study area, the economic adaptability of potential LUTs is as follows:

Table 3.3 Natural adaptations of potential LUTs

District	**Commune**	**Natural Adaptation Coffee**	**Macadamia natural adaptation**	**Number of LMU**	**Area (Ha)**	**Structure (%)**
Dak Glong	Dak Som	N	N	2	1.040,46	7,14
		S1	S1	7	6.271,92	43,04
Dam Rong	Da K'Nang	N	N	1	13,00	0,09
			S1	1	300,00	2,06
		S1	S1	7	2.387,01	16,38
		S3	N	1	700,00	4,80
	Phi Lieng	N	N	3	406,42	2,79
		S1	S1	6	3.452,73	23,70
Total				**28**	**14.571.54**	**100**

- Coffee trees have 20/28 economically suitable LMUs with an area of 12.111,66 hectares (accounting for the highest proportion of 83,12% of the investigated area), there are 06 unsuitable LMUs with an area of 1.459,88 hectares (accounting for 10,02% of the investigation area);

- Macadamia trees have 21/28 LMUs that are very economically suitable with an area of 12.411,66 hectares (accounting for 85,18% of the investigated area), there are 07/28 LMUs that are not suitable with an area of 2.159,88 hectares (accounting for 14,82% of the investigation area). Economically unsuitable land units are mainly due

to low productivity affected by natural conditions. Therefore, some plots may be eliminated (no proposed future land uses) of economically inefficient (naturally adaptable) LUSs.

❖ Evaluating sustainable land adaptation

According to FAO's sustainable land assessment guidelines, combined with analysis of the natural and socio-economic conditions of the study area and consultation with experts in the fields of economics and agronomy, Land, environment,... have identified the main factors affecting the sustainability of LUSs in the study area. In particular, each element is a layer of information, overlaying maps of natural, economic, and social and natural-environmental adaptation to assess sustainable land adaptation. The results of sustainable land adaptation assessment in the study area are as follows:

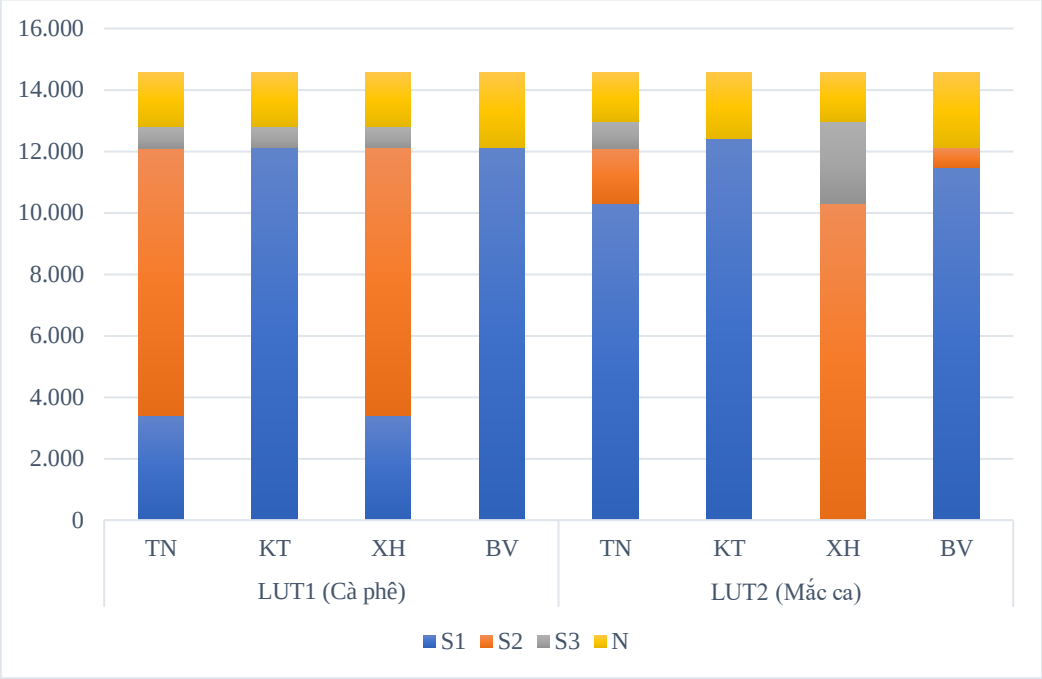


Figure 3.6 Comparison of natural, economic, social and sustainable adaptation assessment results

Comparing the results of assessing natural, economic and sustainable adaptation of land use types, presented in Figure 3.6 shows:

• LUT1 (Coffee): Natural adaptation area (S1+S2+S3) 12.811 ha. This is a perennial and main type of farming in the locality The economic efficiency is quite high, most

production costs are reduced thanks to the majority of family use, and an effective network creates high employment locally. The area of land units with a medium to low level of natural adaptation (S2, S3) all increased one level to a higher level of adaptation (S1), the total area of sustainable adaptation reached 12.112 hectares.

• LUT2 (Maca): Natural adaptation area (S1+S2+S3) 12.973 ha. This type of land use has high economic efficiency, but the local cultivation area is limited or intercropped with other agricultural models. When assessing sustainable adaptation, the adaptive area accounts for 11.485 million ha.

3.5 Solutions to improve livelihoods to reduce impacts on forest resources and environment of Ta Dung National Park

3.5.1 Proposed use of agricultural land

Overlaying the sustainable land adaptation map with the map of agricultural land use planning orientation to 2030 of Dam Rong district and Dak Glong district, the map suggests sustainable agricultural land use. Overlaying the map of proposed sustainable agricultural land use with the map of the current state of sustainable land adaptation. Due to the investigation of the entire agricultural land area, if the LMUs belong to the agricultural land use planning area, the level of sustainable land adaptation of the two coffee and macadamia farming models will be considered. If these LUTs have a low level of adaptation (S3) or no adaptation (N), it is recommended to change the appropriate model or for LMUs with similar adaptations to intercrop this promising LUT.

- In Dak Som Coffee growing area (Zone 1): this area is suitable for growing both types of coffee and macadamia, so it is possible to intercrop with coffee as the main crop. The area is suitable for intercropping model. occupies 6.271,92 hectares. Besides that, there are 1.040,46 hectares mainly due to unfavorable natural conditions for coffee cultivation that can be converted to other types of agricultural cultivation of other annual crops such as corn, cassava, and sweet potatoes.

- Central Coffee growing area (Zone 2): This area includes 02 communes Phi Lieng and Da K'Nang, this area has 627,01 hectares suitable for specialized coffee cultivation (in Da K'Nang commune) , there are about 2.015,25 hectares suitable for intercropping coffee and macadamia trees. In addition, there are 1.150,07 hectares that should be converted from the current status of coffee trees to other types of agriculture that bring economic value to people.

- Coffee growing area, growing large timber trees East - North (Zone 3): This area has 3.197,48 hectares suitable for intercropping coffee and macadamia in Phi Lieng commune, with 269,35 hectares not suitable for the current Status of coffee trees under cultivation.

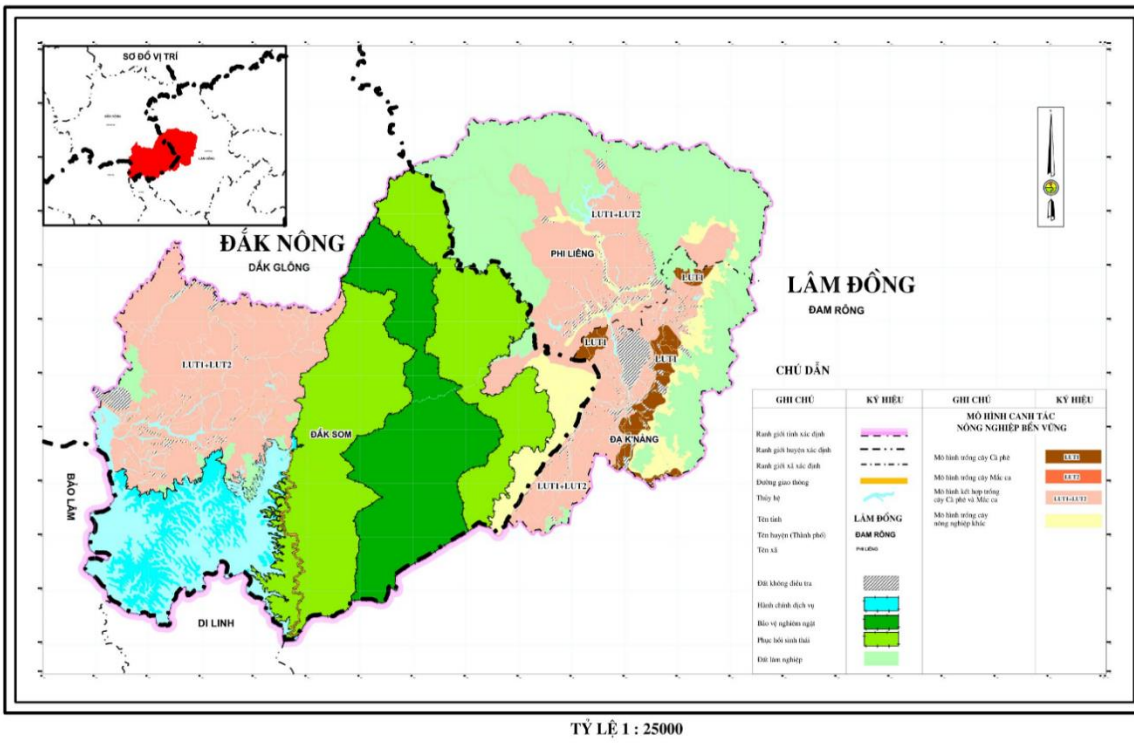


Figure 3.7 The map proposes a sustainable agricultural farming model

3.5.2 Proposing some solutions to deploy production models in the buffer zone combined with conservation of Ta Dung National Park

- Macadamia-Coffee intercropping model.

- Farm economic model.

- Ecotourism, resort, entertainment.

CONCLUSION AND RECOMMENDATIONS

Conclusion

Through the results of the investigation and survey, based on the actual land use situation and the assessment of economic, social and environmental efficiency, the suitability of existing agricultural farming models in the buffer zone of Ta Dung National Park. The research results show that in the study area, there are 02 main types of agricultural production, namely perennial crops (coffee, macca,...) and other annual crops (cassava, corn, beans,...) people's livelihood activities and tourism development in the buffer zone of the National Park have gradually changed the structure of land use and the land fund for the National Park has gradually narrowed. In addition, rising temperatures have increased the amount of runoff and increased agricultural drought conditions and reduced crop growth. In addition, the results of the weighting assessment of sustainability factors showed that the natural land adaptability factor had the highest weight (0.5719) among the sustainability factors. At the same time, the study has carried out agricultural ecological zoning and proposed a sustainable agricultural farming model, zoning and spatial layout of 02 models of coffee and macca. Specifically, as follows:

In the Dak Som Coffee growing area (Region 1): this area is suitable for growing both types of coffee and macca, so it can be planted intercropping with coffee as the main crop, the area suitable for planting the intercropping model accounts for 6,271.92 hectares.

The central coffee growing area (Region 2) in this area includes 02 communes of Phi Lieng and Da K'Nang, this area has 627.01 hectares suitable for specialized cultivation of coffee trees (in Da K'Nang commune), there are about 2,015.25 hectares suitable for intercropping coffee and macca trees.

Coffee growing area, planting large timber trees in the Northeast (Region 3)[1] this area has 3,197.48 hectares suitable for intercropping coffee and macadamia in Phi Lieng commune.

The results of the above study have shown the need to re-plan long-term agricultural crops in the buffer zone of the National Park. In addition, in order to develop sustainable livelihood models based on agricultural cultivation of people in the buffer zone of Ta Dung National Park, it is necessary to train human resources in integrated agroforestry techniques, provide suitable plant varieties and production tools, build community resource management and financial support through concessional loans. These solutions help reduce the pressure of forest exploitation, ensure stable income and protect the environment.

Recommendations

The research results of the new project only stop at the level of proposing sustainable land use for coffee and macadamia land use types and have not considered institutional sustainability factors; environmental factors such as (biomass, ecology); economic factors such as: time factor, discount rate and sensitivity in evaluating costs and benefits. Therefore, it is necessary to conduct a potential assessment for other crops, considering the above factors to comprehensively assess the potential of farming models to help livelihoods improve continuously over time. At the same time, this study has only been conducted for a small area, so the results are still local, and it is necessary to expand the research to areas with similar conditions to have more general results.

[1] Large wood trees suitable for region 3 such as native trees (Doi, Cheesy, Green Lim); wood trees combining Nong – Lam (Black Star, Mother-of-pearl).