

EFFICIENCY OF AGRICULTURAL LAND USE IN COASTAL ALLOY AREAS OF NINH BINH PROVINCE

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ABSTRACT

The coastal alluvial area of Ninh Binh province (former Kim Son district) has a natural area of 6,601.7 hectares, an area with annual alluvial deposits, favorable for agricultural and aquatic development. The study was conducted to evaluate the efficiency of land use in three aspects: economic, social and environmental. The results show that the area has four main types of land use with eight types of land use: specialized crops, annual industrial crops, perennial fruit trees and aquaculture. In which, aquaculture (especially brackish water fish, giant tiger prawns and clams) for the highest socio-economic efficiency, GTSX reached 472.97 million VND/ha. Perennial fruit trees (custard apple, grapefruit, longan) for average effect; specialized in color and sedge low efficiency. However, aquaculture groups have potential environmental risks, the risk of erosion and soil degradation. The study recommends replicating highly effective models, increasing the application of science and technology, improving irrigation and transport infrastructure, managing the use of pesticides and maintaining soil fertility towards sustainable land use.

Keyword: alluvial land, agricultural land use efficiency, solutions.

1. INTRODUCTION

Coastal alluvial area of Ninh Binh Province (formerly Kim Son district) has a natural area of 6,601.7 ha (agricultural land 2,958.1 ha; non-agricultural land 1,682.5 ha; unused land 1,961.2 ha). Kim Son alluvial area is located at the southeast peak of the Northern Delta. It is the place to receive the flow of the water volume contains a lot of sand and sediment of the Day River and Can River to deposit and expand into the sea.

With a variety of land use types suitable to the climate and soil properties of the region. Each effective land use type brings different economic, social and environmental effects.

On the other hand, because it is located at the peak of the Northern coastal plain, the Kim Son alluvial plain is directly affected and greatly devastated by storms and rising sea levels. This characteristic makes it difficult to plan solutions and steps to exploit and reasonably use coastal resources of Ninh Binh province.

2. RESEARCH METHODS

2.1. Method of selecting research sites

Through consulting with experts at the Department of Agriculture and Environment (formerly Kim Son district), I selected Kim Trung commune to study and evaluate land use efficiency.

Table 1. Main characteristics of two coastal alluvial ecological zones of Ninh Binh province

Content	Coastal alluvial areas
Terrain	Low terrain

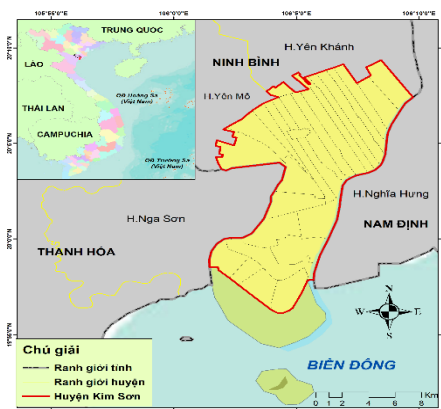


Diagram 1: Location of coastal alluvial areas of Ninh Binh province

Main types of production	Exploitation and aquaculture of aquatic products, especially shrimp, crab, clams, and crabs
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2.2. Investigation and data collection methods

Secondary data sources: collect available documents, data and materials from state agencies such as the Department of Agriculture and Environment and other relevant departments.

Primary data sources: Investigate data related to agricultural production, economic, social and environmental efficiency of land use types. Data collection is through household survey method .

2.3. Methods of synthesizing and analyzing data and documents

The statistics are processed using Excel software.

2.4. Method of evaluating land use efficiency

Evaluate land use efficiency in three aspects: economic efficiency, social efficiency and environmental efficiency.

* Economic efficiency

Economic efficiency is assessed through the following indicators:

Table 2. Classification of economic efficiency assessment indicators (Calculated for 1 hectare)

Rating level	Scoring scale	Production value (million VND)	Ltd. (Million VND)	HQĐV (Time s)
High	3	> 200	> 150	> 1.5
Medium	2	150 - 200	100 - 150	1 - 1.5
Short	1	< 150	< 100	< 1

The summary of economic efficiency classification of land use types is as follows:

- High economic efficiency (C): Land use type with total score of 3 criteria reaching $\geq 85\%$ of the highest score (9 points), equivalent to 7.65 - 9 points.
- Average economic efficiency (TB): Land use type has a total score of 3 indicators reaching 60 - < 85%, equivalent to 5.4 - < 7.65 points

- Low economic efficiency (T): Land use type has a total score of 3 indicators reaching < 60 % of the highest score (9 points), equivalent to < 5.4 points.

* Social efficiency

The summary of social efficiency rankings for land use types is as follows:

Table 3. Classification of social efficiency assessment indicators (Calculated for 1 hectare)

Rating level	Scoring scale	Labor Union (Work)	GTNC (Thousand VND)
High	3	> 550	> 200
Medium	2	400 - 550	125 - 200
Short	1	< 400	< 125

- The social efficiency of each land use type has a maximum total score of 6 points and a minimum of 2 points.

- High social efficiency (C): Land use type with total score of 2 indicators reaching $\geq 85\%$ of the highest score (6 points), equivalent to 5.1 - 6 points.

- Average social efficiency (TB): Land use type with total score of 2 indicators reaching 60 - < 85% of the highest score (6 points), corresponding to 3.6 - < 5.1 points.

- Low social efficiency (T): Land use type has a total score of 2 indicators < 60 % of the highest score (6 points), equivalent to <3.6 points .

* Environmental efficiency

Environmental land use efficiency is assessed through the following criteria:

Table 4. Indicators for evaluating the efficiency of agricultural land use

Economic efficiency	Social effectiveness	Environmental efficiency
-Production value - Intermediary costs -Mixed income	-Labor Value of labor day (thousand VND) - People's acceptance level:	-The impact of pesticides on the environment -Ability to protect and improve soil

Economic efficiency	Social effectiveness	Environmental efficiency
-Capital efficiency	+ Commodity products + Meet the needs of farmers + Reduce poverty rate + Attracting workers + Food security	(reduce the risk of erosion)

3. RESEARCH RESULTS

3.1. Theoretical basis

- *Land use system*: “A land use system is a specific type of land use carried out on a unit of land and related to investment, income and improvement capacity” (FAO, 1983). Land use in agricultural production reflects different activities such as cultivation, livestock, aquaculture, forestry... which have a close relationship with factors related to production such as technology, natural - economic - social conditions, production organization, and value chain (Ton That Chieu & Do Dinh Thuan, 1998).

- *Main land use types*: Land is an important resource for many uses (Dao Chau Thu & Nguyen Khang, 2002): Use on the basis of direct production such as cultivating land for growing crops, making grasslands, planting forests for timber; Use on the basis of indirect production such as making grazing land, livestock barns); Use for protection purposes (preventing land degradation, conserving biodiversity, protecting rare species). The above mentioned forms of land use are considered as the main types of land use. In the dawn of mankind when people only created agricultural products by planting holes to drop seeds or letting livestock roam freely on natural grasslands, these were the forms of the main type of land use called " *rain-fed farming*". Later, when irrigation was applied, people knew how to bring water from rivers and lakes into the fields to cultivate rice and crops. The main type of land use " *irrigated agriculture*" was born.

- *Land use type and land use pattern (Land Use Type - LUT)*: "Land use type is a picture describing

the land use status of an area with production management methods under determined natural, socio-economic and technical conditions" (Dao Chau Thu & Nguyen Khang, 2002): Land use type attributes include production processes, land management characteristics such as cultivation techniques, traction in tillage, technical investment and socio-economic characteristics such as market orientation, capital, labor, land ownership issues...

“Using agricultural land effectively through the arrangement of crop and livestock structures is one of the current issues of concern in most countries in the world. It not only attracts the attention of scientists, policy makers, and agricultural businesses, but also the needs of farmers, those who directly participate in the agricultural production process ” (Luc Thi Minh Hue, 2014) .

3.1.1. Classification of agricultural land use efficiency

* *Economic efficiency*

Economic efficiency is the main goal of all economic activities, reflecting the level of implementation of social needs. Economic efficiency is a socio-economic category reflecting the quality of production and business activities. Improving economic efficiency is an objective and urgent trend of social production. To improve economic efficiency, it is necessary to increase the use of available economic and natural resources in economic activities to serve the interests of people and society, which is an objective requirement of all social production.

* *Social efficiency*

Social efficiency in current land use is determined based on three factors including: One is the level of labor attraction: labor demand, job creation, and income increase. Two is the level of education and scientific understanding: the ability to apply scientific and technical advances to the production process. Three is the life of workers: total income, net profit, and value of working days. Land use is suitable for local farming practices.

* *Environmental efficiency*

Environmental efficiency is an important global issue and is increasingly being focused on, concerned about and cannot be ignored when

evaluating the efficiency of all production activities.

In agricultural production, environmental efficiency is a long-term efficiency, ensuring current benefits without adversely affecting the future. Therefore, the exploitation and use process must be closely linked with the protection of land resources and ecological environment.

Environmental efficiency is assessed based on the level of impact of production activities on the environment such as: causing damage or having negative impacts on the soil environment, water environment, air environment; having negative impacts on the living environment and biodiversity.

3.1.2 . Indicators for evaluating the efficiency of agricultural land use

** Basis for selecting indicators to evaluate the efficiency of agricultural land use*

- Objectives, objects and scope of research on evaluating the efficiency of agricultural land use.

- The need to develop or change the type of agricultural land use in the locality.

- The possibilities of natural, socio-economic conditions and new technical advances proposed for land use changes.

** Principles for selecting indicators to evaluate the efficiency of agricultural land use*

- + The system of assessment indicators must be unified, comprehensive and systematic. These indicators must have an organic relationship with each other and must ensure a scale of comparison.

- + To make an accurate and comprehensive assessment, it is necessary to identify the main indicators that represent true and correct efficiency according to the selected viewpoint and standards, and additional indicators to adjust the main indicators to make the economic content more fully and specifically expressed.

- + The indicators must be suitable to the characteristics and level of agricultural development in our country, and at the same time have the ability to be internationally compared in foreign relations, especially for products that can be exported to foreign markets.

- + The indicators must ensure practicality in the locality, scientific nature and must have the effect of stimulating production development.

** System of indicators to evaluate the efficiency of agricultural land use*

** Economic efficiency assessment indicators*

- + Economic efficiency calculated on 1 hectare of agricultural land

- Production value (T): Is the total value of material products and services created in a land use period (usually one year).

$$T = p_1 \cdot q_1 + p_2 \cdot q_2 + p_3 \cdot q_3 + \dots + p_n \cdot q_n$$

In there:

- + T: Total product value of 1 hectare of agricultural land/year

- + p: Is the volume of each type of product produced/ha/year

- + q: Price of each product on the market at the same time

- Intermediate costs (C_{sx}): Are all material costs converted into money used directly in the agricultural production process (seeds, fertilizers, labor, tools...).

- Mixed income (N): is the value of additional social products created during production time.

$$N = T - C_{sx}$$

- Labor day value (GTNC): Essentially, it is an assessment of the results of investing living labor for each type of land use and each type of crop as a basis for comparison with the opportunity cost of the worker.

$$GTNC = N / \text{number of laborers/ha/year}$$

- Capital efficiency (H): This is a relative indicator of economic efficiency, it shows the efficiency of using variable costs and service revenue.

$$H = N / C_{\text{production}}$$

** Social performance assessment indicators:*

- Ensure food security and stable people's lives;

- Meet the strategic development goals of the locality;

- Attracting more workers, increasing labor utilization, solving employment and increasing income for farmers;

- Education level, scientific understanding level and application of scientific and technological advances in production.

* Environmental performance assessment criteria

- Percentage of land area protected and improved

- Coverage ratio of land use types

- Ability to maintain and improve soil fertility, limit pollution caused by the use of fertilizers and pesticides

- Limit soil degradation and protect soil through appropriate land use.

Determining the environmental efficiency of agricultural land use is very complex and difficult to quantify, requiring long-term research and analysis using modern techniques. Our research topic only stops at assessing environmental efficiency through assessing the suitability of crops for soil conditions in the research area, through the results of investigations on investment in fertilizers, pesticides and the results of interviews with farmers about their comments on land use types.

3.2. Introduction to the research site

3.2.1. Current status of agricultural land use in coastal alluvial areas of Ninh Binh province

Table 5. Area and structure of agricultural land use in the coastal alluvial area of Ninh Binh province in 2024

Order	Soil type	Code	Acreage (ha)	Structure (%)
1.1	Agricultural land	Production	102.56	100
1.1.1	Land for annual crops	CHN	21.87	21.32
1.1.1.2	Other annual crop land	HNK	21.87	21.32
1.1.1.2.1	Flat land for growing other annual crops	BHK	21.87	21.32
1.1.1.2.2	Land for growing other annual crops	NHK	0	0
1.1.2	Land for perennial crops	CLN	80.69	78.68

(Source: Kim Son district land statistics in 2023)

Coastal areas , mainly saline land, includes 3 communes Kim Hai, Kim Trung and Kim Dong with total agricultural land area of 102.56 ha . Of which: Annual crop land is 21.87 hectares, accounting for 21.32% of agricultural land area; Land for perennial crops is 80.69 hectares, accounting for 78.68% of agricultural land area. This is a low-lying area with low nutrient content and poor phosphorus. The strength of the area is aquaculture development. The development direction of the area is to expand the aquaculture area. In addition, corn can be produced on land outside the beach, sedge can be grown, etc.

Table 6. Area of land use types in coastal alluvial areas of Ninh Binh province in 2024

Land type	use	Land type	use	Area (ha)
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Color specialist	1. NX - ND	7.2
Annual industrial crops	2. Sedge	8.9
Perennial fruit trees	3. Grapefruit	22.98
	4. Label	28.58
	5. Sodium	29.13
Aquaculture	6. Brackish water fish	8
	7. Tiger prawns	211
	8. Clams	70.23

There are four main types of land use in this area, including: specialized land, annual industrial crop land, perennial fruit tree land and aquaculture land.

- Specialized land use type with spring corn - winter corn land use type has the smallest area of 7.2 ha
- Annual industrial crops with sedge land use type 8.9ha
- Perennial fruit trees: Grapefruit area is 22.98ha, longan 28.58ha, custard apple 29.13ha
- Aquaculture: Brackish water fish 8ha, giant tiger prawn with the largest area 211ha, clam 70.23ha
- Perennial fruit trees: Grapefruit area is 22.98ha, longan 28.58ha, custard apple 29.13ha
- Aquaculture: Brackish water fish 8ha, giant tiger prawn with the largest area 211ha, clam 70.23ha.

3.2.2. Evaluation of economic efficiency

Evaluating the economic efficiency of land use types is a very important task and is one of the scientific bases for selecting promising LUTs in the future, which is the basis for solving the competition of many types of crops on a land area. However, depending on each region, depending on the development strategy of each stage, different

economic efficiency analysis indicators are used, thereby selecting the most suitable land use type for that region. The higher the indicators, the greater the economic efficiency. The economic efficiency assessment indicators of LUTs are the standards for evaluating the production efficiency of the agricultural sector compared to other sectors.

To assess the economic efficiency of LUTs in sub-regions, we conducted an economic analysis of the production process for the main land use types based on a household survey. The economic efficiency of land use types was assessed through indicators of productivity, output, production value, intermediate costs, added value and value per working day.

When evaluating economic efficiency, production results and costs are based on market prices at the time of determination. In the research topic, market prices in Kim Son district in 2020 were used.

Table 7. Economic efficiency of land use types in coastal alluvial areas of Ninh Binh province

Land use type	Land use type	Production value (million VND)	Point	Ltd (million VND)	Point	HQDV (times)	Point	Total score	Rating level
Color specialist	1. NX - ND	48,435	1	28,055	1	1,455	2	4	T
Annual industrial crops	2. Sedge	84.26	1	47.25	1	1.2	2	4	T
Perennial fruit trees	3. Grapefruit	161.49	2	101.43	2	1.66	3	7	TB
	4. Label	129.6	2	79.59	1	1.6	3	6	TB
	5. Sodium	225.84	3	143.67	2	1.72	3	8	C
Aquaculture	6. Brackish water fish	327.07	3	211.91	3	1.85	3	9	C
	7. Tiger prawns	323.41	3	186.45	3	1.36	2	8	C
	8. Clams	472.97	3	316.98	3	1.97	3	9	C

Source: Compiled from survey data

- Specialized LUT: This type of land use has the following specific average efficiency: GTSX reaches 48.435 million VND/ha; LTD reaches 28.055 million VND/ha; HQDV 1.455 times. With the land use type of Spring corn - Winter corn, the total score is 4 for low economic efficiency.

- Annual industrial crop LUT: in sub-region 1, the industrial crop grown is sedge. The production value reaches 84.26 million VND/ha; the LLC reaches 47.25 million VND/ha with a capital efficiency of 1.20 times. This type of land use has low economic efficiency with a total score of 4. The products of this LUT are mainly used to make products such as sedge mats, which are developed into commodity production.

- Perennial fruit tree LUT: Average production value reached 172.31 million VND; Limited liability reached 108.23 million VND/ha; HQDV was 1.66 times. This is a type of land use with average economic efficiency. There are 3 types of land use:

+ Grapefruit has average economic efficiency with a total score of 7, GTSX reaches 161.49 million VND/ha, LTD reaches 101.43 million VND/ha with capital efficiency of 1.66 times

+ Longan has a total score of 6 for average economic efficiency, GTSX reaches 129.6 million VND/ha, LTD reaches 79.59 million VND/ha with capital efficiency of 1.60 times

+ Custard apple is a very valuable crop, bringing the highest economic efficiency in this LUT (total score 8), GTSX reaches 225.84 million VND/ha, LTD reaches 143.67 million VND/ha with capital efficiency of 1.72 times.

- LUT aquaculture: Average production value reached 374.48 million VND; LLC reached 238.45 million VND/ha; HQDV was 1.72 times. This is the type of land use with the highest economic efficiency, specifically the types of land use are as follows:

+ Brackish water fish land use type has high economic efficiency with total evaluation score of 9, production value reaches 327.07 million VND/ha, LLC reaches 211.91 million VND/ha with capital efficiency of 1.85 times.

+ The land use type of Black Tiger Shrimp has high economic efficiency with a total score of 8, production value reaching 323.41 million VND/ha, mixed income reaching 186.45 million VND/ha with capital efficiency reaching 1.36 times.

+ Ngao land use type has the highest economic efficiency in LUT with a total score of 9, GTSX reaches 472.97 million VND/ha, LTD reaches 316.98 million VND/ha with capital efficiency of 1.97 times.

Thus, the LUT with the highest economic efficiency in sub-region 1 is the aquaculture LUT with the land use type of brackish water fish, giant tiger prawn, and clam. The LUT with the lowest economic efficiency in sub-region 1 is the specialized LUT with the land use type of spring corn - winter corn and the annual industrial crop LUT with the land use type of sedge.

- LUT specializing in rice: With the main land use type being Spring rice - Summer-Autumn rice, the economic efficiency is low, GTSX reaches 92.78 million VND/ha, LTD reaches 55.79 million VND/ha with capital efficiency of 1.375 times. Although the income is lower than other LUTs, the investment level for production is low, the income is stable due to less risk even when there are big fluctuations in weather and consumption market. The preservation and consumption of products of this LUT are also quite easy. Moreover, this LUT also has an important meaning in ensuring food security for the locality.

3.2.3. Evaluation of social effectiveness

* Evaluation of social efficiency of labor

Table 8 shows the labor investment level and average income per laborer of each LUT in the two sub-regions. Different LUTs have different labor attraction levels as well as labor day values. And in each LUT, each land use type and crop rotation formula has different labor attraction levels.

- LUT specialized in color: Spring corn - Winter corn land use type has an average labor cost of 465 but the value of a working day is only 60.33 thousand VND.

- Annual industrial crop LUT specifically sedge planting, this type of land use attracts a lot of labor 611 days, the highest in sub-region 1, but the value of labor day is not high compared to the general level of LUTs and reaches 77,33 thousand VND.

Table 8. Social efficiency of land use types in coastal alluvial areas of Ninh Binh province

Type of SDD	Usage type	Labor	Point	GTNC (thousand VND/work)	Point
Color specialist	1. NX - ND	465	2	60.33	1
Annual industrial crops	2. Sedge	611	3	77.33	1
Perennial fruit trees	3. Grapefruit	230	1	441	3

Aquaculture	4. Label	460	2	173.02	2
	5. Sodium	448	2	320.69	3
	6. Brackish water fish	472	2	448.96	3
	7. Tiger prawns	433	2	430.6	3
	8. Clams	482	2	657.63	3

Source: Compiled from survey data

- LUT perennial fruit trees: land use type: Grapefruit labor day is 230, labor day value is 441 thousand VND; Label labor day is 460, labor day value is 173,02 thousand VND; Na labor day is 448, labor day value is 320,69 thousand VND.

- LUT aquaculture has 3 types of land use for labor days and the highest labor day value in the whole region specifically as follows: Brackish water fish labor is 472, labor day value reaches 448.96 thousand VND; Tiger shrimp labor is 433, labor day value reaches 430.6 thousand VND; Clam labor is 482, labor day value reaches 657.63.

3.2.3. Environmental performance assessment

The soil protection and improvement capacity index is assessed at the average level at the annual industrial crop LUT, the remaining LUTs are at a low level. In particular, the aquaculture LUT is assessed at the lowest level because of the high risk of erosion, nutrient leaching and soil degradation.

The indicator of impact on the surrounding environment during cultivation is assessed as average at perennial fruit LUTs, because these plants are often affected by pests, especially during the flowering and fruiting stage, so people often have to spray pesticides on the plants during this stage. Other LUTs are assessed at a low level, meaning that they rarely use pesticides. Aquaculture LUTs are assessed as the lowest in this indicator, meaning that they have little impact on the environment because the amount of growth stimulants used for fish is insignificant.

3.3. Solutions to improve the efficiency of agricultural land use in coastal alluvial areas of Ninh Binh province

To improve the efficiency of agricultural land use in the area, I would like to propose some solutions as follows:

- Replicate types of land use with high economic efficiency such as aquaculture, specialized crops

and fruit trees; propagate high-quality crops with high economic efficiency such as custard apple and strictly control the production and supply of seed sources, research effective economic production models suitable to the production conditions of each region.

- Regularly open training courses and transfer scientific and technical advances to help farmers improve their understanding of agriculture, invest in building and consolidating internal irrigation systems, and find effective irrigation and drainage solutions.

- Prioritize upgrading and building new important traffic routes, especially routes from the district center to the commune centers and commune and village roads serving production, people's lives, and large agricultural production areas to facilitate farmers' travel and exchange of goods.

- Guide households and individuals to promote the application of science and technology in agricultural production to improve product quality, ensure product quality and market requirements.

- There needs to be a mechanism to manage the use of pesticides to reduce pesticide residues to ensure the soil, water and air environment. Develop a balanced fertilization process of N, P, K.

- To ensure sustainable land use in concentrated agricultural production areas, one of the basic measures that need attention is to maintain and improve soil fertility, provide nutrients to the soil for crops while minimizing the negative effects of intensive farming on soil quality and the environment.

4. CONCLUSION

The coastal alluvial plain of Ninh Binh province has 4 LUTs with 8 types of land use. Of which, the aquaculture LUT has the highest socio-economic efficiency, this is a common LUT in the sub-region. Although it is an LUT with socio-economic efficiency, it does not ensure environmental efficiency. The annual industrial crop LUT has high

environmental efficiency, socio-economic efficiency at low-medium level, the remaining LUTs have medium-low land use efficiency.

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