THAI NGUYEN UNIVERSITY
THAI NGUYEN UNIVERSITY OF AGRICULTURE AND FORESTRY

RESEARCH ON THE POTENTIAL OF AGRICULTURAL LAND IN THE DIRECTION OF COMMODITY PRODUCTION IN DINH HOA DISTRICT, THAI NGUYEN PROVINCE

Major: Land Management
Code: 9 85 01 03

SUMMARY OF DISSERTATION LAND MANAGEMENT

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PUBLISHED WORKS RELATED TO THE DISSERTATION

1. Truong Thanh Nam, Nguyen Ngoc Nong and Le Van Tho (2017). Results of research on building a slope database from worldwide elevation data (ASTER GDEM) to serve the assessment of land potential land and propose solutions to use sloping land in Dinh Hoa district, Thai Nguyen province. Vietnam journal of Agriculture & Rural Development, October 2017, pp. 196-202.

2. Truong Thanh Nam and Nguyen Ngoc Nong (2021). Research on land resource characteristics of Dinh Hoa district, Thai Nguyen province. Journal of Soil Science, No. 65/2021, pp. 18-24.

MỞ ĐẦU

1. Introduction

Vietnam is on the path of integration and strong development. The process of urbanization and industrialization is increasing, putting great pressure on land, especially agricultural land funds.

Dinh Hoa is a mountainous district of Thai Nguyen province, the district center is 50km from Thai Nguyen City along National Highway 3. Agriculture is still the main production sector in the district's economic structure. The XXIII Dinh Hoa District Party Congress determined that agricultural and forestry production development is still the main force and spearhead in developing the district's economic structure, helping farmers escape poverty and get rich. However, investment in development is not much and has not fully exploited the district's potential and strengths. Crop restructuring towards commodity production is currently taking place in most communes in the district, forming a number of concentrated production areas such as bao thai rice in Bao Cuong commune, tea in Thanh Dinh commune. ,...creating many high-quality agricultural products, contributing to the formation of agriculture towards commodity production. However, there are not many commodity production areas, there is a lack of detailed planning, there is no orientation for developing key agricultural products for the district, and there are no in-depth and comprehensive studies for agricultural development in the direction of agriculture. commodity production.

To implement the above contents, it is necessary to evaluate the current status of agricultural land use in Dinh Hoa district, the land potential for commercial agricultural production as well as the consumption market for the district's agricultural products from Having directions and solutions for using agricultural land in the coming time is necessary. Based on the above practice, the implementation of the project **"Research on the potential of agricultural land in the direction of commodity production in Dinh Hoa district, Thai Nguyen province"** is very necessary and meaningful.

2. Goals

Assess the potential of major land use types for commodity agricultural production and propose solutions for sustainable land use

and commodity development in Dinh Hoa district, Thai Nguyen province.

3. Research objects and scope

3.1. Research objects

- Agricultural land fund associated with agricultural land use types in the direction of commodity production and related issues;
- Households and individuals using land for agricultural production.

3.2. Research scope

- Spatial scope: Agricultural land fund has the ability to exploit and use to serve the development of commodity agricultural production within the administrative boundaries of Dinh Hoa district, Thai Nguyen province.

- Time scope: Secondary survey data taken during the period 2015 - 2020; Survey data on land use efficiency was taken in the period 2018-2010; Current land use status as of December 31, 2020; Prices of agricultural products taken in 2020.

- Scope of research content: The dissertation focuses on researching main agricultural crops that have the ability to develop into commodity crops.

4. Scientific and practical significance of the dissertation

- Scientific significance: Provides a scientific basis for proposing commodity-oriented agricultural land use, supplementing the methodology for assessing land potential to serve sustainable land use planning .

- Practical significance: Supplementing the database on land, land potential, suitability for some commodity crops to serve the effective management and use of land resources of Dinh Hoa district , Thai Nguyen province.

5. The new Findings of the Dissertation

Identifying land potential for commodity-oriented agricultural production in Dinh Hoa district, Thai Nguyen province.

Select and propose agricultural land use directions for 04 types of crops in the direction of commodity production suitable to the characteristics and land properties of Dinh Hoa district including: Bao Thai rice, Maize, Tea, and Cinnamon, as the basis for the process of restructuring the agricultural industry towards efficiency and sustainability. On the basis of appropriate assessment of land and

production conditions, the area for crop development by 2030 has been determined as follows: Bao Thai rice 2,000 hectares; Corn 1,200 hectares; Tea 3,000 hectares and cinnamon 5,000 hectares.

CHAPTER 1
RESEARCH OVERVIEW

1.1. Theoretical basis for commodity agricultural land use

1.1.1. Concepts

- Land
- Agricultural land
- Agriculture production land
- Commodity
- Commodity agriculture...

1.1.2. Use agricultural land in the direction of commodity production

- Use of agricultural land
- The need to build commodity agriculture.
- Some factors affecting commodity-oriented agricultural land use.

1.1.3. Effective use of agricultural land in the direction of commodity production

- Efficient land use
- Types of effective agricultural land use

1.2. Evaluate soil for commodity agricultural production

1.2.1. Land assessment methods for commodity agricultural production

- Soil evaluation of some countries around the world
- Soil assessment method according to FAO instructions

1.2.2. Applying multi-criteria evaluation method (MEC) and geographic information system (GIS) in land assessment

- Applying multi-criteria evaluation (MCE) method in land assessment
- Integrating multi-criteria land evaluation (MCE) and geographic information system (GIS) in soil assessment

1.3. Some studies on assessing land potential for commodity agricultural production

Over the past 15 years, many district-level land assessment researchs have been carried out. Some typical works include: Le Thai Bat (2010); Do Thi Tam and Le Xuan Lam (2014); Vu Thi Thuong and Cao Viet Ha (2014); Vu Thi Hong Hanh and Tran Minh Tien (2015); Nguyen Minh Thanh and Tran Thi Nham (2015, 2016); Phan Van Khue et al (2016); Do Van Nha et al (2016) Nguyen Dac Luc et al (2019)…

1.4. Comments drawn from research overview

There are not many studies on assessing land potential to serve the orientation of land use for commercial agricultural production in Thai Nguyen province. The main studies are on investigating, classifying and mapping soil map provincial scope. Therefore, the author's choice of research topic and location has scientific and practical significance.

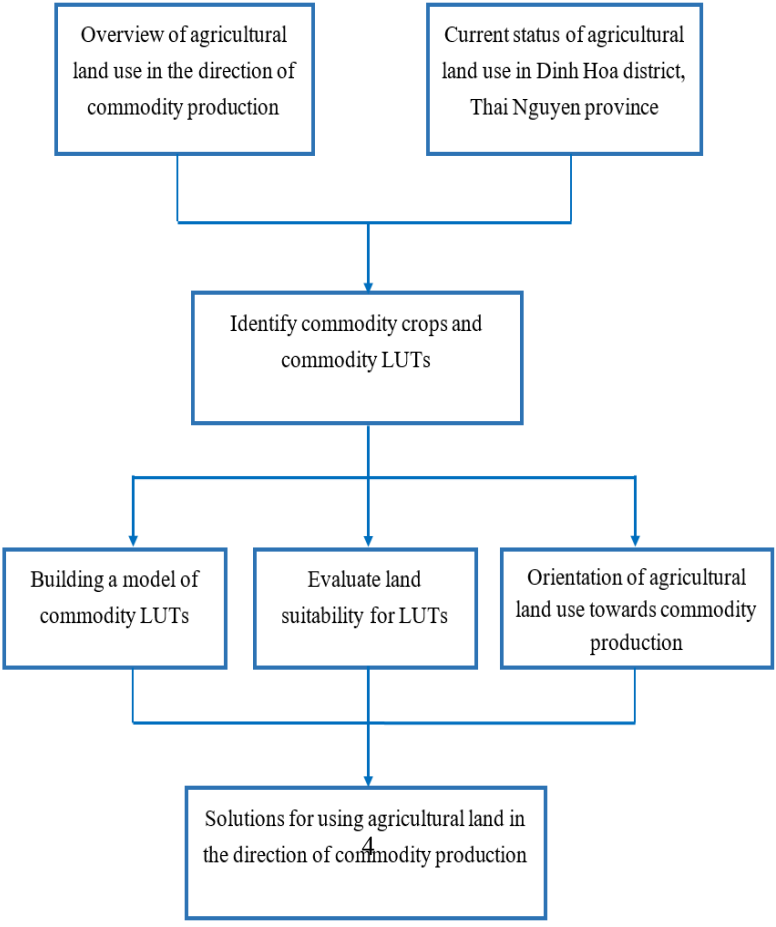


Figure 1.1. Research framework of the research

Chapter 2
RESEARCH CONTENT AND METHODS

2.1. Research content

- Natural, socio-economic conditions
- Current status of agricultural land use
- Select and monitor commodity-oriented agricultural land use models
- Assess land suitability for commodity-oriented agricultural production
- Orientation and solutions for commodity-oriented agricultural land use.

2.2. Methods

2.2.1. Secondary data collection method

Collect all relevant documents available at the Department of Natural Resources and Environment, Department of Agriculture and Rural Development in Thai Nguyên province; Department of Natural Resources and Environment, District Department of Agriculture and Rural Development, Statistics Office in Dinh Hoa district.

2.2.2. Primary data investigation method

Conduct surveys and interviews with farmers using questionnaires and collect information related to the process of agricultural production development, types of crops, land use types and types of land use in the area. The number of survey questionnaires is determined according to the Slovin formula, the number of households surveyed for communes and towns is 360 households in 6 communes representing sub-regions: Sub-region 1: select Tan Duong and Lam Vy communes; Sub-region 2 selected Bao Cuong and Trung Ho communes, and Sub-region 3 selected Son Phu and Diem Mac communes.

2.2.3. Method for evaluating economic efficiency of land use types and types of land use

a. Economic efficiency: Applying instructions for evaluating the effectiveness of land use types according to standard 8409:2012 of the Ministry of Agriculture and Rural Development including: Production value: Calculated by total value in money (VND) of the product obtained by the land use type/ha/year. Production value (GTSX) = Product yield x Selling price; Intermediate costs (CPTG) = Material costs (million VND/ha) + Labor costs (million VND/ha) + Other costs (million VND/ha); Mixed income (TNHH) = Production value - intermediate costs; Capital efficiency: Capital efficiency = Production value/Intermediate costs. The hierarchy to evaluate the economic efficiency of land use types includes 3 levels in table 2.1.

Table 2.1. Decentralized criteria to evaluate economic efficiency

Level	**Point Ladder**	**Production value/ha** *(million VND)*	**Mixed income/ha** *(million VND)*	**Capital efficiency/ha** *(times)*
High	3	> 80	> 60	>=1.5
Medium	2	60-80	40-60	1.2-1.5
Low	1	<60	<40	<1.2

High economic efficiency (H): Grades from 8 to 9;

Moderate economic efficiency (M): Grades from 6 to 7;

Low economic efficiency (L): Grades less than or equal to 5;

b. Social efficiency: Indicators to evaluate the social efficiency of LUTs are based on the criteria in table 2.2. Summary of social efficiency ratings for types of land use as follows: High social efficiency (H) with grades between 8 and 9; Moderate social efficiency (M) with grades from 6 to7; Low social efficiency (L) with grades less than or equal to 5.

Table 2.2. Decentralized criteria to evaluate social efficiency

Level	**Point**	**Ability to**	**Value of workdays**	**People's acceptanc**

	Ladder	attract labor (per day)	(1000vnd/ per day)	e level (%)
High	3	>400	≥ 120	>70
Medium	2	300-400	80-120	50-70
Low	1	<300	<80	<50

c. Environmental efficiency: Considered on the basis of assessing the appropriateness for land use types through the criteria in table 2.3.

Table 2.3. Assessment hierarchy criteria environmental efficiency

rder	Criteria	Grade/rating		
		3	2	1
	Erosion protection coverage level (%)	> 70	> 50 - 70	< 50
	Amount of pesticides for plants	Use exactly/ less than	As recommended, mainly use	Not as recommended

		recommended	chemical pesticides	
	Level of fertilizer use	Use as recommended	Fertilization level differs from recommended by ≤10%	Fertilization level differs from recommended by >10%

Summary of environmental efficiency ratings for land use types as follows: High environmental efficiency (H) with grades between 8 and 9; Moderate environmental efficiency (M) with grades from 6 to7; Low environmental efficiency (L) with grades less than or equal to 5.

2.2.4. Method for determining commodity land use type

According to the criteria for determining commodity crops, the selected commodity crops of Dinh Hoa district ensure at least 02 of the following 03 criteria:

- Has a large proportion of agricultural products (≥70%) and has prospects for developing domestic and foreign markets;

- Have a large enough output and concentrated area to be able to develop commodity production areas; The output must be guaranteed to exceed the consumption needs of people in the district; Concentrated area to form raw material areas with a scale of ≥1% of the total agricultural land area of the district;

- High economic efficiency.

2.2.5. Method of model selection and development

Representative models were monitored in 3 years 2018, 2019 and 2020, the main tracking content was: crop type, land use type, production costs, crop productivity, labor, market consumption, development policy, soil maintenance and protection.

2.2.6. Soil sampling and analysis methods

The survey took samples and applied the soil investigation and mapping process of the Ministry of Science and Technology according to national standards TCVN 9487:2012. The number of studied sections is 144 sections, including 78 main sections and 66 secondary sections. Soil analysis results are the basis for adjusting and building a soil map of Dinh Hoa district at a scale of 1/50,000.

2.2.7. Soil evaluation method

* The soil map was built according to national standard TCVN 9487:2012 on Procedures for investigating and making medium and large scale soil maps.

Spatial map analysis method: Using geographic information system (GIS) computer software tools, overlay map layers to analyze the spatial distribution of different types of land.

*** Soil assessment method according to FAO**

Maps are built, edited and analyzed on geographic information system (GIS) software such as Micro Station, ArcGIS, Mapinfo. Standardize data, synthesize and manage data and present maps on Mapinfo software at a scale of 1/50,000, presented in the appendix with a diagram at a scale of 1/175,000.

*** Multi-criteria analysis method (MCE)**

Use the MCE multi-criteria evaluation method to synthesize hierarchy and evaluation.

2.2.8. Method of consulting experts

Conduct consultations with experts and scientists with in-depth experience and expertise on the research issue. At the same time, consult with professional staff at the Department of Natural Resources and Environment, Department of Agriculture of Dinh Hoa district, some officials at the Department of Agriculture and Rural Development of Thai Nguyen province... about the importance of the criteria in the multi-criteria evaluation method (MCE).

2.2.9. Statistical and data processing methods

Use support programs: Word, Excel, SPSS to process survey data and data collected from evaluation models during the research process.

Chapter 3
RESULTS AND DISCUSSION

3.1. Natural, socio-economic conditions related to agricultural land use

3.1.1. Natural condition

Dinh Hoa is a mountainous district located in the West - Northwest of Thai Nguyen province, the district center is 50km from Thai Nguyen City along Highway 3.

3.1.2. Socio-economic conditions

The value of agricultural, forestry and fishery production (at current prices) by 2020 will reach 1,925,000 million VND, an increase of 78.35% compared to 2015; The production value of Industry - Handicrafts in 2020 (at current prices) reached 325,000 million VND, an increase of 81.56% compared to 2015. Average income per capita increased from 25 million VND in 2015 to 43.8 million VND 2020.

3.2. Assess the current status of agricultural land use

3.2.1. Current status and changes in land use in the period 2015-2020

The total natural land area of the district according to land statistics results as of December 31, 2020 is 51,351.90 hectares. The area put into use reaches 99.71% of the total natural area; The area not yet put into use is 147.97 hectares, accounting for 0.29%.

3.2.2. Agricultural land use types in the district

In 2020, in Dinh Hoa district, there are mainly 10 land use types (LUT). The main and dominant land use type is still forestry land with an area of 35,582.33 hectares, accounting for 69.26% of the total natural area and 73.94% of the agricultural land area; Agricultural land is 11,049.63 hectares, accounting for 23.65% of agricultural land area; Aquaculture land is 1,152.68 hectares.

3.2.3. The selection of commodity crops

3.2.3.1. Identify commodity crops according to commodity ratio and market development prospects

To determine the ability of the district's main agricultural products to become commodity products, the project investigated in 400 agricultural households the proportion of main agricultural products produced in households, the level and ability to consume agricultural products as well as channels to consume these agricultural products. The results are shown in table 3.1.

Table 3.1. Consumption form of main agricultural products and rate of sale to the market

Order	Products	Commodity rate (%)		Consumption level	Object
		Used	*Sale*		
1	Spring rice	80	20	High	Small trader
2	Winter rice	40	60	High	Small trader
3	Corn	30	70	High	Small trader
4	Sweet potato	90	10	High	Small trader, self-selling
5	Potato	90	10	Moderate	Small trader, self-selling
6	Vegetables	30	70	Moderate	Small trader, self-selling
7	Beans	20	80	Moderate	Small trader
8	Peanuts	40	60	Moderate	Small trader, self-selling
9	Cassava	5	95	Moderate	Small trader
10	Orange	40	60	Moderate	Small trader
11	Mango	30	70	High	Small trader, self-selling
12	Lychee	20	80	Moderate	Small trader, self-selling
13	Grape Fruits	30	70	High	Small trader, self-selling
14	Custard apple	5	95	High	Small trader
15	Tea	2	98	High	Small trader
16	Polyscias fruticosa	0	100	High	Small trader
17	Gynochthodes officinalis	0	100	High	Small trader
18	Cinnamon	0	100	High	Small trader

Source: Compiled from investigation results

So with this criterion, the plants that can become the main agricultural commodity crops of the district according to this criterion are selected: Bao Thai rice, corn, tea and cinnamon.

3.2.3.2. Identify commodity crops based on yield and area criteria

The crop structure of Dinh Hoa district in recent years has changed in the direction of developing long-term industrial crops (tea) and medicinal plants. So with this criterion, the trees that can become the main agricultural commodities of the district include: Bao Thai rice, corn, tea and cinnamon.

3.2.3.3. Determine the effectiveness of land use types and types of land use with commodity potential

a. Economic efficiency of land use: In general, the economic efficiency of land use types for annual crops in the three sub-regions is not much different, but the efficiency of types of land use for tea in the third sub-region is higher than the first and second sub-region. The reason is because the third sub-region has favorable terrain, suitable for tea growing, more concentrated production scale, better farming techniques so it has high productivity, easy consumption and high economic efficiency.

Table 3.2. Economic efficiency of types of land use for commodity

Order	Plants	Sub-region	Production value	Intermediate costs	Mixed income	Capital efficiency (times)	Total Grade	Level
			(million vnd)					
1	Bao thai rice	1	43.22	19.53	23.69	1.2	5	Low
		2	45.04	20.01	25.02	1.3	5	Low
		3	44.01	19.95	24.06	1.2	5	Low
2	Corn	1	28.89	12.68	16.21	1.3	5	Low
		2	29.02	12.74	16.28	1.3	5	Low
		3	28.53	12.05	16.48	1.4	5	Low
3	Tea	1	142.67	46.00	96.67	2.1	9	High
		2	140.78	45.75	95.03	2.1	9	High
		3	141.55	47.38	94.17	2.0	9	High
4	Cinnamon	1	1150.08	223.08	927.00	4.2	9	High
		2	1015.05	215.05	800.00	3.7	9	High

Order	Plants	Sub-region	Production value	Intermediate costs	Mixed income	Capital efficiency (times)	Total Grade	Level
			(million vnd)					
		3	1020.02	220.02	800.00	3.6	9	High

b. Social efficiency: The results of synthesizing survey data on indicators of social efficiency criteria of land use types and type of land use by 3 sub-regions are shown in table 3.3.

Table 3.3. Social efficiency of types of land use for commodity

Plants	Sub-region	Workdays	Value per workday (1000vnd)	People's acceptance level (%)	Total grade	Level
Bao thai rice	1	185	98,34	90	8	High
	2	186	103,14	92	8	High
	3	185	101,06	92	8	High
Corn	1	220	82,77	70	6	Moderate
	2	220	83,09	75	6	TB
	3	219	84,38	68	5	Low
Tea	1	450	174,82	95	9	High
	2	450	171,18	90	9	High
	3	450	173,71	96	9	High
Cinnamon	1	465	1778,49	90	9	High
	2	465	1505,38	85	9	High
	3	465	1505,38	90	9	High

c. Environmental efficiency

Table 3.4. Summary of environmental efficiency of types of land use for commodity

Type of land use	Land cover time *(day/year)*	Land cover ability *(%)*	Level of assessment of land cover ability
Bao thai rice	160	44	High
Corn	80	22	High
Tea	365	100	Low
Cinnamon	365	100	Low

Table 3.5. Results of effective decentralization of types land use for commodity

Type of land use	The first sub-region				The second sub-region				The third sub-region			
	E-E	*SE*	*EE*	*Level*	*E-E*	*SE*	*EE*	*Level*	*E-E*	*SE*	*EE*	*Level*
Bao thai rice	L	H	M	M	L	H	M	M	L	H	M	M
Corn	L	M	L	L	L	M	L	L	L	L	L	L
Tea	H	H	H	H	H	H	H	H	H	H	H	H
Cinnamon	H	H	H	H	H	H	H	H	H	H	H	H

In which:

E-E: Economic efficiency;

SE: Social efficiency,

EE: Environmental efficiency

L: Low; M: Moderate; H: High

From the above analysis results, it can be seen that with the commodity crops of Dinh Hoa district, the highest efficiency in all three economic, social and environmental aspects is tea and cinnamon. Other crops need to apply a number of additional solutions to improve production efficiency and protect the environment.

3.2.3.4. Identify commodity and prospective crops

Table 3.6. Commodity crops and market prospects

Criteria	Bao Thai rice	Corn	Tea	Cinnamon
Commodity rate (%)	80	70	100	100
Market	Domestic market	Domestic market	Domestic market + export	Domestic market

development prospects				
Yields (ton)	25,412.0	4,241.0	2,772.5	2,400.0
Concentration area	Sub-region No.2,3	Sub-region No.1,2,3	Sub-region No.3,2,1	Sub-region No.1,2,3
Economic efficiency	Moderate	Low	High	High
Product Quality	Good quality and brand	Good quality	Good quality and brand	Good quality
Evaluation	Need to improve and enhance economic efficiency	Need to improve and enhance economic efficiency	Increase cultivation area according to international standards, focusing on many international markets	Increase cultivation area

Through the above analysis, it is shown that to become a commodity crop, it is required to achieve a high commodity ratio, have market development prospects, have large enough output, have a concentrated area, and Economic efficiency is average or higher, agricultural products are of good quality, basically the selected crops meet the stated criteria.

3.3. Select and monitor a number of commodity-oriented land use models

3.3.1. Model 1: Bao Thai rice

a. Economic efficiency: Results of monitoring the Bao Thai rice model for 3 years from 2018 - 2020 show: Average production value reached 49.13 million/ha; Intermediate cost is 20.98 million/ha, mixed income is 28.14 million/ha/year; Average capital efficiency reached 2.34 times.

Table 3.7. Economic efficiency of the Bao Thai rice model

Year	Production value (million vnd/ha)	Intermediate cost (million vnd/ha)	Mixed income (million vnd/ha)	Capital efficiency (times)	Grade
2018	48.68	21.97	26.71	2.22	C
2019	49.45	20.01	29.44	2.47	C
2020	49.26	20.98	28.28	2.35	C
Average	**49.13**	**20.98**	**28.14**	**2.34**	**C**

b. Social efficiency: Bao Thai rice growing model requires an average of 219 workdays/ha/year, of which the average family labor usage is 122 workdays/ha/year, social labor is 95 workdays/ha/year, the average value of workdays is 230.68 thousand VND. This is a land use model that many households in the research area participate in production, because this model has become a commodity product, an OCOP product of Dinh Hoa district.

c. Environmental efficiency: Bao Thai rice planting model has a coverage time of about 110 days/year, reaching 30.1%.

3.3.2. Model 2: Corn

Table 3.8. Economic efficiency of the corn growing model

Year	Plant	Production value *(million vnd/ha)*	Intermediate cost *(million vnd/ha)*	Mixed income *(million vnd/ha)*	Capital efficiency *(times)*	Grade
2018	Corn	34.55	14.20	20.35	2.43	Moderate
2019	Corn	35.10	14.50	20.60	2.42	Moderate
2020	Corn	35.20	14.10	21.10	2.50	Moderate
Average	Corn	**34.95**	**14.27**	**20.68**	**2.45**	**Moderate**

a. Economic efficiency: Results of monitoring the model for 3 years from 2018 - 2020 show: Average production value reached 34.95 million/ha; Intermediate cost is 14.27 million/ha, Mixed income is 69.29 million/ha/year; Average capital efficiency reached 2.45 times.

b. Social efficiency: The winter corn growing model requires an average of 280 workdays/ha, with an average labor cost of 72.68 thousand VND. This model is suitable for the level, capacity, and production practices of households and localities; On the other hand, the model also provides high economic and social efficiency, the products are created with the purpose of serving the daily needs of households, as well as people in the district.

c. Environmental effectiveness: Regarding the level of pesticide use in production, commonly used pesticides are Golnitor and Antaco, however the dosage is less than the amount of pesticide recorded on the product packaging and the amount used by recommended by authorities.

3.3.3. Model 3: Tea

a. Economic efficiency: Results of monitoring the CLV18 industrial tea model for 3 years show that: Average production value reached 140.11 million VND/ha, mixed income reached 90.88 million VND/ha, however, tea cultivation had Investment costs are high at 49.23 million VND/ha, capital efficiency is 2.85 times. This is also a model with very high economic efficiency, with an average annual yield of about 20.76 tons of tea leaf. On the other hand, the consumption market is stable because there are tea factories that purchase raw materials product processing.

Table 3.9. Economic efficiency of the tea model

Year	**Plant**	**Production value** *(million vnd/ha)*	**Intermediate cost** *(million vnd/ha)*	**Mixed income** *(million vnd/ha)*	**Capital efficiency** *(times)*	**Level**
2018	Industrual tea	157.62	50.52	107.1	3.12	High
2019	Industrual tea	159.57	50.89	108.68	3.14	High
2020	Industrual tea	160.31	51.08	109.23	3.14	High
	Average	**159.17**	**50.83**	**108.34**	**3.13**	**High**

b. Social efficiency: Industrial tea raw materials are grown in a model with a 25-year cycle. This land use model requires about 385 workdays/ha/year, the average workday value reaches 376.56 thousand VND/day. Growing raw tea contributes to high income for

households, this is also a product that can develop commodity production.

c. Environmental efficiency: Tea is a perennial crop, so the coverage time also reaches 100%.

3.3.4. Model 4: Cinnamon

a. Economic efficiency: Results of monitoring the cinnamon growing model for 3 years (2018-2020) are as follows: Average production value reached 585 million VND/ha, intermediate costs were 108.07 million VND/ha, mixed income reached 476.93 million VND/ha, the capital efficiency reached 5.41 times

Table 3.10. Economic efficiency of the cinnamon growing model

Year	Plant	Production value *(million vnd/ha)*	Intermediate cost *(million vnd/ha)*	Mixed income *(million vnd/ha)*	Capital efficiency *(times)*	Level
2018	4th year	350	101.51	248.49	3,45	High
2019	5th year	580	110.64	469.36	5,24	High
2020	6th year	825	112.07	712.93	7,36	High
Average		**585**	**108.07**	**476.93**	**5.41**	**High**

b. Social efficiency: The cinnamon growing model requires about 425 workdays/ha/year, the value of a workday reaches 1,215.62 thousand VND/workday. Cinnamon is considered a high-value commodity that not only helps alleviate hunger and reduce poverty but also contributes to improving the household economy, helping households become rich in recent times.

c. Environmental effectiveness: Cinnamon's ability to protect soil and limit soil degradation due to erosion and leaching is rated at a high level. Regarding the level of pesticide use, cinnamon trees do not use pesticides, mainly use organic fertilizers, households have invested in the right amount of fertilizer according to the procedures and recommendations of the authorities.

3.4. Evaluate land suitability for commodity-oriented agricultural production

3.4.1. Establish land units map

The land units map is built from the overlap of thematic maps and hierarchy of indicators, including: (1) Soil map; (2) Soil layer thickness map; (3) Mechanical component map; (4) Irrigation mode map, (5) Slope map.

Table 3.12. Criteria for building land unit map

Criteria	Criteria hierarchy	Code
1. Soil	Yellow-red soil on clay and metamorphic rocks	G1
	Red-brown soil on basic and neutral magma rock	G2
	Yellow brown soil on ancient alluvium	G3
	Reddish brown soil on limestone	G4
	Red yellow soil on acid magma rock	G5
	Light yellow soil on sandstone	G6
	Alluvial soil in streams	G7
	Valley land due to sloping products	G8
2. Soil layer thickness	> 100cm	D1
	> 70 - 100 cm	D2
	> 50 - 70 cm	D3
3. Mechanical components	Heavy	P1
	Moderate	P2
	Light	P3
4. Irrigation mode	Proactive	Ir1
	Inproactive	Ir2
5. Slope	Below 3^0	Sl1
	3^0- $<8^0$	Sl2
	8^0- $<15^0$	Sl3
	15^0- $<20^0$	Sl4
	20^0- $<25^0$	Sl5
	25^0- $<30^0$	Sl5
	30^0- 35^0	Sl7
	Above 35^0	Sl8

3.4.2. Build thematic maps

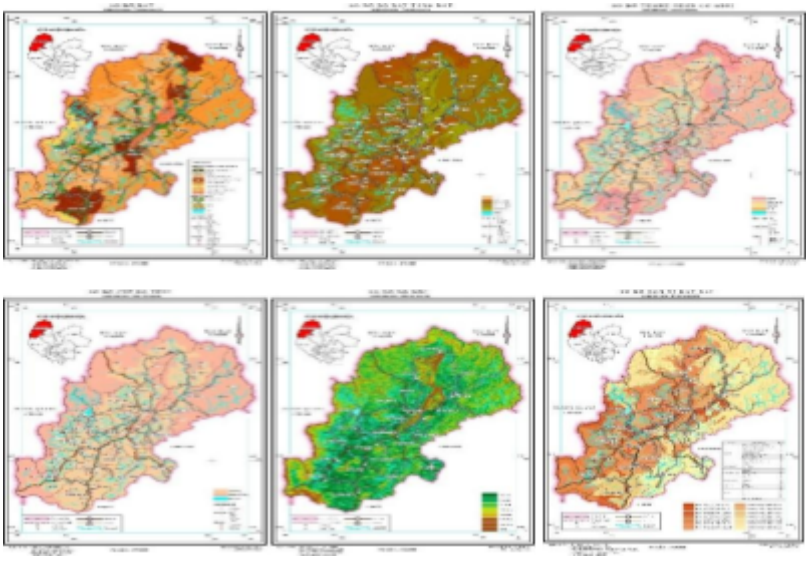
With the selected criteria, thematic maps are built on the basis of soil map, topographic map and land use status map including 5 types: Soil layer thickness map, Mechanical components map, slope map, irrigation mode map and soil map. Simple maps are built, edited and analyzed on ArcGIS and Mapinfo at a scale of 1/50,000.

3.4.3. Land units map

Table 3.13. Summary of area size and characteristics of land units

MU	LMU characteristics (G,De,T,Ir,Sl)	rea ha)	MU	LMU characteristics (G,De,T,Ir ,Sl)	A rea (ha)
	31224	,55	8	21213	5 3,20
	83113	,67	9	71222	5 5,32
	83121	,98	0	62321	5 8,23
	83121	,06	1	41221	5 8,78
	21221	,47	2	52221	6 0,56
	…….				
6	52224	8,13	33	52211	6 259,63
7	12312	2,42			

G: *Soil type****;*** ***De:*** *Soil layer thickness****,*** ***T:*** *Mechanical components****,*** ***Ir:*** *irrigation mode****,*** ***Sl:*** *Slope*



Soil layer thickness map, Mechanical components map, slope map, irrigation mode map and soil map

The land units map of Dinh Hoa district was built from overlaying 5 thematic maps using the map overlay method. The results have identified 133 land units out of a total of 266 land plots with characteristics and properties presented in detail. The area of land unit ranges from 0.55 hectares to 6259.63 hectares.

3.4.4. Land suitability assessment for commodity land use types

3.4.4.1. Determine land use requirements of commodity land use types

Table 3.14. Land use requirements of commodity crops

Plant	Suitable level	Soil type (G)	Soil layer thickness (De)	Mechanical components (T)	Slope (Sl)	irrigation mode (Ir)
Bao Thai rice	S1	7,8	2,3	2		1
	S2	8	1	3	,3	2
	S3	3	-	1		-
	N	1,2,4,5,6	-	-	,6,7,8	-
Corn	S1	1,7	2,3	2	,2	1
	S2	5,7,8	-	3	,4	2
	S3	2,6	1	1	,6	-
	N	4,6	-	-	,8	-
Tea	S1	5	3	3		1
	S2	1,2	2	2	,3,4	-
	S3	2,4,8	-	1	,6	2

	N	4 ,6,7	1	-	,8	-
Cinnamon	S 1	2 ,5	3	2	,2	1
	S 2	1 ,6	2	3		2
	S 3	3 ,4	-	1		-
	N	7 ,8	1	-	,6,7,8	-

S1: Very suitable; S2: suitable; S3: less suitable; N: not suitable.

3.4.4.2. Level of land suitability for selected land use types

As a result of classifying land suitability according to the scoring method from the land use requirements of the LUTs based on the ecological requirements of the land units, we have determined the area of different levels. Suitable according to 04 levels: Very suitable (S1), suitable (S2), less suitable (S3) and not suitable (N).

The results of evaluating land suitability classification for each LUT show that:

- The potential for developing LUT specializing in rice (Bao Thai Rice) is 13,217.07 hectares, accounting for 26.08%;

- The potential for developing specialized crop LUTs (Corn) is 36,536.00 hectares, accounting for 74.09%;

- The potential for LUT development of perennial industrial crops (Tea) is 42,162.39 hectares;

- Potential for developing LUT Medicinal plants (Cinnamon) is 33,460.93 hectares.

3.4.5. Evaluate suitability for land use types according to Multi-criteria evaluation (MCE)

To have more basis for providing land use orientation in the district in the coming time, the research applies appropriate assessment of land use types by integrating GIS technology and MCE method.

Table 3.15. Suitable area for each type of crop

Land use type	Very suitable (S1)	Suitable (S2)	Less suitable (S3)	not suitable (N)
Bao Thai rice	5,321.22	452.05	7,511.23	36,027.18
Corn	17,105.27	4,877.57	15,689.25	12,988.48
Tea	17,070.55	12,668.58	13,458.27	7,205.55
Cinnamon	12,853.87	4,588.99	13,308.77	17,558.25

Table 3.15 shows that: the suitable area for rice at levels S1, S2, S3 accounts for 6.25% respectively; 1.70%; 3.07% of the assessed area, the rest is not suitable. The results of land suitability assessment using the MCE method also provide suitable maps for each type of tree shown in the appendix.

3.5. Orientations and solutions for developing commodity agricultural products

3.5.1. Use orientation for commodity land use types

3.5.1.1. Legal basis for the development of commodity land use types

Based on the regulations of the Government, the People's Committee of Thai Nguyen province and the People's Committee of Dinh Hoa district.

3.5.1.2. Land use orientation

Table 3.16. Land use orientation until 2030 for commodity crops

Type of land use	Area by 2020 (ha)	Suitable area (ha)	Area by 2030 (ha)	Location
Bao Thai rice	1,330.7	5,373.04	,000	Sub-region 2: Bao Cuong, Trung Hoi, Thanh Dinh, Phuong Tien, Phuc Chu, Dinh Bien, Dong Thinh. Sub-region 1: Thanh Dinh, Binh Yen, Trung Luong. LMU: 3, 8, 11, 15, 17, 21, 48, 64, 100

Corn	961.0	17,055.80	,200	Sub-region: 1; 2; 3 Land map units: 5, 7,12, 16, 22, 23, 25, 40, 45, 66, 72, 84, 91, 105
Tea	2,586.50	16,710.52	,000	Sub-region 3: Thanh Dinh, Binh Yen, Trung Luong, Diem Mac, Phu Tien, Phu Dinh, Son Phu, Boc Nhieu, Binh Thanh. Land map units: 2, 4, 17, 18, 19, 24, 30, 32, 52, 54, 55, 58, 65, 70, 82, 97, 103, 121
Cinnamon	2,900	12,875.76	,000	Sub-region 1: Linh Thong, Quy Ky, Lam Vy, Tan Thinh, Bao Linh, Kim Phuong and Tan Duong. Sub-region 2: Bao Cuong, Trung Hoi, Thanh Dinh, Phuong Tien, Phuc Chu. Land map units: 33,35,41,44,47, 56,57,64,68,77,78,104 ;29, 30, 81, 83, 88, 92, 99, 117, 125, 130

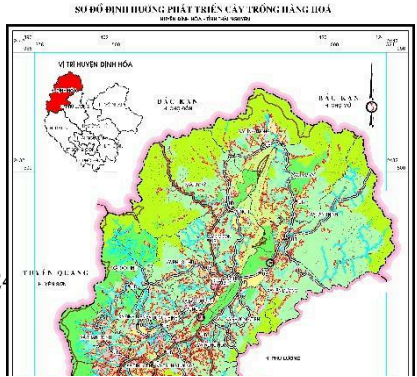
3.5.2. Solutions for commodity-oriented agricultural development

3.5.2.1. Solutions on policy mechanisms

- *Land policy*
- *Capital and credit policy*
- *Policy on science and technology*
- *Building policy mechanisms*

3.5.2.2. Solutions to improve infrastructure for agricultural production

Investing in infrastructure to serve agricultural production; Prioritize the development of road systems, irrigation works, electricity, etc. in the concentrated production areas of



the district's commodity products. Upgrade and expand the inter-village road system, increase investment in expanding wholesale markets; Encourage and associate with businesses to invest in cold storage and irradiation systems to meet export requirements.

3.5.2.3. Solutions for branding and product consumption markets

Focus on building and developing brands for district products associated with the development of OCOP products. Tea products, bao thai rice, fruit trees and medicinal plants are built in the direction of "strong brands", ensuring competitive advantage in the market. Develop and enforce regulations on intellectual property rights for key branded products of Dinh Hoa district in particular and Thai Nguyen province in general.

CONCLUSIONS AND RECOMMENDATIONS

1. Conclusions

1. Dinh Hoa is a mountainous district of Thai Nguyen province, with favorable climate and soil conditions. The total natural land area of the district is 51,351.90 hectares, the area put into use reaches 99.71% of the total natural area; The area not yet put into use is 147.97 hectares, accounting for 0.29%; an agricultural land area of 48,119.32 hectares, accounting for 93.66% of the total natural area, of which agricultural land is 11,384.10 hectares, accounting for 11.15% of agricultural land. Perennial crop land has 5,062.06 hectares, forestry land has 35,582.32 hectares, aquaculture land has 1,152.88 hectares and other agricultural land has 0.02 hectares. The survey results identified 10 land use types with 21 types of land use distributed in all 3 sub-regions of the district. At the same time, the criteria for crops to become commercial agricultural products of the district have been determined and must satisfy at least 2/3 of the criteria: (i) have a large proportion of goods and have market development prospects; (ii) have large enough output and concentrated area to be able to develop commodity production areas; (iii) high economic efficiency, good quality agricultural products.

2. Results of monitoring 4 agricultural land use models in Dinh Hoa district in the 3 years 2018 - 2020 show that: The commodity crops of Dinh Hoa district are determined to include: Bao Thai rice, corn, tea and cinnamon. Cinnamon and tea trees bring the highest economic efficiency with mixed income for tea and cinnamon trees of

108.34 - 476.93 million/ha/year respectively; Capital efficiency reaches 3.13 - 5.41 times. These are also commodity crops with high social and environmental efficiency. Although corn and rice are cost effective and have a high acceptance rate among people (due to their compatibility with simple farming practices and techniques), they are not environmentally sustainable.

4. Results of assessing land potential for commodity production in Dinh Hoa district using the land assessment method according to FAO show that: The whole district has 133 land map units of 266 land plots and areas of units. Land unit area range from 0.55 hectares to 6259.63 hectares with identified characteristics and properties. The results of classifying the suitability level for 04 types of commodity plants are as follows:

- The land use type for specializing in rice (Bao Thai rice) is 13,217.07 hectares, accounting for 26.08%, of which: Very suitable area (S1) has 5,373.04 hectares, accounting for 10.90%, the suitable area Suitable (S2) has 433.15 hectares, accounting for 0.88%, less suitable (S3) has 7,410.88 hectares, accounting for 15.03%. The limiting factor is low to moderate fertility, partly due to inactive irrigation and light mechanical components.

- Land use type of specialized land for growing crops (Corn): Very suitable area (S1) has 17,055.80 hectares, accounting for 34.59%, suitable area (S2) has 4,915.98 hectares, accounting for 9.97%, Less suitable (S3) has 14,564.22 hectares, accounting for 29.54%. The limiting factor is a high slope ≥ 250 and inactive irrigation.

- Land use type for growing perennial industrial crops (Tea): Very suitable area (S1) has 16,710.52 hectares, accounting for 33.89%, suitable area (S2) has 12,106.45 hectares, accounting for 24.55%, less suitable (S3) has 13,345.42 hectares. Limitations are due to slope toxicity ≥ 250, inactive irrigation, some have light mechanical factors, and low fertility.

- Land use type for Medicinal plants (Cinnamon tree): Very suitable area (S1) has 12,875.76 hectares, accounting for 26.11%, suitable area (S2) has 5,262.26 hectares, accounting for 10.67%, less suitable (S3) has 15,322.91 hectares, accounting for 31.07%. Limiting factors are high slopes from 150 - 250, heavy mechanical components and limited irrigation.

4. Results of assessing land potential and suitability of different types of commercial land use have identified the development area for 4 types of commodity crops by 2030 including: Bao Thai rice 2,000 hectares; corn 1,200 hectares; Tea 3,000 hectares and cinnamon 5,000 hectares. To develop commodity-oriented agricultural production in the coming time, groups of solutions must be implemented synchronously, in which we need to focus on the following groups of solutions: Policy, organization of production, techniques, and marketing. consumption market.

2. Recommendations

1) Based on the results of land assessment and appropriate classification for land use types with potential and advantages of the project, Dinh Hoa district needs to direct the good implementation of land use planning associated with the project. agricultural production to form commodity agricultural production areas.

2) Continue to have more in-depth research on the quality of nutrients in soil of different types of land use in each area of Dinh Hoa district to supplement quantitative indicators to serve the highest efficiency assessment in terms of environment.