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**Evaluate efficiency of slope-farming at Nghia Dan district, NgheAn province, Vietnam**

 Dinh Van Dung<sup>1, \*</sup>, Dinh Thi Kim Hao<sup>2</sup>, Hoang Huu Tinh<sup>3</sup>
<sup>1</sup> Faculty of Civil Engineering, Vinh University, 182 LeDuan street, NgheAn province, VietNam;

<sup>2</sup> Faculty of Biology, Vinh University, 182 LeDuan street, NgheAn province, VietNam.

<sup>3</sup> Faculty of Information Technology Vinh University, 182 LeDuan street, NgheAn province, VietNam

 \*Corresponding author: hoanghuutinh@gmail.com
 

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**Abstract**

Cultivation on slopes not only has brought income to mountain people but also protect environmental, to reduce the soil erosion and surface runoff [5]. NghiaDan district located in the northwest of NgheAn - one of Vietnam's central provinces that over 66.16% of natural land is sloping (slope grade from 3 to over 25 degree). In this project, we study and analyze the patterns of cultivation on slopes being applied in Nghia Dan, thereby select ones bringing the highest economic efficiency, effective social impact and environmental effectiveness of each slope - farming. Initial results show that, there are up to 11 land use types (LUTs) include five intercropping LUTs (rice + maize - soy beans, bean- cassava, cassava - maize, water melon + maize, cassava - rubber tree intercropping) and six monocropping LUTs (cassava, sugar cane, orange tree, rubber tree, acacia tree, pineapple) are cultivated. Land with slopes 3 - 8 degree is suitable for cultivating LUT spring-summer rice and winter corn-soybeans. At slopes 8-15 degree, the most efficient LUT is medium sugarcane. At slopes 15-20 degree, it's a good choice to apply the growing orange.

**Keywords:** Agricultural, Slope-farming, Land use type, Cultivation.
 

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**1. Introduction**

Located in the Northern West of NgheAn province, Vietnam, Nghia Dan District covers 75.578 Km<sup>2</sup> natural land. It has not high hills and mountains, rising from the North West to South East, its surrounding include 300 - 400 meter high mountains above the sea. The central area has up-side-down bowl hills, intermixing smooth 50 - 70 meter high valleys among them. Such condition of surface created plenty of land acres for cultivation in Nghia Dan District. However, the whole area of cultivated land of the district locates on the high topography, so the land use here also faces difficulties, such as erosion causes the land's reduction quality.

A glance at the table 1 provided reveals that in the natural land of Nghia Dan district, Slope land accounts for 66.16%, in which 45.72% is the slopes from 16 to 25 degree. With the high slope (especially the slope of 16-25 degree), the selection and plant layout accordingly is essential, it is not only bring higher productivity, but also resistant to leaching and erosion is very important. Farmers were already aware of the importance of agriculture on sloping land, so they were more focused on the selection of plant structure and farming practices accordingly.

**Table 1** Land distribution on different elevations at Nghia Dan district

Land	areas (ha)	Percentage	Slope level	areas (ha)	Percentage
Flat land	25574	33.84			
Slope land	50004	66.16	3 - 8°	7675	15.35
			9 - 15°	19467	38.93
			16 - 25°	22862	45.72

**Table 2** The type of land use on different slopes

Slope level	LUTs	Description of to-grow plants
3 - 8°	Rice + Maize - soy beans intercropping	Spring – summer crop, rice is grown in early February, and will be reaped at the end of July. The maize- soy beans intercropping is grown in the middle of August (in the middle of rainy season) to ensure the irrigation for both maize and soy beans, and it is usually reaped in early November.
	Bean– cassava intercropping	Beansintercropped cassava with the space 2x2m and it is growntwiceper year
9 - 15°	Cassava – maize intercropping	Cassava are grown straight line (1x1m), and it is cultivated 2- 3 times for three first years
	Water melon + Maize	Water melon being grown in March, April, and it is reaped in early July. Maize is grown in summer crop and winter one.
	Cassava	Cassava is grown in early January and February and reaped in the November and December. Each cultivation cycle is 4 years: 3 years cultivated and 1 yearuncultivated
	Cassava – rubber tree intercropping	The space between rubbers line are 5m, that is for growing Cassava
>15°	Sugar cane	Each crop can be harvested up to 2 - 3 times.
	Orange tree	For orange tree, the productivity of rising ground in Nghia Dan is so high. From the third year, Oranges starts being reaped and the average productivity is 70 piculs/hectare.
	Rubber tree (long time industrial-tree)	Rubber garden is normally is about 25 acre (500x500m), which design with growing wholes. Spring crop is the best time for growing rubbers (February – march).
	Acacia tree (Forest trees)	Planting season: spring season from February to March, autumn from July to September Holes staggered between rows crocodile shaped fangs. When partial hoe to good soil: black soil to a foam party. Acacia trees grow fast in the first few years and after 8 -10 years will harvest
	Pineapple	Pineapple average from second year onwards race starts for harvest in spring ( March , april ) and autumn (August - October) and designed according to the contour. Planting density is 6.0 thousand buds / hectare

## 2. Materials and methods

### 2.1 Materials

This research was conducted on steep area, which used in cultivation at Nghia Dan district, NgheAn province, Vietnam

All Land use typeswhich cultivated in slopesat Nghia Dan district, NgheAn province, Vietnam

### 2.2. Methods

Investigations, collect data on the extent of slope and their distribution in Nghia Dan district

Assessing the effectiveness of different types of land use in slope including: economic efficiency, social impact and environmental effectiveness

Evaluate efficiency of economic of land use types by means of production value (PV), production cost (PC), net revenue (NR), the efficiency of using capital (EUC), workday value(VLPD)

Gross production value of 1 ha of cultivated land per year(PV) = p1.pr1 + p2.pr2 + ...+ pn.prn

In there:

p: production volume per ha per year

pr: price of each production in market at the same time

Net revenue of 1 ha of cultivated land per year (NR) = PV – PC

PC: production costs of 1 ha of cultivated land per year

The efficiency in the use of capital (EUC) = NR/PC

The value of labor per day (VLPD = NR/(The number of workdays/ha/year))

Evaluate efficiency of social by the number of labor days and the value of wage per day, compare with each LUT. Evaluate efficiency of environmental: In each type of land use, we have conducted a survey and compared the ability of land surface cover, erosion control, soil improvement ability, conscious use of fertilizers in farming.

### 3. Results

#### 3.1. Land use types (LUTs)

We survey the structure of plants cultivated on different slopes in the study area, the results are presented in table 2. In which, in the slope between 3 and 8 degrees has 3 types of plant structure, primary short-term food crops. Slope from 9 to 15 degrees with 4 types of land use, mainly industrial crops. With a slope higher than 15 degrees, farmers grown industrial plants and forest trees, according to the survey, there are four main types of land use.

#### 3.2. Evaluate efficiency of Land use types be planted on slopes in Nghia Dan district

##### 3.2.1. Economic efficiency

A point cannot be lack in this consideration of land use is economic efficiency. This is the base to seek the technical solutions and selection of land use pattern. Assessing the efficiency of land use through categories: production value (PV), production cost (PC), net revenue (NR), the efficiency of using capital (EUC), the value of labor per day (VLPD).

According to above table, area with slopes from 9 to 15 degrees, LUT for growing Cassava – rubbers intercropping brings the highest efficiency of using capital, it is 1,42 times. This value highest on slopes from 3 to 8 degree is cultivation Rice + Maize - soy beans intercropping (0,91 times). With the rising ground higher 15 degree, LUT for growing orange tree brings the highest economic efficiency.

##### 3.2.2. The environment effectiveness

The sustainability of environment is also one of the requirements of sustainable land use. Patterns of using land sustainably in terms of environment require the protection of soil nutrition, prevention from the decline of land and the land ecology.

Environmental effectiveness is evaluated based on the following indicators: Coverage, the ability to protect and improve soil, Ability to anti pest. And they are assess by 3 levels: High: \*\*\*, Average: \*\*, low: \*

Overall view of the each LUT specific indicators by way of conclusion, the protective effect of the LUT environment as follows; LUTs which high environmental efficiency, including: Rice + Maize - soy beans intercropping, bean intercropped cassava, cassava intercropped rubber; The lower level there is LUT: Cassava – maize intercropping, Water melon + Maize + Maize and Pineapple.

**Table 3** Economic effect of mainly annual crops per hectare of each type of land use

Steep slope	LUTs	PV (million VND /acre/year)	PC (million VND)	NR (million VND)	VLPD (VND)	EUC (time)
3-8°	Rice + Maize - soy beans intercropping	114.55	60.00	54.55	10500	0.91
	Bean – cassava intercropping	29.12	16.00	13.12	7500	0.82
	Cassava – maize intercropping	26.10	14.00	12.10	7500	0.86
9-15°	Water melon + Maize+ Maize	137.55	64.00	73.55	22500	1.15
	Cassava	27.50	15.00	12.50	7500	0.83
	Cassava – rubbers intercropping	63.00	26.00	37.00	24000	1.42
	Sugar cane	31.40	17.00	14.40	30000	0.85
>15°	Orange tree	210.00	100.00	110.00	30000	1.10
	Rubber tree (long time industrial-tree)	32.00	18.00	14.00	30000	0.78
	Acacia tree (Forest trees)	36.70	20.00	16.70	9750	0.84
	Pineapple	27.50	15.00	12.50	7500	0.83

(The source from Nghia Dan district agricultural division. Final report 2014) [3]

\*\*\*\* 1\$ =22400 VND

**Table 4** The efficiency of environment of each type of land use

Slope level	LUTs	Coverage	Soil improvement ability	Anti pest
3 - 8°	Rice + Maize - soy beans intercropping	***	***	**
	Bean – cassava intercropping	***	***	*
	Cassava – maize intercropping	**	**	*
9 - 15°	Water melon + Maize + Maize	**	**	*
	Cassava	***	*	**
	Cassava – rubbers intercropping	***	**	**
	Sugar cane	***	**	**
>15°	Orange tree	***	**	*
	Rubber tree (long time industrial-tree)	**	*	***
	Acacia tree (Forest trees)	**	*	***
	Pineapple	**	*	**

**Table 5** Social effect of each type of land use

Slope level	LUTs	The number of work days	The value of labor day (VND)
3 - 8°	Rice + Maize - soy beans intercropping	70	10500
	Bean – cassava intercropping	60	7500
	Cassava – maize intercropping	60	7500
9 - 15°	Water melon + Maize + Maize	150	22500
	Cassava	50	7500
	Cassava – rubbers intercropping	160	24000
	Sugar cane	200	30000
>15°	Orange tree	200	30000
	Rubber tree (long time industrial-tree)	200	30000
	Acacia tree (Forest trees)	65	9750
	Pineapple	50	7500

(The source from Nghia Dan district agricultural division. Final report 2014) [3]

### 3.2.3. Social impact

The social efficiency of land use patterns is assessed in terms of requirements: level of job tackling, the capacity of attracting laborers, the requirement of capital investment, the consumption of product in the market, the guarantee of people's lives in accordance with cultivation, decline in starving families.... This article used two indicators to assess, it is the work days and the value of labor day.

It is clear that, at the inclined 9 - 15°, Cassava intermixing rubbers have the number of labor days and the value of wage per day also reaches the highest. At the slope higher than 15°, LUTs of Orange trees and rubber need plenty of labor power and the value of wage must be up to 30000VND, three times as much as the pineapple's value. At the slope 3 - 8°, Rice + corn intermixing soy beans has the number of labor days and the value of wage per day also higher another LUTs.

## 4. Discussion

According to FAO (2000) [2], there are 1 billion 476 million hectares of agricultural land in the world, hills sloping accounts for 65.9%, in which 544 million hectares is arable land lost abilities produce. The mountains in the world with a slope of 10 degrees represent 50 - 60% is agricultural land. Every year, upland rice cultivation on slopes have been contributing 3.8% of global rice production. Most distribution of slopes cultivation concentrate mainly in India (6.2 million hectares), Brazil (3.1 million hectares), Indonesia (1.4 million hectares) and scattered in neighboring countries of approximately 7.0 million hectares [1].

In Vietnam, sloping account for about 74% land resources, it is a huge resources for Agricultural cultivation. When cultivate on slopes, erosion and leaching occurs very frequently. In addition, Vietnamese farmers can not use both anti-erosion measures and soil protection, beside that they could cultivate with inappropriate land used types

On the slopes necessary to develop efficient cropping patterns and land use sustainability, thence improve and recovery soil fertility and increase cultivation product, creating a natural environmental landscape diversity.

The type of farming must be effectively applied appropriately on each soil type, topography, farming practices and market needs of each different region.

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In VietNam, there are 3 models of cultivation are growed:

- Growing of vegetable
- Planting of fruit trees and vegetable crops with short days
- Forestry crops

This research was conducted on slope-farming and all Land use types which used at Nghia Dan district, Nghe An province, Vietnam. We have evaluated the effectiveness of economic, environmental and social aspects of 11 types of land use are cultivated in this study area. Thereby select the LUT bring the highest economic efficiency, effective social impact and environmental effectiveness of each slope – farming.

## 5. Conclusions

According to the result of evaluating the effectiveness of use of agricultural in the sloping land of Nghia Dan - Nghe An, we draw the following conclusions:

- In slope 3-8° LUT spring-summer rice + maize intercropped soybeans for higher income, labor solve local redundancy. On the other hand, there is land cover regularly.
- With slope 9 - 15°, the LUT Cassava intermixing rubbers not only bring high economic efficiency but also make effective social and environmental
- With slope > 15°, the suitable LUT growing orange.

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