

RELATIONSHIP BETWEEN SOME BASIC INVENTORY FACTORS AND ECOLOGICAL FACTORS AND FALLOW PERIOD OF FOREST REHABILITATION AFTER SHIFTING CULTIVATION IN MUONG LAT DISTRICT, THANH HOA PROVINCE

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SUMMARY

Determining the relationship between some inventory factors and ecological factors and fallow period of forest rehabilitation after shifting cultivation has very important meaning in proposing effective solutions for reforestation, contributing to the protection of the ecological environment, limiting soil erosion, and soon reached the forest criteria. Results from 95 temporary plots (each plot covering 1000 m²) showed that: number of tree species has a significant and positive relationship with fallow periods, with porosity, soil layer thickness and cover of lianas and shrubs. The density and mean height of trees with total tree height from 2 m have a significant and positive relationship with fallow periods, soil layer thickness and cover of lianas and shrubs. The research results are the basis to determine the time for forests formed and effect measures to forests to restore after shifting cultivation.

Keywords: Ecological factors, fallow period, forests restoring after cultivation, inventory factors.

I. INTRODUCTION

Muong Lat is a frontier district located in remote area of Thanh Hoa province, with an area of nearly 6.6 thousand ha of rehabilitation forest, accounting for about 8.1% of the total forest area of the whole district [3]. More than 90% population of the district are ethnic minorities, difficult economic conditions lead to deforestation for shifting cultivation becomes popular. On fallow land after shifting cultivation form, one layer of vegetation has been gradually restored.

Therefore, the study of the relationship between some basic inventory factors (number of species), density (N (trees / ha)), height (H_{vn}, m,) with the ecological factors (soil layer thickness (D, cm), porosity (P %); slope coverage (CP %) ...) and fallow period of rehabilitation forest after shifting cultivation is very necessary. From the research results can propose a resolution to restore forests in the study area.

II. METHODOLOGY

2.1. Inherited method

Research inherits the relevant documents have been published by the scientific work, the legislation, the basic material for investigation by the competent authorities relating to the field of research.

2.2. Data collection

Investigation on 95 temporary sample plots, each has an area of 1000 m² (25 x 40 m) to determine the number of species; density; the average height of trees with total tree height from 2 m; land survey to determine soil depth (D, cm), porosity (P%), slope (α) and cover (CP%)...

2.3. Data analysis

- The particle density of the soil (Pd)

Determined by methods Picnomet:

$$Pd = P / (P + P_1 - P_2) \text{ (g/cm}^3\text{)} \quad (1)$$

Where: D is the particle density of the soil; P is the volume of dry land taken for analysis (g); P₁ is the average volume picnomet having water (g); P₂ is the volume picnomet having water and land (g).

- Bulk density (Bd)

Determined by the formula:

$$Bd = P/V \text{ (g/cm}^3\text{)} \quad (2)$$

Where: *Bd* is Bulk density; *P* dry soil mass (g);
V volume of soil (cm³).

- Soil porosity (P%)

Determined by the proportion and density:

$$P\% = (1-Bd/Pd)*100 \quad (3)$$

Where: *Pd* is particle density (g/cm³); *Bd* is bulk density (g/cm³).

- Determining the relationship between some inventory factors of forest recovered after shifting cultivation with ecological factors and fallow periods through multivariate function:

$$Y = b_0 + b_1*X_1 + b_2*X_2 + \dots + b_n*X_n \quad (4)$$

Where: *Y*: is the dependent variable - is the inventory factors; *X_n*: is the independent variable - ecological factors and fallow period; *b_n* is parameter.

III. RESULTS AND DISCUSSION

The basic factor of the forest inventory after shifting cultivation, including: species (*N* of tree species), density (*N* (trees / ha)), height (*H_{vn}*, m) ... ecological factors, including soil layer thickness *D* (cm), the porosity *P* (%); α slope ($^\circ$); *CP*% coverage, canopy cover. According to fallow period, a number of ecological factors change and forest inventory factors of rehabilitation after shifting

cultivation also changed. There is a relationship between them. The process of rehabilitation after shifting cultivation to create conditions for restoration of ecological factors and reverse the ecological factors has the effect of promoting a forest restoration process faster.

3.1. Relationship between species (*s_{species}*) of forest rehabilitation after shifting cultivation with ecological factors and the fallow period

In the process of arising and development of plants, some species will increase over fallow period. The ecological factors directly influence the process of forest regeneration and succession. Soil properties related to the situation of natural regeneration of vegetation recovery. When vegetation appears will cover the ground helping with physical properties, soil chemistry increasingly improved. The ecological factors representing soil properties as soil depth *D* (cm), the porosity *P* (%). Where, the slope α and coverage *CP*% are two important studied ecological factors. The results determine the parameters of the relationship equation between forest mloai restored after shifting cultivation with ecological factors and the fallow period was shown in Table 1.

Table 1. Parameters of the relationship equation between forest species recover after shifting cultivation with ecological factors and the fallow period

Criteria	Equation		
	$m_{species} = b_0 + b_1 * A_{(year)} + b_2 * D_{(cm)} + b_3 * P_{(\%)} + b_4 * CP_{ \% } + b_5 * \alpha$	$m_{species} = b_0 + b_1 * A_{(year)} + b_2 * D_{(cm)} + b_3 * P_{(\%)} + b_4 * CP_{ \% }$	
R²	0,7843	0,7014	
Parameters	<i>b₀</i>	6,4491	7,5978
	<i>b₁</i>	1,0319	1,0464
	<i>b₂</i>	0,1789	0,1806
	<i>b₃</i>	-0,5478	-0,5752
	<i>b₄</i>	0,1456	0,1546
	<i>b₅</i>	0,0426	
P-value	<i>b₀</i>	0,1241	0,0645
	<i>b₁</i>	4,40E-09	2,78E-09
	<i>b₂</i>	1,72E-06	1,43E-06
	<i>b₃</i>	0,0064	0,0041
	<i>b₄</i>	0,0233	0,0157
Conclusion	<i>b₅</i> is insignificant	All paramaters are significant	

The results in Table 1 showed that the equation $m_{\text{species}} = b_0 + b_1 * A_{(\text{year})} + b_2 * D_{(\text{cm})} + b_3 * P_{(\%) } + b_4 * CP_{\% } + b_5 * \alpha$ with a coefficient of determination relatively high ($R^2 = 0.7843$). However, parameter b_5 with $\text{Sig.tb5} = 0.2144$ is greater than 0.05, that means b_5 is insignificant and the number of species is not dependent on slope factor. Therefore, the correlation equation is limited to 4 variables: time A (year), soil layer thickness D (cm), the porosity P (%); cover CP (%)), the results are as follows:

$$m_{\text{species}} = 7,5978 + 1,0464 * A_{(\text{year})} + 0,1806 * D_{(\text{cm})} - 0,5752 * P_{(\%)} + 0,1546 * CP_{(\%)} \quad (\text{a})$$

The coefficient of determination $R^2 = 0.7014$ shows the relationship between m_{species}

of forest restored after shifting cultivation with ecological factors and fallow periods relatively strong. All parameters are significant ($\text{Sig.tbi} < 0.05$).

3.2. Relationship between N ($H \geq 2$ m) of forest rehabilitation after shifting cultivation with ecological factors and the fallow period

From the data collected for N ($H \geq 2$ m) on the sample plots in each fallow period, establishing the relationship between N ($H \geq 2$ m) of forest rehabilitation after shifting cultivation with ecological factors is the soil layer thickness D (cm), the porosity P (%); α slope; CP% coverage and a fallow period (years). Results are summarized in Table 2.

Table 2. Parameters of the relationship equation between N ($H \geq 2$ m) of forest rehabilitation after shifting cultivation with ecological factors and the fallow period

Criteria	Equation		
	$N_{(H \geq 2m)} = b_0 + b_1 * A_{(\text{year})} + b_2 * D_{(\text{cm})} + b_3 * P_{(\%)} + b_4 * CP_{\% } + b_5 * \alpha$	$N_{(H \geq 2m)} = b_0 + b_1 * A_{(\text{year})} + b_2 * D_{(\text{cm})} + b_3 * CP_{(\%)}$	
R²	0,8019	0,6729	
Parameters	b_0	-3,9199	-169,7022
	b_1	0,0347	28,9013
	b_2	0,0093	2,5932
	b_3	0,2288	2,6711
	b_4	-0,0436	
	b_5	0,0032	
P-value	b_0	2,8E-13	5,7E-07
	b_1	0,0629	5,2E-16
	b_2	0,0226	0,0443
	b_3	0,1356	0,0021
	b_4	1,9E-08	
		0,4186	
Conclusion	b_3 and b_5 are insignificant	All parameters are significant	

The results in Table 2 showed that the equation $N(H \geq 2 \text{ m}) = b_0 + b_1 * A(\text{year}) + b_2 * D(\text{cm}) + b_3 * P(\%) + b_4 * CP\% + b_5 * \alpha$ having b_3 and b_5 are insignificant ($\text{Sig.tb5} > 0,05$) and $N(H \geq 2 \text{ m})$ does not depend on the porosity and slope. Therefore, our study only considers relations N ($H \geq 2 \text{ m}$) with soil depth, coverage and fallow period in the form of equation $N(H \geq 2 \text{ m}) = b_0 + b_1 * A(\text{year}) + b_2 * D(\text{cm}) + b_3 * CP(\%)$. The results showed that the coefficient of determination $R^2 =$

0.6729. Thus the relationship between N ($H \geq 2 \text{ m}$) with ecological factors and fallow period relatively tight. This relationship is expressed by equation (b):

$$N(H \geq 2 \text{ m}) = -169,70 + 28,90 * A(\text{year}) + 2,5932 * D(\text{cm}) + 2,6711 * CP(\%) \quad (\text{b})$$

3.3. Relations between the forest restored after shifting cultivation with ecological factors and the fallow period

Similar to N ($H \geq 2 \text{ m}$), our study established the relationship between forests

restored after shifting cultivation with fallow period A (years). Results are ecological factors as soil depth D (cm), the summarized in Table 4.3. porosity P (%); slope α ; coverage CP% and

Table 3. Parameters of the relationship equation between forests restored after shifting cultivation with ecological factors and the fallow period

Criteria	Equation		
	$\bar{H}_{(H_{vn} \geq 2m)} = b_0 + b_1 * A_{(year)} + b_2 * D_{(cm)} + b_3 * P_{(\%)} + b_4 * CP_{ \% } + b_5 * \alpha$	$\bar{H}_{(H_{vn} \geq 2m)} = b_0 + b_1 * A_{(year)} + b_2 * D_{(cm)} + b_3 * CP_{(\%)}$	
R²	0,8235	0,7501	
Parameters	b ₀	-23,5153	0,9979
	b ₁	32,6291	0,2110
	b ₂	1,8703	0,0028
	b ₃	-6,2438	0,0007
	b ₄	4,1144	
	b ₅	-0,5423	
P-value	b ₀	0,7880	0,0074
	b ₁	2,5E-16	0,0071
	b ₂	0,0132	1,3E-12
	b ₃	0,1338	0,0085
	b ₄	0,0024	
	b ₅	0,4493	
Conclusion	b₃ and b₅ are insignificant	All parameters are significant	

The result showed that the coefficient of determination of the relationship between the ecological factors and fallow period relatively tight (R² = 0.8235). However, two parameters b₃ and b₅ are insignificant, that means $H_{vn} \geq 2$ m does not depend on the porosity and slope. The equation of the relationship was established between the forest restored after shifting cultivation with ecological factors and the fallow period is limited to 3 variables (soil depth D (cm), coverage CP% and fallow period A (year)). This equation with the coefficient of determination R² = 0.7501, at the tight and is expressed through the equation (c):

$$\bar{H}_{(H_{vn} \geq 2m)} = 0,9979 + 0,2110 * A_{(year)} + 0,0028 * D_{(cm)} + 0,0007 * CP_{(\%)} \quad (c)$$

IV. CONCLUSIONS

- The number of tree species has a strong and positive relationship with fallow periods, porosity, thickness of soil and vegetation cover.

- The density of trees with total tree height from 2 m has a strong and positive relationship with fallow periods, soil layer thickness and vegetation cover.

- The mean height of trees with total tree height from 2 m has a strong and positive relationship with fallow periods, soil layer thickness and vegetation cover.

- The results of this research are the basis to determine the time formed forest and measures affecting forests for forests restored after shifting cultivation.

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**QUAN HỆ GIỮA MỘT SỐ NHÂN TỐ ĐIỀU TRA CƠ BẢN
VỚI CÁC NHÂN TỐ SINH THÁI VÀ THỜI GIAN BỎ HÓA CỦA RỪNG
PHỤC HỒI SAU CANH TÁC NƯƠNG RẦY TẠI HUYỆN MƯỜNG LÁT,
TỈNH THANH HÓA**

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TÓM TẮT

Xác định quan hệ giữa một số nhân tố điều tra cơ bản với các nhân tố sinh thái và thời gian bỏ hóa của rừng phục hồi sau canh tác nương rẫy có ý nghĩa hết sức quan trọng trong việc đề xuất giải pháp hiệu quả cho phục hồi rừng, góp phần bảo vệ môi trường sinh thái, hạn chế xói mòn đất và sớm đạt tiêu chí thành rừng. Từ số liệu điều tra 95 ô tiêu chuẩn tạm thời với diện tích ô 1000m² và qua xử lý cho thấy: số loài cây có quan hệ chặt và đồng biến với thời gian bỏ hoá, với độ xốp, độ dày tầng đất và độ che phủ cây bụi, thảm tươi; Mật độ và chiều cao trung bình của những cây có chiều cao vút ngọn từ 2m trở lên có quan hệ chặt và đồng biến với thời gian bỏ hoá, với độ dày tầng đất và độ che phủ cây bụi, thảm tươi. Kết quả nghiên cứu trên đây là cơ sở để xác định thời gian hình thành rừng và biện pháp tác động cho rừng phục hồi sau canh tác nương rẫy.

Từ khóa: Nhân tố điều tra, nhân tố sinh thái, thời gian bỏ hoá, rừng phục hồi sau nương rẫy.

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