

The Technique of Agroforestry at Communal Forest Areas in Pejarakan Village, District of Gerokgak, Regency of Buleleng, Bali Province

I Putu Gede Ardhana^{1*}, Sunardi²

¹ Department of Biology, Faculty of Sciences, Udayana University, Denpasar, Indonesia

² Branch Office for Forest Inventory and Land Classification Unit Denpasar, Indonesia

ABSTRACT

Since 2003, the technique of agroforestry with alley cropping systems has been implemented at the forest areas in Pejarakan Village, District Gerokgak, Regency of Buleleng, Bali Province. These activities are expected to support the progress of welfare for farmers, though they have been neglected to preserve forest around village. The result of the research shows that the result of the activities do not fulfill its first expectation. The analysis on the compositions and structures of vegetations in this research shows that the dominant type of species which was mainly cultivated had the character of Importance Value Index, while the balance of species among diversity index was still low at all of the communal forest areas and even at the slope sides. The composition and the structure of species were still few, and the vegetation itself was disturbed by people. With regard to illegal loggings, cuttings top branches or twigs often occurred, and these activities brought about obstacle growth of trees in communal forest areas. It is concluded that the technique of agroforestry at the communal forest areas has few compositions of species and structure of vegetations, so the diversity of species becomes very poor and unstable, either for plants in forestry or for agricultural crops. The researcher could not determine what species of vegetations is superior at this area. Therefore, it necessarily needs some more time for intensive observations and research at this communal forest areas.

Keywords: *agroforestry technique, communal forest areas, composition and structure of vegetation, forest area, species diversity*

INTRODUCTION

The area of dry land in Indonesia reaches about 80 million hectares from the total territory of Indonesia [1]. In the country, the island of Bali has about 218,119 ha of dry land which is concentrated in the northern and eastern areas of the island [2]. The study about dry land was located in the communal forest (HKM) areas of Pejarakan Village, District of Gerokgak, Regency of Buleleng, Bali Province. The annual precipitation is 1400-1700 mm that falls mainly from December to March [3]. According to the map of soil types in Bali, the site belongs to chocolate and latosol soil type which are mainly made up of volcanic ash.

Within the government Regulation of the Minister of Forestry, number: P.01/Menhut-II/2004, Article 3, it is stated that in order to

realize sustainable development for forestry and to improve the welfare of local communities, it is necessary to empower the local communities with community-based forest management system which is called Communal Forest (HKM). HKM is one of the systems that involves the participation of other parties who are permitted to take advantage from forest production in anywhere within the forest areas.

The activities of HKM is expected to function as a means of improving the people's social welfare with regards to efforts for the land conservation, so that this activities can balance on the needs to improve the social welfare with the needs to conserve the forest areas. The HKM activities are already carried out with the alley cropping system which is one of the agroforestry techniques used as the implementation for forestry productions. The site of HKM has been known to be located at the forest resources in western territory in Bali island, especially around Gerokgak District, Pejarakan Village, Regency of Buleleng.

*Corresponding author: I Putu Gede Ardhana
Department of Biology, Faculty of Sciences, Udayana University, Denpasar, Indonesia
Email: crescentbali@indo.net.id

In such a territory, each Head of the Family (or, *Kepala Keluarga* (KK)) from farmers' group have been given each arable land of 0.5 ha. In this location of study, 100 families have cultivated about 50 ha of the area. The farmers group carry out the land management activities by employing the alley cropping system. Within this system, they obtain the crop of trees and the seasonal agricultural crops. The trees are planted in path lines which are 6 meters wide. These paths form a space between forest plants and seasonal agriculture crops.

At the time of the preliminary study, the space (interface) becomes narrower because the canopy trees make shade trees with plant age 7 (seven) years. Furthermore, the utilization and process of soils at interface of land space begin to decrease and, thus, abandon the cultivation of seasonal agricultural crops which has been rarely performed. The various types of vegetations have been covered by the community plants species as a habitat or niche that forms the dispersion pattern, the pattern of density and the pattern of mastership degrees of each type of vegetation in this area.

The locations of the study site have different slope conditions, namely, the flat site (0-8%), the ramp site (9-15%), a-bit steeping site (16-25%) and steep site (26-45%). These locations represent the different types of vegetation. This difference in vegetational type brings the difference in distributional pattern for each type, so we can calculate the form of relative frequency, the relative density, the relative dominance and the pattern of importance Value Index. Each type makes three summations and it shows the pattern of Importance Value Index (IVI), or "index of Important value". This value is usually used to determine the Index Diversity (ID) for vegetational compositions. The absolute association determines the role of each vegetational type in relation to environmental factors. Each plant species with regard to environmental factors can be seen in the process of soil formation. It is to say that the land becomes the main factors for material, climate, relief or landscape, time and organisms.

Vegetational compositions and the structures of the alley cropping system usually mean the probe properties of occupied habitat [4]. Therefore, in the activities of HKM location, they would be determined by conducting research Analysis of Vegetation in this site. The results of vegetation analysis are expected to be used for materials and advice in forest management in the next period which aims to

improve the welfare of the surrounding community and within the forest area.

The purpose of this study is to determine the compositions and the structures of vegetation in the cultivational area of alley cropping, the degree important value index of each type vegetation (IVI), diversity index and the balance of species diversity (ID) in HKM activity after a seven-year-old forest stands.

MATERIALS AND METHODS

The scheme of research

This research employed the plot method in sampling technique, that is, we determined the square-shaped plot for observations (Fig. 1). We brought several plot in the right and left side along the main line and used main lines (transects) as the path for observations. There were four transects, the distance between each was 100 meters. These transects cut off the path and were divided into four classes in the slope (KL). Each KL along each transects formed square plots for observation. We, eventually, had 16 square plots for observations and the size of each plot was 2 m x 2 m for collecting data of seedlings, 5 m x 5 m for collecting data of saplings, 10 m x 10 m for collecting data of poles and 20 m x 20 m for collecting data of trees.

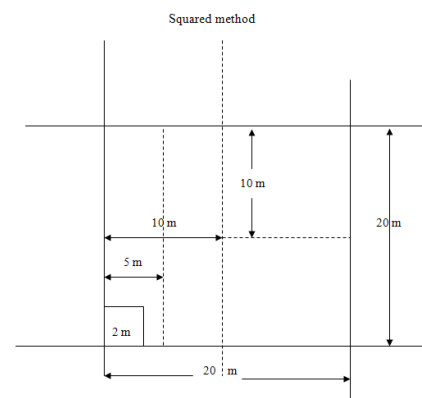


Figure 1. The plot for observation for growth stage of plants

Note : 20 m x 20 m - for collecting data of trees
10 m x 10 m - for collecting data of poles
5 m x 5 m - for collecting data of saplings
2 m x 2 m - for collecting data of seedlings

We brought basic usages of this KL from the map for classifications of slopes in forest land enacted by the General Director of Forest Inventory and Forest Land Usage [5]. According to this map, these plots were classified into (Figure 2):

a. KL 1 range between 0-8% for flat criteria

- b. KL 2 ranged between 9-15% for the criteria ramp
- c. KL 3 ranged between 16-25% for the criteria a bit steep
- d. KL 4 ranged between 26-45% for the criteria steep

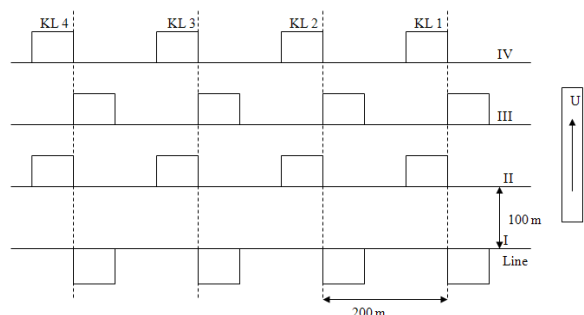


Figure 2. The planning plots for each point in different kl observation

In order to analyse the compositions and structures of vegetation, we used the plot the size of which was 20 m x 20 m for the growth rate in various the pole, 5 m x 5 m for sampling rate, 2 m x 2 m for seedlings in each level of trees. We brought samples and collected data from all vegetation which existed in these plots, and these ranged from seedlings or undergrowth plants, saplings poles to trees. The criteria to determine the growth stage of these vegetations are:

- The level of seedlings and undergrowth plants with diameter ≤ 2 cm and with height ≤ 1.5 m
- Level of saplings with diameter > 2 cm to < 5 cm with height > 1.5 m
- Level of poles with diameter ≥ 5 cm to < 10 cm
- Level of trees with diameter ≥ 10 cm

The Research Site

We surveyed this study site at Pejarakan Village, Gerokgak District, Regency of Buleleng, Bali Province. In this village, there was a land management for alley of cropping system called HKM in 50 ha where farmers group 'Wanna Sources Makmur' managed the system since 2000. The research was conducted from March to May 2007 when the cultivation of seasonal agricultural crops began to be stopped or left untreated by the farmers group. At that time of the study, the forest stands were seven years old. The location of the research can be seen in Figure 3.



Figure 3. Research site

The Analysis of Vegetational Composition and Structures

- a. Density (Density) = Σ all individuals of each species / total area of plot
- b. Relative density (RD) = (density value of each species / total density of all species) x 100%
- c. Frequency = Σ found types in the plots samples in each plots
- d. Relative frequency (FR) = (frequency value of type / value of the frequency of all species) x 100%
- e. Dominance (abundance) = Σ a type of basal area / total area of plot
- f. Relative dominance (DR) = (dominance of a species / total dominance of all species) x 100%
- g. Important Value Index (IVI) = degree of mastership of each type of vegetation

$$IVI = RD + FR + DR \quad (6)$$

$$IVI = RD + FR \quad (7)$$

- h. Species diversity index (I) or

$$I = \Sigma P_i \log P_i \quad (8)$$

I (0.00 to 3.00) = Index of diversity (diversity index)

I < 1: low diversity

$1 \geq I < 2$: medium diversity

$2 \geq I < 3$: high diversity

P_i = Number of individual species (n_i) divided by the number of individuals in the sample plots (N) or (n_i / N)

$P_i \log P_i$ = Log of price

RESULTS AND DISCUSSION

The Vegetational Compositions and Structures

The result of the analysis of vegetational compositions and vegetational structures in the stage of plant growth forest are as follows. The level of saplings, the poles and the trees consisted of 5 (five) forest plant species which spread across multiple slope classes (Table 1).

Table 1. The vegetational compositions and structures of forest plants at stage of saplings, poles, and trees cultivated on the some classes in Pejarakan village

Slope Classes	Vegetation Composition (Species)	Local Name	Vegetation Structure (Stage)		
			Saplings	Poles	Trees
KL 1 (0-8%) (flat)	<i>Azadirachta indica</i> Juss	Intaran	√	√	√
	<i>Leucaena glauca</i> Benth	Lamtoro	√	√	√
	<i>Swietenia macrophylla</i> King	Mahoni	√	√	√
	<i>Albizia falcata</i> L.	Sengon	-	-	√
KL2 (9-15%) (ramp)	<i>Azadirachta indica</i> Juss	Intaran	√	√	√
	<i>Leucaena glauca</i> Benth	Lamtoro	√	√	-
	<i>Swietenia macrophylla</i> King	Mahoni	√	√	√
	<i>Dalbergia latifolia</i> Roxb.	Sonokeling	√	-	√
KL3 (16-25%) (a bit steep)	<i>Azadirachta indica</i> Juss	Intaran	√	√	√
	<i>Leucaena glauca</i> Benth	Lamtoro	√	√	-
	<i>Swietenia macrophylla</i> King	Mahoni	√	√	√
	<i>Dalbergia latifolia</i> Roxb.	Sonokeling	√	-	-
KL 4 (26%-45%) (steep)	<i>Azadirachta indica</i> Juss	Intaran	√	√	√
	<i>Leucaena glauca</i> Benth	Lamtoro	√	√	√
	<i>Swietenia macrophylla</i> King	Mahoni	-	√	√
	<i>Dalbergia latifolia</i> Roxb.	Sonokeling	√	√	-

From the results of analysis of the vegetational compositions and structures of plantings at the stage of the seedlings cultivation,

we could found 11 (eleven) agricultural plant species which spread across multiple slope classes (Table 2).

Table 2. The vegetational composition and structure of forest stand at the stage of seedling cultivation (seedlings) on the slopes in the of some classes Pejarakan village

Slope Classes	Vegetation Composition (Species)	Local Name	Vegetation Structure (Seedling stage)
KL 1 (0-8%) (flat)	<i>Capsium frutescens</i> L.	Cabe	√
	<i>Cajanus cajan</i> Linn	Undis	√
KL 2 (9-15%) (ramp)	<i>Azadirachta indica</i> Juss	Intaran	√
	<i>Arachis hypogaea</i> L.	Kacang tanah	√
	<i>Mimosa pudica</i> Linn.	Putri malu	√
	<i>Paspalum conjugatum</i>	Rumput kawat	√
	<i>Tridax procumbens</i> L.	Sasak	√
	<i>Dalbergia latifolia</i> Roxb.	Sonokeling	√
	<i>Shontenia ovata</i>	Walikukun	√
KL 3 (16-25%) (a bit steep)	<i>Capsium frutescens</i> L.	Cabe	√
	<i>Arachis hypogaea</i> L.	Kacang tanah	√
	<i>Ocimum basilicum</i> forma <i>citratum</i> Back	Kemangi	√
	<i>Dalbergia latifolia</i> Roxb.	Sonokeling	√
KL 4 (26-45%) (steep)	<i>Shontenia ovata</i>	Walikukun	√
	<i>Ocimum basilicum</i> forma <i>citratum</i> Back	Kemangi	√
	<i>Leucaena glauca</i> Benth	Lamtoro	√
	<i>Mimosa pudica</i> Linn.	Putri malu	√
	<i>Paspalum conjugatum</i>	Rumput Kawat	√
	<i>Tridax procumbens</i> L.	Sasak	√
	<i>Dalbergia latifolia</i> Roxb.	Sonokeling	√

Important Value Index (IVI%) in Forest Stand

Mahogany has the highest IVI of 177.3%, 161.0% and 162.4% growth stage in the third saplings, poles and trees at flat slope classes (KL1), respectively. In ramps slope classes (KL2), *Lamtoro* has the highest IVI (127.6%) at the saplings, while the highest IVI at the poles and trees, 144.6% and 166.4%, belonged to

Intaran. These plants had also the highest IVI in all stage of growth at steep slopes (KL 3), that is 137.0%, 148.0% and 161.6%, respectively, and the stage of saplings and poles at steep slope (KL 4), that is 132.7%, 164.5%, respectively. Meanwhile, at the level of trees, Mahogany species turned out to be the highest IVI in KL 4 (133.1%) (Table 3).

Table 3. Relative density (RD), relative frequency (FR), relative dominance (DR), importance value index (IVI) levels based on forest plant saplings, poles, and trees on slopes in the village of some classes Pejarakan

Slope Classes	Forest Plants	Vegetation Structure											
		Sapling Stage				Pole Stage				Tree Stage			
		RD %	FR %	DR %	IVI %	RD %	FR %	DR %	IVI %	RD %	FR %	DR %	IVI %
KL 1	<i>Intaran</i>	32.3	41.7	34.6	108.6	33.8	40	29.2	103.1	11.1	22.2	9.1	42.5
	<i>Lamtoro</i>	3.2	8.3	2.6	14.1	7.7	20	8.2	35.9	11.1	22.2	9.0	42.3
	Mahoni	64.5	50.0	62.8	177.3	58.5	40	62.6	161.0	66.7	44.5	51.3	162.4
	<i>Sengon</i>	-	-	-	-	-	-	-	-	11.1	11.1	30.6	52.8
	Total	100	100	100	300	100	100	100	300	100	100	100	300
KL 2	<i>Intaran</i>	21.0	27.3	24.1	72.4	51.5	40	53.1	144.6	60	50.0	56.4	166.4
	<i>Lamtoro</i>	47.4	36.3	43.9	127.6	7.3	20	6.1	33.4	-	-	-	-
	Mahoni	26.3	27.3	27.6	81.2	41.2	40	40.8	122.0	35	37.5	38.4	110.9
	<i>Sonokeling</i>	5.3	9.1	4.4	18.8	-	-	-	-	5	12.5	5.2	22.7
	Total	100	100	100	300	100	100	100	300	100	100	100	300
KL 3	<i>Intaran</i>	48.3	42.9	45.9	137.0	51.3	46.1	50.6	148.0	57.1	50	54.4	161.6
	<i>Lamtoro</i>	17.2	14.3	14.3	45.8	5.3	15.4	3.9	24.6	-	-	-	-
	Mahoni	31.0	35.7	36.9	103.7	43.4	38.5	45.5	127.4	42.9	50	45.6	138.4
	<i>Sonokeling</i>	3.5	7.1	2.9	13.5	-	-	-	-	-	-	-	-
	Total	100	100	100	300	100	100	100	300	100	100	100	300
KL 4	<i>Intaran</i>	48	41.7	43.0	132.7	63.1	37.5	63.9	164.5	41.2	40	43.9	125.1
	<i>Lamtoro</i>	32	33.3	41.1	106.4	6.2	18.7	4.6	29.5	11.8	20	10.1	41.8
	Mahoni	-	-	-	-	26.1	25.0	26.5	77.7	47.0	40	46.0	133.1
	<i>Sonokeling</i>	20	25.0	15.9	60.9	4.6	18.8	5.0	28.3	-	-	-	-
	Total	100	100	100	300	100	100	100	300	100	100	100	300

Diversity Index (Index of Diversity (ID)) in Forest Stand Forest Plants

The highest diversity index (ID) which put in trees on slopes at saplings and poles stage was occupied by *Intaran*, that is 0.16 and 0.16, respectively; whereas at the level of tree stage, Mahogany was the highest (0.12). Mahogany also showed the highest ID value at the third level of

the growth stage for saplings, poles and trees, that is 0.15, 0.16 and 0.16, respectively, at KL 2 and KL 3. If put in a row, these variables valued 0.16, 0, 16 and 0.16. In KL 4, *Lamtoro* showed the highest ID (0.16) at saplings, Mahogany the highest ID value (0.15) at the poles, and *Intaran* the highest at trees level (0.16) (Table 4).

Table 4. The type and level of diversity index (index of diversity) based on forest plants id saplings, poles, and trees at slopes classes at pejarakan village

Slope Classes	Forest Plants	Vegetation Structure								
		Sapling Stage			Pole Stage			Tree Stage		
		Ni	(Ni/N)	ID	Ni	(Ni/N)	ID	Ni	(Ni/N)	ID
KL 1 (0-8%) (flat)	<i>Intaran</i>	10	0.32	0.16	22	0.34	0.16	2	0.11	0.11
	<i>Lamtoro</i>	1	0.03	0.05	5	0.08	0.08	2	0.11	0.11
	Mahoni	20	0.65	0.12	38	0.59	0.14	12	0.67	0.12
	<i>Sengon</i>	-	-	-	-	-	-	2	0.11	0.10
	Total (N)	31		0.33	65		0.038	18		0.44
KL 2 (9-15%) (ramp)	<i>Intaran</i>	4	0.21	0.14	35	0.52	0.15	12	0.60	0.13
	<i>Lamtoro</i>	9	0.47	0.15	5	0.07	0.08	-	-	-
	Mahoni	5	0.26	0.15	28	0.41	0.16	7	0.35	0.16
	<i>Sonokeling</i>	1	0.05	0.07	-	-	-	1	0.05	0.07
	Total (N)	19		0.51	68		0.39	20		0.36
KL 3 (16-25%) (a bit steep)	<i>Intaran</i>	14	0.48	0.15	39	0.51	0.15	4	0.57	0.14
	<i>Lamtoro</i>	5	0.17	0.13	4	0.05	0.07	-	-	-
	Mahoni	9	0.31	0.16	33	0.43	0.16	3	0.43	0.16
	<i>Sonokeling</i>	1	0.04	0.05	-	-	-	-	-	-
	Total (N)	29		0.49	76		0.38	7		0.30
KL 4 (26-45%) (steep)	<i>Intaran</i>	12	0.48	0.15	41	0.63	0.13	7	0.41	0.16
	<i>Lamtoro</i>	8	0.32	0.16	4	0.06	0.08	2	0.12	0.11
	Mahoni	-	-	-	17	0.26	0.15	8	0.47	0.15
	<i>Sonokeling</i>	5	0.20	0.14	3	0.05	0.06	-	-	-
	Total (N)	25		0.45	65		0.42	17		0.42

Agricultural Crops and Undergrowth Species

Table 5 indicates that *cabe* had the highest IVI (110%) at the class of flat slope (KL 1), while *Kacang tanah* had the highest IVI, that is 66.08%

and 98.24% at grade slope ramp (KL 2) and somewhat a-bit steep (KL 3), respectively. *Rumput kawat* had the highest IVI (61.91%) at the class of steep slopes (KL 4).

Table 5. Relative density (RD), relative frequency (FR), importance value index (IVI) of agriculture crops and plant cultivation several classes at aisle village slope pejarakan

Slope Classes	Agricultural crops dan Undergrowth species	Relative Density (%)	Relative Frequency (%)	Importance Value Index (%)
KL 1 (0-8%) (flat)	Cabe	60	50	110
	Undis	40	50	90
	Total	100	100	200
KL 2 (9-15%) (ramp)	Intaran	3.0	7.69	10.69
	Kacang tanah	43.0	23.08	66.08
	Putri Malu	3.0	7.69	10.69
	Rumput Kawat	16.7	15.39	32.09
	Sasak	11.4	15.39	26.79
	Sonokeling	8.6	23.07	31.67
	Walikukun	14.3	7.69	21.99
	Total	100	100	200
KL 3 (16-25%) (a bit steep)	Cabe	10.71	28.6	39.31
	Kacang tanah	69.64	28.6	98.24
	Kemangi	1.79	7.1	8.89
	Sonokeling	14.29	28.6	42.89
	Walikukun	3.57	7.1	10.67
	Total	100	100	200
KL 4 (26-45%) (steep)	Kemangi	6.35	14.29	20.64
	Lamtoro	3.17	14.29	17.46
	Putri Malu	3.18	7.14	10.32
	Rumput Kawat	47.62	14.29	61.91
	Sasak	22.22	14.29	36.51
	Sonokeling	17.46	35.70	53.16
	Total	100	100	200

The Diversity Index or the Index of Diversity (ID) of seasonal crops and undergrowth plants had all worth <1.0. The ID value of seasonal agricultural crops and undergrowth plants was the highest (0.16) at KL 1 in which the Undis occupied this position, while KL 2 was occupied

by *Rumput Kawat* (0.60). Meanwhile, in KL 3, *Kacang tanah*, *cabe*, and *Sonokeling* had almost the same ID value (average 0.11). In KL 4, *rumput kawat* had the highest ID (0.15) among other slope classes (Table 6).

Table 6. Diversity index (ID) on the cultivated of seasonal agricultural crops in some classes slope in alley cropping at Pejarakan village

Slope classes	Agricultural crops and undergrowth species	Total Species in 4 Sample Plots (Ni)	Pi = (Ni/N)	Diversity Index (ID)
KL 1 (0-8%) (flat)	Cabe	6	0.6	0.13
	Undis	4	0.4	0.16
	Total	10		0.29
KL 2 (9-15%) (ramp)	Intaran	1	0.03	0.04
	Kacang tanah	15	0.43	0.16
	Putri Malu	1	0.03	0.04
	Rumput Kawat	6	0.17	0.60
	Sasak	4	0.11	0.11
	Sonokeling	3	0.09	0.09
	Walikukun	5	0.14	0.12
	Total	35		1.16
KL 3 (16-25%) (a bit steep)	Cabe	6	0.11	0.10
	Kacang tanah	39	0.7	0.11
	Kemangi	1	0.02	0.03
	Sonokeling	8	0.14	0.12
	Walikukun	2	0.04	0.05
	Total	56		0.41

Slope classes	Agricultural crops and undergrowth species	Total Species in 4 Sample Plots (Ni)	Pi = (Ni/N)	Diversity Index (ID)
KL 4 (26-45%) (steep)	<i>Kemangi</i>	4	0.06	0.08
	<i>Lamtoro</i>	2	0.03	0.05
	<i>Putri Malu</i>	2	0.03	0.05
	<i>Rumput Kawat</i>	30	0.48	0.15
	<i>Sasak</i>	14	0.22	0.14
	<i>Sonokeling</i>	11	0.18	0.13
	Total	63		0.60

We could see that the composition and structure of plant vegetation in the forest stand has some variations for the plant species, growth stage of saplings, poles and trees on each classes of slopes, except on a bit steep slope class (KL 3) and steep (KL 4). Only five species of forest plants were found in the compositions of forest plant, namely, *Intaran*, *Lamtoro*, Mahogany, *Sonokeling* and *Sengon*. These plants were distributed equally in each class of slopes (KL 1, KL 2, KL 3 and KL 4), and were given estimations (DR), and Important Value Index (IVI). *Intaran* and *Lamtoro* grew wild, while Mahogany, *Sonokeling* and *Sengon* were cultivated as main crops in the line.

At the flat class of slope (KL 1), the composition of plant species were dominated by Mahogany, while at the slope classes (KL 2), *Lamtoro* became the most common species. At KL 3 and KL 4, the compositions were dominated by *Intaran*. In each class of slope, the hightof INP defined activities in research areas, and was obtained from the sum of variable value (RD), (FR), and (DR) of each type. INP was the sum of (KR), (FR), and (DR) researching types [6] and the high INP was the type of power (dominant) (Soegianto, 1994 in [8]).

At flat slope class (KL 1), Mahogany had the highest value of RD, FR, and DR in the level of saplings, poles and trees. Meanwhile, the value of IVI indicated the highest evaluations, that is, 177.3%, 161.0% and 162, 4% against other forest plant species. The *Sengon* saplings and even small trees were found in KL 1, and these were only mature trees with IVI = 52.8%. In slope class (KL 2), *Intaran* had the highest value at the level of poles (144.6) and trees (166.4%), while *Lamtoro* at the level of saplings had the highest IVI (127.6%). Only a small quantity of *Sonokeling* was found, even it could not be found at slope class (KL 2). Such variations may be caused by the presence of pruning branches and *Lamtoro* and *Sonokeling* were used for animal feed. This situation reduced the number of these plants.

At rather a-bit slope class (KL 3), *Intaran* dominated as forest plants and had the highest IVI value among other species at the level of

saplings (137.05%), of the poles (148.0%) and of trees (161.6%). At this slope class (KL 3), *Lamtoro* and *Sonokeling* were not found at the level of trees since they might have been cut down illegally. At steep slope class (KL 4), *Intaran* dominated the forest stands but only at the level of saplings (132.7%) and poles (164.5%), while Mahogany had the highest IVI (133.1 %). At the level of trees, *Lamtoro* could only be found in small amounts (IVI = 41.8%), while *Sonokeling* was not found at all at this level in KL 4 and KL 3. The pruning branches and illegal logging were suspected to happen at KL 4 evident from some leaves which remained in *Lamtoro* and *Sonokeling*.

At each slope class, the difference of dominance for forest plant species was strongly caused by the Mahogany and *Sengon* planting activities which were carried out from 2000 in these areas. Thus, Mahogany became the major species for reforestation and planting activities at the flat slope class (KL 1). In 2003 the exchange of species had been carried out at each slope class. As a result of orientation for production forest area in Pejarakan Village, the forest plant species were converted into *Intaran*, Mahogany, and *Sonokeling* [9].

Planting also gradually led to differences in growth rates of different forest plants, leading to the finding of the structure of vegetation at the level of saplings, poles and trees. In addition, some species might have been dead or cut down illegally, so the number of individuals and species were diminished.

In each class slope, the communal forests showed unstable ID value in which the value was less than one (<1). In these study sites, it referred to the fact that the species vegetative compositions were less found. That also meant that they were in a stage in which the pioneer species such as shrubs and bush were yet dominant because continua ring cares and burning leaves have created these conditions.

In addition to the above factors, at first, in flat class of slopes (KL 1), the diminished DR of *Lamtoro* and *Sonokeling* was caused by cutting shoots of sprout leaves for folder at dry season.

Consequently, the crops of *Sonokeling* became growing slowly. The pruning of branches or twigs greatly affected the growth of a plant species because it is these actions numbers of leaves that had the role to relate the process of photosynthesis and respiration.

The DR values were relatively reflected by the diameters of basal area of trees which had an effect on the crown density of the forest plants. The stages of planting were considered similar when domination (DR) > 70% was evaluated, and as sufficient the value of DR 40%-70% was evaluated as rare [8]. At the study sites, at the level of saplings, poles, and trees, the dominant species on each class of canopy density slope was quite rare until intermediately tolerant (40%-51.3%). Such conditions sunlight is still more likely to get into the forest stage that could be utilized by crops.

As for the crops which were planted in the alleys, the dominant crops which had high (RD=60% at KL 1) were *Cabe* and *Kacang tanah* (RD = 69.64% at KL 3), while *Lamtoro*, Putri Malu, Sp. Undis and *Walikukun* were less dominant at each class of slope. Among the dominant species, the high IVI was also considerably supported by the presence of vegetative compositions such as RD, FR, DR of each species [6; Soegianto, 1994 in [8]]. From result of the research, at KL 1 *Cabe's* IVI = 110%; at KL 2 and KL 3 *Kacang tanah's* IVI = 66.8% and 98.24%; and at KL 4 *Rumput Kawat's* IVI = 61.91%. At flat slope class (KL 1) Undis reached relatively high density (RD = 40%) with IVI = 61.91%, lower than *Cabe*, but this species was not found at ramp, a-bit steep and steep slope classes (KL 2, KL 3 and KL 4). These conditions were probably caused by the presence of the surface layer of soil erosion at steep slopes which take places every year in the rainy season, making the soil layer depleting, thin and unproductive for Undis planted.

As for crops which were planted in the alleys, the conditions at KL 1, KL 2, KL 3 and KL 4 showed that the community was not yet stable, that is the ID was only less than one (<1). However, at KL 1, Undis had the highest value, while at KL 2 and KL 4 *Rumput Kawat* had the highest value. At KL 3, *Kacang tanah* was the highest. *Rumput Kawat* was one kind of grass which farmers planted for the purpose of animal feeds. The low value of ID was affected by low new pioneer species which could live in cultivative fields due to tillage treatments that were continually performed in every planting season.

At the production forest areas in Pejarakan village, communal forest members may cultivate plant crops within 3-5 years and carry out the reforestation on each slope class. Within these 3-5 years, communal forest members must participate in maintaining these forest conditions, and they are permitted to get crops as fodder, firewood and for other personal use around the areas. This condition was associated with the government effort to involve communal forest to preserve and maintain forest sustainability by protecting forests from illegal actions. The productive forests formed the kind of artificial forest which was decided by human inventively [10].

Undisturbed forest ecosystem plays an important role for soil and water conservations. Humans beings need to preserve the forest to help protect preserve and prevent damages of forest ecosystem as well as to participate in the efforts of the government in reforestation of degraded lands. The production forest area of Pejarakan Villages in Regency of Buleleng has long experienced on degradations with natural conditions and local disturbances such as loggings and forest encroachments. The degradations occurred from 1997 to 1999 on the era of reform and have been continuing until today [9].

Careful management for production forests should be carried out by implementing agroforestry techniques which emphasize on the maintenance of forest plants in order to materialize the productive forest conditions, so be improve are safe able to the benefits and the welfares of local communities through independent, professional and sustainable management of the business. In addition to wood, the forest production will offer other products such as firewood, animal feed or food, medicinal plants, and utilities crops cultivation which the interface on the aisle. If the community is about to be involved in the cultivation, special management activities should be taken into account, such as preparation for planting seasonal crops started from the rainy season on October by doing the cleaning of weeds every July and tillage conducted in August.

Despite the fact that reforestation efforts had been carried out since 2003, satisfactory results were difficult to see with regard to the relative density, relative frequency, relative dominance, importance value index and diversity index of other forest plant species which were not many. Therefore, it is necessary to plant or to replant back another forest plant species on each class of slope, especially on a-bit steep slopes class (KL

3) and steep (KL 4), which aims to improve soil and water conservation. At the classified areas of Pejarakan village, the vegetation of forest plants was not popular indicated by the rank from rear to intermediate tolerant (40%-51.3%). This condition makes the sunlight could get into forest floors to help the productions of cultivated crops at study sites. We need to try planting another crop species at flat slope class (KL 1) and ramp class (KL 2) in accordance with these tolerance of shade by canopy trees to which provide areas at Pejarakan Village, Gerokgak District, Regency of Buleleng can run continuously.

CONCLUSION

Based on the results and discussion in the previous sections, some conclusions can be made as follows:

1. As for the species compositions and structure at HKM areas, there were only 5 (five) species of forest plants and 11 (eleven) plant species, including seasonal crops under agricultural cultivation. The vegetative structures on level of saplings, poles and trees were found in forest plants and seasonal agricultural crops; undergrowth plants were found in plant seedlings level.
2. The patterns which represent each vegetative types from the degree of important value index (IVI) became various among species at each class of slope which are represented by particular space. This species is characterized by the high IVI value among seasonal agricultural crops, forest plants and undergrowth plants. Thus, vegetative association types which represent study sites need to be determined.
3. The pattern of balance or stability of each kind for better forest plants and seasonal agricultural crops and undergrowth plants is still very small. In other words, the stability of the diversity of each species is still in the category of low diversity ($ID = <1$).

REFERENCES

1. Great IGAMS (2006) Concept and strategy development of Dryland Agriculture, National Seminar on Development of Dry Land Agriculture Towards a Prosperous Farmer. Denpasar.
2. Agricultural Statistics of Bali Province (1991). Agricultural Statistics of Bali Province. Office of the Bali Provincial Department of Agriculture, Denpasar. p.165.
3. Daryono (2002) Identification of elements of climate, nature rain, Climate Zone Evaluation

- Oldeman and Schmidt-Ferguson Bali region based on Data Updates, Master Thesis, Udayana University. Denpasar.
4. Ardhana IPG (2009) Component analysis methods and techniques biotic teaching material. Natural Science-Biology of Udayana University, Denpasar.
5. The Center for Forest Inventory (1999) Minutes of the technical instructions forest preserv, Center for Forest Inventory National Forest Inventory and Land Use Department of Forestry, Jakarta.
6. Tjitrosoedirdjo S, Utomo IH, Wiroatmodjo J (1984) Weed management in plantation. PT. Scholastic. Jakarta.
7. Fachrul MF (2007) Sampling methods Bioecology. Earth Literacy. Jakarta.
8. Indriyanto (2006) Forest Ecology. Ed. 1. Earth Literacy. Jakarta.
9. The Forest Service (2006) Development of dry land agriculture with Social Forestry Models in the Province of Bali. National Seminar on Development of Dry land Agriculture Towards a Prosperous Farmer. Denpasar.
10. Arief, A. (1994) Forest, nature and environmental impact. Ed.1. Indonesia Torch Foundation. Jakarta.