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Analysis of shifting cultivation practices and Teak Regeneration and Soil Nutrient on Fallow Lands in Bago Mountains, Myanmar

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မြန်မာနိုင်ငံ၊ ပဲခူးရိုးမတွင် လုပ်ကိုင်နေသည့် ရွှေပြောင်းတောင်ယာနည်းစနစ်နှင့် တောင်ယာ လုပ်ကိုင်ပြီး အနားပေးထားသည့် မြေများတွင် ကျွန်းဧမ္မတာမျိုးဆက်ပင်များနှင့် မြေဆီလွှာ ပြောင်းလဲမှု အခြေအနေများကို လေ့လာခြင်း: သုတေသနလုပ်ငန်း

ဒေါက်တာရိုစီနေဝင်း၊ လက်ထောက်ညွှန်ကြားရေးမှူး၊ အမြဲတမ်းအတွင်းဝန်ရုံး
ဘီလီနေဝင်း၊ လက်ထောက်သုတေသနအရာရှိ၊ သစ်တောသုတေသနဌာန

စာတမ်းအကျဉ်း

ဤလေ့လာမှုတွင် ပဲခူးရိုးမ၌ လက်ရှိကျင့်သုံးနေသည့် ရွှေပြောင်းတောင်ယာနည်းစနစ်ကို သိရှိနိုင်ရန် မေးခွန်းများဖြင့် လူမှုစစ်တမ်းကောက်ယူ၍ ဆန်းစစ်လေ့လာခြင်းနှင့် မြေအနားပေး ကာလမတူသည့် ဖုန်းဆိုးမြေများ (၃ နှစ်၊ ၅ နှစ်၊ ၁၀ နှစ်၊ ၁၅ နှစ် နှင့် နှစ် ၂၀) နှင့် သဘာဝတောတွင် ၂၀ မီတာ x ၂၀ မီတာ အကွက်ငယ်များချမှတ်၍ ဓမ္မတာမျိုးဆက်ခြင်း နှင့် မြေဆီလွှာပြောင်းလဲမှုများကို နှိုင်းယှဉ် လေ့လာခဲ့ပါသည်။ ဤလေ့လာမှုကို ခပေါင်းကြိုးဝိုင်းအတွင်းရှိ ခပေါင်းရွာတွင် ပြုလုပ်ခဲ့ပါသည်။ လူတွေ့မေးမြန်းချက်အရ ရွာသားများသည် ရွှေပြောင်းတောင်ယာလုပ်ကိုင်ရန်အတွက် ဝါးတောများကို အဓိကထား ရွေးချယ်ကြပြီး ပျမ်းမျှမြေအနားပေးကာလမှာ ၁၄ နှစ်ဖြစ်ပါသည်။ ထို့အပြင် ခပေါင်းရွာရှိ လူဦးရေမှာ တည်ငြိမ်မှုရှိပြီး ပျမ်းမျှအိမ်ထောင်စုဦးရေ ၅၀ မှ ၆၀ ရှိ၍ ရွှေပြောင်းတောင်ယာလုပ်ကိုင် ရန်အတွက် ရရှိသည့် မြေဧရိယာမှာ အတော်အသင့်ကျယ်ပြန့်ပါသည်။ ဤအချက်များသည် ရွှေပြောင်းတောင်ယာကြောင့်ဖြစ်နိုင်သည့် သစ်တော ပြုန်းတီး မှုကို လျော့နည်း စေနိုင်ပါသည်။ ၁၉၈၉ မှ ၂၀၀၀ ခုနှစ်အတွက် ရွှေပြောင်းတောင်ယာအကွက်များကို သက်ဆိုင်ရာ ဂြိုလ်တုဓာတ်ပုံများမှ NDVI သုံး၍ ဖော်ထုတ်ခဲ့ရာ အကွက်အားလုံးဖော်ထုတ်နိုင်ခြင်း မရှိသော်လည်း ၆၃- ၇၃% အထိ ဖော်ထုတ်နိုင်သဖြင့် NDVI သည် အသုံးဝင်သည့် tool တစ်ခုဖြစ်ကြောင်း တွေ့ရှိရ ပါသည်။ ဓမ္မတာမျိုးဆက်ခြင်း အခြေအနေကို လေ့လာဆန်းစစ်ချက်အရ ကျွန်းဓမ္မတာ မျိုးဆက်ခြင်းမှာ သဘာဝတောတွင် ကောင်းမွန်သော်လည်း ဖုန်းဆိုးမြေများတွင် ကျွန်းမျိုးဆက်ပင်များ၏ အရေအတွက်မှာ အလွန်နည်းကြောင်း တွေ့ရှိရပါသည်။ ထို့ကြောင့် ကြိမ်ဖန်များစွာ တောင်ယာမီးရှို့ခြင်းသည် ကျွန်းဓမ္မတာမျိုးဆက်ခြင်းကို ထိခိုက်စေ နိုင်ကြောင်း လေ့လာသုံးသပ်မိပါသည်။ သစ်ပင်များ၏ ဖွဲ့စည်းတည်ဆောက်မှုမှာ သဘာဝတောများ နှင့် ဖုန်းဆိုးတောများတွင် inverse J ပုံစံတည်ရှိပြီး စွန့်ပစ်ထားသည့် ဖုန်းဆိုးမြေများတွင် သစ်တောများ လျင်မြန်စွာ ပြန်လည်ကြီးထွားလာမှုကြောင့် ဖုန်းဆိုးသက်တမ်း များလာသည်နှင့်အမျှ အပင်ကြီးထွားမှု တိုးလာသည်ကို တွေ့ရှိရပါသည်။ ရွှေပြောင်းတောင်ယာကို နှစ်စဉ်ရွှေပြောင်းလုပ်ကိုင်ခြင်းကြောင့် သဘာဝတောနှင့် ဖုန်းဆိုးမြေများတွင် PH မှလွဲ၍ မြေဆီလွှာဂုဏ်သတ္တိများအားလုံး သိသိသာသာ ကွာခြားခြင်း မရှိကြောင်း လေ့လာတွေ့ရှိ ရပါသည်။

Analysis of Shifting Cultivation Practices and Teak Regeneration and Soil Nutrient on Fallow Lands in Bago Mountains, Myanmar

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Abstract

This study analyzed the shifting cultivation practices by interview, tree regeneration and soil nutrient on fallow lands by setting up 20 m x 20 m plots in natural forest and fallow lands with different ages (3- years, 5-years, 10-years, 15-years and 20-years old). This study was conducted in Kabaung viallge which was located in Kabaung Reserved Forest. According to the interview, the villagers especially choose the bamboo forest to open their shifting cultivation plots and the average fallow period is 14 years. Moreover, the population in the study area is quite stable (50- 60 households) and the available area for shifting cultivation is considerable large. These factors may reduce the deforestation of the study village. NDVI could be extracted 63 - 73% of shifting cultivation plots for 1989 – 2000 and it was a useful tool for extraction of previous year shifting cultivation plots in Kabaung village. According to the regeneration status, teak regeneration was good in natural forest but the number of teak seedlings was considerably low in fallow lands with different ages. So, it can be suggested that repeated burning may cause the problem for teak regeneration. Stand structure was in normal pattern in all fallow lands and the growth of trees gradually increase with increasing age of fallows due to the rapid forest re-growth on abandoned fallow lands. As the duration of cultivation was only one year, all soil properties except PH were not statistically different among the fallow lands and natural forest.

Keywords: Kabaung village, NDVI, fallow lands, teak regeneration, stand structure, soil properties

Contents

Analysis of Shifting Cultivation Practices and Teak Regeneration and Soil Nutrient on Fallow Lands in Bago Mountains, Myanmar

1. Introduction

Nowadays, deforestation and forest degradation become significantly urgent challenge all over the world due to increasing population density and developing urbanization activities. This causes a crisis and very sensitive feature of outlook in most developing countries. Like other developing countries, Myanmar is experiencing forest degradation and facing with the challenging task of restoring its degraded forests and enhancing the natural stock of teak not only by natural but also by artificial means.

FAO (2006) estimated that an area of 466,000 ha or 1.7% of forested area of Myanmar was destroyed annually between 2000 and 2005. Shifting cultivation is one of the major factors of forest degradation in Myanmar. The Forest Department has estimated that 22.8% of the total land area is affected by shifting cultivation. Shifting cultivation is said to be the main underlying cause for deforestation in Myanmar. The concept of most of the officials and researchers in Myanmar is that shifting cultivation is a destructive land use that should be stagnant. Improper land use, such as steep-slope cultivation, shifting cultivation without proper fallow period has an impact on the degradation of forests (Sein Thet and Ohn Win, 1995). Population pressure reduces the fallow period cycle and shifting cultivation becomes a major cause of forest depletion and degradation. In Myanmar, population reached about 53 million in 2004 with a growth rate of 1.84%. As the result of increasing population, in Chin State, the fallow period has been reduced from 10 years in the early 1960s to 3 - 7 years and in northern Shan State from 10 - 12 years in 1970 to 0 - 5 years (Maung Gale II, 1967). In case of Narkhaw in Kyaukme Township, northern Shan State, the period has gone down to zero (San Win, 2004). Although shifting cultivation is one of the causes for deforestation and forest degradation, there are still a few researches especially on regeneration and soil properties in fallow lands. This study aims to fulfill this gap.

2. Objectives

The objectives of this study are-

(1) To study the shifting cultivation system practicing in the study site
(2) To observe the distribution pattern of shifting cultivation plots
(3) To analyze the forest regeneration and soil properties in different fallow plots

3. Study area

In Myanmar, shifting cultivation practice prevails in Kachin, Kayah, Kayin, Chin and Shan states. However, there were a lot of people who live in the reserved forests of the Bago Mountains, like Karen people who also practice shifting cultivation. The government established

Karen Area in which they were freely allowed to conduct shifting cultivation since the colonial times.

The Karen people are the original inhabitants in Bago Mountain Areas and have been practicing shifting cultivation prior to the time of setting the Karen Area. The study area, Kabaung village, is one of the Karen villages in the Bago Mountain Areas.

Kabaung Village is situated in Kabaung Reserved Forest. The people who live in Kabaung Village depend mainly on shifting cultivation for their livelihood. According to the interviews, the name of the village was changed to "Kabaung" after 1948. The head of the village said that the government had given them 11 compartments for shifting cultivation. Since then, they have been practicing long fallow type shifting cultivation.

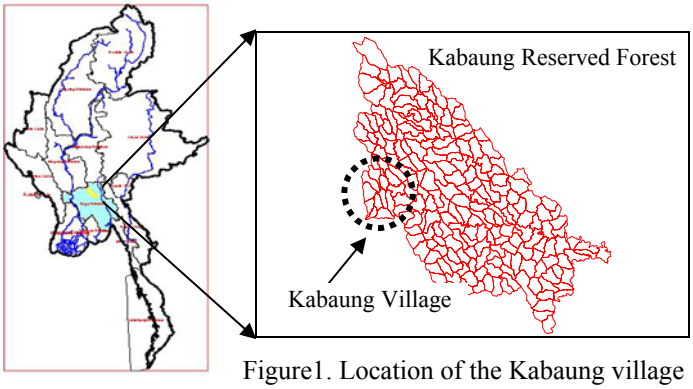


Figure1. Location of the Kabaung village

4. Materials and Methods

4.1 Household survey

Household survey was carried out with every household by using a simple questionnaire form to get information about agricultural calendar, fallow period, number of households, number of household members, population and kind of crops grown in shifting cultivation fields.

4.2 Extraction of shifting cultivation by using NDVI

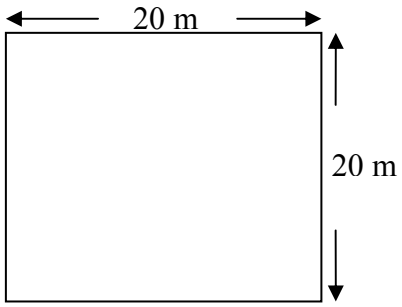
Every shifting cultivation plot for 2 years (2005 and 2006) was mapped by using GPS. Garmin GPS III plus and GPS V were used. These GPS data were overlaid on the Quick bird image and digitized the boundaries of each shifting cultivation plot for 2005 and 2006. Then, the area for each plot was calculated in ArcGIS. 2005 (40 plots and 97 ha) and 2006 (46 plots and 100ha) were conducted. For 1989 - 2000, for which field observations could not be made, the shifting cultivation plots were traced by using Normalized Difference Vegetation Index (NDVI).

For study on the distribution of the shifting cultivation plots, each NDVI calculated image was reclassified with a most suitable threshold NDVI value. NDVI values were different for each image. After that, the boundary of each plot was digitized and analyzed.

To identify shifting cultivation plots, the area, shape, and chronological change in plant cover were taken into consideration. Plots much smaller or larger than the sizes of actual shifting cultivation plots obtained from the field survey were excluded. Areas having NDVI values lower

than the threshold value for several consecutive years were determined as "other" areas (such as settlements, roads, permanent agriculture) and also excluded.

4.3 Analysis of tree regeneration and soil properties in fallow lands



Two sample plots of 20 m x 20 m were set up in each fallow stand of 3-, 5-,10-,15-,20- years and natural forest (F3, F5, F10, F15, F20, NF). In each plot, trees (DBH ≥ 5cm), saplings (DBH < 2-5 cm) and seedlings (DBH < 2cm) were enumerated, identified and measured DBH and total height. Soil samples were collected from the surface soil (0-5 cm) at four interior points in each plot. All samples were air-dried and analyzed at the soil laboratory of Forest Research Institute.

5. Results and discussion

5.1 Shifting Cultivation Practices in Kabaung Village

(i) Type of Shifting Cultivation

The people who live in this village make shifting cultivation fields around their village. The distance between their village and shifting cultivation field is not so far. The farthest plot is about 3 miles from their village. Each household selects a plot depending on the family size and available labor. The plots are shifted every year.

There is no significant land allocation for shifting cultivation in this area. If one would like to practice shifting cultivation in others' fallow land, he has to get permission from the previous farmer who had cropped the land before.

(ii) Fallow Period

Fallow period ranges between 7 and 42 years for rice fields. No systematic fallow management and fire protection for fallow land was observed. The following figure shows the fallow period of shifting cultivation in the study area. The average fallow period is 14.28 years.

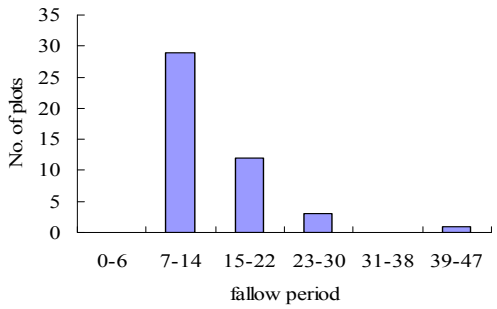


Figure 2 Fallow period of the study area

(iii) Crop Production

The primary goal of every household in the study area is to produce enough crops for their own consumption during the year and to keep enough seeds for next year's sowing. The main crops they grown are rice, glutinous rice, cotton, sesame and chili.

(iv) Period of Cultivation

For Karen people in the study area, a season of shifting cultivation starts in early January and ends in mid December (i.e one year). Site selection begins in January and they select the areas in which Kyathaung bamboo is grown. So, *Bambusa polymorpha* is the indicator for site selection in the study area. Agricultural calendar for Karen shifting cultivators is as follows in table 1.

Table 1. Agricultural calendar for shifting cultivation in Kabaung village

Month	Weather	Shifting Cultivation Activities
January	Cool, dry	Selection of the shifting cultivation sites, clearing the shifting cultivation plots
February	Warm, dry	Cutting trees and bamboos in shifting cultivation sites, left to dry
March	Hot, dry	Burning the dry slash in shifting cultivation fields
April	Hot, dry	Piling and re-burning incompletely burned slash
May	Hot, dry	Construction of the field shelter
June	Warm, rainy season	Planting rice, sesame, cotton, chili
July	Warm, humid, heavy rain	Begin weeding
August	Warm, humid, heavy rain	Continue weeding
September	Warm, humid, less rain	Final weeding
October	Cool, stop rain	Early maturing rice ripens. Begin harvest (cutting, drying, threshing).Store in granaries.
November	Cool, dry	Late maturing rice ripens. Begin harvest. Store in granaries. Sesame and chili also ripen.
December	Cool, dry	Complete harvest. Begin carrying rice to village for food.

(v) Size of Plots

In 2005, 40 households opened the shifting cultivation plots among 54 households. The total area of shifting cultivation plots was 980,128 m^2 and average size was 24,503m^2. In 2006, among 54 households, 46 households practiced shifting cultivation. The total area of shifting cultivation plots is 1004,454 m^2 and the average size of plot is 21,835 m^2.

(vi) The Condition of Rice Production

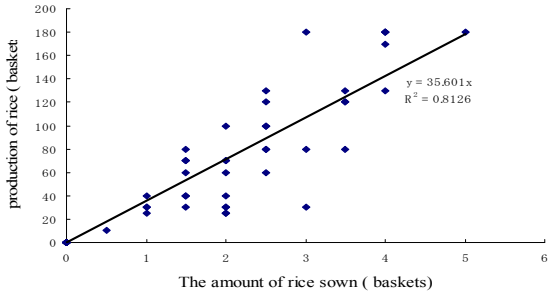


Figure 3. The amount of rice sown and rice production

According to the figure 3, the rice production in some shifting cultivation plots is very low. The most serious problems are decrease of soil fertility, damage by wild boars, health problems of the family members and weeding density. Farmers have no knowledge on making compost for better rice production. It is needed to give them technologies that can help increase rice production.

5.2 Distribution pattern of shifting cultivation plots

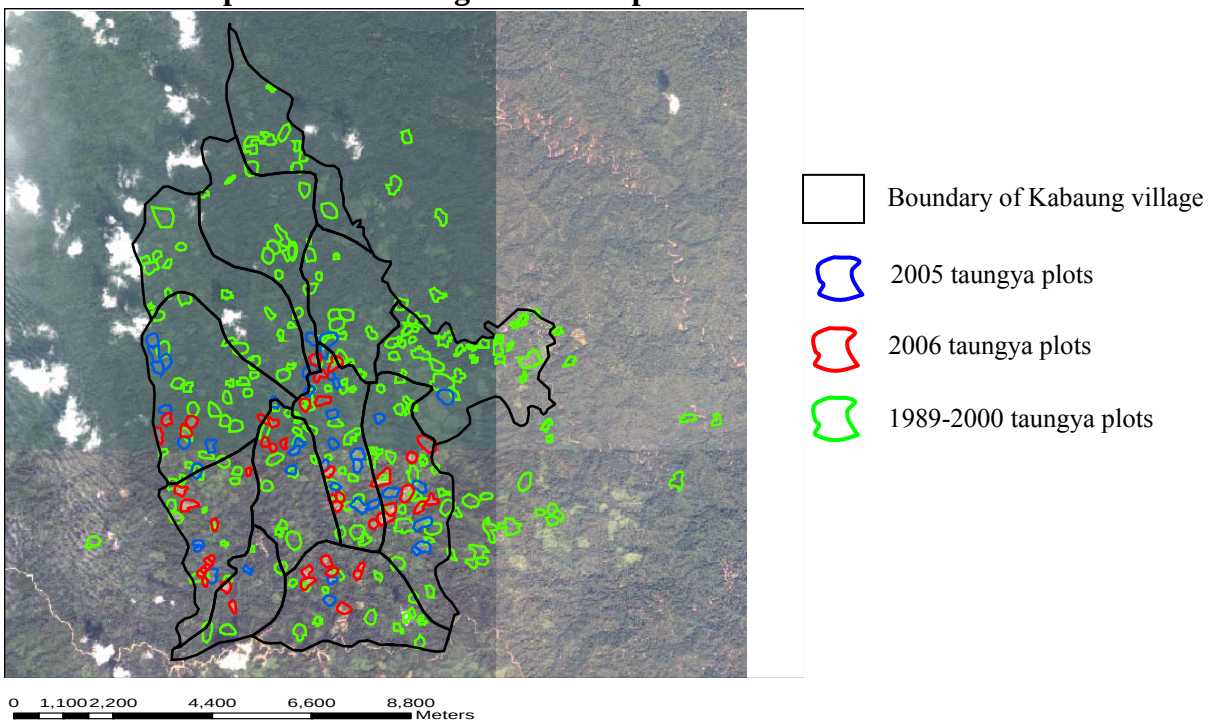


Figure 4. Shifting cultivation plots from GPS data (2005-2006) and estimated shifting cultivation plots (1989-2000) from NDVI

Figure 4 shows the shifting cultivation plots for 2005 - 2006 which were made from GPS data, field observations and shifting cultivation plots from 1989 - 2000 which were estimated from NDVI calculation.

According to the interview, in the previous years, shifting cultivation was carried out at distance away from the village but in 2005 and 2006, they practiced shifting cultivation not so far from the village. It can clearly be seen in figure 4. The villagers conserve the forest near the village and a few shifting cultivation plots can be seen around the neighbourhood of the village.

According to the analysis of the historical distribution of the shifting cultivation plots, only a few shifting cultivation plots overlapped between 1989 - 2006. It can be imagined that fallow periods of the shifting cultivation plots in Kabaung village are more than 10 years. The household survey for 2005 and 2006 reveals that the average fallow period is 14 years.

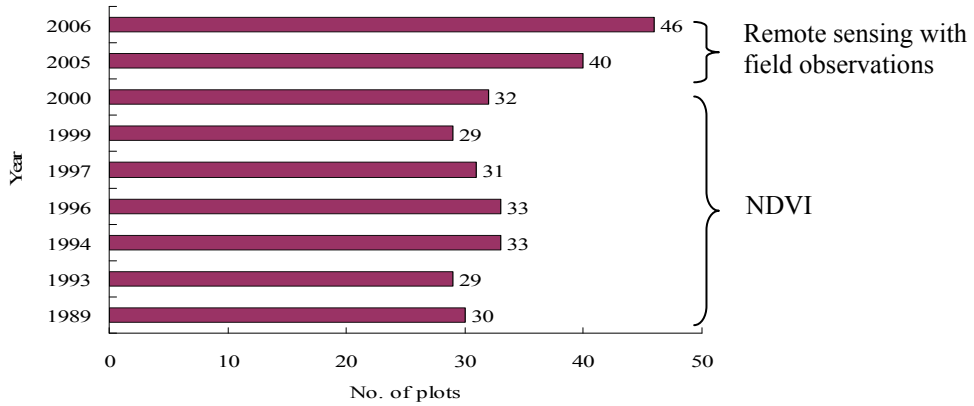


Figure 5. The number of shifting cultivation plots in 1989 - 2006

By seeing figure 5, the shifting cultivation plots in 1989 - 2000 are less than those of 2005 and 2006 which were estimated from field observation and GPS data. Therefore, it was observed that, all shifting cultivations plots for 1989 - 2000 were not able to be estimated by using NDVI but 63 - 73% could be extracted. NDVI is a useful tool for extraction of previous year shifting cultivation plots in Kabaung village.

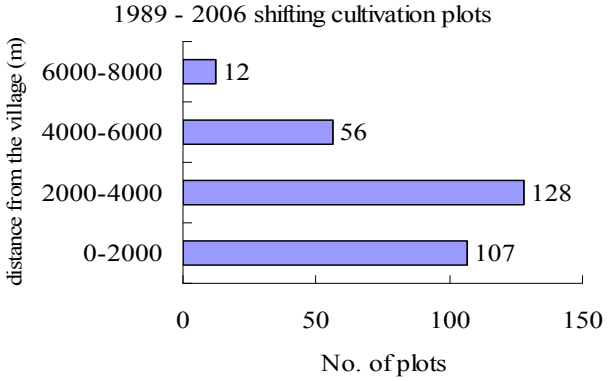


Figure 6. Distribution of the shifting cultivation plots from the village

In order to find out the distribution of the shifting cultivation plots from the village, the distance was classified into 2000 m interval. Figure 6 shows that most of the shifting cultivation

plots are 0 - 2000 m and 2000 - 4000 m away from the village. So, it can be seen that the villagers practiced shifting cultivation not so far from the village because they have to stay overnight in their huts for watching their fields.

5.3 Analysis of diameter distribution, forest regeneration and soil properties

5.3.1 Diameter frequency distribution in natural forest and fallow lands

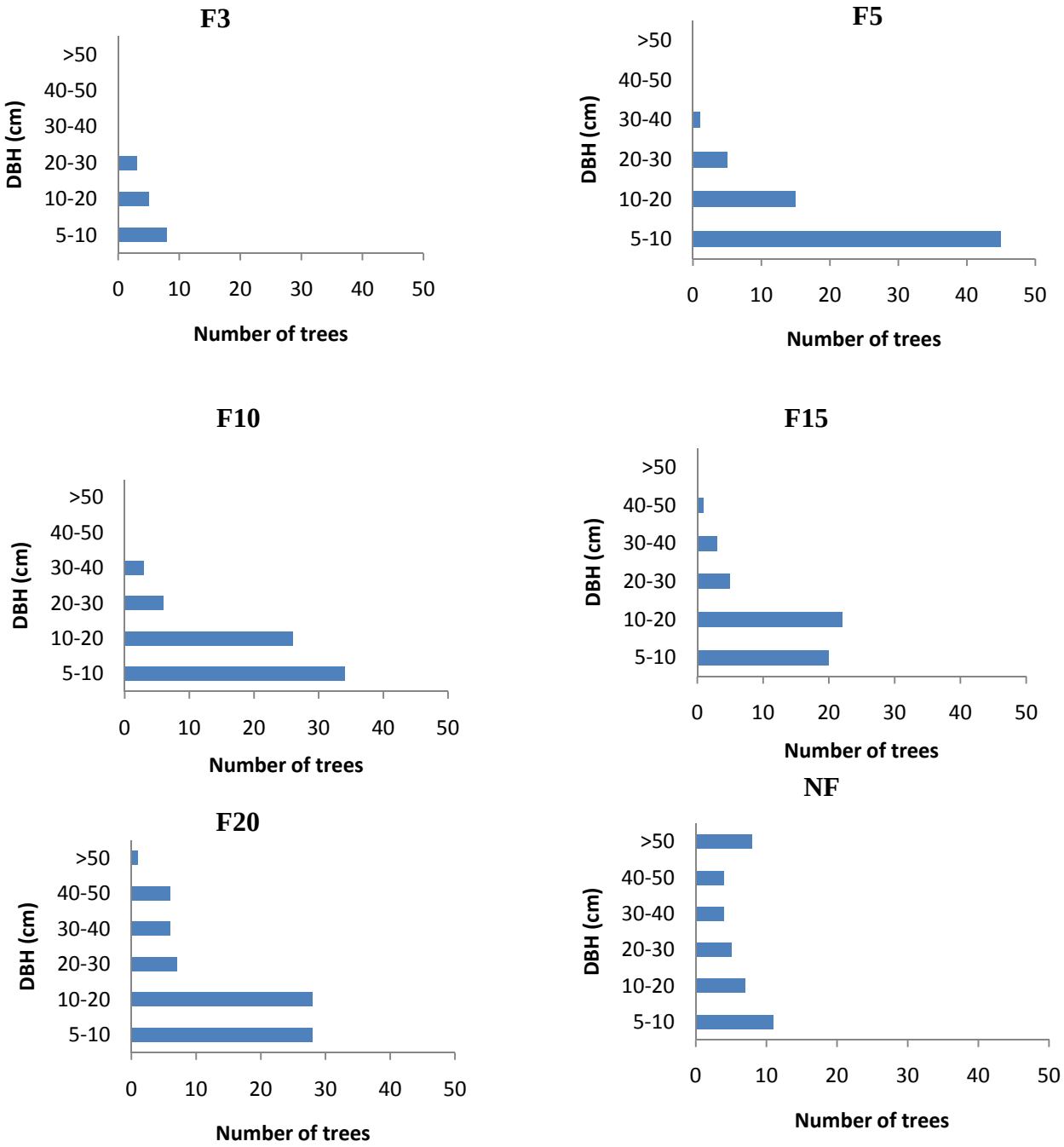


Figure 7. The diameter distribution pattern of trees in natural forest and fallow lands

The diameter distribution by stand number in the forest is one of the parameters for assessing the forest in line with the sustainable forest management (Tin Myo Aung, 2012). In normal distribution, the smaller DBH classes have the larger stand numbers which are gradually declining in the larger DBH classes (Lamprecht, 1989). In this study, to assess the diameter distribution of all trees with ≥5 cm DBH, the DBH were categorized into six DBH classes: 5-10, 10-20, 20-30, 30-40, 40-50, >50 cm (Figure 7).

In the natural forest, the higher number of trees was recorded in the DBH 5-10cm, followed by 10-20cm, 20-30cm, 30-40 cm and 40-50cm DBH classes. The number of trees which has >50 cm was higher than that in DBH classes of 10-20cm, 20-30cm, 30-40 cm and 40-50cm.

In 3-years-old fallow, only three DBH classes, 5-10cm, 10-20cm and 20-30cm, were presented. In 5 and 10 years fallow lands, the trees with DBH classes of 40-50 cm and > 50 cm were missing. In 15 years old fallow land, the trees with DBH class of > 50 cm was missing. The 20 years old fallow had the better performance of DBH class distribution than the other fallow lands as shown in Figure 7. In all fallow lands, the stand structure was found in normal distribution pattern. It means the number of trees in small diameter classes is greater than those in big diameter classes.

5.3.2 Status of natural regeneration in fallow lands

For regeneration status analysis, Teak (*Tectona grandis*) was selected. Teak is the most important tree species in Myanmar in terms of timber production and plantation development programmes.

For analysis of natural regeneration in fallow lands, the status of regeneration was defined as follows. (Uma Shankar 2001, Bhuyan et al. 2003; Reddy and Ugle 2008):

a. good regeneration (G= adequate number of seedlings and saplings which contribute to the adults)
b. fair regeneration (F= fair amount of seedlings but the number of saplings is lower than the number of adults or, in some cases, the number of saplings and adults are equal)
c. poor regeneration (P= individuals in either the seedling or sapling stage are missing)
d. no regeneration (N= the trees occur in the adult phase only)
e. new species (New= a considerable amount of individuals are found in the seedling and sapling stages)
f. under-story species (U= bushes undergrowth species).

Table 2. Status of natural regeneration in natural forest and fallow lands

Site	Species	seedlings	sapling	Adult	Status
		Number			
Natural Forest	Teak	34	20	5	G
F20	Teak	3	4	7	F
F15	Teak	12	10	11	F
F10	Teak	14	3	11	F
F5	Teak	3	7	25	F
F3	Teak	0	0	0	N

In natural forest, 5 teak trees (20% of total number of teak trees) were in adult phase while 34 of individuals (58% of total number of teak trees) and 20 of individuals (22% of total number of teak trees) were in juvenile phase and showed the good regeneration status. In 20-, 15-, 10- and 5 years old fallows, the number of individuals in saplings is smaller than that in adult phase and showed the fare teak regeneration. In 3 years fallow land, there was no teak regeneration. According to the finding of Fukushima et. al (2007), teak was dominant species in natural forest, but it was not found in the investigated fallow forest stands. She also found that teak was observed in some fallow fields in which swidden cultivation might not have been opened frequently but it might decrease after repeated cutting and burning. In this study, teak regeneration was good in natural forest but the number of teak seedlings was considerably low in fallow lands with different ages. So, teak regeneration might be future problem due to the repeated burning in the study area.

5.3.4. Soil properties in fallow lands

Table 3. Soil properties in natural forest and fallow lands

soil depth	soil properties	Natural Forest	fallow land				
			20-years	15-years	10-years	5-years	3-years
0-5 cm	PH	7.1	7.1	7.1	7.1	7	6.9
0-5 cm	Total N%	0.04	0.03	0.03	0.05	0.04	0.05
0-5 cm	Ava P %	0.00088	0.00022	0.00025	0.00036	0.00051	0.00024
0-5 cm	K %	0.005	0.008	0.008	0.008	0.006	0.009
0-5 cm	Ca %	0.30	0.25	0.33	0.27	0.26	0.20

Mean values for soil properties in the surface soil (0-5 cm) were statistically tested. The mean PH value among the natural forest and different fallow lands was statistically significant ($F= 6.40$, $p= .021$). Differences between the mean values of total nitrogen (N^+), available phosphorus (P), potassium (K^+), calcium (Ca^{2+}) and organic matter (OM) were not significantly different among investigated stands. This result was agree to the finding of Fukushima et. al

(2007), in which she found that there was no significant decrease in TC and TN in the surface soils of the current and young fallow fields in the S village. This is probably because duration of cultivation was only one year.

6. Conclusion

This study analysed the type of shifting cultivation practice which is their main livelihood. Livestock rearing was observed in some families to provide their daily food. They make shifting cultivation plots around their village and the plots were shifted every year. According to the interview, the villagers specially choose the bamboo forest to open their shifting cultivation plots and the average fallow period is 14 years. Moreover, the population in the study area is quite stable (50- 60 households) and the available area for shifting cultivation is considerable large. These factors may reduce the deforestation of the study village. NDVI could be extracted 63 - 73% of shifting cultivation plots for 1989 – 2000 and it was a useful tool for extraction of previous year shifting cultivation plots in Kabaung village.

Stand structure analysis showed that the stand structure was in normal distribution pattern in all fallow lands with greater number of trees in small diameter classes than those in big diameter classes. The growth of trees gradually increase with increasing age of fallows due to the rapid forest re-growth on abandoned fallow lands.

According to the regeneration status, teak regeneration was good in natural forest but the number of teak seedlings was considerably low in fallow lands with different ages. So, it can be suggested that repeated burning may cause the problem for teak regeneration.

Analysis of surface soil properties described that all soil properties except PH were not statistically different among the fallow lands and natural forest. It might be duration of cultivation was only one year.

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