# Chapter 3

# Farmers' management of shifting cultivation and crop diversity in reduced rotation cycle

## 3.1 Introduction

Numerous studies have been conducted about traditional shifting cultivation with long fallow periods, and the adverse consequence of shorter fallow on productivity, especially upland rice (Beer, 1983; Raintree and Warner, 1986 and Unruh, 1990). In Mae Sariang of Mae Hong Son province during 1960s, Karen and Lua communities were reported to maintain upland rice yield at 1.0-1.5 ton $ha^{-1}$ with shifting cultivation cycles of up to 20 years (Hinton, 1973; Grandstaff, 1980 and Kunstadter *et.al.*, 1978). With land limitation in 1990s, fallow periods were reduced to 3-5 years and productivity of upland rice declined to 0.8 ton $ha^{-1}$ (Grandstaff, 1980). Similar decline in upland rice yield was reported among the Karen in Mae Chaem area (Wangpakapattanawong, 2001). This raises a question of maintaining reasonably higher yields of upland rice with low inputs strategy as suggested by Greenland (1975). The management of shifting agriculture was also highly complex with a large combination of biodiversity of crop, vegetable and flower species as well as many useful wild species for vegetable and fruits (Anderson, 1993; Kampolkul, 2003 and Sutthi, 1996).

In Tee Cha where shifting cultivation cycle is now reduced to 7 years rotation, farmers appeared to have succeeded in maintaining productivity and diversity of upland rice and associated swidden crops. They have also managed their short fallow with

*Macaranga denticulata*, the pioneer tree species in the area. Without the abundance of *Macaranga*, farmers say that the yield of upland rice would be poor and unstable. Consequently, shortage of rice as the staple food for household consumption is likely to be severe before the next harvest.

In this chapter the field investigation was undertaken with the fallowing objectives:

- to identify key management practices that allow farmers in Tee Cha to continue their shifting cultivation under land pressure,
- to examine and assess social, cultural and agronomic practices that may be adapted to cope with the change to the intensification of shifting cultivation with reduced fallow, and
- to determine the extent to which the distribution of *Macaranga* occur in the land use for shifting cultivation.

### 3.2 Materials and Methods

The study was carried out in the village of Tee Cha from 2000 to 2005, employing a range of methods to collect primary and secondary data. A guideline for agrodiversity assessment was applied to assess management of shifting cultivation at different hierarchical levels, from village landscape down to individual fields of selected farmers (Brookfield *et al.*, 2002; Stocking, 2000 and Rerkasem, 2000). Participatory rapid appraisal (PRA) was used to collect management data by village meeting from groups and key informant interviews (Mc Cracken *et al.* 1987; Chambers, 1992 and Pretty, 1975). Field walks with farmers were carried out regularly through the different seasons to provide in-depth information and their knowledge about key management practices, local identification of plant species, land races of traditional crops and upland rice. Field observation was carries out regularly, at least once a month during the growing periods of upland rice cultivation. Records were made of farmers' management of swidden field, upland rice and other traditional crops and wild species, associating in the upland rice plots.

Measurements were made in sample plots (10m X 10m) to collect data on abundance and species diversity in 8 farmers' fields in order to derive diversity index, such as Species richness and Shannon-Weaver index. There were 3 samples in each farmer's field.

These indices can be calculated as fallow

- Species richness was the total number of species present in the sample plot.

- The Shannon-Weaver index (Power and McSorley 2000) is calculated by.

$$H' = -\sum_{i=1}^{s} pi \ln pi$$

When s = total number of type were found

$pi$ = proportion of the number of type i divided by total number of plant in each plot

As swidden crops are grown with upland rice at different times and harvested at different stages before, during or after rice harvest, this study made comparison of diversity between the timing in the cropping season was 2 months, 4 months and 6 months after sowing upland rice, of the farmer's field was selected in 2004 (Nopphon plots) to monitor and record the change in numbers of species, plant counts were made in non-destructive samples (20m X 20m) with 3 replicates. In addition data on rice varieties used by each household were collected from household survey conducted during the year 2000 to 2005.

With the availability of household plots in shifting cultivation on scale map (Chapter 2), it was possible to record the distribution of *Macaranga* with assistance of key informants and household interview. Field observations were made in cropping year 2000 to 2005 to distinguish sparse and densely populated of *Macaranga* patches. Mapping of distribution was identified according to individual land holdings.

## 3.3. Results

### 3.3.1 Management of shifting cultivation

Management decisions of shifting cultivation are based on both communal and household decisions depending on resource availability, i.e. land use, labour of household and specific tasks to be carried out throughout the growing season. Shifting cultivation land is considered both communal and individual ownerships. This complexity of management (Appendix B) has helped the Pwo Karen in Tee Cha to maintain their traditional shifting cultivation up to date.

**1) Management of shifting cultivation in Tee Cha with based collective decision making**

Gathering and celebration for New Year ceremony (Kreng Sung Koo) in February period provide a good opportunity to begin discussion about which fallow field should be cleared for cultivation, and when would be the most suitable time for slashing, burning and planting the next crops. The New Year gathering also provides the forum to set up the schedule for village meetings to select fallow field for cultivation and this sometimes delays until the end of February. In the meeting, decision is made to allocate land for every household in the community. The negotiation process is often very complicated in order to find out which household occupies land in excess of their available labour so that land will be available for re-distribution to other households or landless families. Priority is often given to those related to the land owning family, i.e. kin relationships, but there are some limitations. For example, a younger brother has no right to cultivate the field

above his elder brother on the upper slope. In addition, spiritual belief is also involved in the process of land allocation. Chicken wing-bone divination is commonly employed to indicate whether the spirit of the land gives permission for cultivation of good crop. If the result is negative, all households in the community have to go through this process and the results provide for revision of land allocation. At the end, all of the households in the community would have land for cultivation of upland rice. None of the household in Karen community is without land for cultivation of subsistence crops. This traditional practice may be extended to other cash crops in other area, example cabbage growing in the Karen community in Mae Chaem (e.g. Nakabutara and Rerkasem, 1992). More understanding of the system of land allocation in Karen community requires detail social and anthropological studies.

**2) Slashing and burning the fields**

Once the land is available to the household, the family labor would engage in slashing small trees and lopping branches off big trees. This is commonly done in March-April. Labour exchange is also common for slashing. There are un-cut areas between the fields i.e. area on the rigde tops, steep and narrow gullies, natural conservation areas and headwater areas. The slashed fields are then left to dry before burning.

Normally, drying the biomass took place for about 2-3 weeks after slashing. In the middle of April firebreak would be constructed to prevent accidental fires on the dry plant residues before actual burning. Fire watching is also practiced after slashing. Accidental fires are catastrophic, as they would result in uneven and incomplete burning which are

disastrous for the rice yield, so the fields often have to be abandoned. Bush fire protection requires communal efforts. Firebreaks also prevent the escape of fire into the uncut forest in or between the fields. In the 2000-2004 burn, the amount of fuel averaged 48.7 ton $ha^{-1}$. Burning would be decided upon before the onset of the opening rain in late April. Poor burning of wet residues could result in poor crop harvest and high demand of labour for piling and re-burning of the un-burned residues. Chicken sacrifice is carried out with offerings to spirits before burning so that the land and forest spirits would leave the field before burning starts (Khui Leng Khui Lang). Then, with another sets of offerings, the spirits are invited to return to the field at the time of rice planting. Farmers would select the site with a live tree trunk for performing the rite. Chicken and homemade liquor would be used as offering to the spirits. One to two weeks after burning, the farmer begins to clean his/her allocated area by gathering, piling and re-burning some remaining plant materials, by household labor. After the cropping field had been cleared and re-burned, each farm family prepares a shelter in their field. The shelter is where the sacrificial meals are prepared, and next to it shrines are erected during planting, harvest, and other ceremonies. Farmers may stay here overnight to guard the fields just before and during harvest. The shelter was used as a temporary barn to store rice during the harvest.

Either before or just after the planting time, the owners of plots along the main field boundary would have the responsibility to construct the field fences with splitting bamboo to keep large grazing animal out of the area.

**3) Planting upland rice and swidden crops**

Seed of upland rice and swidden crops will have to be well prepared prior to planting in May. Exchange of germplasms may be necessary when severe crop loss was experienced in the previous season or the need to change for new seeds. However, seed exchanges are often limited within kinship groups, especially for rice seeds. Introduction of new rice from neighboring villages are common in the area. Upland rice is the primary crop. The Karen prefers non-glutinous rice for their staple food crop and the glutinous rice usually for the desert or for brewing rice liquor for local ceremonies for offering to the spirits. Normally glutinous rice is planted on the upper slope and non-glutinous rice planted at of the lower part of the slope to prevent the rice varieties mixing together. According to farmers, cooking quality of glutinous rice is ruined when contaminated with non-glutinous grain. Usually the farmer will plant more than 1 variety the upland rice and more than 20 species of swidden crops together in the same field. When planting of the field is completed, the farmer will plant "Bue Che Bao". This is ceremonial seven-hole rice in a small square (Figure 3.1), used for predicting the planting date of next year and for placating the spirit.

**Figure 3.1** "Bue Che Bao" is ceremonial seven-hole rice in a small square.

**4) Weed, pest and diseases**

Weeding would normally be done three times during the entire cropping season. Hand weeding is the common practice with simple tools. The crops in the fields are subjected to a variety of pests and diseases and effective control measures have yet to be found. Ants and other soil insects begin to carry off crop seeds after planting. Rats, birds and wild pig are potentially picking up the seeds and destroy crop plants. The farmers make fence traps and snares in various forms to deal with rats, which they also eat. Many insects and diseases attack the crops, but the farmers have only prayers to fight them off.

In Tee Cha, villagers had many ceremonies during the growing season normally in the July, namely:

- "Lue Mee" is seven-hole rice spirit ceremony to ask the spirit help for good productivity.
- "Zhe Kur" is land spirit ceremony to ask for protection of the crops by the land spirit.
- "Zeng Za Sie" is trees spirit ceremony that farmers call on the spirit in the trees to protect the crops.
- "Ta Ke Klur" is the ceremony to ask for protection from bad spirits.

**5) Rice harvest**

Many swidden crops have begun to be harvested even before the rice harvest. This aspect will be dealt with in detail later. Harvesting of upland rice occurs between October to the end of November, depending of maturity of the rice variety. For example, Bue Zu is one of early maturing rice varieties and Bue Mue Tabong is one of the late maturing varieties. The glutinous type matures earlier in comparison with the non-glutinous rice. Farmers used labor exchange for harvesting and harvesting of each field is commonly completed within the day. Bundles of rice are left lying in the field for sun drying 2-3 weeks before threshing. Threshing and seed winnowing are carried out by individual household. A big bamboo basket is used for rice threshing to prevent post harvesting loss. The grain may be stored in bamboo container, wrapping with wild leaves to prevent rat attack. Dried grain is carried home for storage in the village after threshing.

**Table 3.1** Activities of rotational shifting cultivation of farmers in Tee Cha village.

| Activities | Timing(month) | Management Decision |
|---|---|---|
| 1. Village meeting | - | - |
| 1.1. New year ceremonial | February | Communal |
| 1.2. Selection of field plot for cropping | February | Communal |
| 1.3. Land allocation to each household | February | Communal / Household |
| 1.4. To ask permission land spirit | February | Household |
| 2. Slashing and looping big trees | March | Collection |
| 3. Drying and burning | | |
| 3.1. Firebreak construction | April | Communal |
| 3.2. Control burning | End of April | Communal |
| 3.3. Land spirit ceremonial (in the 7 days after burning) | April-May | Household |
| 3.4. Cleaning | May | Household |
| 3.5. Shelter | May | Household |
| 3.6. Fencing | May | Household |
| 4. Preparing seeds (rice & swidden crops) | May | Household |
| 4.1. Planting pre-rice-swidden crops | May | Household |
| 4.2. Planting upland rice | May | Collection |
| 4.3. Planting seven-hole rice | May | Household |
| 4.4. Planting post-rice-swidden crops | May | Household |
| 5. Rice establishment | June-July | Household |
| 6. Weeding | | |
| 6.1. First weeding | June | Household |
| 6.2. Second weeding | July | Collection |
| 6.3. Third weeding | August | Collection |
| 7. Spirit ceremonial | | |
| 7.1. Seven-hole rice spirit ceremonial | July | Family |
| 7.2. Land spirit ceremonial | July | Family |
| 7.3. Trees spirit ceremonial | July | Family |
| 7.4. Protection bad spirit ceremonial | July | Household |
| 8. Animals protection | July | Household |
| 9. Harvesting swiddens | July-January | Household |
| 10. Harvesting and staking | End of Oct - Nov | Collection |
| 11. Rice drying | November | Household |
| 12. Threshing | December | Household |
| 12.1. Rice spirit ceremonial | December | Household |
| 13. Transportation | December | Household / Collection |
| 14. Storage | January | Household |

**Source:** Key informant interview and field survey 2000-2003.

### 3.3.2 Management of short fallow

As mentioned earlier, the farmers in Tee Cha have managed their shortened fallow with *Macaranga denticulata*. The management of *Macaranga*, however, varies considerably in both cropping and fallowing phases of the shifting cultivation. While individual farmers are clearly in possession of their fields during the cropping phase, fallow fields are returned to community and the management of fallows depends upon communal management, rules and regulations to enhance fallow regeneration.

#### 1) Cropping phase

In the cropping phase, germination of *Macaranga denticulata* is almost complete when the upland rice is about 2 month old. Small *Macaranga* seedlings with 2 purple cotyledons can be easily observed among the rice. Germination of *Macaranga* appears in patches with varying densities in the field. In weeding time, the farmers do not treat the *Macaranga* as weeds; seedlings are left in the field to grow in association with upland rice and other swidden crops. Thinning may be carried out in dense spots to reduce seedling competition at early stages and the impact of *Macaranga* on rice crop at later stages of growth, leaving 8-10 plants $m^{-2}$ for seedling survival. Where *Macaranga* are sparsely populated transplanting is often tried to increase plant population. By the time of rice harvesting, *Macaranga* may reach > 1.0 m in height with single stem above crop canopy. Patchiness of *Macaranga* stand is related to many factors. Burning affects germination and survival of seedlings depend on suitable micro sites. Growth and development of *Macaranga* also vary greatly. Poor seedlings (small and weak) would

find great difficulty to survive during the dry season after rice harvest. Self thinning process may be in operation during stand establishment in the fallowing periods. The dynamics of *Macaranga* will be fully presented in the next chapter.

**2) Fallow phase**

Management of *Macaranga* during fallow periods is basically based on eco-management of natural regeneration process. Any interference in the regeneration process is prevented and controlled if possible. Construction of firebreaks to protect accidental fire into fallow is commonly rule and management every year in March. Large animals, i.e., cattle and buffaloes, are allowed for free grazing in young fallows. Destruction due to animal grazing was observed to be insignificant. Animals do not feed on *Macaranga* and damage of plant parts can be recovered with new branching in the following wet season. During the hot-dry season *Macaranga* drops almost all of its leaves, except those new leaves on young meristems. In the densely populated area of *Macaranga*, litter accumulated under fallow forest is fairly thick and prone to accidental fire. Experience of accidental fire occurred in the 2001 field. Consequently, the burned part was abandoned in the next cropping season.



**3) Distribution of *Macaranga denticulata***

The distribution of *Macaranga* in shifting cultivation fields was estimated and the overall distributions of sparsely and densely populated plots, defined by farmers, are shown in Figure 3.2. It may be seen that the distribution of *Macaranga* between shifting

cultivation fields vary greatly, e.g. mostly dense in 2000 and sparse in 2003 plots. The underlying reason for these differences is unknown. Species composition and vegetation structure of these fallows are observed to be greatly different. Fallow regeneration of the 2003 plot is the poorest. In fact, the farmers have delayed to open up this plot when the full shifting cultivation cycle was completed, in order to allow more time for the vegetation to develop to more maturing stage.

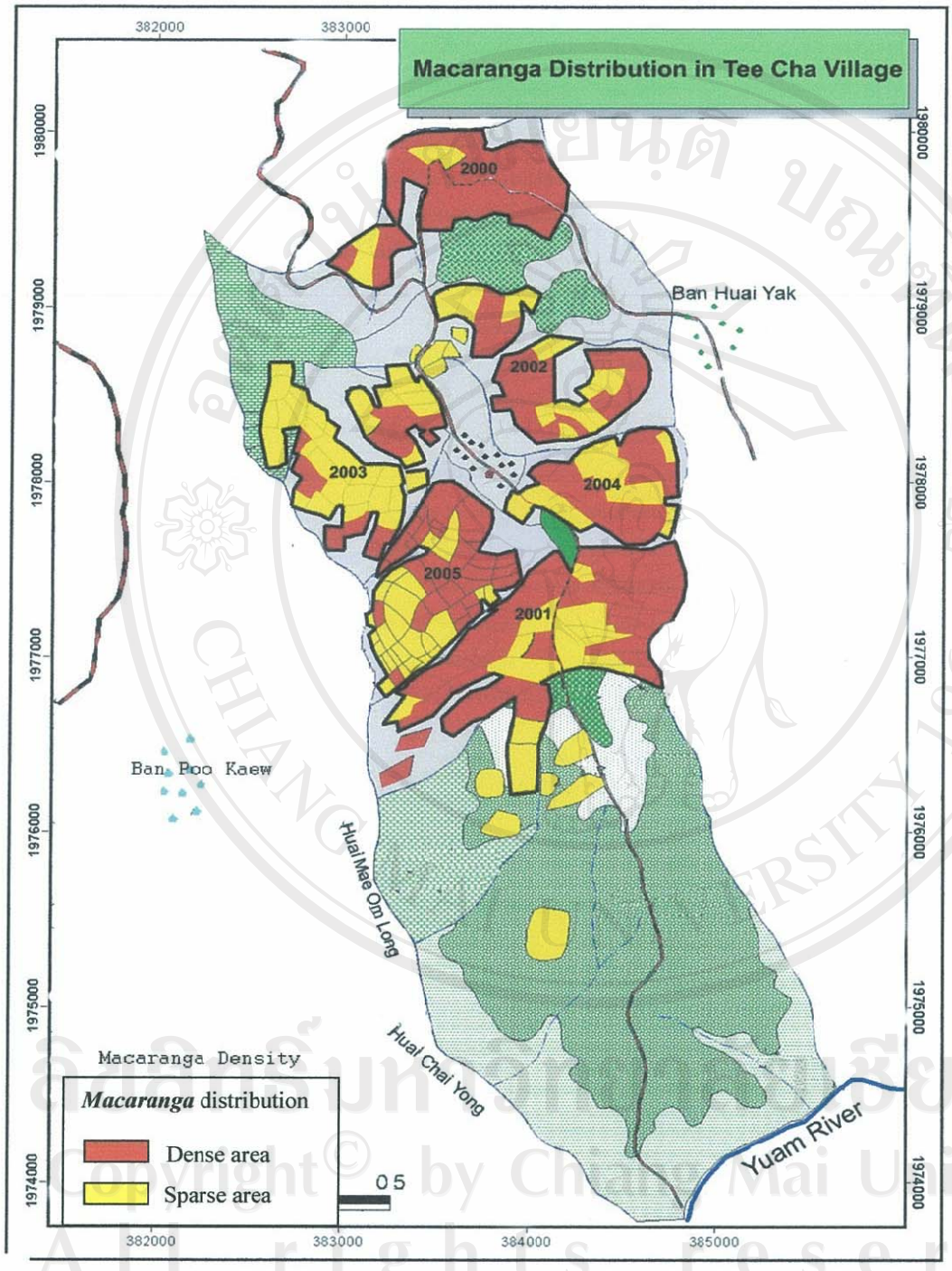


**Figure 3.2** Distribution of *Macaranga denticulata* density in rotate field of Tee Cha Village.

### 3.3.3 Maintenance of crops diversity

Despite all the changes, farmers in Tee Cha could maintain their shifting cultivation system with rich diversity of upland rice and swidden crop species. The richness of agro-biodiversity is traditionally managed and conserved over generations. The maintenance in the face of land use change and alternative practice of shorter fallow regeneration with *Macaranga* are presented below.

**1) Genetic diversity of upland rice**

In Tee Cha farmers are planting both glutinous and non-glutinous rice type for their own requirement. There are some 17 named varieties in total (year 2000-2004), i.e. 12 varieties of non-glutinous and 5 varieties of glutinous type respectively (Table 3.2). On average, a household would grow 3-5 varieties, depending upon the conditions of the field and their preference. The upper part of field is planted to glutinous rice to prevent mixture of non-glutinous rice planted in the lower part. This study in 2000-2004 was found that the rate of abandonment or variety turnover was high, even when the number of local varieties grown in the village remained stable. Abandonment and acquisition of varieties appear to be the norm (Table 3.3). The numbers of farmers who planted to local upland rice varieties were recorded between year 2000-2004 and results give in Table 3.4. For non-glutinous rice, 3 majorities of farmers grow were Bue Bang, Bue Gau and Bue Mue Ta Bong. In case of glutinous rice, Pa Ai Khu Phae remained the dominant variety during the study periods. The distribution of rice varieties in shifting cultivation fields is shown in Figure 3.3-3.8 for cropping year 2000-2005 respectively.

**Table 3.2** The names of local upland rice varieties in Tee Cha village between year 2000-2004.

| Rice type | Local names |
|---|---|
| Glutinous | Pa Ai Khu Phae |
| | Pa Ai Ki Kal |
| | Pa Ai Goal |
| | Pa Ai Chai |
| | Pa Ai Chair |
| Sub total number | 5 |
| Non-glutinous | Bue Bang |
| | Bue Gau |
| | Bue Goal |
| | Bue Kee |
| | Bue Paw Low |
| | Bue Pho Lae |
| | Bue Mue Ta Bong |
| | Bue Chu |
| | Bue Khu Koo |
| | Bue Tho Lae |
| | Bue Mue |
| | Bue Care |
| Sub total number | 12 |
| Total Number 2 | 17 |

**Source:** Household interview in 2001-2004

Pa Ai and Bue are Pwo Karen name that refer to glutinous and non-glutinous respectively.

**Table 3.3 Rice** varietal turnover in Tee Cha, 2000-2004

| Variety name[a] | Farmers growing the variety (no.) | Growers as percent of village[b] (N=36) | Acquired[c] | Abandoned[d] |
|---|---|---|---|---|
| Bue Bang | 15 | 42 | 7 | 4 |
| Bue Gau | 14 | 39 | 3 | 1 |
| Bue Goal | 8 | 22 | 4 | 1 |
| Bue Kee | 3 | 8 | 1 | 1 |
| Bue Paw Low | 10 | 28 | 5 | 2 |
| Bue Pho Lae | 3 | 8 | 1 | 0 |
| Bue Mue Ta Bong | 13 | 36 | 5 | 1 |
| Bue Chu | 10 | 28 | 7 | 3 |
| Bue Khu Koo | 1 | 3 | 0 | 0 |
| Bue Tho Lae | 2 | 6 | 1 | 2 |
| Bue Mue | 1 | 3 | 0 | 0 |
| Bue Care | 1 | 3 | 0 | 0 |
| Pa Ai Khu Phae | 25 | 69 | 6 | 5 |
| Pa Ai Ki Kai | 3 | 8 | 1 | 3 |
| Pa Ai Go | 7 | 19 | 3 | 4 |
| Pa Ai Chai | 4 | 11 | 2 | 1 |
| Pa Ai Chae | 1 | 3 | 1 | 0 |

**Note:** [a]In the Karen name

[b]Total number of farmers who grew the specified variety at least once during the 5 years study.

[c]Number of farmers who started to grow the variety after not growing it for more than 1 year during the 5 years study.

[d]Number of farmers who grew the variety and then stopped for at least 1 year during the 5 years study.

**Table 3.4** Number of farmers planted to local upland rice varieties during year 2000-2004.

| | Number of Farmers | | | | |
|---|---|---|---|---|---|
| Local name | 2000 | 2001 | 2002 | 2003 | 2004 |
| Bue Bang | 11 | 10 | 13 | 10 | 8 |
| Bue Gau | 8 | 9 | 9 | 12 | 9 |
| Bue Goal | 4 | 5 | 7 | 4 | 3 |
| Bue Kee | 2 | 2 | 2 | 3 | 3 |
| Bue Paw Low | 5 | 4 | 7 | 8 | 7 |
| Bue Pho Lae | 1 | 1 | 2 | 2 | 3 |
| Bue Mue Ta Bong | 9 | 5 | 7 | 10 | 8 |
| Bue Chu | 3 | 3 | 3 | 7 | 4 |
| Bue Khu Koo | 1 | 1 | 1 | 1 | 1 |
| Bue Tho Lae | 1 | 3 | 3 | 2 | 1 |
| Bue Mue | 0 | 1 | 2 | 0 | 0 |
| Bue Care | 0 | 1 | 0 | 0 | 1 |
| Pa Ai Khu Phae | 17 | 16 | 21 | 22 | 14 |
| Pa Ai Ki Kal | 2 | 1 | 3 | 3 | 1 |
| Pa Ai Goal | 5 | 4 | 5 | 4 | 1 |
| Pa Ai Chai | 1 | 1 | 1 | 1 | 1 |
| Pa Ai Chair | 1 | 2 | 1 | 1 | 2 |
| Total | 32 | 32 | 35 | 36 | 36 |

**Source:** Household interview in 2000-2004.

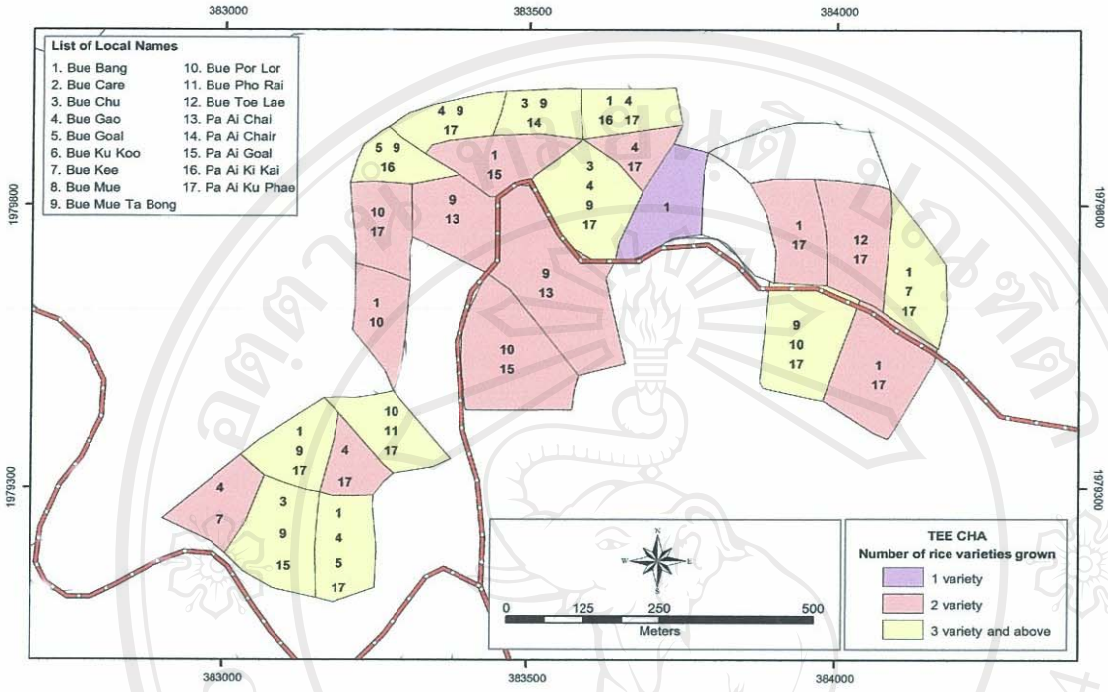


**Figure 3.3** Distribution of upland rice varieties used in cropping year 2000.

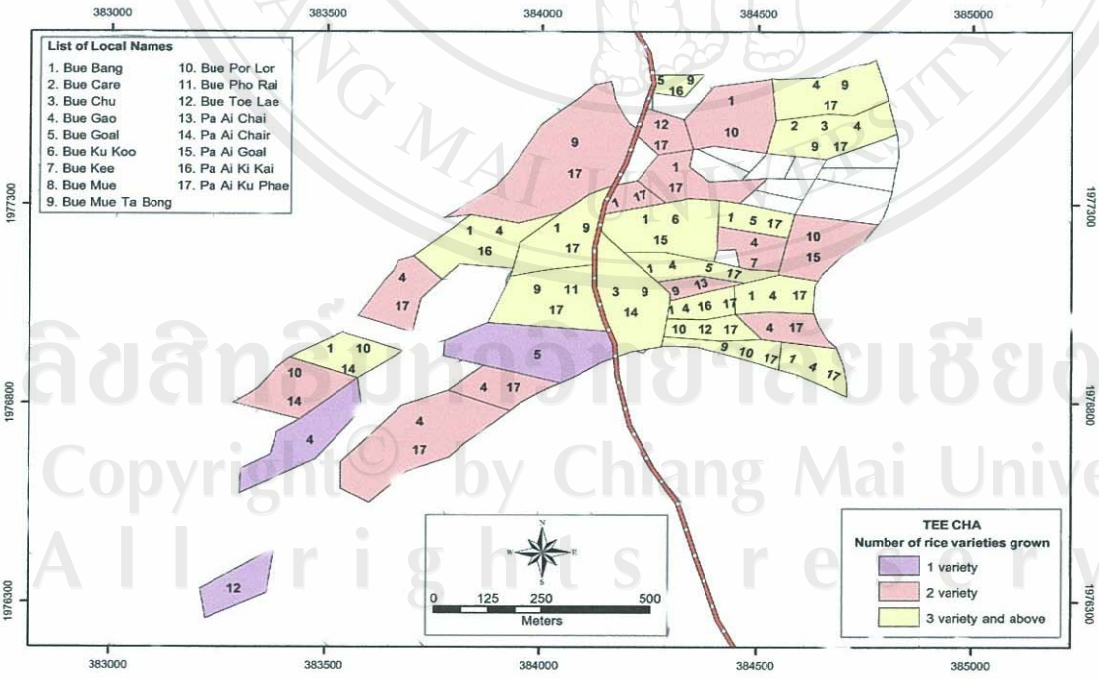


**Figure 3.4** Distribution of upland rice varieties used in cropping year 2001.

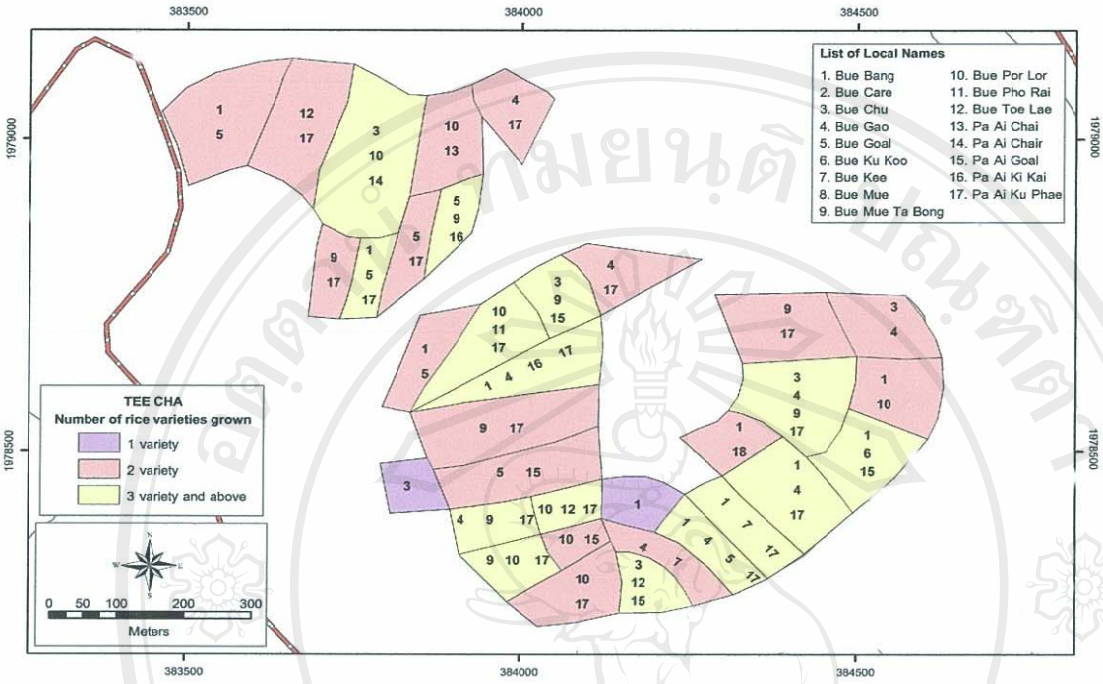


**Figure 3.5** Distribution of upland rice varieties used in cropping year 2002.

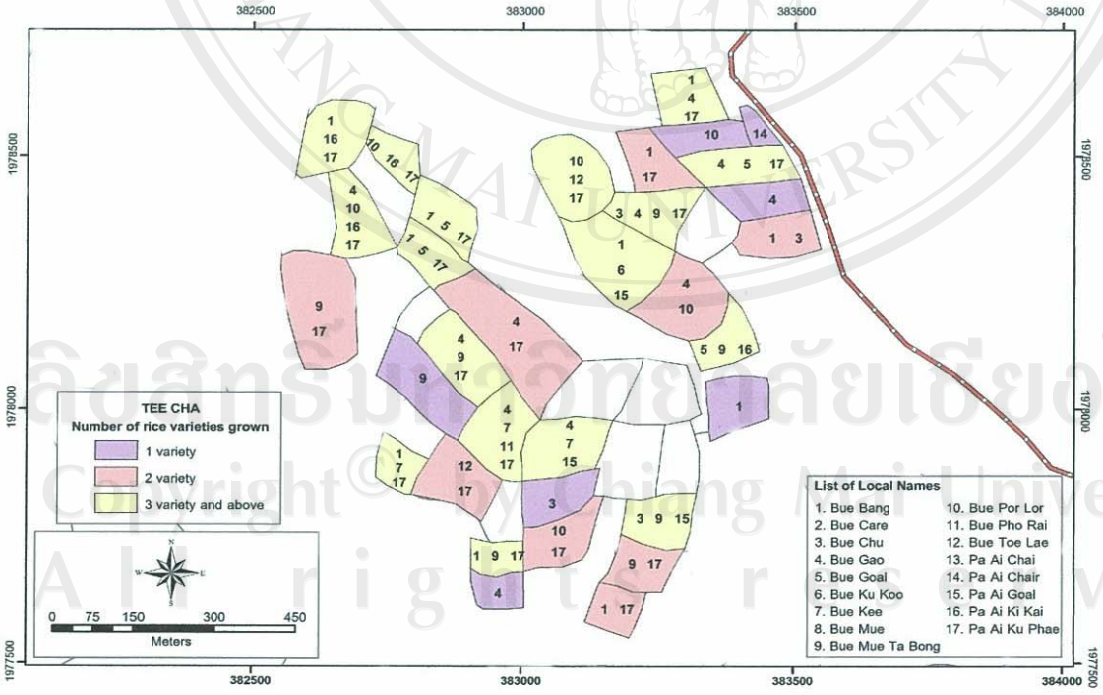


**Figure 3.6** Distribution of upland rice varieties used in cropping year 2003.

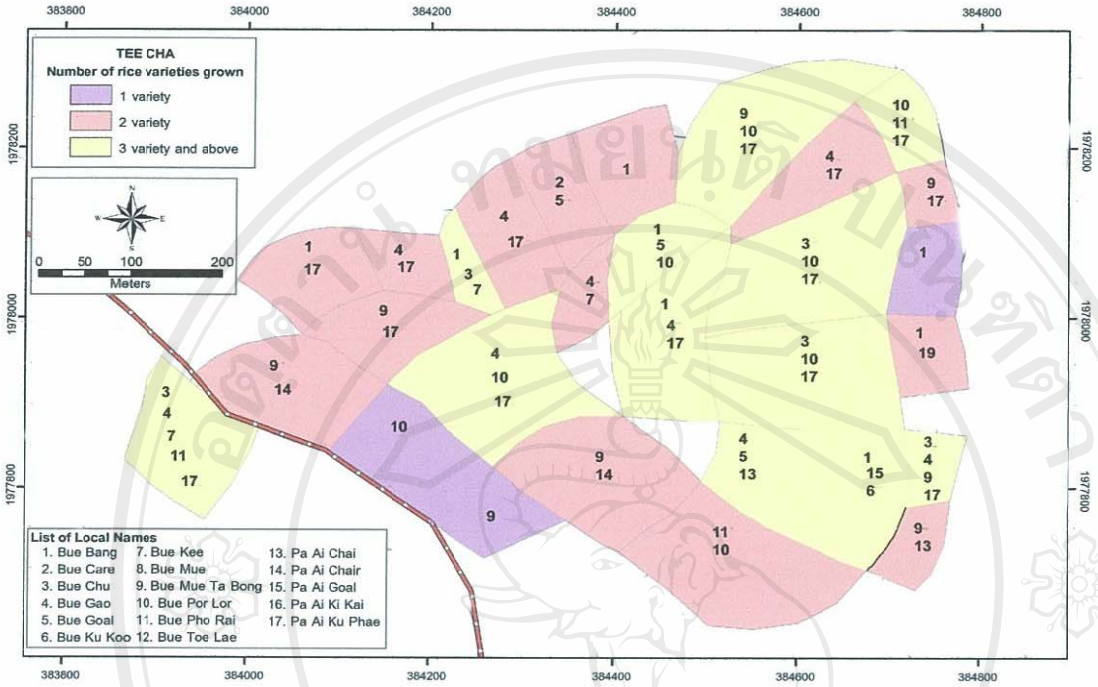


**Figure 3.7** Distribution of upland rice varieties used in cropping year 2004.

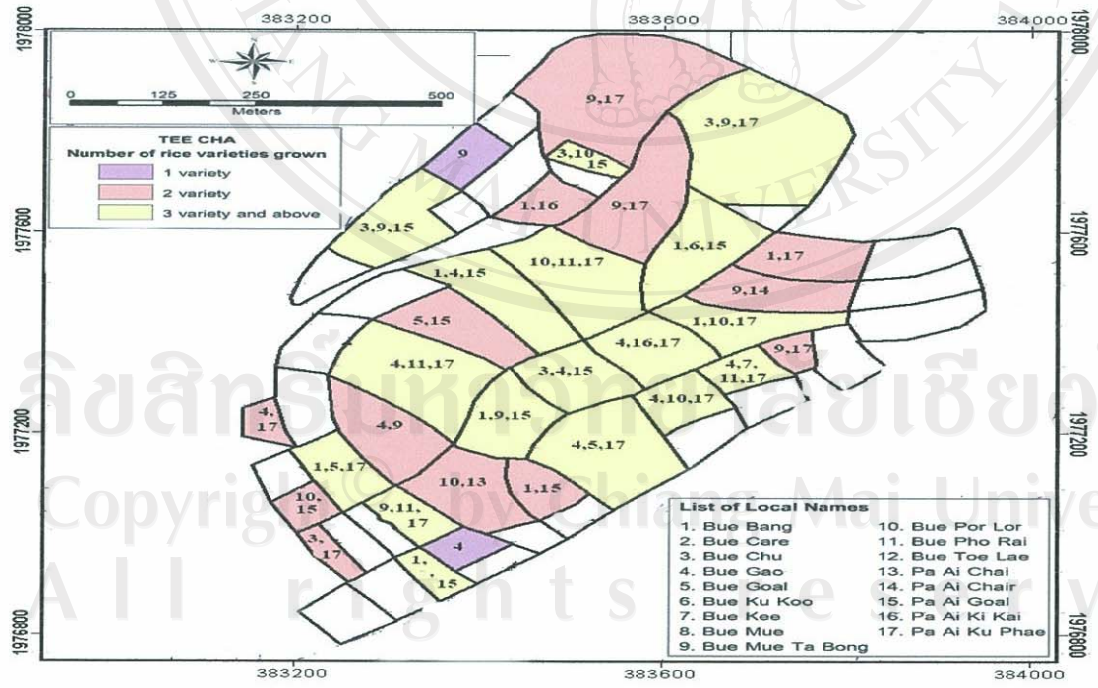


**Figure 3.8** Distribution of upland rice varieties used in cropping year 2005.

**2) Species diversity of swidden crops**

The total number of swidden crops grow in Tee Cha was found to be as high as 56 species. The swidden crops ranged from cereals, grain legumes for food crops to vegetables, spices, cut flowers, for cooking as well as ceremonial purposes (Table 3.5). They are sown in association with rice in the main fields. The data of sowing or planting of swidden plot relative to upland rice help to classify those swidden crops into 3 major groups, 1) sown immediately after burning before growing upland rice, 2) sown simultaneously with upland rice as seed mixture and 3) sown after upland rice sowing ( Table 3.6). Individual farmers may also change the number of species they grow from year to year (Table 3.7). On the other hand, the average number of species grown by farmers in the whole village remained fairly constant 35 species during the study periods from 2001-2004.

**Figure 3.9** The non-rice crops among upland rice in shifting cultivation field.

**Table 3.5** Crop species grown by farmers in the cropping year 2001-2004 and their usage.

| No. | Common name or local name | Scientific name | Growth duration (month) | Main use | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Fo | Fe | V | S | Or | M | SC | O |
| 1 | Chili | *Capsicum sp.* | 7 | * | | * | * | | | * | |
| 2 | Glutinous corn | *Zea mays* | 5 | * | * | | | | | | |
| 3 | Taro | *Colocasia antiqurum Schott* | 7 | * | | | | | | | |
| 4 | Cassava | *Manihot esculenta Crantz.* | 5 | * | | | | | | | |
| 5 | Sweet potato (white) | *Ipomea batatas* | 7 | * | | | | | | | |
| 6 | Sweet potato (red) | *Ipomea batatas* | 7 | * | | | | | | | |
| 7 | Yam bean | *Pacchyrhizus crosus* | 7 | * | | | | | | | |
| 8 | Yams | *Diocorea alata L.* | 4 | * | | | | | | | |
| 9 | Pumpkin | *Cucurbita pepo L.* | 7 | * | | * | | | | | |
| 10 | Pumpkin | *Cucurbita pepo L.* | 7 | * | | * | | | | | |
| 11 | Winter melon (long) | *Benincasa hispida* | 7 | | | * | | | | | |
| 12 | Winter melon (round) | *Benincasa hispida* | 7 | | | * | | | | | |
| 13 | Cucumber | *Lagenaria bucantha* | 5 | | | * | | | | | |
| 14 | Small Cucumber | *Cucurbita pepo* | 4 | | | * | | | | | |
| 15 | Squashes | *Luffa acutangula* | 4 | | | * | | | | | |
| 16 | Gourd | - | 5 | | | * | | | | | |
| 17 | Bitter gourd | - | 5 | | | * | | | | | |
| 18 | Local eggplant (long) | *Solanum sp.* | 7 | | | * | | | | | |
| 19 | Local eggplant (round) | *Solanum sp.* | 7 | | | * | | | | | |
| 20 | Egg plant | *Solanum spp.* | 7 | | | * | | | | | |
| 21 | Egg plant (brittle) | - | 7 | | | * | | | | | |
| 22 | Lima bean | - | 6 | | | * | | | | | |
| 23 | Back bean | - | 7 | | | * | | | | | |
| 24 | Centro | *Centrosema pubescens* | 7 | | | * | | | | | |
| 25 | Long bean | - | 3 | | | * | | | | | |
| 26 | Winged bean (long) | *Psophocarpus tetragonolobus* | 3 | | | * | | | | | |
| 27 | Winged bean(short) | *Psophocarpus tetragonolobus* | 3 | | | * | | | | | |
| 28 | Okra | *Hibicus escutentusl* | 3 | | | * | | | | | |
| 29 | Roselle | *Hibicus Sabdariffa* | 3 | | | * | | | | | |
| 30 | Ginger | *Zingiber officinata Rose* | 6 | | | * | * | | * | | |
| 31 | Lemon grass | *Cymbopogon citratus* | 4 | | | * | * | | | | |
| 32 | Millet | *Seteria italica (L.) Beauv* | 7 | * | | | | | | * | |
| 33 | Local millet | - | 7 | * | | | | | | | |
| 34 | White seeded sesame | *Sesame indicum L.* | 7 | * | | | | | | * | |
| 35 | Back seeded sesame | - | 7 | * | | | | | | * | |
| 36 | Small seeds sesame | *Perilla frutescens Britt.* | 7 | * | | | | | | * | |

**Table 3.5** Crop species grown by farmers in the cropping year 2001-2004 and their usage (continues).

| No. | Common name or local name | Scientific name | Growth duration (month) | Main use | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Fo | Fe | V | S | Or | M | SC | O |
| 37 | Cotton | *Gossypium arboreum* | 10 | | | | | | | * | * |
| 38 | Phak E-Leun | *Isodon ternifolius* | 3 | | | * | | | | | |
| 39 | Lettuce | *Brassica sp.* | 2 | | | * | | | | | |
| 40 | Tobacco | *Nicotiana tobacum* | 8 | | | | | | * | * | * |
| 41 | Leaf mustard | *Brassica juncea* | 1 | | | * | | | | | |
| 42 | Shallot | *Allium cepa L.* | 3 | | | * | * | | | | |
| 43 | Onion | - | 5 | | | * | * | | | | |
| 44 | Coriander | *Foeniculum vulgare* | 3 | | | * | * | | | | |
| 45 | Tomato | *Lycopersicum sp.* | 5 | | | * | | | | | |
| 46 | Rape | *Brassica napus L.* | 3 | | | * | | | | | |
| 47 | Job's tear | *Coix lachryma-jobi L.* | 8 | * | | | | | | * | * |
| 48 | Small Job's tear (long) | *Coix puellarum* | 8 | * | | | | | | * | * |
| 49 | Small Job's tear (round) | *Coix puellarum* | 8 | * | | | | | | * | * |
| 50 | Krang Kui | - | 7 | | | | | | | | * |
| 51 | Wan sai | - | 3 | | | * | * | | | | |
| 52 | Burmese marigold | *Cosmos caudatus HBK.* | 7 | | | | | * | | * | |
| 53 | Marigold | *Tagetes patula L.* | 7 | | | | | * | | * | |
| 54 | Safflower | *Carthamus tinctorius L.* | 7 | | | | | * | | * | |
| 55 | Po ne te | - | 7 | | | | | * | | * | |
| 56 | Dawk Talom | *Gomphrena globasa L.* | 7 | | | | | * | | * | |

Sources: Field survey and household interview in 2001 and 2002

Fo=Food, Fe=Feed, V=Vegetable, S=Spice, Or=Ornamental, M=Medicine, SC=Spirit Ceremony, and O=Others

**Table 3.6** Swidden crops species in the rotational shifting cultivation.

| Time of Planting | Number of species | Swidden crops grown |
|---|---|---|
| Before upland rice | 13 | Chili, Corn, Taro, Cassava, Yams, Pumpkin (long), Pumpkin (round), Bitter gourd, Lima bean, Winged bean (long), Winged bean (short), Cotton, and Tomato |
| Mixed with the rice seed and sown at the same time | 39 | Chili, Winter melon (long), Winter melon (round), Cucumber, Small cucumber, Squashes, Local squashes, Local eggplant (short), Local eggplant (long), Local eggplant, Egg plant (brittle), Back bean, Yard long bean, Winged bean (long), Winged bean (short), Okra, Roselle, Millet, Fox tail millet, Sesame (while), Sesame (back), Sesame (small), Cotton, Phak E-leun[1], Lettuce, Tobacco, Leaf mustard, Shallot, Coriander, Small Job's tear (round), Small Job's tear (long), Krang Kui[1], Wan sai[1], Burmese marigold, Marigold, Safflower, Ponadang, and Dawk Talom. |
| After upland rice | 12 | Sweet potato (red), Sweet potato (white), Yam bean, Yams, Bitter gourd, Lima bean, Winged bean (long), Ginger, Lemon grass, Shallot, Onion, and Job's tear |

**Source:** Household interview in 2002.

**Note:** 1= local name

**Table 3.7** Changes in Species Richness among sample households between year 2001-2004.

| Sample Household | Farmer's Plots | Number of swidden crops | | | | |
|---|---|---|---|---|---|---|
| | | 2001 | 2002 | 2003 | 2004 | Average |
| 1 | Mayo | 42 | 46 | 47 | 37 | 43 |
| 2 | Takae | 26 | 35 | 35 | 33 | 32 |
| 3 | Thongdee | 41 | 41 | 39 | 36 | 39 |
| 4 | Daloy | 28 | 33 | 39 | 33 | 33 |
| 5 | Pongsawan | 41 | 41 | 48 | 42 | 43 |
| 6 | Nayo | 19 | 27 | 34 | 29 | 27 |
| 7 | Kaewloy | 38 | 31 | 30 | 31 | 33 |
| 8 | Pawda | 37 | 31 | 40 | 32 | 35 |
| 9 | Krawchui | 35 | 35 | 52 | 39 | 40 |
| 10 | Tanee | 40 | 38 | 43 | 37 | 40 |
| 11 | Luyo | 30 | 30 | 37 | 27 | 31 |
| 12 | Kuiloy | 33 | 33 | 35 | 26 | 32 |
| 13 | Sauchi | 44 | 41 | 47 | 47 | 45 |
| 14 | Ducare | 34 | 29 | 37 | 38 | 35 |
| 15 | Liyo | 22 | 32 | 41 | 26 | 30 |
| 16 | Peeda | 39 | 38 | 46 | 38 | 40 |
| 17 | Tucare | 43 | 49 | 36 | 38 | 42 |
| 18 | Lar | 38 | 36 | 42 | 37 | 38 |
| 19 | Suyo | 36 | 37 | 37 | 39 | 37 |
| 20 | Dachui | 30 | 30 | 40 | 32 | 33 |
| 21 | Dipo | 21 | 26 | 25 | 25 | 24 |
| 22 | Padikae | 40 | 36 | 44 | 43 | 41 |
| 23 | Murkur | 24 | 25 | 28 | 22 | 25 |
| 24 | Pho | 41 | 38 | 34 | 34 | 37 |
| 25 | Noppon | 31 | 30 | 47 | 42 | 38 |
| 26 | Kika | 18 | 31 | 29 | 32 | 28 |
| 27 | Caredo | 32 | 32 | 42 | 24 | 33 |
| 28 | Daeng | 39 | 35 | 26 | 39 | 35 |
| 29 | Chaemui | 36 | 39 | 46 | 47 | 42 |
| 30 | Dichai | 36 | 32 | 46 | 45 | 40 |
| 31 | Kan | 36 | 36 | 39 | 31 | 36 |
| 32 | Mongchai | 29 | 29 | 36 | 34 | 32 |
| 33 | Nalong | 22 | 20 | 35 | 38 | 29 |
| 34 | Pabai | 29 | 31 | 27 | 15 | 26 |
| Average | | 33 | 34 | 39 | 34 | 35 |

**Source:** Household interview in 2001-2004.

**3) Diversity of swidden crops between household**

The swidden crops are grown with upland rice in the cropping area. From 8 farmer' plots in the year 2000, 40 days after upland rice was sown , it was found that, the Species Richness as indicated by the number of species was ratter different, ranging from 9 to 30 species in Da and Dicare plots respectively (Table 3.8). This study also shows that some households had high Species Richness but, low Shannon-Weaver index. In Yadui plot, for example, only few species, including Brassica, cotton and chili, were dominant. The rest of about 25 species were present with sparse distribution. In contrast, Dicare plots contain about the same species richness but they are more evenly distributed. These suggest that the number of species grown and their distribution depend on household decision and their agronomic practices. Farmers will not allow of black bean, for example, to exceed 3-5 plants/ 3-5 rai plots due to its potential to smother upland rice.

**Table 3.8** Diversity, measured as Species Richness and Shannon-Weaver indices, of swidden crops in the fields of invididual farm households.

| Farmer's plots | Planted Area (rai) | Number of Sample(s) | Sample Size (m x m) | Species Richness[1] | Shannon-Weaver Index[2] |
|---|---|---|---|---|---|
| Noppon | 4 | 2 | 10 x 20 | 23 | 0.61 |
| Da | 3 | 1 | 20 x 20 | 9 | 0.24 |
| Dicare | 6 | 2 | 10 x 20 | 30 | 0.98 |
| Yadui | 5 | 1 | 20 x 20 | 29 | 0.31 |
| Krawchui | 6 | 2 | 20 x 40 | 24 | 0.23 |
| Thongdee | 5 | 2 | 10 x 20 | 28 | 0.70 |
| Anong | 4 | 1 | 20 x 20 | 16 | 0.38 |
| Tucare | 8 | 2 | 10 x 20 | 22 | 0.79 |

**Notes:** [1]Species Richness was the total number of species present in the sample plot.
[2]Shannon-Weaver Index was derived from $H'=\Sigma P_1 \ln P_1$ when $P_1$ is proportion of individuals to total number of species in the plot.

**4) Diversity between timing in the cropping season**

In2004, Thongdee's plot was chosen to monitor the change in swidden crop diversity by measuring species diversity at 2 months, 4 months, and 6 months after sowing rice. Results showed that the number Species Richness at 2 months and 4 months were higher than that at 6 months with numbers between 22 to 25 species (Table 3.9). Almost 10 species were harvested already by the end of the 4 $^{th}$ month. Leaf mustard is one of the early harvest crops that provides household fund at this period when wild vegetables in the forests can not yet available. In this plots, large number of species are fairly distributed, especially after harvesting dense patches of leaf mustard, giving the Shannon-Weaver index between 2.08-2.16 when the number of upland rice was excluded

**Table 3.9** The diversity crops between times in the cropping season of Thongdee plot year 2004.

| Months after rice sowing | Sample plot (no) | Species Richness[1] | Shannon-Weaver Index | |
|---|---|---|---|---|
| | | | Total[2] | Except rice[3] |
| 2 | 3 | 23 | 0.58-0.78 | 0.34-0.66 |
| 4 | 3 | 22-25 | 0.19-0.22 | 2.08-2.16 |
| 6 | 3 | 13-17 | 0.28-0.38 | 1.11-1.28 |

**Notes:** [1]Species Richness was the total number of species present in the sample plot.

[2]Shannon's Index was derived from $H'=\Sigma P_I \ln P_I$ when $P_I$ is proportion of individuals to total number of species in the plot.

[3]Shannon's Index was derived from $H'=\Sigma P_I \ln P_I$ when $P_I$ is proportion of individuals to total number of species in the plot excluding upland rice.

**3.4 Discussions**

Management of shifting cultivation in Tee Cha remains highly diverse and complex with mixture of communal and household decisions. Many rules, customs and traditions are being kept despite the changes in customary and allocation and ownerships, management of fallows and the role of natural leader (Ran Ku). Upland rice in shifting cultivation plays many roles in Karen society with multiple dimensions. Karen beliefs in rice spirit, Khwan Khao or life essence of rice. Therefore, roles are being often to pay spiritual respects throughout the entire production processes from the beginning of site selection to harvesting and storage. The spiritual belief is quite common among Karen community (Bue Paw, 2004 and Santasombat, 2003), but this has been changed to certain extent in order to cope with social, economic and ecological conditions as well as limitation due to various pressures.

In Tee Cha, community rule is over riding Ran Ku who was previously the most powerful in the village. The shifting cultivation fields has transferred communal or leader decision to land owning families. The negotiation process will have to be settled before land clearing and burning. Accidental fire is another factor that requires community management for control after slashing. Heavy tasks in land preparation, planting, maintaining, harvesting and carrying produce to storage require collective efforts from either the community as a whole or labour exchange arrangement.

Therefore, shifting cultivation is serving not only to fulfill family need, but it also supports the entire community with ecology as well as social integrity of village society.

Despite the change in response to land scarcity, farmers in Tee Cha are able to maintain their shifting cultivation up to now.

The maintence of shifting cultivation in Tee Cha is also relating to the maintence of crop diversity to serve various purposes during the cropping year as well as the fallowing years. Without shifting cultivation, the diversity of farmers' livelihoods would be reduced greatly without other viable alternatives (Chapter 2).

Few attempts have been made with external assistant supersets to develop alternative agriculture (Table 2.5, Chapter 2), only few farmers have been able to keep agroforest plots with mixture of annual and perennial species and fish ponds. *Leucaena* strips for permanent agriculture have almost disappeared with no maintenance. Paddy fields are abandoned due to water shortage. Nevertheless, 1-2 farmers picked up the idea and develop permanent production systems such as coffee under secondary forests, mixture of fruit trees, plantation crops and cardamoms and others. With infrastructure improvement, agriculture system in Tee Cha would be intensified rapidly with increasing demands from external markets.

Intensifying shifting cultivation is blamed to be associated with the loss in crop diversity and wiped out local germplasms of traditional varieties (e.g. Sutthi, 1989; Santasombat, 1998 and Ganjanaphan *et al.*, 2004). This is often found to be not so simple and straight forward. Local people have specified to cope with such the change to a large extent. A Hmong community in Pah Poo Chom or Lahu in Loh Pah Krai, the typical farmer pioneer shifting cultivations with opium, could maintain largely their traditional crops previously grown in association with opium and upland rice in other forms of land

use, e.g., homegarden with complex structure and diverse species composition, edges between agricultural fields and agroforest system (Rerkasem *et al.*, 2002). Maintaining large number of crop varieties in a village is not so important with respect to biodiversity conservation. In upland rice, high rate of varietals turnover both within and between village ecosystems is the determinant of local germplasm conservation on farm (Sirabanchongkran *et al.*, 2004). Those consist of married couple with one or both individuals immigrating from other village are likely to grow less common varieties. Strong kinship networks are the key to germplasm conservation of upland rice. Freezing conservation within a village is highly to have negative implication for biodiversity conservation.

One of the most important element in maintaining shifting cultivation in this particular village is the alternative management for short fallow in rotation developed by farmers' themselves (Chapter 2). Although management of *Macaranga* requires little effort in compassion to agricultural crops, but certain practices of traditional shifting cultivation is important to determine germination, seedling recruitment and establishment of *Macaranga* to improve fallow. Burning, for example, promotes germination of seed bank in the soils. Effects of $CO_2$ may help to promote seed germination.