Chapter 8

General Discussion

In the traditional systems, as long as fallow is left long enough to allow natural vegetation to regenerate and reach maturing stage without any interruption, clearing and burning of the above ground biomass would release adequate nutrients necessary to maintain yield of upland rice (Kunstadter *et al.*, 1978). Both internal and external pressures are impinging on traditional shifting cultivation, e.g., population, migration, commercialization as well as government policies (Rerkasem and Rerkasem, 1994 and Rerkasem, 2001). These pressures are giving to reduce fallow period in shifting cultivation. Degradation of shifting cultivation occurs when the loss of fallow biomass, soil fertility decline and build up of weeds disease and pest (Nye and Greenland, 1960; Trenbath *et al.*, 1990 and Warner, 1991) and crop yields decline (Grandstaff, 1980). The Pwo Karen of Tee Cha village could manage system which has the fallow period shortened to only 6 years, with cropping in the 7th years. Farmers maintained that their system of shifting cultivation is sufficiently productive, provided that there are dense stands of a particular tree called Pada (*Macaranga denticulata*) in the fallow.

8.1 The situation of study village

The situations in Tee Cha village have changed greatly in land use and management of shifting cultivation for the past few decades. In the past, the changes of land use are due to internal pressure, e.g. by the splitting up of village, building up of population and to certain extent increasing access to external market and off-farm job opportunities. The external pressure, government policies had very small contribution to social, economic and land use of the local community. In the same time, the Pwo Karen tradition is dominated by kinship network and influence strongly by customary rule and spiritual beliefs in organizing and allocation land for upland rice productions. The shifting cultivation lands belong to community. From this tradition role, every one of Karen's farmer in the community could have the land for upland rice productions. This may be one of the reasons that are why shifting cultivation remains in existence despite the many unfavorable conditions against the system.

Recently, the strong government policies enforced to protect the existing natural forests and conserve ecological, and the external supports and services, e.g. recent road improvement are expected to have impact on shifting cultivation and village land use. Market information is impinging strongly on the local community with increasing access of information. On the other hand, increase farmer' aspirations to intensity production with in many areas turn out to be negative trade off to natural resources biodiversity and watershed as a whole (Allen, 1994 and Ganjanaphan *et al.*, 2004). Change in land use and management of shifting cultivation may move forward sustainable intensification and these depend on local capacity and ability to cope with the change (Brookfield, 2001). To sum up, these may lead to land use system of farmer for reducing the cycle rotate of shifting cultivation. Further questions are: How can the farmers maintain productivity of the shifting cultivation with reduced cycle?; Are there any problems and constraints on succession destruction and regeneration of shifting cultivation?; Can these be overcome and how?

8.2 Farmers' management of shifting cultivation and crop diversity

The farmers who have management decisions of shifting cultivation based on both communal and household decisions depending on resource availability practices. Shifting cultivation land is considered both communal and individual ownerships. Many rules, customs and traditions are being kept despite the land use changes in customary and allocation and ownerships, management of fallows and the role of natural leader. 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).

The maintence of shifting cultivation in Tee Cha, when reduced fallow cycle, from 10-15 years to 7 years rotated cycle, is also relating to the maintence of crop diversity to serve various purposes during the cropping phase, upland rice 17 varieties and swidden crops 56 species (Chapter 3), as well as fallowing phase, 176 species (Chapter 4). Without shifting cultivation, the diversity of farmers' livelihoods would be reduced greatly without other viable alternatives (Chapter 2).

The farmers could adaptive management by use the *M. denticulata*, the pioneer tree species in the area, to enrich crops productivity especially upland rice (Chapter 5). They had good practiced to maintain growth and development of *Macaranga* for survivor in the shifting cultivation field where was very greatly both cropping phase e.g. when burning could be promoted germination of seed bank in the soils or in weeding time, the farmers did not treat the *Macaranga* as weeds, seedlings are left in the field to grow in association with upland rice and other swidden crops and fallow phase e.g. construction of firebreaks to protect accidental fire into fallow is common rule and management every year for regeneration of fallow forest.

8.3 Fallow succession and regeneration of *Macaranga* in reduced cycle.

To enrich short fallow, farmers' management of *Macaranga* to enrich fallow area did not have any effect on species diversity and species composition for forest fallow regrowth. In successional stages, species richness is varying and maximum species diversity occurred at the beginning of fallow successional stage after harvesting of upland rice with dominant of grasses and herbaceous species mixed with the remaining climax tree species and controlled the number of *Macaranga* before proceeds to later stages of successive with face dominant vegetation. The pattern of species richness and species composition in fallow forest in this study are similar to other studies with longer fallow periods (e.g. Sabhasri, 1978 and Schmidt-Vogt, 1995). In terms of fallow productivity, the managed fallows with dominant of *Macaranga* also give high biomass production of fallow vegetation up to 45 ton ha^{-1} and higher than the Lua shifting cultivation with long fallow system regrowth as reported by Sabhasri (1978). The biomass of *Macaranga* dominated fallow in this study could be higher than about 60% and that reflects efficient nutrient accumulation within the limit cycle of 7 years.

For the dynamics of *Macaranga*, seed is relatively short-lived and almost total loss in viability within only 7 months after fruit maturity. Less than 20% of buried seeds within 10 cm below ground would represent potential numbers for seedling recruitment. The recruitment of seedling is very large but the survival of seedling in the first year is very low. However, the number seedling in sparsely populated area is

10,000 seedlings ha^{-1} higher than numbers of *Macaranga* trees (4,000 ha^{-1}) in densely area in the 7 years regrowth. So that, the seedling competition within and between species could be very strong at early stages of fallow regrowth and led to self-thinning of *Macaranga*, stands form the first few years before stabilizing. Low rate of *Macaranga* seedling survival in sparsely populated *Macaranga* area may be caused by many factors. The role of AM fungi might help higher rate of survival in densely populated *Macaranga* area, especially the few first dry seasons. This needs feather investigation.

8.4 The effects of *Macaranga denticulata* on Upland rice in short fallow

After seven years of regrowth above ground, average biomass was 48.7ton ha^{-1} and below ground biomass average was 15.7 ton ha^{-1} in densely populated *Macaranga* patches and above ground biomass contained 536 kg N, 38 kg P, 253 kg K, 132 kg Ca and 46 kg Mg ha^{-1}. Comparing with the mature fallow of 8 years rotation in the village of Pa Pae in the same vicinity where no *Macaranga* was found (Sabhasri, 1978), 143 kg N, 16 kg P and 176 kg K ha^{-1} of above ground biomass were reported to have accumulated in the 63 ton ha^{-1} (Zinke *et al.*, 1978) which lower than in densely population *Macaranga* patches.

For the grain yield of upland rice, there was significantly higher in areas of densely populated *Macaranga.* The rice yields in areas of densely populated *Macaranga* were relatively stable with an average at 2.6 tons ha^{-1} over 5 years of study. In sparsely populated area, rice yield was low and unstable with an average of 1.3 tons ha^{-1}, ranging between 0.8-1.8 tons ha^{-1}. With *Macaranga* in managed fallow, the yield of upland rice could maintain as high as long fallow systems. In Dong

Luang, a Pwo Karen community in the Mae Sariang, rice yield in long fallow of > 10 years was reported as high as 2.3 tons ha^{-1}. Shorting fallow period could reduce rice yield as low as 0.9 tons ha^{-1} (Hinton, 1978). In general, when fallows are shortening, yield of upland rice in Northern Thailand would less than 0.8 tons ha^{-1} and yields in excess of 1.5 tons ha^{-1} had become uncommon in most hilly area (Grandstaff, 1980). Applications of chemical fertilizers were illustrated to restore upland rice yields to almost 3.0 tons ha^{-1} (Chapman, 1973).

8.5 The association between *Macaranga denticulata* and AM-fungi

The growth of *Macaranga* plants responded to AM fungi inoculation that occurred when N and P were applied. The response to AM inoculation when N was applied without P produced 100 % of plant height more than uninoculated plants did and this affects as when N and P fertilizer were applied without AM inoculation. The total dry matter and nutrients accumulation of *Macaranga* seedling after 6 months, the response of shoot, root and total plant to AM inoculation occurred when N was applied without P that effected nearly equal to the effect of N and P application. These results could be supported by the study of Smith and Read (1997). That was increasing amount of mycorrhiza increased plant growth, nutrient accumulation and well to use the nutrients in soil. Moreover, Marschner and Dell (1994) as well as Taylor and Harrier (2001) found that AM fungi were known to improve the nutritional status of plants (e.g., N, P, K, Ca, Mg, Mu, Cu and Zn) resulting in increasing growth.

8.6 Restoration of degraded fallows with supplement ash and fertilizers.

In short fallow regeneration, there could lead to deterioration of shifting cultivation due to soil fertility decline restoration of soil fertility is the dominant factor in maintaining upland rice productivity. Results from this thesis have indicated that restoration of soil fertility in degraded fallows with low population of *Macaranga* is possible to some extent with improved fallow biomass for burning and application of fertilizers. From chapter 7, adding burned biomass, adding fertilizer (nitrogen and phosphorus) and additional burned biomass was given, together with nitrogen and phosphorus application almost could increase upland rice yield.

The resource of *Macaranga* has helped to restore those nutrients and enrich fallow vegetations, preventing them from further degradation similar to traditional long fallow cultivations. The importance of maintaining long fallow to restore soil fertility has been raised in other studies in Northern Thailand (Zinke et al., 1978; Nakano, 1978) and elsewhere (Greenland and Kowal, 1960; Sanchez, 1976; and Nye and Greenland, 1960). When fallows are degrading, Ca, P and K are referred in adequately to the soil from the ash after burning.

Emphasizing to the importance of almost nutrients in fallow vegetation, the recovery of nutrients from fallow soil and below ground recovery process in nutrient cycling should be emphasized. Where successful fallow enrichment can achieve, *Macaranga* in this case, an enormous amount of N in the roots (in Nopporn's plot) could contribute significantly to upland rice after burning. Results from this study showed that significant proportion has come from the roots after burning e.g. the grain yield of ash removed treatment of Nopporn's plot (Table 7.5) which was higher than conventional treatment of Tucare's plot (Table 7.12). Nutrient accumulation from fallow litters showed that is not overlooked. In *Macaranga* abundant fallow, the plant produced thick and lays leave canopy and shredded regularly during the dry season. The study showed litter in the area of *Macaranga* abundant that was 36 % higher than other area (Chapter 5).

8.7 General conclusion

The Pwo Karen in Northern Thailand could manage the short cycle of rotational shifting cultivation system, with fallow period to only 6 years and 1 year of cropping, by using the *Macaranga denticulata*, the pioneer tree species in the area to regenerate fallow and produce the productivity and sustainable of subsistence crops. They have diversity of management by use their traditional knowledge. They could adapt management to conserve and maintain abundance diversity crops both in cropping phase and fallow phase in the shifting cultivation field and enriching crops productivity especially upland rice.

8.8 Future research

This thesis was aimed to explore how the farmers manage *Macaranga denticulata* and the effects of regeneration fallow and enriching crop productivity. However, further research works are required to be investigated in the fallow subjects:

1. What is the lower time limit for the *Macaranga* enriched fallow period below six years but above three years which have been shown to be insufficient?
2. If not seed production and recruitment of seedlings, which were clearly not limiting, what causes much more severe self thinning sparse *Macaranga* patches, leading to its patchiness?

3. How this system might be transferred to other shifting cultivation systems on acidic, infertile soils in the region?