

Highland Agriculture: From Better to Worse

Chantaboon Sutthi

This paper reviews agricultural practices and genetic resources used in the mountains and uplands of Thailand. It describes indigenous farming systems, presents an inventory of cultivated plants and indicates their wide range of uses.

It is the author's opinion that the contemporary impact of market forces and development projects combined with the diminishing availability of land, owing to administrative intervention and population increase, has led to a type of agricultural impoverishment. By "impoverishment" I mean that as some farmers have become unable to either find virgin forest to clear or maintain fallow periods exceeding ten years, they have had to rely less on nutrients released from the biomass and more on labour intensive methods. The range of plants cultivated has decreased. The move from subsistence to commercial farming has also been a move from complex multiple cropping systems to simple if highly demanding, monocropping regimes. This move from a highly diverse inventory of plants to specialisation is also evident in the loss of varietal diversity: fewer varieties of rice are grown today than in the past. Development in a commercial sense has brought more work for farmers, greater dependence on markets over which they have no control and a decline in the community bank of domesticated genetic resources.

Mountain Agriculture

High altitude agriculture is a type of slash-and-burn or swidden cultivation, an ancient form of farming widely practised by forest dwellers all over the world. There are many reasons why highlanders engage in this type of cultivation and experts affirm both its efficient use of labour and land and the fact that under low population pressure it is an ecologically informed system of management.

There are two quite distinct systems used in the highlands of Thailand.

1. Pioneer Swiddening (also known as slash-and-burn cultivation, primary forest swiddening, primary forest cultivation, shifting cultivation).

This pattern of cultivation is conducted by felling and burning the biomass and growing crops on the cleared land for as long as possible. The length of the cultivation period may vary from one to more than 20 years depending on fertility levels and composition of the soil. When the soil is exhausted, when there is a problem with weeds, disease, pests or the like, it is time to move to a new area, preferably of virgin forest. Highlanders using land in this manner periodically exhaust their resources and are forced to move again and again to find a better area in which to take up farming. We might say that this type of cultivation makes it necessary to move on forever.

This form of cultivation, known after Conklin as “pioneer swiddening”, is followed by the Meo (Hmong), Yao (Mien), Akha, Lisu and Lahu. For this farmers require primary forest and in Thailand between 15 and 20 percent of all highlanders grow opium as their main cash crop. Opium is particularly suited to the cooler mountain climate of the north at about the 1,000 metre contour.

The area cultivated covers the main watershed catchments which give rise to the four most important tributaries of the Chao Phraya, the Ping, Wang, Yom and Nan which provide the principal source of irrigation for the central plains. We could say that highlanders who practise shifting cultivation are placing the national catchment at risk and threaten to cause a lot of damage. It was in fact this fear, as well as the growing of opium, which pushed the government to start development work in the 1960s.

2. Cyclical Swiddening (Secondary forest cultivation, secondary forest swiddening, bush fallowing, continuing cultivation, bush fallow rotation, recurrent cultivation, rotational bush fallow, cyclical bush fallow, land rotation). This form of cultivation is also a type of slash-and-burn which allows the vegetation to regenerate for subsequent clearing. This method provides the basis for permanent settlement by communities of Karen, Lua, Htin and Khamu. These people do not move with anywhere near the same frequency as pioneer swidders. Some Karen for instance have occupied their village sites for longer than 200 years.

The period for which land is used is largely set by the cultural preferences of the occupying group. The Htin and Lua prefer to use fields for one year after which they are abandoned to allow the vegetation to regenerate. One subgroup of the Htin are forbidden by custom to cultivate the same plot of land for more than one year. The length of the fallow depends not only on custom. Soil fertility, how much land the community has available and the intensity of cultivation are all taken into account. High population densities may make it necessary to return and clear the land before the natural vegetation has regenerated a biomass and nutrient bank of sufficient magnitude to ensure healthy plant growth.

There are three types of land tenure traditionally followed by cyclical swidders. These are distinguished as follows:

PROBLEMS

2.1 Communal Estates. All of the farm land belongs to the community. Nobody can either buy or sell it. At the beginning of each agricultural year all householders are consulted before a decision is taken about what farming activities will be undertaken and which areas will be cleared for cultivation. Sometimes one large area is cleared communally and subdivided into individual household lots. Sometimes two large areas are cleared. This pattern is followed by both the Lua and Karen. Land cleared under this system is preferably used for one year and left fallow for about ten.

2.2 Private and Public Tenure. Under this type of tenure some land belongs to individuals and some to the community. Both Lua and Karen use this dual system of tenure. The conditions under which individual ownership is allocated are decided upon by those holding rights of usufruct. How community land will be used is decided by the village. How private land will be used is decided by the owners. Householders who hold outright ownership are able to sell without referring the matter to the community.

Most of those who hold private land are descended from late-comers to the village who arrived after the best lands were already appropriated and worked on a communal basis. These people did not easily fit into existing reciprocal arrangements and were often constrained to work the remaining less fertile land.

As population has increased and people have become more aware of what lowland markets have to offer, land tenure arrangements have become increasingly complex. Generally villages that use this system have one or two areas which remain under traditional tenure as communal estates. Fields are used for one year followed by a three to six year fallow.

2.3 Private ownership. It is said that land has always been privately owned. As noted above, the conditions under which

land in the vicinity of communal estates is claimed by individuals are arranged and agreed to by the people themselves.

The highland Lua do not generally recognise private ownership but this rule is either waived or ignored by more recently settled groups. Cultivation strategies are decided upon by the farm-owner who is not obliged to seek approval from fellow villagers. Owners may buy or sell at their discretion. Under this system Karen and Lua still use fields for one year and leave them fallow for three to six. Htin and Khamu cultivate for two to five years, and then abandon fields for three to ten.

Karen and Lua not only swidden hill sides they also construct irrigated terraces for growing rice. The labour invested in these is acknowledged as a qualification for private ownership and this can be transferred at the owner's discretion. The Htin and Khamu do not practise this form of rice cultivation.

Indigenous Technology

Even though swidden cultivation as practised by highlanders is often called backward or even destructive of the natural resource base, the system is, under normal conditions, ecologically viable, well adjusted to the environment and covers a wide range of activities starting with land selection, up to harvest and beyond including seed selection for the next season. Highlanders have practised agriculture for millennia and their accumulated wisdom is still pertinent to contemporary conditions. Traditional knowledge of the agricultural cycle can be summarised as follows.

Site Selection

Factors considered by farmers when selecting fields include location, aspect (orientation to the sun), wind, elevation, soil type, productive potential, and slope.

PROBLEMS

Farmers know where to grow early varieties of rice which are adapted to quite specific ecological niches, such as hill top sites where the soil is drier and less likely to become saturated. What may be called medium varieties must be grown on the middle slopes where soil moisture is higher. Annuals need much more moisture and must be grown on the gentle downhill slopes. Flat land on shoulders, beneath ridges and near large streams is generally more fertile but unsuitable for planting. Highlanders realise that if they sow in these places, plant maturation will be delayed, more weeds will grow and therefore more labour will be required to keep the garden clear. Opium latex grown on such sites is very viscous and easily lost because it does not congeal quickly, running irretrievably down the poppy stems.

Sunshine is also considered to be a matter of primary importance. Otherwise suitable areas with too much shade are avoided. This is particularly critical for opium poppy plantations, which require intensive care and much labour over a limited harvesting period (about 10 days, plus or minus three days). Highland opium growers know that sunlight stimulates the release of latex from the pod. Much attention is therefore given to the influence of site conditions on the speed of opium poppy maturation.

If there is enough land available, farmers will choose several plots in different places. Most families maintain about one to three areas for opium growing but this also depends on their access to labour. Sites exposed to maximum sunlight are cultivated and planted first. This is called "hot land" where the poppies mature most quickly. The second plot is preferably chosen from land on which sunlight falls later in the day. There is usually one to two hours difference in the duration of radiation between the first and second fields. This "middle-hot land" is cultivated, planted and harvested after the first. The third area is called "cold land" and receives sunlight later in the day than the other two fields, about two to three hours less sunshine per day than

the “hot land”. The size of these fields is determined by available labour. Where only one site is developed a system of relay planting is practised. Ten to fourteen days after the first seeds are sown the exercise is repeated. The crop matures in the same sequence in which it was planted. The harvest can then be managed quite comfortably.

Differences in site selection and variations in planting times have led to some misunderstandings among those who study opium poppy growing in Thailand. The most widely accepted opinion is that there are three varieties of opium poppy where in fact there is only one.

Wind is also an important factor. On exposed sites where the wind is strong, turbulence is not only likely to damage young poppy plants but also makes it difficult to harvest the resin. If, after incisions have been made to bleed the latex, the pods are persistently knocked together, the harvest can be lost. What is not thrown to the ground is smeared on the pods in a thin layer which cannot be scraped off. Strong winds do not damage rice but fallen stalks make harvesting difficult.

Vegetation is also used as an indicator because it signals the presence of soil types specifically suited to various crops. The land on which *Gigantochloa albociliata* Munro grows is considered to be “lowland”, hot and unsuitable for opium but good for rice. Here the clay content is always high. *Dendrocalamus hamiltonii* Nees grows at about 1,000 metres, thriving on loamy soils suitable for growing rice and fair to marginal for opium poppy. *Litsea cubeba* Pers. is an indicator of high altitude, good for poppy but unsuitable for rice. Where plants like the giant mountain fishtail palm, *Caryota obtusa* Griff. or *Dendrochide stimulans* Chew occur, they indicate a high productive potential for opium latex, much higher than obtained on the same soil in the absence of this vegetation.

Soil is another important factor. Many observers have reported that vegetation is more important but highlanders themselves say that it is possible for a wide range of plants to grow on land to which they are not well adapted and that the critical test in site selection is a careful examination of the soil itself.

Each ethnic group has its own method of soil classification, which involves physical tests. Soils are classified principally by examining the colour, texture, structure, weight, and composition. Parent material is assessed by examining rocky outcrops in the vicinity. If limestone is found, the soil is classified as having a satisfactory clay content and therefore suitable for growing opium. If there is sandstone, the soil is classified as sandy or loam suitable for growing rice. They not only carry out a visual check but also manipulate samples. If a soil has a high proportion of clay, it becomes sticky and slippery when moisture is added. When this type of soil is dry, it crumbles into small pieces. Sometimes farmers dig 15 centimetre observation holes. If the soil sticks to the blade of the tool, it is classified by its clay content. Some groups, particularly Lisu, inspect the soil by digging a hole about 15-20 centimetres deep, taking the fresh sample and squeezing it tightly in the palm then opening the hand. If the soil retains the shape of the palm, it is classified as clay. This test should be done during the winter season but not after recent rainfall. The Lahu also weigh soil. The Meo pull out a plant with a stem about one centimetre thick. If the soil sticks to the roots, it is classified as clay. After rain, the Lahu Sheleh check the underside of leaves to see if there is a deposit of soil particles thrown up by the explosive impact of raindrops. If there is a deposit the soil is classified as light. The absence of a deposit indicates that the soil is heavy and has a high clay content.

Frost is a hazard carefully avoided, especially for the opium poppy. Farmers always select steeper sloping land away from the valley floors on which frost is likely to form.

Distance from the village is also a consideration. Bulky crops like rice are difficult to transport and because they attract the attention of scavenging birds and animals are best located near villages. This is not always possible and the condition of tracks and roads and the availability of transport is also considered.

Field Preparation

The cutting and felling of trees and other vegetation is the first operation. Generally speaking, pioneer swiddeners are more skilful at clearing primary forest than cyclical swiddeners. Trees are cut to fall in a position where they will not pose a danger when the rains come. If logs are felled incorrectly, they may slide or roll downhill and injure crops and people. Because clearing is a perilous activity, precise rules of conduct are followed. Trees are felled in sets rather than individually. To avoid accidents, cutting commences with axemen working uphill and abreast of each other on the same contour. The trees are cut so that they remain standing. When the axemen reach the top of the ridge, they wait until their group is entirely accounted for and out from under the canopy before the trees at the top of the ridge are felled. As these trees fall, their weight triggers a domino effect and with a loud series of cracks the forest comes crashing down.

Planting

From long experience hill people know how to space the plants out in a manner appropriate to different soils. If the soil is very fertile, farmers space plants well apart. The space between individual rice plants grown on the most fertile land is 50 centimetres, on soils with normal levels of fertility 45 centimetres, for lower than normal 25 centimetres, and for low fertility soil 20 centimetres. There is no exact standard measure; parts of the body are used in much the same manner as followed by lowland Thai farmers. The distance between the elbow and the end of the middle finger, about 45 centimetres, is suitable for planting rice on high fertility soils. When planting

on low fertility soil, the placement of seeds is measured from the elbow to the wrist, about 25 centimetres.

It is a comment on the perversity of nature that the rice people prefer to eat is not as productive as less palatable varieties. To get around this problem, satisfy people's taste preferences and the need to produce a harvest of sufficient quantity, many types of rice are grown in the same field. A study of highland rice cultivation in the north and west of Thailand found that a typical field may have from one to five varieties of rice. Researchers have also discovered that single panicles often contained rice with a wide variety of characteristics.

Labour

It is often said that those who cultivate hill country use more energy than lowlanders because they walk up and down steep slopes and must constantly maintain their balance. It is assumed that this must put a heavier load on them than on lowland farmers. What truth there is in this I cannot say but it is clear to me that highlanders know how to conserve their energy.

When small family groups sow seed, they start at the bottom of the hill and work upward in a zigzag fashion walking back and forth along the contour. The harvest proceeds in the same fashion but from the top down. This is quite logical considering the nature of the work. If the work team is a large group organised under a system of reciprocal labour exchange, those planting move straight up the hill maintaining equidistance from each other. From the top they descend once more, moving in lines parallel to their ascent. This enables them to optimise their use of labour in the most efficient way.

When harvesting opium, a quite deliberate strategy is followed. The tappers keep incised poppies in their line of sight and sidestep backwards away from the pods as they cut. This

is done so that the harvesters can avoid carrying away valuable latex stuck to their clothes and body.

Traditional knowledge of swidden agriculture as described above is an integral part of highland culture. It has been built up over the centuries on the basis of careful observation, trial and error and by exchanging information with neighbours. When Red Lahu (Lahu Nyi) select rice seed, they do not take it at random. They only take the rice which falls first in threshing. Other highlanders carefully collect the most perfect plants from their rice fields, tie these together in a bundle and thresh them before commencing the harvest in earnest.

Crop Species

Highlanders are principally rice-based farmers. Even though Meo, Yao, Lahu, Lisu and Akha started many years ago to grow opium as a cash crop, this does not mean that they have always grown opium. Each year some people, for reasons of their own, decide against growing opium. If they have suitable land, their first choice is to grow rice to eat.

Rice is their staple crop and by far the most important in their life. According to their way of looking at the world, reinforced to a large extent by their relative isolation, they favour the independence of self-sufficiency. The priority given to self-sufficiency makes it necessary for them to grow a range of crops wide enough to minimise their dependence on lowland markets. The plants grown in the cropping system are primarily for domestic consumption. If for some reason the rice crop fails, supplementary food crops provide a type of crop insurance which guarantees survival.

Opium is not only the most important economic plant but is also used as a medicine. Just as the opium derivative codeine is one of the world's most widely used drugs, so does

PROBLEMS

opium itself hold a prominent place in indigenous herbal and esoteric medicine. Hill people still grow a wide range of medicinal herbs. There is another wide category of plants which they grow for use in traditional ceremonies. Most rituals require the use of some plant materials. The actual varieties used however, differ from group to group.

Another important group is the fibre plants used in weaving, dress making and making containers.

Pioneer swideners also grow maize. At the beginning of the rainy season, maize is planted in fields suitable for opium poppy. Towards the end of the rainy season (September and October), the maize is harvested and poppy sown. This double cropping of maize and opium is very well adapted to conditions. During this period it is impossible to fell, dry and burn vegetation and clearing the maize fields is a much easier task, especially if they have been well looked after. To plant opium poppy after maize not only minimises the task of soil preparation but also greatly reduces the need for weeding. When maize is grown, the field is weeded at least once (in fact usually twice). Maize not only keeps the land in good shape for the subsequent opium poppy crop but is also the principal source of fodder for pigs and chickens (used frequently as an offering to the spirits) and for making whisky.

Swidden Crops

Plant materials grown in swiddens can be classified by the uses to which they are put. A list of swidden crops is provided in Appendix II.

1. **Staple food crops.** Rice is clearly the most significant food. Meo, Yao, Akha, Lisu, Lahu, Karen and Lua all eat hill rice. The Htin and Khamu eat glutinous rice.

2. **Vegetables.** These plants are used frequently and the

list includes, Chinese mustard, Chinese cabbage, Chinese radish, Chinese Kale, Chinese chives, Indian spinach, *Mesona* sp., peas, beans, garlic, shallot, cumin, Pe-tsai, lettuce, ginger, cucurbits, chilli, egg plant, cockroach berry, chives, okra, tomato, Australian arrowroot, yam bean and the very young opium-poppy. Altogether there are about 48 species of kitchen plants which are known to be used for cooking. There are many more not yet identified.

3. **Animal feed.** Plants used for animal feed include, maize (non glutinous type), the leaves of the grain amaranth, sweet potato, papaya, banana, rice, taro and pigeon pea.

4. **Supplementary food crops.** This group includes yams, yam bean, sweet potato, taro, cocoyam, cassava, arrowroot, Australian arrowroot, potato, sunflower, millets, sorghum, maize (glutinous type), popcorn, beans peas, opium-poppy seed, pumpkin seed, sesame and *Perilla frutescens* Britt. Of these, yams, taro, cocoyam, sweet potato, potato and maize are eaten if the rice crop fails.

5. **Fruits eaten** include papaya, pineapple, melon, water melon, bananas, peach and cucumber.

6. **Herbs, spices and condiments.** These are used to add taste to food. The list includes garlic, lemon grass, fennel, sweet basil, hoary basil, holy basil, chilli, coriander, cumin, parsley, kitchen mint, soya bean (fermented) and *Isodon ternifolius* Kudo, *Oenanthe stolonifera* Wall. and *Heracleum burmanicum* Kurz.

7. **Oil.** Opium-poppy oil and sesame oil are used as cooking oil as well as to keep the opium smoking lamp lit. Some Meo villagers know how to extract the oil from castor bean. This is used for lighting.

8. **Preserved and fermented foods** such as Chinese mustard (dry) and soya bean (fermented)

9. **Sugar:** sugar cane and kaoliang

10. **Fibre and utensils:** These include hemp, cotton, bird chilli, bottle gourd and smooth loofah. Hemp is used for making thread which is woven into cloth. Bottle gourds are used as water containers and receptacles for seeds and salt, as well as for spoons and ladles. The fibre of smooth loofah is used as a scrubber. Highland addicts use the stems of three year old bird chillies to make opium pipes. They believe that this prevents constipation.

11. **Religious and ceremonial crops.** These are planted as a matter of necessity for use in rituals and ceremonies according to the beliefs of each ethnic group. For instance the Akha grow shallot, taro and ginger in their swiddens before planting other crops. This is done to protect the field from the influence of bad spirits that might otherwise come and damage the plants and also bring bad luck to the farmer. Karen and Lua plant cockscomb, globe-amaranth, cosmos flower and marigold for a rice spirit calling ritual. Yao believe that safflower is an ancestor of opium poppy. They grow it in their opium gardens and hope that by looking after the whole family their opium will mature properly without untoward interruption from supernatural beings. Yao of the Tung sub-clan use fermented Chinese mustard as an offering to their ancestors. White Meo hold a pumpkin ritual. Akha still use the bottle gourd as a water ladle in a well ritual in which it is forbidden to use any other material. Almost every group uses rice (rice grains, cooked rice, pop rice) to make offerings to the spirits. The Meo use maize and finger millet powder in a ritual to exorcise bad spirits. Sorghum is used in the form of pop sorghum for spirit offerings. Opium is used in the highest form of spirit worship conducted by the Lahu Sheleh. Sesame oil is an essential item in the Yao ceremony of ordination. Lahu and Yao use many *Vigna unguiculata*(L.) Walp. (L.) in the new rice eating ritual and new year celebrations, which require spirit offerings.

12. Decoration and cosmetics. Some ethnic minorities use plants from their swiddens for personal decoration. Akha woman and children use the small bottle gourd as an ornament by threading a string through a hole drilled in its neck and hanging it from the waist. Karen use Job's tears (*Coix lachryma-jobi*) Lin. of the *stenocarpa* Stapf. variety and *Coix puellarum* Bal. to sew on their jackets or thread into a necklace or bracelet. Lisu men weave wheat straw into their jackets. Meo grow a herb called "foo", which they bleed by scraping the underside of the leaf. The discharge is smeared on their cheeks as a rouge.

13. Cash crops. The most important economic crop of the Meo, Yao, Lahu, Lisu and Akha is opium. The Karen and Red Lahu are well known as chilli producers. Castor bean is grown even though it is not very profitable. The Pwo Karen grow sugar cane in small fields near their villages. The cane itself is not sold but crushed and boiled to make sweets for sale. Siam cardamom is grown by the Pwo Karen of Uthai Thani Province.

14. Alcohol and narcotics. Many plants in the gramineae family are grown for making alcohol. Rice, maize, sorghum, foxtail millet and finger millet are used for this purpose. Opium and tobacco are grown to supply habitual users but only opium is grown in any quantity.

15. Medicinal plants. Highlanders grow many medicinal plants. Unfortunately these have yet to be studied seriously, identified and chemically analysed. The scientific names of most of these plants are not yet known. The most effective of these medicinal plants are widely recognised and knowledge of their preparation and properties continually exchanged by the various groups. The medicinal usefulness of opium is known even to non-opium poppy growing people such as the Karen, Lua, Htin and Khamu. Other curative plants used widely include shallot, Indian spinach, lemon grass, ginger, cockscomb, pineapple, papaya, banana, peach, tobacco, para cress, sweet potato, castor bean, holy basil, cumin, fennel, *Kaempferia* sp., *Curcuma*

domestica Valetou, *Cannabis sativa* Lin.. Some Karen use the "ivory" rice variety mixed with other herbs to treat some health complaints. They believe that "ivory" rice has the same curative properties as real ivory.

16. Other Swidden Crops: Maize stems are used as temporary wall fillers in field maize storage huts. Safflower is used to dye glutinous rice yellow, red or orange for special ceremonies. Maize, sorghum, kaoliang, foxtail millet, sunflower and castor bean are used as path and boundary markers. The Yao and Meo make soya bean curd (tofu).

Non-Swidden Plants

There are also many plant materials cultivated outside swidden areas. Under this heading, I will discuss the crops grown in household gardens and trees and shrubs established in small orchards and plantations. As in the previous section on swidden crops, this information will be classified by use. A list of scientific and common names is provided in Appendix III.

Kitchen plants are grown close to the village, around houses or in fenced-off gardens behind houses. Because of the nature of pioneer swiddening there is less need for the Meo, Yao, Akha, Lisu and Lahu to grow perennials. The only perennial grown in any quantity is the peach. This tree matures relatively quickly and is easy to look after. They are usually planted in swiddens that have become unprofitable to cultivate. Karen, Lua, Htin and Khamu, who practise cyclical swiddening centred on a permanent settlement, are more likely to grow perennials. They are more likely to find themselves in a position where they can secure some benefit from either exchange or sale of the fruit in lowland markets. Almost all orchard trees grown by highlanders are also grown by Thais. These annuals and perennials are identified below.

1. **Vegetable matter.** This classification covers both crops and perennials. Different parts of the plants are eaten such as the flower, fruit, trunks, shoots, leaves and young leaves. Any list should include, Welsh onion, *leucaena*, giant granadilla, citron, tea Asiatic penny-wort, hog plum, wild spider flower, sesban, horse-radish tree, yellow dock, *Cordyline fruticosa* Goppert, *Gymnema inodorum* Decne., *Oroxylum indicum* Vent., *Coccinia grandis* Voigt, *Sauropus androgynus* Merr.; bamboo *Zizania latifolia* Turcz., *Hibiscus sabdariffa* Lin., *Acacia pennata* Willd. subsp. *insuavis* Neilsen, *Talinum paniculatum* Gaertn., *Morinda citrifolia* Lin., *Solanum indicum* Lin., *Lasia spinosa* Thw., *Ipomoea aquatica* Forsk.

2. **Plants to Chew (Masticatory).** Highlanders such as the Lahu, Karen, Akha, and Lisu chew betel nut. Karen and Lua grow both the betel palm and betel pepper. Hill people who maintain close relations with northern Thai also make fermented tea or *miang*.

3. **Beverage.** The only plant in this group is tea. Coffee is raised commercially and promoted by many development projects but is not as a rule brewed by the highlanders.

4. **Fruit :** marian plum, mango, custard apple, sweet sop, carambola, durian, tamarind, star gooseberry, santol, jack fruit, mulberry, Malay apple, guava, pomegranate, coconut, giant granadilla, Indian jujube, Indian bael, pomelo, oranges, longan, Thai sapodilla plum, *Baccaurea ramiflora* Lour.

5. **Herbs, spices and condiments:** tamarind, garangal, citronella grass, Indian borage, roselle, lime, turmeric, *Piper sarnentosum* Roxb., *Polygonum odoratum* Lour., *citrus hystrix* DC., *solanum stramonifolium* Jacq., *Houttuynia cordata* Thunb., *Boesenbergia pandulata* Holtt.

6. Other Non-Swidden Plants:

6.1 Construction. Thirteen types of bamboo are used widely.

6.2 Fibre. Kapok is used for stuffing mattresses and pillows. *Stirculia guttata* Roxb. and three as yet unidentified species are used for making rope.

6.3 Dye. *Baphicacanthus cusia* Brem., indigo and turmeric.

6.4 Utensils. All bamboos are used as household and agricultural tools. Bamboo is one of the most frequently used plant materials in everyday life. *Sida acuta* Burm., and the substems of the coconut palm fronds are also used for making brooms.

6.5 Fencing. Physic nut is planted to serve as a living fence around houses.

6.6 Soap and Shampoo. As roads link villages with lowland markets, the use of *Sapindus rarak* A.DC., the soap nut tree grown in well-established villages of the Karen and Lua, is gradually being replaced by commercially manufactured soap and shampoo. Some remote Karen and other settlements still use this plant as soap and shampoo. During World War II when commercial soap was in short supply, the northern Thai also used the soap nut tree.

7. Religious and Ceremonial. Only a few non-swidden species are used for these purposes: *Acacia rugata* Merr., *Piper betel* Lin., *Zingiber ottensii* Valetton, *Zingiber cassumunar* Roxb., bamboo.

8. Cash. There are three types of cash crops: tea, betel pepper and Siam cardamom.

9. **Ornamentals.** Thai people have long used ornamental plants. Most ornamental plants appear to have been adopted from the Thai by Karen, Lua, Htin and Khamu. There are many plants which can be listed including some medicinal plants such as blood flower, peacock's crest, Indian shot, chrysanthemum, cosmos flower, garden dahlia, zinnia, sponge tree, jasmine, gardenia, orange jasmine, queen of the night, cloth of gold, Indian rosebay, frangipani, trumpet flower, Cape lilly, cockscomb (var. *cristata*); *Hippeastrum* spp., *Chloranthus officinalis* Bl., *Kalanchoe pinnata* Pers., *Hibiscus schizopetalus* Hook.f., *Hibiscus rosasinensis* Lin., *Talauma candollei* Bl., *Pavetta* spp., *Celosia* sp., *Bougainvillea spectabilis* Willd., *Kalanchoe* sp., *Yucca gloriosa* Lin., *Rosa damascena* Mill., *Ixora* sp., *Zebrina pendula* Schnizl., *Strobilanthes* sp., *Cordyline* sp..

10. **Medicinal:** tea, Asiatic pennywort, cockscomb (var. *cristata*), sweet flag, bowstring hemp, Capelily lily, hog plum, trumpet flower, ringworm bush, coffee senna, tamarind, physic nut, star cactus, Spanish dagger, clove, nutmeg, betel palm, lime, tobacco, guava, betel pepper, pomegranate, Indian bael and cotton; *Baphicacanthus cusia* Brem., *Oroxylum indicum* Vent., *Kalanchoe pinnata* Pers., *Tinospora crispa* Miers ex. Hook., *Tinospora glabra* Merr., *Solanum indicum* Lin., *Boesenbergia pandulata* Holtt., *Curcuma* sp., *Zingiber cassumanar* Roxb., *Zingiber ottensii* Valetton, *Talinum paniculatum* Gaertn., *Strobilanthes* sp., *bougainvillea spectabilis* Willd., *Capparis* sp., *Garuga pinnata* Roxb., *Viburnum inopinatum* Craib, *Piper cha-ba* Hunt, *Ixora* sp., *Alpinia* sp.,

The plants listed above indicate the richness of genetic resources in both swidden and non-swidden fields. We can see, as expected, that food plants are more commonly grown than any others. There are 350 species which have been identified; of these 198 or 57 percent are staple food crops, vegetables, supplementary food crops, cereals, herbs, spices, condiments etc. Only 86 varieties of medicinal plants or 25 percent of the total have been identified. The role that these plants play in maintain-

ing an economy of semi-subsistent self-reliance is clearly documented.

Cropping Systems

The traditional wisdom which regulates planting is an integral part of their economic system. Food is grown for both domestic consumption and livestock. Farmers know what is appropriate to a specific environment and they carefully determine the size of their fields according to available labour. Rice is clearly the most important crop and cultivation is managed in much the same way by all highlanders. However, what farmers call rice fields are planted with so many other crops that it would be more accurate to name them by the management systems used.

1. **Mixed cropping system.** In this system rice is the main crop usually found in association with maize and opium poppy. It is principally used by pioneer swiddeners such as the Meo, Yao, Akha, Lisu and Lahu but is also a feature of cyclical swiddeners such as the Karen and Lua. Minor crops such as those listed under "swidden crops" are scattered in appropriate micro-environments throughout a field where rice usually predominates.

These crops are not planted in rows. Green squash may be planted close to fallen timber, or next to the trunk of a burnt-out tree, or in the shelter of a field hut where it can climb onto the roof. Egg plant, chilli or lemon grass may be planted where it can be easily gathered on the way home. Millet, sorghum and kaoliang may be planted to indicate the perimeter of a field or to mark a footpath running through a garden.

Where this works well, farmers may harvest food from a single field for at least six months. Some crops can be left in either fields or field huts for a year; such as egg plant, cockroach berry, coco-yam, taro, cassava, chilli, pumpkin, wax-gourd and some types of cucumber, beans etc. Some plants grow all year round in swidden fields. Pioneer swiddeners grow crops to eat

for ten to eleven months. Cyclical swiddeners appear to be less successful in this and can eat directly from their fields for only seven to eight months. Pioneer swiddeners have access not only to a wider variety of crops but also to greater quantities and are constantly harvesting from rice, maize and opium poppy fields. Cyclical swiddeners have only their hill rice fields to draw on. This practice of mixed cropping in swiddens is remarkably efficient in its use of labour committed to weeding. There is also a pleasing absence of the problems which plague kitchen gardens located closer to the village, which require both fencing and special weeding and are frequently invaded by hungry livestock.

2. Sequential cropping system. This is followed by pioneer swiddeners who grow opium, maize and rice. It is designed to enable the farmer to optimize household labour over a limited period, particularly between harvesting rice and planting opium poppy.

Glutinous maize is planted at the beginning of the rainy season, followed by rice. Both fields are intercropped with other food plants. Maize is harvested before rice. Soon after this, the opium poppy is sown as a second crop in the maize fields. Many other vegetables and semi-annuals, such as chilli and egg plant, are grown among the poppies. After the opium is harvested, these are left to mature.

If conditions are right, this sophisticated system is very efficient. For how long it has been used is not clear but the words of one elder provide an indication, "We've used these systems for as long as I can remember". Perhaps they practised this form of management about a hundred years ago when they started to grow opium, long before cropping systems courses were introduced into the universities.

3. Relay cropping system This system is very much like sequential cropping only instead of glutinous maize, non-

glutinous maize is grown for animal feed. Opium poppy seed is sown under the maize before it is harvested.

Maize plays an important role in opium poppy cultivation because it not only reduces the amount of labour required by keeping down weed growth, it also protects seedlings from the explosive impact of late rain. Heavy rain can up-root the delicate seedlings and surface run-off wash them away. The maize canopy lets in enough sunlight for the seedlings to grow, keeps the ground temperature down, reduces the rate of soil moisture loss and maintains a better dew point ratio. Maize, then, serves the dual role of acting as a guard if precipitation is too generous, and enhancing both moisture retention and dew point condensation if there is no rain at all.

4. **Mono-cropping system.** Traditionally crops have rarely been grown in this system, under which a single type of plant is planted, but development project promotion of cash crops has now made it quite common. Hemp, cotton and sugar cane have been grown for sometime. Lettuce, cabbage, tomato and other temperate vegetables are more recent additions.

Research and Genetic Resources: current situation

In 1960 a major development programme was mounted with the stated objectives of stopping swidden agriculture, reducing opium growing, replacing opium with other cash crops and promoting permanent agriculture and settlement. Since then, many new crops have been introduced, mainly to replace opium. Most of the introduced plants are already well known to highlanders. They are improved varieties bred to provide a larger harvest. As most readers will appreciate, these plants place considerable demands on growers. They require careful management and expensive inputs (fertilizers, pesticides, herbicides etc.) and in this respect are quite different from the plants highlanders have habitually used. However, government extension workers report that they receive a good response from highlanders. Most of these new plant materials are grown in accessible areas that

extension workers can visit regularly without having to face too many difficulties. The range of introduced plants includes new varieties of rice, cabbage, lettuce, garlic, Jamaica sorrel, mung bean, black bean, longan, cassava, sugar cane, maize, Pe-tsai, dahlia, foxtail millet, sweet orange, sesame, ginger, egg plant, shallot, potato, peach, ground nut, mango, common bean, kapok, castor bean, pineapple, tomato, tobacco, tea, tarmarind. sweet sor, santol, jackfruit, Malay apple, guava, pomelo etc.

Many kinds of improved varieties have become highlander cash crops but of course the profitability of each depends on individual village market conditions. (A list of introduced crops is provided in Appendix IV).

Plants in this category include,

Vegetables: cabbage, Chinese cabbage, ginger, garlic, common bean, lettuce, shallot etc.

Field crops: soya bean, sesame, mung bean, black bean, foxtail millet, peanut, cotton, potato, cassava, sugar cane, maize etc.

Fruit and beverage: tea, peach, sweet orange, pineapple etc., and some improved varieties of tobacco (Virginia type).

Of these crops, maize is the most frequently planted. This is due to many factors but mainly because opium growing farmers such as the Meo and Yao at Nan, Chiang Rai, Tak, Petchaboon and Kampaeng Phet are well acquainted with it.

New cash crops have also been introduced:

Vegetables: celery, parsley, kohlrabi, Brussel sprout, turnip, cauliflower, Pe-tsai, aubergine, spinach, zucchini, bell pepper, fennel, head lettuce, Japanese cucumber, Japanese onion, leek, asparagus, tomato, sweet pea, etc.

Beverages: coffee, chrysanthemum tea, Jamaica sorrel etc.

Fruits: litchi, apple, Chinese pear, Japanese apricot, passion fruit, strawberry etc.

Field crops: red kidney bean, pinto bean, Lima bean, potato for processing into chips, etc.

Flowers: carnation, statice, gladiolus, strawflower, gypsophila, chrysanthemum etc.

However, even though there are now many improved crops varieties and cash crops in hill tribe communities, many villages have developed markets for their traditional crops. This depends on the environment and the market situation. Opium should also be included in this list because it is still grown in isolated spots.

This category of traditional crops includes a local variety of peach which is pickled, hemp grown for both its fibre and as a narcotic, coriander (seed), tea, rice, (plain rice sold in Chiang Mai as a vitamin rich rice), glutinous rice (black grain type), lab lab bean, rice bean, Chinese mustard, Siam cardamon and betel pepper.

Research work also commenced about 1960. The Department of Agriculture, Ministry of Agriculture and Cooperatives, set up a research and experimental station in the highlands at Doi Mussur in Tak province on about the 950 metre contour. The extension crops subject to research and experiment included Arabica, robusta and liberica coffees, avocado, macadamia nut, cherri moya, litchi, longan, pomelo, sweet orange, mandarin orange, tea, mulberry, asparagus and strawberry. A considerable number of domesticated perennials have been added to the highlanders' inventory but lack of funds and personnel has limited the range of experimental work.

About 1963, the Department of Public Welfare (DPW) established four Hill-Tribes Self-Help Land Settlements (official translation). These were at Chiang Rai (Amphoe Mae Chan), Chiang Mai (Amphoe Chiang Dao), Tak (Doi Mussur in Amphoe

Muang) and Petchabun. The settlements carried out basic work on crops such as carrot, kohlrabi, Pe-tsai, Kwang Tung, sweet pea, cabbage, beet, water melon, radish, turnip, lettuce, cauliflower, litchi, coffee, tea, apple, pear etc.

In Tak, at the DPW Doi Mussur "settlement", pasture experiments were set up as a component of a livestock extension project. This project received help from New Zealand and American Peace Corp volunteers. Pasture establishment experiments were carried out with clover and other legumes as well as the following grasses: Rhode, Guinea, Guatemala, Napier, paspalum, timothy, cocksfoot and sorghum. The adaptation trials also tested fodder crops such as rape, swede, velvet bean, kudzu, cow pea, centrosema, Lucernes (alfalfa) etc. This work ceased in 1967 when security became a problem.

The Rice Department (subsequently renamed The Rice Research Institute), in cooperation with the Department of Public Welfare, carried out experiments with more than 100 varieties of rainfed as well as irrigated rice, such as *nang mol* S4. The feasibility of growing wheat was also explored. All this work was carried out at Doi Mussur, Tak between 1963 and 1966.

The Royal Project, which was set up in 1969 and commenced work in 1970, was the first agency to seriously analyse and experiment with various crops. Academic personnel from Kasetsart, the agricultural university in Bangkok, the Agricultural Faculty of Chiang Mai University and the Mae Jo Institute of Technology and Agriculture, also of Chiang Mai, and various offices of the Ministry of Agriculture and Cooperatives carried out work with support from the United States of America Department of Agriculture (USDA). Some 69 agricultural research projects involving both plants and animals were carried out between 1971 and 1985. Work concentrated on new and improved varieties of crops, only a few of which could be called traditional hill tribe plants.

PROBLEMS

Although USDA support was withdrawn in 1986 the Royal Project is determined to continue research and experimental work on highland agriculture with the support of private funds from His Majesty the King, other donors and the Narcotics Administration Unit located in the US Embassy, Bangkok.

The United Nations/Thai Programme for Drug Abuse Control (UNPDAC) also provided funding for research aimed principally at identifying opium replacement crops. This programme, started in 1973 introduced a considerable number of new and improved varieties, many of which have become important cash crops. The list includes:

Vegetables: Chinese radish, Chinese mustard, Chinese kale, Chinese cabbage, rhubarb, eggplant, heading mushroom, hot pepper, broad bean, tomato, musk melon, green pea, day lily, onion, cauliflower, head lettuce, broccoli, cabbage, carrot, Brussel sprouts, cucumber, sweet pepper, celery, parsley, sweet fennel.

Herbs and Spices, Condiments and Medicinal Plants: balm, summer savory, anise, rue, majoram, thyme, lavender, caraway, chicory herb, mint, cumin, tansy, coriander, sage, basil, horehound, camomile, digitalis, clary, borage, dill, rosemary, dandelion, tarragon, elecampane, fenugreek, curcuma, wild majoram, sweet majoram, henbane, danggui, peppermint, cardamoms, pyrethrum, hop, saffron, vanilla etc.

Field crops: sunflower, safflower, red kidney bean, Lima bean, pinto bean, sweet corn, sorghum, castor bean, potato etc.

Flowers: marigold, zinnia, alyssum, aster, carnation, dahlia, pansy, salvia, petunia, snapdragon, nasturtium etc.

Fruits: strawberry, apples, peaches, passion fruit etc.

UNPDAC also promoted perennial trees and shrubs, especially Arabica coffee. Arabica coffee varieties on which experimental work has been carried out include bourbon, catura, catuai, typica, catimor, Blue Mountain, Arusha, hybrid de Timor, coorge, coorge kent, geisha, kent, kaffa, Villalobos 954, K7, H - 17 - 1, DK 1 - 6, S-6, S - 12, S - 795, S - 947, S - 952,

S - 333, S - 645, S - 1934, S - 288 etc. The current extension favourites are varieties which also grow in the lowlands without shade, such as catimor, catuai and catura.

At about this time, the Thai-Australian Highland Agronomy project grew out of a cooperative arrangement between the Tribal Research Centre, Faculty of Agriculture, Chiang Mai University, and the Australian Development Assistance Bureau (ADAB). Its initial objective was to provide technical assistance to improve the nutritional quality of savannah grassland. Pasture agronomists introduced new germplasm from the legume and grass family such as *Desmodium* spp, *Panicum*, spp., *Stylosanthes* spp., *Macroptilium* spp, *Macrotylona* sp., *Glycine wightii*, *Trifolium* spp., *Lupinus* spp., *Setaria* spp., *Brachiaria* spp., *Paspalum* spp., Lucerne, Buffel and Kikuyu grass etc. This project also looked at livestock husbandry (especially cattle and pigs), perennials as fodder, plus also the impact of eucalyptus and pines. In the field, they looked at agricultural extension strategies and the provision of credit.

For nearly thirty years now, development work has been promoted by both government and private agencies. Their activities have brought about many changes in the way in which agriculture is practised in the highlands. The most important change has been the gradual realignment of highlander priorities from a subsistence orientation to one that places people in a much more dependent relationship on the world outside their villages. The emphasis on cash crops is aimed at enabling them to secure higher incomes. This often means that only one crop need be grown. Some farmers now expect to buy food crops for home consumption.

An example of such a community is the Meo village of Ban Khun Klang, Amphoe Chom Thong, Chiang Mai, who grow cabbage and strawberries as their cash crops and have to buy their rice and other food crops from either the Chom Thong district market or traders. The nearest market to the village clearly does not determine the price which is formed in the much wider context

of the national economy. This makes for a high degree of vulnerability. In 1985, many of the Yao in Phayao who grow only cotton and maize for sale, suffered so severely when their crops were badly damaged that they had to ask for rice from the Phayao DPW, Hill-Tribes Development and Welfare Centre to get enough to eat.

Another detrimental impact which has accompanied the widespread adoption of monocropping systems is germplasm erosion. A recent survey in which I was involved found that many kinds of plants which used to be grown have disappeared. This is especially evident in communities favourably served by roads and transport services.

Specialisation also encourages farmers to change their scale of operation, fell more forest to increase the size of their holdings and bring marginal land under cultivation with machines, thus increasing the risk of serious soil erosion.

Rice is another crop which causes both academic researchers and development workers concern. The speed at which varieties possessing many good adaptive qualities are being replaced by higher yielding improved varieties that require careful management, especially the application of fertilizer, is a serious if incipient problem. In response to this, DPW along with the Rice Research Institute (RRI) undertook responsibility in 1980 to collect and conduct experiments with many varieties of hill rice. From 1983-1984 the International Board for Plant Genetic Resources gave support to this effort by passing through the International Rice Research Institute, the RRI and the Ministry of Agriculture and Cooperatives a request that the author, in cooperation with other field workers of the provincial Hill Tribe Welfare and Development Centres, collect samples of all available types of highland rice. Rice cultivars collected over the period 1980-1984 include more than 1100 varieties, all of which are kept at the National Rice Germplasm Centre, Pathum Thani Province.

Other traditional crops still grown are being collected. In 1986 the Tribal Research Institute, in a joint project with Chiang Mai University, began to gather legumes. Other plant materials are being collected to establish their scientific names, describe their structure, fertility, productivity, utility, chemical content and other characteristics. Legumes were singled out as a high priority because they are an important source of protein, alongside meat recovered from wild animals, fish and domestic livestock. At the time of writing more than ten distinct types had been identified.

Based on the experience of how subsistence and semi-subsistence traditional agricultural systems like those of the highlands of Thailand have changed in other parts of the world, profound underlying changes have yet to exhibit the full extent of their impact here. Aggressive "Top-Down" development projects which think for people and assume that as experts they know best can often come to decisions which in the long run endanger the wide variety of indigenous germplasm by replacing it with a few improved varieties. There are many examples of this having happened. *Pin kaew* rice used to be the best known rice grown in Thailand. It won many world rice competitions in the 1920s and 30s but already germplasm is difficult to find. The same thing has almost happened to the "400 variety" of rice grown by the Lahu Nyi and Meo. This variety grows very well on or about the 1,000 metre contour. The disappearance of this variety does not serve the government's policy to encourage highlanders to give up opium growing and to help them establish permanent villages. In the absence of the "400 variety" Meo and Lahu Nyi have been forced to abandon high altitude settlements and relocate in areas suitable for growing paddy rice and marketable cash crops. It is interesting to note that this variety first disappeared from communities served by extension workers who commenced work quite recently (1980). After searching for more than six years, we think that we have found a source of this seed with the Lisu. Good quality germplasm is required by plant breeders. In the sample found a single panicle sets from 300 to

400 seeds and under really favourable conditions spreads out to establish up to ten stems.

The Future

Clearly, rice is only one of many food crops traditionally grown by highlanders in a system of cultivation which includes a multitude of medicinal plants and others grown for use in rituals.

Many plants have recently been introduced into cropping systems by highlanders and extension workers to maintain favourable soil characteristics. Amongst these is found lablab bean *Lablab purpureus*(L.), sweet and rice bean *Vigna umbellata* (Thunb.) Ohwi & Ohashi. These plants will play an increasingly important role, particularly in the development of more intensive land use.

Since the 1970s, lowland Thai farmers in Kampaeng Phet province have developed a pattern of mixed cropping alternating between maize and rice bean which has proved to be quite successful in maintaining soil fertility. The rice bean can be sown by itself and also mixed with maize to inhibit weed growth until harvested in late December, early January. The germination of weeds in the following season will be greatly reduced, enabling farmers to single crop maize for a considerable period. Meo, Yao and Lisu have adopted this mixed cropping system. Since 1975 the rice bean has been introduced into their cropping systems on steep slopes and produced very encouraging results. Those who use it, especially the Yao, have found they can bring steep slopes classified as loamy soils under long term cultivation where previously they were restricted to two to three years before it became necessary to fallow. Some of the fields cultivated by this method have now been used continually for more than 10 years and produce good harvests, slightly reduced in more recent years, but still sufficient to justify farming. Good yields have been maintained even though clearing is restricted to burning instead

of plowing. By planting maize and rice bean in a mixed cropping system farmers are able to extend the period of land use well beyond that which prevailed in the past.

As this system is extended to other highland villages we can expect, especially in communities which grow maize as animal feed (such as the Meo, Yao, Akha, Lisu and Lahu), that it will have a very positive impact on the development of land use intensification and enable more people to earn their livelihood than was possible under traditional extensive agriculture. Not only does the method reduce the need for weeding but it also produces a cash crop for sale. If it is to produce problems, one can expect them to be manifest in an increasing pest population. Highlanders have shown that they are willing to use pesticides on crops grown on fertile soils. However, if heavy use is made of pesticides, further problems are likely to be experienced.

During the period in which considerable attention has been given to highland development, both academics and agricultural extension workers have attempted to identify a cropping system focused on hill rice within a relay or sequential cropping system by selecting several plants, especially legumes, that would serve as a good second crop. Experiments have been carried out with several varieties of beans such as mung bean, soya bean and peanut, and also kitchen plants which could be grown before or after the harvest. An inter-cropping system has been tried unsuccessfully. Some of the plants used in the experiment need too much water. Some plants whose water requirements are low are intolerant of cold weather. Until about 1980, lowland farmers in Chiang Mai province planted lablab bean, which is tolerant of cold, dry conditions in their upland rice fields, under a sequential cropping system and achieved good results. Highlanders have adapted this system and also achieved good results as long as the rains do not stop completely in the critical period between October and November. Lablab bean has also been grown as a second crop after rice for as long as four years.

Even though rice and lablab bean are not grown in sequence as widely as possible, it may well prove to be important in the future. Intensive research needs to be carried out to see if this combination would enable farmers to reduce the fallow period of rice fields, particularly those of the Lua, Karen, Htin and Khamu, most of whom are subsistence farmers who grow rice for their own needs and very few cash crops. Lablab bean could provide a cash crop which contributes to soil conservation. The use of fertilizer may be necessary.

During this present period of rapid population growth any technique which would make it possible to intensify land use should be investigated.

Much more work should have been done earlier on traditional plant associations, cropping systems and the way in which these fit into the wider socio-economic system. Some of the traditional crops have proved to have greater commercial value than was anticipated. One example of this is hemp *Cannabis sativa* Lin., which Meo use principally as a fibre to make clothing which is sold in considerable quantities on the Chiang Mai market. It has been estimated that the value of the hemp sold is worth about two million baht per year. Other examples include; peach (pickled), coriander (seed), betel pepper, Siam cardamon and even the trees which provide shade for coffee trees, *maa khaen* (*Zanthoxylum limonella* Alston), which can be used as a herb, spice or condiment. This is planted by Lampang highlanders as shade for their coffee and farmers have made so much money from them that they must be recognised as an important cash crop in their own right.

Conclusion

In this paper I have identified some of the salient characteristics of contemporary agriculture in the highlands and uplands. Most farmers have a long history of occupation and the agricultural systems developed over the centuries have only been subject to drastic change over the past few decades. These

changes have involved a considerable loss of independence and self-sufficiency. If the genetic diversity of the indigenous systems is not to be lost, deliberate intervention on the part of researchers and other scientists is a matter of considerable urgency. Development projects themselves could gainfully pay more attention to the sophistication of traditional farming and help avoid a situation where exposure to soil erosion and vulnerability to both the lowland market economy and biological over-specialisation could place the welfare of highland communities at risk.

References

- Anderson, E.F. (1986) "Ethnobotany of Hill Tribes of Northern Thailand. I. Medicinal Plants of the Akha" *Economic Botany* 40 (2): 38-53.
- Anderson, E.F. (1986) "Ethnobotany of Hill Tribes of Northern Thailand II. Medicinal Plants of the Lahu" *Economic Botany* 40 (4): 442-50.
- Black, Robert (1985) *Three language check lists of plant names* (Thai-English-Scientific), Klang Wiang Karnpim Co., Ltd: Chiang Mai.
- Department of Agriculture (1979) *List of Plant Names* Germplasm Standard Subdivision, Field Crops Division: Bangkok (In Thai).
- Isara Sooksathan et al (1983) "Research on Industrial Oil Crops for Opium Substitution on the Highlands of Northern Thailand" (Final report on research, July 1980 - June 1983) Highland Agriculture Project, Kasetsart University: Bangkok (mimeo).
- Kunstadter, P., S. Sabhasri, and T. Smitinand (1978) "Flora of a Forest Fallow Farming Environment in Northwestern Thailand" *Journal of the National Research Council* Thailand Vol. 10 No. 1.
- Kwanyeun Wichapan et al (1976) "Essential Oil Production in the Highlands of Northern Thailand"

- Misc. Invest., No.85/Rep. No.4,
Applied Scientific Research Cor-
poration of Thailand: Bangkok
(mimeo).
- Lin, Chao-Hsiung
(1975) "Vegetable Herb and Flower Seed
Production Trials", UN/Thai Pro-
gramme for Drug Abuse Control,
Bangkok: Thailand (mimeo).
- Oradee Sahawatcharin
(1985) ***National Tree Planting Day 2529***
P. Sampanpanit Ltd. partnership:
Bangkok (In Thai).
- Pavin Punsri et al
(1984) "Research on Small Fruit Produc-
tion as Substitute Crops for Opium-
Poppy" (Final report, October 1979
- September 1984) Highland Ag-
riculture project, Kasetsart Univer-
sity: Bangkok (mimeo).
- Pavin Punsri et al
(1985) "Exotic Fruit production as a Sub-
stitute for Opium Poppy in the
Highlands of Thailand" (Final
Report, August 1982 - July 1985)
Highland Agriculture Project,
Kasetsart University: Bangkok
(mimeo).
- Pisit Voraurai et al
(1979) "Ornamental Plants as Replace-
ment Crops for Opium Poppy in
Northern Thailand" (Final Report,
May 1976 - May 1979) Faculty of
Agriculture, Chiang Mai University:
Chiang Mai (mimeo).
- Purseglove, J.W.
(1974) ***Tropical Crops, Dicotyledons***
Longman: London.

PROBLEMS

- Purseglove, J.W.
(1975) ***Tropical Crops, Monocotyledons***
Longman: London.
- Reader's Digest
Encyclopaedia (1972) ***Garden plants and flowers*** Reader's
Digest Association Limited: Lon-
don.
- Sanong Voraurai
(1980) Personal Communication, May -
June.
- Tang, Robert C.,
(1977) "Report of the Vegetable and Flow-
er Seed Production Consultant"
UN/Thai Programme for Drug
Abuse Control: Bangkok (mimeo).
- Tang, Robert C.,
(1977) "Report on the Vegetable and
Flower Seed Production potential
in Northern Thailand" UN/Thai
Programme for Drug Abuse Con-
trol, Bangkok, Thailand (mimeo).
- Tem Smitinand
(1980) ***Thai Plant Names*** Funny Publica-
tions Ltd., Bangkok.
- "Thai-Australia
Highland Agronomy
Project First Report"
(1972-1975) Report to the Department of Public
Welfare and Chiang Mai University
on Pasture Agronomy Research
(mimeo).
- Zeven, A.C. and P.M.
Zhukovsky (1975) ***Dictionary of Cultivated Plants and
their Centers of Diversity, Exclud-
ing Ornamentals, Forest Trees and
Lower Plants*** Centre for Agricul-
ture, Publishing and Documenta-
tion: Wageningen.