# 00

# INNOVATIONS IN SEED AND CROP MANAGEMENT

## by Indigenous Groups in Nghe An province, Vietnam

*Tran Thi Tuyen, Nguyen Thi Viet Ha, Nguyen Thi Trang Thanh and Vo Thi Vinh**

### Introduction

Shifting cultivation, or swidden farming, has been practised by traditional societies for thousands of years, mostly in the humid tropics, and throughout its long history it has proven to be a dynamic and evolutionary system (see Tiwari, ch XX, this volume). There have been many studies of swidden cultivation that compare it with wet-rice cultivation (e.g. Padoch, 1985; Cramb, 1989; Conelly, 1992; Hunt, 2000; Mertz et al., 2009). However, while upland ecosystems have a lot of potential for development, they are very vulnerable, so there is a need for a holistic and environmentally friendly approach. A diverse range of adaptive fallow and tree-cropping systems have been developed by local communities in their efforts to modify upland farming to meet evolving rural conditions (Fox, 2015). There have been reports of progress in crop diversification and management in some parts of the world, such as Amazonian Peru (Brookfield, 2015), and in ch XX of this volume, Cairns and Brookfield document the resilience of farming people in Nagaland, northeastern India, who developed multiple skills and quickly adapted to changing conditions. In Vietnam, upland farming systems have a wide diversity of plant genetic resources (Tran, D.V. et al., 2015). The indigenous knowledge of ethnic minorities has enabled diversified systems of shifting cultivation to dominate mountainous areas of Nghe An province. These systems are generally suitable for sloping land conditions and are similar to those described by Rambo (1996) in his studies of the Tay ethnic group in Vietnam's northwestern mountains. However, the cultivation systems of Nghe An have a hot and moist environment, and are focused on plant varieties capable of surviving in total dependence on the weather, where others may fail in these conditions.

* Dr. Tran Thi Tuyen, Department of Resource and Environment Management, School of Agriculture and Resources, Vinh University, Nghe An province, Vietnam; and Dr. Nguyen Thi Viet Ha, Dr. Nguyen Thi Trang Thanh and Dr. Vo Thi Vinh, all of the School of Social Sciences Education, Vinh University, Nghe An province, Vietnam.

The shifting cultivators of Nghe An have a long history of nomadic farming. They face an increasing population, limited ecological conditions, water supplies restricted to rainfall alone and challenging socio-economic conditions, but they have nevertheless been innovative in their selection and management of crops, and have made significant progress, particularly in the development of crop varieties. The domestication of rice over countless generations has been one of the most important achievements of these mountain-dwelling ethnic groups. A lot of their rice varieties have never been identified scientifically, but exist only under their local names.

This chapter refutes the suggestion that shifting cultivation is a static practice and its practitioners incapable of improving or intensifying their farming systems. It supports the notion that if left to their own devices, granted tenure over their land and given help on their terms, shifting cultivators will be every bit as innovative as their counterparts in modern agriculture.

## The study area

This study was conducted in Tri Le commune, in the southwest corner of Que Phong district, in Nghe An province (Figure 00–1), more than 30 km from the district centre. Tri Le commune has a long international border with the Lao PDR. It has three ethnic groups: Thai, Hmong and Khmu. They live in 33 villages with a total of 1851 households and 9537 people.

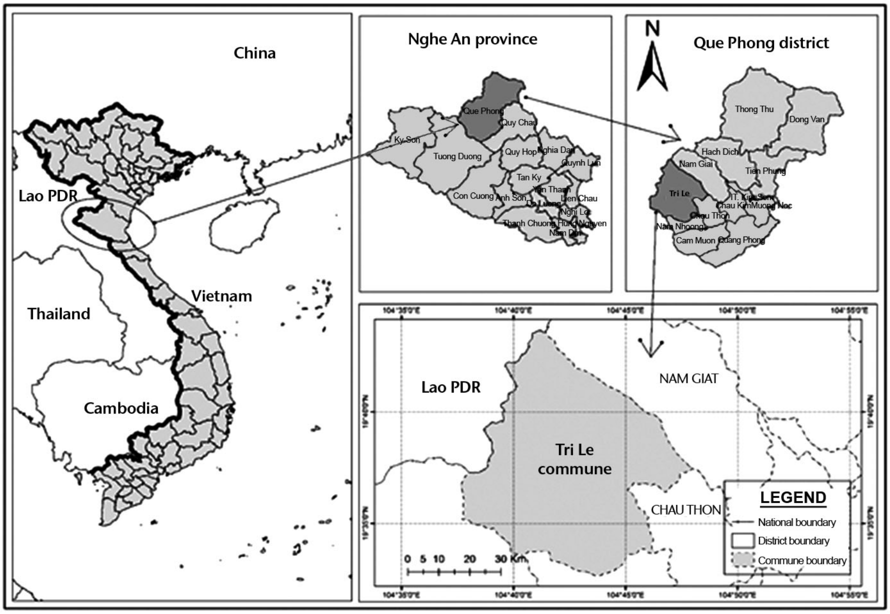



**FIGURE 00-1**: Location of the study area, in Tri Le commune, Que Phong district, Nghe An province, Vietnam.

The topography is strongly divided, with high mountains ranging between altitudes of about 1800 and 2000 metres above sea level. The average annual rainfall is 2000 mm. The soils are mainly ferralsols, with humus on the mountains making for relatively thick soil. The forest in the area is rich with diverse bamboo species, but much of the vegetation cover is regenerated forest, with dominant small tree species and an understorey of shrubs and herbs. One characteristic of this vegetation is its ability to recover quickly. Cultivated land is mostly reclaimed by the original farmer, after fallowing. In the past, the choice of plots to open for cultivation was governed by traditional laws, but the government has now granted ownership of the land to the farming families.

## Methods

### *Field observations*

Observations were carried out simultaneously in two rice fields of each study village, one growing old (traditional) varieties and the second growing new varieties, at different times according to the seasonal calendar. The crops were thus observed at the time of seed sowing in May and June, and later at harvest time in October. This provided information on the development of the new varieties, why and how they were chosen, and planting, fertilizing and harvesting for each plant. In this way, we could assess the flexibility and creativity of the farmers.

### *Sociological investigation*

Ten villages of Tri Le commune were involved in the study. Thirty individuals were interviewed from each village, making a total of 300 interviews. The gender and age structures of these groups were controlled. Each group of 30 was divided into 15 men and 15 women; their age was divided into three groups: 18 to 30 years old, 30 to 60 and over 60. There were 10 respondents from each age group. In addition to gender and age, the interviewees were also chosen for their ethnic backgrounds. The 300 respondents were divided equally into three groups of 100 each for Khmu, Hmong and Thai people. On the basis of these criteria, individuals were otherwise chosen randomly. The division by gender and age groups was aimed at assessing indigenous knowledge according to gender and age. The selection of individuals for informal and semi-structured interviews was not limited by numbers and focused on older people in the various communities because they were regarded as 'special people' holding 'special information'. The different ethnic groups had different approaches to crop management and these differences were used in assessing the economic effects of various cropping methods.

### *Using questionnaires designed for the purpose*

A questionnaire can be a cost-effective research tool for use in data collection. However, a number of sequential steps should be followed in planning and designing a questionnaire, to ensure that the questions are handled consistently by all interviewers and that during the interview process the interviewer can answer or clarify respondents' queries. In the questionnaire for this study, the farmers were asked about traditional methods of seed selection (morphology, colour, seed quality, etc.), the time of seed selection and the way the seeds were preserved for the following season. The farmers were also asked to compare different preservation methods that were considered at the time of selection and the way these methods might affect the productivity of the crop.

### *Semi-structured interviews about discovering and selecting superior seeds*

Because of the differences in age, gender and ethnicity in the survey, a semi-structured approach was adopted in order to develop interviewees' responses and obtain richer information. All methods were used to get closer to vital information on selection processes and preservation and storage of seeds so that each locality was able to plant the best varieties of crops.

## Innovations in seed and crop management

### *Salient practices in the discovery and selection of superior seeds*

As the population of the study area grew, the communities used many ways of collecting and developing new crop varieties in response to pressure for more food. Seed-exchange relationships were built with other ethnic communities in their area, and with people of the same ethnic group in other districts. The seed exchanges even crossed international borders, with new varieties sourced from communities in the Lao PDR. Farmers selected new varieties on the basis of their performance according to topography and soil, and as a result, food crops became increasingly abundant. Nowadays, the communities of Tri Le commune grow about 20 varieties of rice and 12 varieties of maize. Experience accumulated over many generations has led farmers of the Thai ethnic group to work according to a simple rule: 'never sow a piece of land with a single species. On the contrary, plant more than four or five rice varieties'.

Rice is the most important food crop, directly feeding more people than any other crop in the uplands. In the past, the farmers saved their best rice fields to produce seed for the following season. However, the methods by which rice varieties are now selected have come from improved farming practices. Farmers have moved away from the system of using an entire field for seed stocks and have made painstaking and elaborate efforts to discover and select good seeds from many fields. They say that good seeds are found on developing panicles that are about 40 to 50 cm long, and are weighed down with stocky, heavy grains (Figure 00-2). The panicles are harvested individually, dried in the sun, and taken back to the village.

**FIGURE 00-2:** Good rice-seed indicators: Panicles heavy with grain (left) compared with a field that can be overlooked for future seed stocks (right).

*Photos:* Tran Thi Tuyen.

### *Innovations in collecting superior seeds*

Breeding plays an important role in cultivation. Therefore, farmers are very interested in breeding, by helping nature to produce superior plants. In the past, they believed that 'seedlings belong to the mountain gods,' so that the grain from some fields was routinely saved for the next season. This method is still used by some households. However, they found that after a long period of cultivation, they collected many seeds of poor or inferior quality from their seed-production fields. At the same time, they noticed that other fields contained a lot of good seeds. Consequently, the selection of varieties for the next year's crop has been extended to other fields and the methods of selection have also changed.

Farmers have begun assessing the quality of developing crop plants at an early stage, and 87% of farmer respondents said they chose to assist the natural breeding of superior plants on the basis of observations in their upland fields. The best plants in their fields are marked from the flowering stage for maize and from panicle initiation for rice. In the case of maize, they watch for multiple branches on the male inflorescence at the apex of the plant's stem. The flower should be about 20 cm long and of a uniform colour. They also note the direction of the cobs, or ears, as they develop (Figure 00-3).

They then monitor the ripening phase on each chosen plant. The important aspects are the texture and colour of the grains, or kernels. When the grain is ripe and mature, a close watch is kept on how the hardness of the grain increases during the waxy state. The farmers also examine the colour, viscosity and grain density of individual cobs and eventually select the best plants (Figure 00-4). When the maize is ready to be harvested, the farmers cut the leaves around the selected cobs so that they receive the most sunshine. These cobs are left on the plants for about two weeks after the rest of the crop is harvested.

**FIGURE 00-3**: Indicators of good seed for future maize crops: Multiple flowers (left) and flowers growing towards the sun (right).

*Photos:* Tran Thi Tuyen.

**FIGURE 00-4**: Grain density (left) is one criterion by which farmers select seeds for future crops. Once selected, cobs on the chosen plants are deprived of shady leaves (right) and are left in the sun for about two weeks after the rest of the field is harvested.

*Photos:* Tran Thi Tuyen.

The process of selecting rice seeds based on the state of the developing panicles has proven itself to be a more effective means of judging good quality plants. Seed rates, seed germination rates, plant growth rates and yields have all improved. Under the old, traditional system, the percentage of broken seeds was quite high. As shown in Table 00–1, the percentage of broken seeds has fallen and the germination rate has improved, along with a higher percentage of healthy plants. At present, rice seeds are planted at a rate of 8 to 11 seeds per dibble hole, and overall productivity has risen (Figure 00–5).

**FIGURE 00-5**: Seeds are planted at a rate of 8 or 11 per hole (left), and the germination rate has risen to 97%, with more than 90% of plants regarded as healthy (right).

*Photos:* Nguyen Dinh Chien.

**TABLE 00-1**: Effectiveness of innovative methods of seed selection in study villages.

| *Criteria* | *Old method* | *New method (Innovation)* |
|---|---|---|
| Broken grain (%) | 21.3 | 13.1 |
| Germination rate (%) | 83 | 97 |
| Rate of healthy plants (%) | 79.1 | 91.3 |

### *Diverse rice varieties*

Some of the rice varieties grown by the communities of Tri Le commune were domesticated from nature by the local people. While they still find a place in the swiddens of the study communities, they are nowadays at risk of disappearing. Such loss of biodiversity poses the wider risk of losing cropping characteristics that may be invaluable in the scientific breeding of future food plants with the ability to withstand the challenges of climate change. Several of these domesticated varieties are worthy of mention, including two varieties that were discovered by Hmong people, and in their language, are known as *plej maiv khiav* and *plej txuas txhas*.

*Plej maiv khiav* is a sticky (or glutinous) rice discovered in a high mountain meadow by a woman called *Maiv*. The rice now bears her name. She took seeds and planted them, but the rice had not reached maturity before the experiment was disrupted by warfare. Later, she tried again, and the rice plants were tall and the grain was large, round and reddish in colour. The flavour was very delicious, and the new variety became popular. Its yield was not high, but the quality was very good.

*Plej txuas txhas* (literally, rice joint bone) was discovered by a Hmong hunter who claimed to have observed a mother bird feeding it to a chick with broken legs. After a while, the chick was healed. As a result, the farmers planted the variety and used it to treat injured chickens, ducks and even pigs, by feeding them the grain or applying it to the wound. They say it has proven effective. This rice variety has coarse, ruby-red coloured grain. It is not good to eat. Farmers grow only small quantities of it, for use in treating injured livestock.

*Khau ngan* (silver rice) is a glutinous variety discovered and domesticated by the Khmu people. It is named for its morphological characteristics and rarity. When grown in a field, the leaves reflect the sunlight, making the crop appear to be as white as silver. This is best seen at dawn, when a field of this variety shines and glitters. The grain is very fragrant, even when it is in the field, and when it is cooked it is fragrant and sweet. This rice variety is currently very rare.

There are four distinct groups of glutinous rice varieties grown in the study villages: red, yellow, black and white. Some have been introduced from other parts of Nghe An province and from Laos. Examples include *cày nọi* (small chicken), a rice variety introduced to the Khmu community following a seed exchange. It is a tall-growing variety with long, white sticky grains. When cooked it is soft, fragrant and sweet. *Kah dam doi* (black sticky rice) is another 'outside' variety, offering a different colour and flavour.

*Oryza glutinosa* Lour., a synonym of *Oryza sativa* L. [Poaceae]

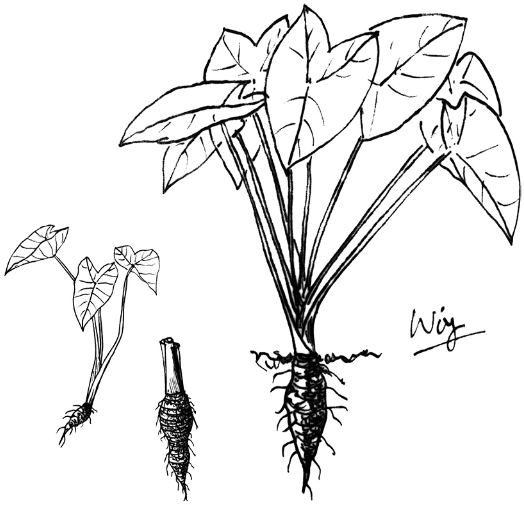
Many varieties of glutinous or sticky rice are widely consumed across Asia. They have opaque grains, a very low amylose content (one of the components of starch) and are very sticky when cooked. However, despite their name, these varieties do not contain dietary gluten. They owe their existence to careful selection over countless years by farmers who favoured seeds with the single mutation that stood this plant apart from ordinary rice.

### *Maize*

The maize varieties grown by the study communities are similarly very diverse, and as mentioned earlier, farmers commonly grow up to 12 varieties of maize in their swiddens. They are divided into two main groups: glutinous and hybrid maize. The glutinous varieties either had local origins (and were claimed to be 'native'), or they were naturally selected and imported from Laos. Hybrid maize was introduced later with support from the government. One variety produced by selective breeding across the border in Laos is called *purple sticky corn*. It is a sticky corn with dark purple, aromatic grain. It is the main raw material in local sticky-grain dishes and traditional cakes made in Hmong communities.

### *Taro*

This tropical food plant was introduced to the study communities by Hmong people carrying it across the border from Laos. It is grown for its starchy corms, which are harvested when the plant decreases in height and the leaves begin to turn yellow. Hand tools are usually used to harvest the corms. Soil around the corm is loosened and the corm is pulled up. Hmong farmers often leave small tubers in the ground, adding moisture to encourage regrowth, rather than replanting a field. Corms of a small round variety of taro are peeled and made into cakes.



*Colocasia esculenta* (L.) Schott [Araceae]

Taro is one of the most ancient of cultivated crops. It is believed to be native to the lowland wetlands of Malaysia, but is now widely naturalized throughout the tropics and, in many places, is a staple food. Its starchy corms were first introduced to the study area from Laos, across the border, as an emergency food in the midst of a serious drought. It has since become a local perennial crop.

## Covering seed with dried vegetation

In the past, when fields were cleared of vegetation for new cultivation, farmers usually burnt all of the plant residues. Dry branches left after burning were collected and burnt again, until there was no dry matter left on the field. What was left was fertilizing ash, but about 20 years ago, farmers began to regard the ash with some scepticism: although there was a lot of it left by the fires, after the first rain most of it had disappeared. This kind of awareness has helped farmers over recent decades to change their practices.

Nowadays, after sowing, farmers use dry matter to protect the seeds. Using the available organic matter, dried leaves, sticks and small branches are laid on the surface of the soil, with thicker patches covering newly-sown seedbeds (Figure 00-6). This simple technique not only protects the seeds, but also protects and rehabilitates the soil. The dry matter reduces erosion by rain and wind and increases the porosity of the soil and its ability to absorb water. It therefore improves soil moisture, reduces surface run-off and evaporation, reduces weed growth and increases the stability and structure of the soil surface. These effects increase the efficiency of fertilizer. Farmers reduce their investment in land preparation, weeding and fertilizer, while increasing the amount of organic matter and plant nutrients in the soil. The use of dry vegetation in this way creates good conditions for seed germination and strong

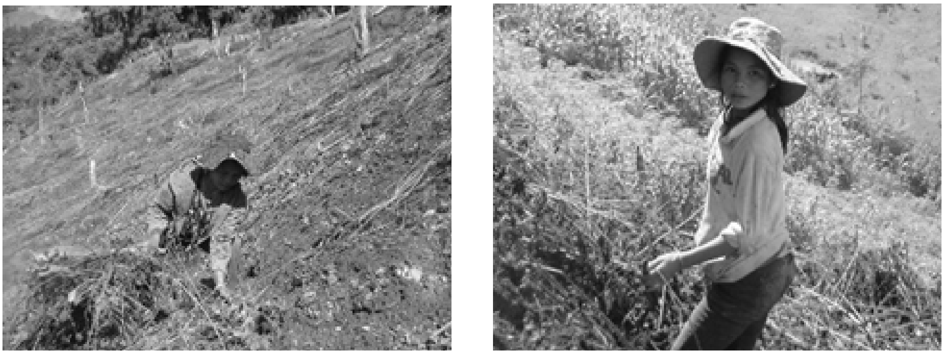


**FIGURE 00-6**: Gathering dried vegetation (right) and using it to protect newly-planted seeds on a sloping field (left).

*Photos:* Tran Thi Tuyen.

root and plant growth. This new practice has increased and stabilized yields and the quality of sustainable crops. It is regarded as one of the most important innovations in the study villages, and has become the basis for sustainable use and management.

## Selection of suitable varieties for intercropping

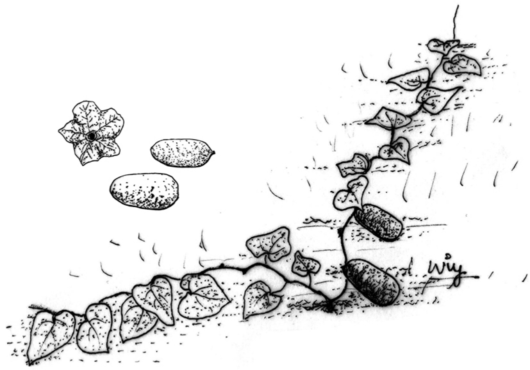
Swidden fields are usually covered by various plants. Over the past three decades, farmers in the study villages have been improving their performance in intercropping techniques. The progression from fields covered by a single crop to intercrops of 'matching' plants can now be divided into three phases:

### *(1) Mainly monocultures of rice*

This stage was a common practice more than 30 years ago. The shifting cultivation cycle included a fallow period of about 15 years, after which the main crop was drought-tolerant rice with three local varieties of sticky rice, such as *Plej maiv khiav*, *Plej txuas txhas* and *Ple do hay khau ngan* (silver rice). Most farmers cultivated a good, drought-tolerant variety called *Xuong*, which delivered satisfactorily high yields of about 1.5 tons/ha, so about 30 years ago, *Xuong* was the most popular variety throughout the mountainous area of Nghe An province. However, in the survey area (Tri Le commune), 83% of households were, even then, cultivating the locally domesticated *Plej maiv khiav* variety.

### *(2) The stage of the intercropping experiments*

The idea of planting taro into rice fields arose nearly 20 years ago, when rice crops were lost to drought and relatives of the Hmong people in Laos sent taro as a relief measure. However, the productivity of rice decreased when it was forced to compete with the high stems and shading leaves of taro. Moreover, the taro tubers occupied a large area of land and made it unsuitable for growing rice. The staple crop was pushed aside. Thus the necessity for protecting vital crops emerged, not because of the limitations of monoculture plantations, but because 'outside' crops were being introduced. The first formula (as mentioned) was planting rice and taro in each field. This was followed by rice with cucumbers. Unlike taro, cucumbers were intercropped with rice when farmers believed the vegetables would relieve their hunger and thirst when they were working in upland fields away from their homes. The outcome was much the same as with taro: the variety of cucumbers was one that climbed, wrapping itself around the rice, breaking it and slowing its development. Rice yields were once again reduced.



*Cucumis sativus* L. [Cucurbitaceae]

Cucumbers were used by Hmong farmers as an experimental intercrop with rice. Early efforts failed because the cucumbers climbed up and over the rice. Success was found with a variety that did not climb. While being a lucrative market vegetable, cucumbers are 95% water and low in essential nutrients.

### *(3) 'Matched' crops in the fields*

After the early trials, farmers improved their intercropping systems. They found which crops should be planted together, and have reported considerable benefits from intercropping (Table 00-2). Today, taro is commonly grown, with high yields, but it is not intercropped with rice. Instead, rice is intercropped with a different variety of cucumber, one that does not creep, but crawls along the ground in higher elevations (Hmong farmers). In addition, rice is intercropped with pumpkins and gourds at lower elevations (Thai, Khmu people).

Maize is intercropped with beans. The beans are sown 50 days after the maize. After the maize is harvested, the beans are still green for some months. They climb on the dried maize, covering and improving the soil, before their fruit is harvested. Using this procedure, following crops grow and develop well, they face less competition from weeds, and yields are higher.

Until recently, Thai people in the study villages planted monocrops of cassava. This led to severe soil erosion, so that after two or three years of cropping there was little soil remaining. Recently, they began planting peanuts along with the cassava and, as a result, the soil has been protected and soil fertility has increased, so this system has high economic efficiency.

**TABLE 00-2**: Farmers' comparisons of the effectiveness of intercropping and monocropping.

| *Aspect* | *Intercropping* | *Monocropping* |
|---|---|---|
| Yields and income | Stable, high value | Unstable, low prices, precarious |
| Labour | Low, gender-balanced | Low, gender-balanced |
| Food Security | Diverse, improved health | No diversity |
| Impact of the weather | Adaptable<br>Stable yields<br>Pests controlled | Difficult to adapt<br>Unstable yields<br>Pests and diseases |
| Greenhouse gas emissions | High biomass<br>Longer cultivation cycle | Low biomass short cultivation cycle |
| Soil erosion | Little impact | High risk |
| System functions | Nitrogen-fixing species | High inputs of NPK fertilizer |
| Ecological | Multi-functional, high biodiversity | Low functionality, low biodiversity |

*Note:* Results synthesized from participatory surveys conducted by researchers with the participation of Hmong and Thai communities in Minh Chau and Muong Long villages, Tri Le commune, Que Phong district, March and April 2018.

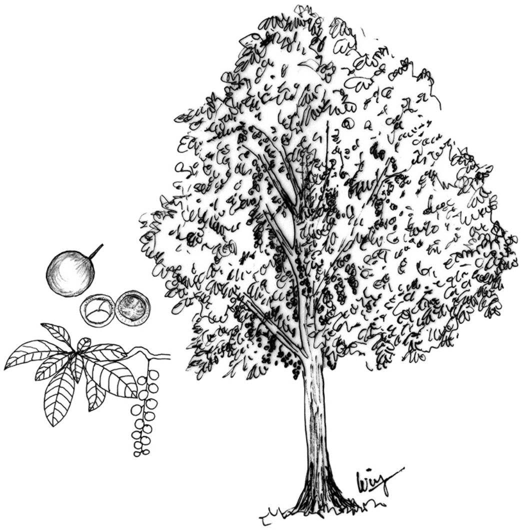
## Matching varieties to soil types

Before planting, the farmers choose a forest plot with the most suitable terrain. Based on long experience, they say that gullies with gentle or light slopes are the best for rice and maize. In this type of land there are few vines with thorny sprouts or rough spines. The soil is black, spongy and moist, contains a lot of humus and is populated by earthworms. It is preferred for growing rice because it gives the highest productivity. As well as recognizing the favourable lie of the land and the colour of the soil, the farmers plunge sharp knives about 30 cm into the ground. If soil adheres to the knife when it is withdrawn, it is deemed to be good soil.

Maize is the second most preferred crop, but the soil should be lighter and drier to grow good maize. Other plants that prefer the same soil conditions are planted together with the two main food crops. According to the study-site farmers, the change to finding the right soil type for each crop, rather than expecting crops to thrive on any patch of cleared forest land, has increased production efficiency and land use.

## Using the signs of nature as crop-management indicators

The management of seasonal crops is often based on the annual cycle of fruit trees in the forest. Over many years of swidden farming, the Thai people in the study area have learned to recognize the stages of growth of upland rice. This knowledge has been written into proverbs, such as: 'July is the month that rice grows high; in August it is making panicles. The rice is in the foot of the buffalo in September, and it is broken if it is not harvested in October'. This indicates the need to work in the rice fields every month and the urgent necessity to tend to the changing needs of the crop, or it will be lost.



*Baccaurea annamensis* Gagnep. [Phyllanthaceae]

This wild forest species is common in the study area. Its annual cycle is observed by farmers as a precise guide to the seasons, and hence an indicator for the timing of farming activities. The fruit are sweet, but slightly acidic. Although they are eaten locally, there is no market for them.

As they worked in their fields in different seasons, the farmers also noticed that bird calls corresponded to the task in front of them. It was as if the birds were reminding them of their seasonal tasks, and urging them on. The Thai farmers mimic the songs of the birds as a kind of seasonal calendar for managing their crops. In February to March, a bird called *thua lốc* sings '*bò xài cá lộc*', meaning it is the time of slash and burn; from April to May, *coong cót* birds call 'tree felling, fire'. This is the time of the dry *foehn* wind, which is most favourable for burning swiddens. To leave felled trees longer than this will risk 'heavy' weather, in which it is difficult to achieve a good burn, and that leads to slow, weak germination. In June, the birds sing 'sow and run', because sowing must end in that month, or fast-growing grass and regenerating forest will overtake the crop and there will be no harvest. In July, a bird called *thac dưt* calls 'fast growing rice' – a message that says the rice is already 20 to 30 cm high and is growing rapidly. From August to September a bird called *Pò vách* sings '*Pó nạo cổ*', urging farmers to weed grass from the rice field. Finally, in October, *vi* birds call '*quạt xôi*', signifying that it is time to harvest and cook the new rice.

This indigenous knowledge of seasonal management of rice crops by the Thai people of western Nghe An province not only reminds farmers of the seasonal calendar but also expresses the close relationship, deep understanding and harmony that exists between people and nature in mountainous areas.

## Protecting and storing seeds

Protecting and storing seeds for the following year's crop is a critical component of seed treatment and plays a vital role in the study site's agriculture production. In addition to improved breeding techniques, the ways in which local people preserve their seed have been changing over time. Seed preservation is undertaken in a variety of ways to ensure both the quantity and quality of the seeds. The most effective of methods ensures that the seeds do not rot and are viable when planted for the next round of cropping. The focus on quality begins in the harvest, when harmful factors such as insect damage (termites, locusts, beetles, grubs, larvae, spiders, and so on) and excessive moisture are avoided.

### *Using field huts*

One of the most popular means of protecting seeds from insect damage is to store them in a raised field hut (Figure 00–7), the design of which has been modified over time. Sometimes the seed huts have a keeper – a person to watch over the seed, but often they are simply unmanned.

Hmong farmers make seed-storage huts with high floors, with an average floor area of about 4 m x 5 m. Smaller models may measure about 3 m x 4 m. The floor is between 2 m and 2.5 m above the ground – safe from animals and heavy rain. The huts are made with locally available materials, such as wood, bamboo and rattan, and many of them have the appearance of a small house, with room for the rice, a place to rest, a fireplace, a pot of water, and room for labouring tools such as an axe, a rake, a hoe and a dibble stick.

**FIGURE 00-7**: Next season's seeds stored in a field hut.

*Photo:* Tran Thi Tuyen.

In the past, seed-storage huts in the upland fields had no keeper, or human presence. In order to protect the seeds from the depredations of birds, Hmong farmers often made scarecrows and created devices to generate noises to keep the birds at bay. But the birds and termites still found ways to eat the seeds, so other ways had to be found to protect them. The recent seed-storage huts of the Hmong people are much more substantial structures, even though they still go without a human presence (Figure 00–8). They are supported by four strong columns and the walls are made of woven bamboo. Time invested in building stronger huts means the people worry less about the safety of their seeds. The heavy use of bamboo and leaves of other trees means the new huts keep the seeds dry and safe.

**FIGURE 00-8**: A new-style seed-storage hut on a hillside swidden.

*Photo:* Tran Thi Tuyen.

As for the crop itself, the rice and maize were traditionally stored in specially built houses on the swiddens or, at least, away from the villages. This had several disadvantages: people had to journey to the remote buildings and carry the grain home for consumption; the farming families were unable to keep a close watch on their grain supplies; and there was a risk that wildfires could consume their staple foods. Nowadays, the family homes are more likely to house all of their swidden products, or small houses are built near the houses and the grain is carried in for storage after harvest (Figure 00-9).

### *Storing the seed near the kitchen fire*

Fire plays a vital role in the traditional culture of Thai, Hmong and other ethnic groups. Within each house, the fireplace is not only for cooking and sitting together around the flames, but also for preserving important things like food, beliefs – and seeds. This is a popular way of preserving vital seed stocks in the study area. Every kitchen – or cooking area within each house – has shelves made from wooden sticks, that are usually about 2 m long, alongside or above the fireplace. Kitchen utensils are hung there. This is also a place for keeping seeds, often hung in dry bunches (Figure 00-10). There is nearly always a small open wood fire burning. After harvesting, the seeds and plant products are carried to the home and a beam is suspended near the fireplace, where the heat and smoke dry kernels and prevent the seed being invaded by bacteria, mould, insects and moisture. The kitchen fireplace not only symbolises the security of the home, but also protects the family's wealth, invested in the next crop.

### *Storing seed on the floor*

Another method for storing seeds in the house is simply to leave them on the floor. Preservation is natural and without sophisticated technology. Usually, some fruits and vegetables are stored on the cool ground, which maintains sufficient moisture to keep taro corms ready to sprout. However, this method of storing seeds is open to attack

**FIGURE 00-9**: Panicles of rice drying in the sun before storage (left) and a grain-storage house in a Hmong village (right).

*Photos:* Tran Thi Tuyen and Nguyen Thi Viet Ha.

**FIGURE 00-10**: Seeds for next year's crop, preserved in the heat and smoke of the fireplace in a Hmong house.

*Photos:* Tran Thi Tuyen and Nguyen Thi Viet Ha.

by rodents and cockroaches, so the farmers have improved it by storing the seeds in bamboo bowls kept in a dark corner, or constructing small platforms to hold the raw materials for their crops about half a metre above the floor (Figure 00–11).

## Exchanging seeds with neighbours and kin, within the village or other minority groups, and at markets

The exchange of goods is part of the traditional culture of ethnic minorities living in the mountains of Nghe An province, and this applies particularly to exchanges of seeds of food-crop varieties. In the past, the economy of mountainous Nghe An was self-sufficient. They bought or exchanged among members of their communities or – in the case of the Hmong – with consanguine groups across the border in Laos. Very few products came to the villages for cash sale. Up to the present day, seed

**FIGURE 00-11**: Storing seeds on a platform in the house (left) and taro corms stored in a house, waiting to be planted in the following season (right).

*Photos:* Tran Thi Tuyen.

exchanges remain popular in the area, especially for maize and rice. In many cases, maize varieties are exchanged for rice, in others rice varieties may be exchanged for taro, meat or fish. Farmers in the study area have formed a seed-exchange network that aims to ensure the availability of seeds among its members. Although the network involves a close-knit and largely localized group of farmers, it is very weak. As a consequence, along with a decrease in the area of upland fields, the popularity of many local varieties has been declining, and many have, in fact, disappeared.

When the nascent market economy prevails in addition to the traditional exchanges, farmers may buy seed from members of their community or from outside agencies, such as private companies or government nurseries and farms (Figure 00-12). However, the varieties that are bought are mainly hybrid maize, lime and ginger; indigenous varieties of rice and maize are seldom sold, but are traded in traditional exchanges among small groups of villagers.

### *Setting traps*

As well as making seed-storage field huts, the Thai people of Nghe An set traps to prevent animals from entering their fields. Traditionally, such traps were made of bamboo and wood (Figure 00-13), but huge metal contraptions that illegally kill wild

**FIGURE 00-12:** Sources of seeds for many varieties of crops: local seed-exchange networks (top left); local markets (top right and bottom left); and private companies or government nurseries and farms (bottom right).

*Photos:* Tran Thi Tuyen and Nguyen Thi Viet Ha.

animals have lately been added to the 'protection' arsenal. In the past, crop protection was the sole motivation for setting traps, but nowadays the small traps of the past are becoming increasingly hard to find.

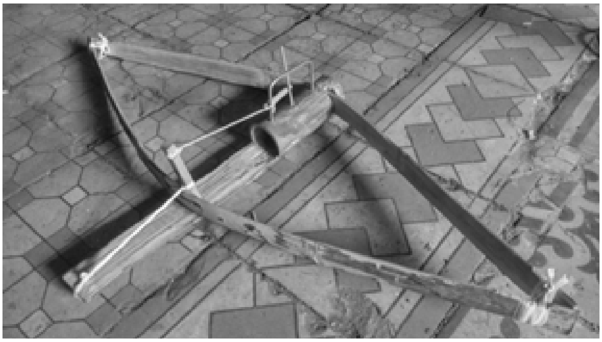


**FIGURE 00-13**: A bamboo trap for catching mice.

*Photo:* Nguyen Thi Viet Ha.

### *Scarecrows*

Scarecrows are commonly used to scare birds away from fields where crops are growing. Traditionally, these were made of straw, but nowadays they are made of mixed materials, including cloth and paper. Hmong people improved the effectiveness of field scarecrows by making part of them from bamboo or wood which makes a noise when the wind blows.

### *Fencing*

Thai farmers in western Nghe An province build barriers around the fields to protect their crops. In the past, swiddens were often left without fences, or only particular sections were fenced off against cattle. Recently, the fence system has become more elaborate and more effective. The fence is made of bamboo poles that are split into small rods and tied together with rope, which is attached to the field hut. Farmers resting in the hut can pull on the rope, making the fence clatter, thus scaring hungry animals away from their crops.

## A pipeline to transport rice

An innovation of Hmong people in the study area has saved days of back-breaking labour, particularly for the women. Reckoning that dry grain will flow like water, the farmers developed a pipeline made from plastic pipes stretching from swiddens on high slopes to a road below (Figure 00-14). The pipe 'worms' its way through the intervening forest, and is anchored to tree roots. In the upland field, rice is harvested and the grain is funnelled into the mouth of the pipe. It flows so rapidly down the steeply-inclined pipeline that fabric baffles must be installed at the bottom to halt the flow in order to catch the rice on canvas sheets at the roadside. From there, the rice is packed into bags and carried to the village on motorcycles.

The pipeline has proven to be highly efficient, in socio-economic terms. Previously, when harvested grain was stored in a field hut on the swidden, it had to be carried to the village in back-buckets (Figure 00-15). This heavy work was done mostly by women, toiling down precipitous mountainsides. Households that produced a lot of rice and needed help to transport it had to pay the carriers 60,000 Vietnamese

**FIGURE 00-14:** The rice-grain pipeline: A farmer checks the pipes before the grain flow begins (top left); grain is fed into the mouth of the pipe in the upland field (top right); fabric baffles halt its flow at the bottom, where it is caught on a canvas sheet (bottom left); from where it is bagged to be carried back to the village on motorcycles.

*Photos:* Tran Thi Tuyen and Nguyen Thi Viet Ha.

dong (about US$2.58) per bag. The pipeline has done away with much of this heavy labour and transportation expense. The women are freed from hard and time-consuming work; they have more time to care for the needs of their families and supervise the education of their children. Public health will also improve.

## Planting new food-crop varieties with advanced technology

The advent of a market economy has been affecting the cultivation practices of mountain communities in Nghe An province. New crops are being planted, in addition to the staple foods, for their high economic efficiency. The people of Tri Le commune have begun growing lemons,

**FIGURE 00-15:** Carrying rice in a back-bucket.

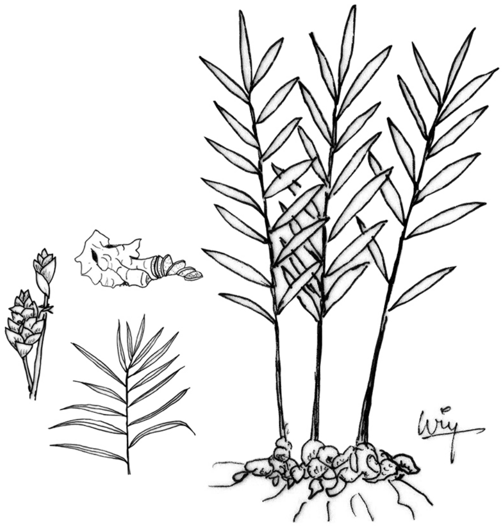
*Photo:* Tran Thi Tuyen.

ginger and *Acacia* trees, and with scientific and technological help, have changed their cultivation practices and restructured their crops to increase peoples' income and reduce poverty.

The changes have been supported by the government and commercial enterprises, with the district administration giving priority to capital investment to support lemon growing. The enterprises sign contracts to lend farmers seeds, supplies and fertilizers, and send technicians to guide them in planting the trees, caring for them and protecting them. The lemon trees have high productivity, averaging 35 to 45 tons/ha, and stable consumption provides an average income of 350 to 450 million Vietnamese dong (US$15,062 to $19,390) per hectare.

In order to expand the area of lemon trees, a local company has organized training and technical guidance for farmers, along with a commitment to purchase the harvested fruit. The technical help covers planting techniques, fertilizing, watering, trimming, clearing and pruning the trees and maintain a canopy to ensure the highest productivity. Farmers have created drainage systems to avoid rainy-season diseases such as root rot. In order to make greater use of the lemon orchards, many households have planted ginger and are raising chickens under the trees (Figure 00-16). Some Tri Le commune farmers who planted lemon trees on trusses combined with ginger and chicken farming claimed to earn five or six times more than when they planted rice and maize.

Environmental-protection techniques are also applied with the new crops. People plant *Acacia* trees at the top of slopes to prevent erosion and landslides. Lower down, ginger or legumes are planted in contour strips to limit surface runoff and retain soil moisture (Figure 00-16). In some places, only about 70% of ginger production is harvested. The rest is left to spread and develop until the next season, while helping to retain water and reduce soil erosion.



*Zingiber officinale* Roscoe
[Zingiberaceae]

Ginger has been introduced by some farmers at the study sites to make greater use of land occupied by lemon orchards. This plant originated in island Southeast Asia and spread around the world, its rhizomes making a popular kitchen spice used in many cuisines. A relative of turmeric, cardamom and galangal, ginger is no longer found in the wild.

**FIGURE 00-16**: Ginger (above, left) and lemon trees (above) are planted along the contours of a sloping field (left) in Minh Chau village, Tri Le commune.

*Photos:* Tran Thi Tuyen and Nguyen Thi Viet Ha.

## Conclusion

Shifting cultivation and its progress over the centuries is a long story. It has generated a wealth of knowledge among ethnic-minority communities that still depend upon it for their livelihoods. While this knowledge has accumulated over time and experience, it has been passed down in oral tradition from one generation to the next, to be used and passed on. However, its preservation has not been a matter of conservatism; it has been developed and improved in accordance with changing conditions. The cultures of ethnic minorities play an important role in biodiversity conservation (Sharma et al., 2006), and other aspects of their wisdom, gathered over generations of struggle in a difficult environment, seek to ensure economic, social and environmental protection through an extraordinary closeness to nature. Such precious knowledge should be collected, improved upon, or coordinated with modern technology to apply to rural development programmes or to develop new farming systems based on valuable experience. The depth of this experience extends to seed selection, crop preservation, soil erosion control, soil selection, crop rotations and crop management associated with cultivating sloping land.

Research has revealed a wealth of indigenous knowledge related to seed and crop management, including seed selection and preservation. Ethnic groups involved in this study have made innovative improvements to land selection, crop combinations and cultivation techniques to not only assure harvest quality but also to protect sloping land. All are based on traditional knowledge, and all have great value. However, the management of crops and cultivars in the study area is limited and the conditions, methods and means of harvesting and preserving agricultural products from sloping land remain quite simple and are less than safe. Due to distance, the steepness of the terrain and scattered production, most harvest work is done by human labour. Tools and means of harvesting are also very simple, because upland swiddens do not lend themselves to the application of machinery. As a result, labour productivity is low, and most tasks take time and effort. Farm products are stored in houses, depending on the weather, so the quality of trade is poor and uncertain. In years of heavy rain, agricultural products rot or become mouldy and the sun is unable to dry much of the finished products. Marketing is difficult because there is no place to preserve agricultural products properly and quality suffers as a result. Therefore, it is necessary to make use of the knowledge of these people, according to their languages, customs and habits, and make reasonable improvements by combining their knowledge with advanced scientific and technical advice on agroforestry production. We could then expect that their native innovative thinking, together with the application of technical progress, would lead to positive advances now and in the future.

## Acknowledgements

This chapter was completed with the help of teachers, students and native speakers at the study sites. Particular thanks go to Luong Van Thuy, of the Khmu ethnic group, a secondary school geography teacher in Que Phong district, Nghe An province, who provided support in surveying rice, maize and shifting cultivation among the Khmu people; Va Ba Cu, a student majoring in environmental and resource management, who translated indigenous knowledge from Hmong into Vietnamese and provided language support for the survey in Tri Le commune, Que Phong district, Nghe An province; and Nguyen Dinh Chien, a geography teacher in Nghe An province, who provided information and photographs of important events, such as burning fields and sowing seeds.

## References

Brookfield, H. (2015) 'Shifting cultivators and the landscape: An essay through time', in M. F. Cairns (ed.) *Shifting Cultivation and Environmental Change: Indigenous People, Agriculture and Forest Conservation*, Earthscan from Routledge, London

Cairns, M. F. (ed.) (2007) *Voices from the Forest: Integrating Indigenous Knowledge into Sustainable Upland Farming*, Resources for the Future Press, Washington, DC

Cairns, M. F., Keitzar, S. and Yaden, T. A. (2007) 'Shifting forests in northeast India: Management of Alnus nepalensis as an improved fallow in Nagaland', in M. F. Cairns (ed.) *Voices from the Forest: Integrating Indigenous Knowledge into Sustainable Upland Farming*, Resources for the Future, Washington, DC, pp341-378

Cramb, R. A. (1989) 'The use and productivity of labour in shifting cultivation: An East Malaysian case study', *Agricultural Systems* 42, pp209-226

Fox, J. (2015) 'Foreword', in M. F. Cairns (ed.) *Shifting Cultivation and Environmental Change: Indigenous People*, Agriculture and Forest Conservation, Earthscan from Routledge, London

Hunt, R. C. (2000) 'Labor productivity and agricultural development: Boserup revisited', *Human Ecology* 28, pp251-277

Mertz, O., Padoch, C., Fox, J., Cramb, R.A., Leisz, S.J., Lam, N.T. and Tran, D.V. (2009) 'Swidden change in Southeast Asia: Understanding causes and consequences', *Human Ecology* 37, pp259–264

Padoch, C. (1985) 'Labor efficiency and intensity of land use in rice production: An example from Kalimantan', *Human Ecology* 13, pp271–287

Rambo, A. T. (1996) 'The composite swiddening agroecosystem of the Tay ethnic minority of the northwestern mountains of Vietnam', in B. Rerkasem (ed.) *Montane Mainland Southeast Asia in Transition*, Chiang Mai University, Chiang Mai, pp69–89

Sharma, K. K., Jaiswal, A. K. and Kumar, K. K. (2006) 'Role of lac culture in biodiversity conservation: Issues at stake and conservation strategy', *Current Science* 91(7), pp894–898

Tran, D.V., Vu, V. L. and Nguyen T. T. L. (2015) 'Plant genetic diversity in farming systems and poverty alleviation in Vietnam's Northern mountain region', in M. F. Cairns (ed.) *Shifting Cultivation and Environmental Change: Indigenous People, Agriculture and Forest Conservation*, Earthscan from Routledge, London