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Culture, Environment, and Farming Systems in Vietnam's Northern Mountain Region

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Abstract

This paper examines the interrelationships between the cultures of ethnic minority groups in Vietnam's Northern Mountain Region (NMR) and their farming systems. The NMR is highly variegated in terms of topography, climate, and biodiversity and has a very high level of cultural diversity. It is home to more than 30 different ethnic groups. Each of these groups has its own distinctive culture and is associated with a specific ecological setting. As each group has interacted with the particular environment in which it lives, it has developed its own somewhat distinctive farming system. The study of these farming systems can reveal the particular ways in which different groups and cultures have interacted with and adapted to the specific environmental conditions in which people carry out their production activities.

Keywords: Vietnam's Northern Mountain Region, farming systems, ethnic minorities, indigenous knowledge, cultural adaptation

Introduction

The agricultural systems of the ethnic minorities living in Vietnam's Northern Mountain Region (NMR) are commonly perceived by people in the lowlands, including government officials and scholars, as "backward" and environmentally destructive [Jamieson *et al.* 1998: 20]. The minorities are usually characterized as living a nomadic lifestyle dependent on shifting cultivation. In fact, only a small proportion of upland people still engage in shifting cultivation. Most populations are sedentary and employ farming methods that are extremely well adapted to the difficult environmental conditions of the mountains. This paper examines some interrelationships between the cultures of ethnic minority groups, the environments they occupy, and their farming systems. The primary focus will be on the culture and farming systems of three ethnic groups living in three different

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environments that have evolved into three distinct cultural landscapes (*vung van hoa canh quan*). These are the "rock pocket" agricultural system of the White H'Mong of the high mountains, the "composite swiddening" agricultural system of the Da Bac Tay of the low mountains, the rice-cinnamon agroforestry system of the Red Dao of the mid-elevation mountains.

By making a greater effort to understand both the cultures and the farming systems of ethnic groups in the uplands, we can learn much about indigenous knowledge of natural resource management as well as increase our understanding of the process by which cultures adapt to changing environmental and social conditions. This kind of understanding is essential to scientists, policymakers, and all others who are concerned with achieving more effective management of natural resources and improving the living standards of local people in Vietnam's mountains.

Before going into detail about these three groups, it is necessary to define the key terms of culture, environment, and farming systems:

What Is Culture?

Culture is the property of a community of people; each member of the community has acquired culture from his or her parents, siblings, friends, neighbors, books, etc. Throughout the life of an individual, each of these members does not cease to maintain, recreate, and enrich the community's culture through interacting social processes. It can be said that culture is born through these interacting social processes.

Culture is often said to have five basic characteristics: (1) culture is acquired through learning, (2) culture is shared, (3) culture is a symbolic system, (4) culture has the ability to adapt, and (5) culture is a system comprised of various components that to some greater or lesser degree must fit together to constitute a more or less coherent way of life. When the natural or social environment changes, culture also changes in order to adapt to the new situation.

In many parts of the world, indigenous peoples have developed a particular way of life that is adapted to an environment in which resources are not plentiful. Where environmental conditions are extreme, such as in the far northern latitudes of the Arctic or in the arid interior regions of Australia, people must disperse seasonally and avoid intensive exploitation of resources in any one place for an extended period of time. In better watered temperate and tropical regions, especially in river basins, complex agricultural societies with high population densities have developed. In these societies, most people have to spend all of their lives cultivating the same relatively small area. Under such sedentary conditions, they have to cooperate with kinspeople and neighbors. Family structures, kinship systems, patterns of settlement and inheritance, house styles, land tenure systems, and even religious beliefs and rituals, are all suited to a particular type of production activity, which is in turn appropriate to a particular set of environmental conditions. They are part of a total way of life designed to guarantee the

continuing existence and prosperity of the community.

Culture therefore plays an important role in resource management. For example, Kinh (ethnic Vietnamese) farmers in the Red River Delta are master ecologists in the cultivation of wet rice in the level and well-watered delta environment [Le Trong Cuc and Rambo 1993]. They know how to maintain a high and stable yield of rice. There are few farmers anywhere else in the world who can surpass them in doing this. To people who have created a thriving wet rice civilization in the delta, the mountains are a strange and alien environment. They have no experience in cultivating on sloping land dependent on rainfall. So when they migrated to the uplands in large numbers during the past 50 years, they faced severe difficulties in adapting their cultivation methods to sloping land. Using the shifting cultivation methods of the ethnic minorities was impossible, because this method not only requires much traditional experience, but is associated with settlement patterns, ways of life, social institutions and rites that are completely alien to the Kinh people.[1)] Thus, the Kinh people simply brought their traditional cultivation methods from the Red River Delta to the uplands and applied them to the mountainous areas. This has caused rapid degradation of the natural environment and many other problems.

In any case, the Kinh were unlikely to copy the methods employed by the mountain minorities because they tend to look upon the cultivation methods of the ethnic minority people as *backward*. They judge cultivation strategies on sloping land in terms of the standards they evolved in the very different environment of the delta. Anthropologists use the term "ethnocentrism" to designate the habit that many people have of using their own (in this case, lowland Kinh) culture as the standard against which to compare and evaluate other cultures. People evaluate the development of other cultures using their own set of ladder rungs, by which one group of people is said to be *improving* or *developing*; another group is labeled *backward* or *slow to develop* [Jamieson *et al*. 1998: 17–19]. This perspective blinds us to an important dimension of culture. It prevents us from seeing that our own culture has the form it has because it had to adapt to a particular set of ecological and social conditions. What is better in one community in one specific period or location may be *worse* in another community or at another time. From this perspective, to say that one system is more *backward* or *more advanced* than another system has little meaning, because each system reflects adaptations to a particular situation. To put it another way, each culture is a product of the evolution of a particular

1）An additional constraint on Kinh adaptation to the environment of the mountains is their strong traditional cultural preference for rice as their staple food. In the mountains, therefore, they have concentrated their efforts on increasing rice yield and opening new areas for planting wet rice. The food plants of the mountainous areas (maize, cassava) are felt to have lower value and are used by the Kinh only as food for domestic animals, or are consumed in periods of food scarcity, when rice is lacking. The Kinh have not been interested in planting fruit trees, despite their suitability in the uplands.

social system in a specific ecological-physical environment.

Under conditions of rapid change in both the social and the biophysical environment, it becomes increasingly difficult for culture to adapt in a timely manner to changing conditions while still retaining a necessary level of coherence [Jamieson 1996]. This perspective emphasizes the need to examine in more detail culture's constant transformation and emerging structures of adaptation in the NMR. But agricultural and other development programs and research have been distorted by our failure to understand the process of adaptive change in the northern uplands.

Development is often simply an attempt to speed up the process of adaptation through the piecemeal introduction of packages of technology while ignoring the necessary integrity of the cultural system. One of the biggest challenges of development is to maintain balance between changing in order to adapt and maintaining a healthy level of integrity in the cultural system. This problem is at the core of successful long-term development and the effective management of natural resources. It will be useful if we can learn to think of these problems in the context of the evolving relationship between social systems and ecological systems.

What Is the Environment?

Environment can be defined as the combined external conditions affecting the life, development and survival of an organism, a population, or an ecosystem. An "environment" is a set, or combination, of specific values of biotic and/or abiotic variables occurring at a certain place. Thus, the environment is the totality of physical and biological conditions that affect the survival of people and cultures. It includes physical factors such as climate, terrain, soils, and water resources, and biological factors such as vegetation and animals. The environment of a human group also includes those social and economic forces that impinge on its survival. These social environmental factors include access to markets, government policies on land use and land allocation, and the flow of information from the outside world.

Each culture has its own cultural model of the environment. Ecological anthropologists have well documented the very different ways in which different cultures classify plants, animals, soils, and other environmental phenomena. These cultural models influence the way in which people adapt to their environment.

What Is a Farming System?

A farming system is simply a special type of system. A system is composed of an orderly set of interdependent and interacting components, none of which can be modified without causing a related change elsewhere in the system. The whole of the natural world is the biggest such system, composed of subsystems, each of which functions as through it were an independent whole although it is simultaneously part of other systems. System analysis has simply formalized techniques for investigating these

interactions in any situation, including agriculture. A systems approach to agricultural production recognizes agriculture as a complex bio-economic activity in which several factors (resources and inputs) are manipulated in varying numbers, amounts, sequences and timing by the farmer to satisfy a range of objectives in a given environmental settings. Each farm is a highly organized, integrated set of operations, which exists in a complex of natural, social and economic environments whose interactions shape in the individual farm system [Haines 1982].[2)]

A farming system may be defined as a specific agricultural enterprise satisfying well-defined objectives and involving various kinds of plant and/or animal inputs together with the practices and operations with which they are managed in a given environmental setting [Okigbo 1975]. A farm is not simply a collection of crops and animals to which one can apply this input or that to expect immediate results but rather a complicated interwoven mesh of soils, plants, animals, implements, workers, and other inputs and environmental influences with the strands held and manipulated by a person called a farmer who has given his preferences and aspirations attempts to produce outputs from inputs and technology available to him both natural and socio-economic that result in his farming system [CGIAR/TAC 1978]. The main effort in farming is the management of the environment and crops to ensure that favorable conditions for high levels of photosynthesis can be attained by the plant while minimizing all factors (weeds, pests, diseases, etc.) that could rob the farmer of the yield of economic products.

In Vietnam, particularly in the mountains, most agricultural production is based on the family farming system. This is defined as a farm operation based primarily on family manual and animal labor, where the family consumes a considerable proportion of the farm output, but a significant proportion is sold or bartered at nearby markets.

The family farming system consists of three basic subsystems that are closely linked and interactive, namely:

- The household, constituting the decision-making unit and determining the objectives, mobilizing resources, influencing the transformation process, deciding on thedisposal of resulting products.
- The farm, on which crop and livestock (and fishing) activities are implemented, providing employment, food, and cash for the farm household.
- Off-farm employment, which can complement or compete with the farm for resources (labor, capital) and provides supplemental income.

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2) Systems thinking, theories and applications have grown since Second World War and have found early applications in the military, business and industry. Applications of systems theory and methodologies to agricultural problems increased during the 1970–80 period, as shown in discussions of different authors including Duckham and Masefield [1970], Dent and Anderson [1971], Ruthenberg [1971] and Spedding [1975], IRRI [1976], CGIAR/TAC [1978], and Okigbo [1981].

Cultures, Environment, and Agriculture in Vietnam's Northern Mountain Region

The Northern Mountain Region occupies around 103,000 km^2, about one third of the country's area, and contains about 12 million people, 15 percent of the national population, living in more than 2,000 communes (administrative villages).[3] Over one-third of these communes (707 of them, or 35.2 percent) are at an altitude of over 600 m, and 783 communes (39 percent) are at an altitude between 200 and 600 m. There are a series of mountain ranges, with some peaks 3,000 m or so in height, and several large intermontane basins. Due to the varied and fractured topography, there is a wide range of ecosystems.

There are more than 30 ethnic minorities in the Northern Mountain Region, comprising over half the ethnic groups in the entire country, with a population of over 6 million people. These groups belong to 7 main language groups. The different ethnic groups, each with its own distinctive culture, are associated with different ecological settings. As each group has interacted with the particular environment in which it lives, it has developed its own somewhat distinctive farming system. These farming systems display the particular ways in which different groups and cultures have interacted with and adapted to the specific environmental conditions in which people carry out their production activities.

Cultural Landscapes of the Northern Mountain Region

The Northern Mountains can be divided into three different altitudinal zones, each of which forms a distinctive cultural landscape, to use a term coined by Ngo Duc Thinh [1993]. These are the high mountain zone, the low mountain zone, and the mid-elevation mountain zone:

The *high mountain zone* includes the highest and the most inaccessible areas, usually with an altitude above 800 m. Water is frequently scarce and the temperatures are quite low. Relatively speaking, these are the most remote and isolated areas; economically, this is the most underdeveloped area. The main ethnic groups are the H'Mong, the Lo Lo, and, in some places, the Dao. The H'Mong includes many different sub-groups: Black, White, Green, Red, and Flowered. They immigrated to this area from China some 300 years ago. They have maintained the integrity of their culture and many of their agricultural traditions while adapting their practices to local conditions. The H'Mong are well known for their shifting cultivation and rock pocket cultivation practices. Their main crops are corn and upland rice. Some H'Mong have also constructed terraced wet rice fields on

3) See Rambo [1997] for a comprehensive review of the NMR.

steep mountain slopes.

The *low mountain zone* is relatively better watered, has warmer temperatures, and is closer to transportation, markets and services, towns, and other villages. Some people live in the bottom of valleys, where there is flat land. Usually the low mountainous regions are around 200 to 300 m. in elevation. The population consists of many ethnic groups, the most populous being the Tay, the Muong, and the Thai.

The Thai came here 700 to 800 years ago. There are two main groups, the White Thai and the Black Thai. They live in nucleated villages with the houses pressed closely together. The chief agricultural activity of the Thai people is wet rice cultivation. Formerly, Thai stilt-houses were large and expensive. Thai people did not sell their houses, but instead left them to their eldest sons.

The Tay are the largest of Vietnam's minority populations. Referred to as Tho in French ethnologies from the colonial period, the Tay speak a language belonging to the T'ai language family that is widely spread across mainland Southeast Asia. The Tay are concentrated in the provinces of Ha Giang, Tuyen Quang, Cao Bang, Lang Son, Bac Kan, and Thai Nguyen in the central and northeastern parts of the NMR.

The Muong people were separated from the Kinh people about 1,000 years ago. With respect to language and origins, they are seen as having close ties with the Kinh; while socially, and culturally, they are closer to the Thai people. They are wet rice farmers who live on the margin between the mountains and the plains.

Many of the ethnic groups who are living in this zone farm paddy fields in the valleys combined with swidden fields on hillsides around the valleys. This combined system of farming wet rice fields and swidden fields is exemplified by the composite swiddening agroecosystem of the Da Bac Tay living in the Da River Watershed.

The *mid-elevation mountain zone* is located in between the high and low mountain zones. Here, one often meets Kho Mu, Xin Mun, Ha Nhi, or any of a number of ethnic groups who typically inhabit high or low mountainous regions, especially the Dao people. Different groups often live side by side, in different villages within the same commune. Because of this, several groups share many characteristics. Their farming systems often combine elements of farming systems that we find in the high mountains with those from lower parts of the uplands.

Although this system of elevational zoning is useful for categorizing cultural landscapes in the NMR, it should be recognized that the boundaries of the zones are relative and established by convention. Reality is more complex. One may meet Dao living in areas lower than the villages of the neighboring Tay, as in the case of the Cao Son village of the Dao in Da Bac. One can encounter Thai collecting wood in Pha Din mountain pass, or H'Mong living beside Tay in Suoi Dong village (Bac Quang district, Ha Giang province). One is surprised to learn that the population of the H'Mong in high mountainous regions district Na Hang is closely related to the H'Mong people in and around Tuyen Quang town. Everything is relative and subject to change. This is the result of a number

of cultural adaptations and community inter-mixing, and influenced by immigration, as well as by the impact of war.

Case Studies of the Farming Systems of Three Ethnic Groups in Different Zones of the NMR

I would now like to concentrate on the role of culture in natural resource management, emphasizing the ability of culture to change in adaptive ways. As illustrative examples, I will now present case studies of three different ethnic groups, each living in a different environmental zone and employing different farming systems, as shown in Table 1.

The White H'Mong living in the high mountain zone of Ha Giang province practice unique rock pocket agriculture. The Da Bac Tay of the low mountain zone of Hoa Binh province are notable for their composite swiddening system. The Red Dao living in the mid-elevation mountain zone in Yen Bai province practice a famous form of agroforestry in which cinnamon trees are planted in fallowed swidden fields. Each group employs quite different resource management procedures that are the outcome of their distinctive cultural backgrounds interacting with a very specific combination of terrain features in a specific socio-economic opportunities as well. I believe these three cases are vivid illustrations of a very widespread phenomenon to which lowland scientists and policy-makers have been slow to give proper recognition.

A Farming System in the High Mountain Region: White H'Mong Rock Pocket Agriculture

Although the H'Mong are commonly portrayed as nomadic shifting cultivators, in fact, many H'Mong groups have been settled in the same place for generations and practice fixed cultivation involving quite ingenious and sustainable techniques of land management. The White H'Mong of the high limestone mountains of the Meo Vac-Dong Van Plateau (Ha Giang province), who are the subject of this case study, live in a region with scarce agricultural land, scarce water, and a harsh climate [Tran Duc Vien 2001].

The Ha Giang high mountains are steep limestone peaks with an elevation exceeding 1,000 meters above sea level. The climate is sub-temperate, and the soil is lateritic due to weathering. Maize is the main crop and is the staple food of the White H'Mong. Except for a very small area of wet rice fields in the valleys that can only be cultivated in the

Table 1 Ethnic Groups of the NMR and Their Farming Systems

Ethnic Group	Landscape	Farming System
White H'Mong	High mountains	Rock pocket agriculture
Da Bac Tay	Low mountains	Composite swiddening
Red Dao	Mid-elevation mountains	Agroforestry

rainy season, almost all of their land is devoted to raising maize. Most of their fields are rainfed and rock-covered.

The White H'Mong of Ha Giang classify their agricultural fields into three categories: level fields, rock pockets, and sloping fields.

Level Fields

In level fields a plow can be used for preparing soil. This kind of field is intensively cultivated with long period of cultivation. Each level field is normally cultivated for 2 to 3 seasons with rice or maize, and then one crop of beans is planted. This is followed by one more crop of rice or maize and then a final crop of barley or Job's Tears (*Coix lachryma*). Then the land is left fallow. During the planting season, the farmer will weed and fertilize.[4)]

Rock Pockets

Under the difficult conditions, they have devised a very unique cultivation system: rock pocket agriculture (called *te kho de* in H'Mong). The "pockets" are formed by rearranging rocks on the slopes to form a wall that protects the small patch of soil inside it. Soil erosion is reduced in these pockets, so cultivation can continue for 6 to 7 years, or even up to 10 years, after which the soil has eroded and the plot will be abandoned for a new one. In some cases, however, people carry soil and animal manure from the valleys up to the rock pockets. This may then be considered to be permanent agriculture.

The people make the most of rock pockets, even though they can only plant one hill of maize in the smaller pockets. In average the size for these pockets just about 1 m^2. The task of making bunds is attended to very carefully: they gather scattered rocks and arrange them in an interlocking fashion to make bunds in order to conserve soil moisture and fertility in rock pockets; or they arrange them to make terraced fields. By rearranging scattered rocks, the farmers can significantly reduce soil erosion. This explains how the H'Mong have been able to intensively cultivate the high mountainous regions over a considerable period of time.

In February, when the weather grows warmer, with light rain, after harvesting beans from the sloping fields, farmers start to hoe rock pockets (and plow dry land sloping fields). They use hoes and sickles to clear grass and hoe each rocky pocket. In many regions, farmers use a local basket named *quay tau* to carry soil from other places and pile it up in the rock pockets. Before planting, farmers also pile horse manure compost, mixed with rice straw and grass ash, in a corner of their field, which they reserve for later

4) This method of field usage is different from that used by the Mon-Khmer groups, who abandon their fields after 1 to 3 years of cultivation for a period of fallow. Also, the Mon-Khmer groups use the dibble stick as their main cultivation tool.

application. This practice is very suitable for the biological characteristics of maize in the high mountainous region climatic conditions.

In March, farmers burn dried grass in the rock pockets in order to make fertilizer, which they mix into the soil before seeding. Before planting, the kernels are removed from the cobs and soaked in water until they germinate. When they begin to sprout, the seeds are sown. By then, the rainy season has started.

Rock pocket agriculture requires three sessions of weeding. During the first weeding session in mid-April and the second session of weeding in the beginning of June, soil unearthed in the process of weeding is placed around the maize. The last session of weeding is in July, this time without utilizing unearthed soil.

After harvesting, the rock pockets are left fallow until the following February. Grass is then cleared in order to plant again. In addition to maize, various kinds of beans (such as *Vigna radiata*, *Phaseolus lunatus*, etc.) are planted. Besides intercropping with beans (such as *Myenna Pru-rien*, *Phaseolus vulgaris L.* or *Vigna Unguiculata*) the farmers also intercrop maize with other vegetables, such as cucumbers or green mustard. Seeds are mixed with manure during application of manure to the maize fields. When the maize germinates, the other plants also germinate, and the maize stem will become a climbing post for the beans.

Sloping Field Cultivation

Sloping field cultivation (called *te xa* in H'Mong) used to be the most common type of agriculture, and it still occupies the largest area. But after the government's "closed door" forest policy and land allocation program were implemented the situation changed. Such fields are now considered to be swidden fields. They can still be found, but the area is not as large as it used to be. Sloping fields are made in primary forest, regenerated forest, or even on *Imperata*-covered hills. The level of intercropping and overlapping of crops is quite high.

In both dry fields and rock pockets, the initial tasks are to select the field, to fell small trees if there are trees there and cut grass or just pull out all of the grass by hand. They may burn it to make ash but they do not do this in the same way that swidden farmers do. However, the land here is cultivated intensively, not extensively. The farmers construct bunds to conserve soil moisture, fertilize, and plow frequently in order to make the soil fine.

H'Mong farmers use well-adapted tools that have been designed through experience over the course of many generations: the H'Mong's plows, butterfly-hoes (called *cuoc buom*—butterfly hoe—in Vietnamese because it looks alike a butterfly), sickle, and seeding pipe (a tool made from bamboo or wood to put seed of maize or rice in holes in the soil), for example. The so-called Meo plow is very sturdy. Its shaft is large and durable. The plowshare is thick with an obtuse tip. These plowshares are forged by H'Mong blacksmiths, and can weigh up to 4 kg. They are capable of plowing in rocky mountain-

ous regions where few other types of plow could be used, but their use is quite limited. Hoes are more commonly used. Plows are used on less steep land, while hoes are used on steeper land.

There are many types of maize, such as sticky (glutinous) maize and maize for domestic animal consumption. The latter is further subdivided into two varieties, rapid-growing (three months) and slow-growing (six months). The slow-growing variety is more common because of its higher yield. Although the price of seed for some high-yield varieties is subsidized by a government development project, in most areas, in some seasons, people still use local varieties. The high-yield varieties (HYVs) are only planted in good soils in the flatter fields where they can give a higher yield or in areas that run along with main road where government official can easily observe what people have planted. People adopted some of the HYVs because both the seeds and fertilizers were subsidized by government, and they can be used for domestic animal consumption; but they do not expand the area planted with HYVs because (1) they require good soil while the area of good soil is very limited, (2) they require the application of chemical fertilizers which most H'Mong households are too poor to afford and (3) the grain grown from HYV seed cannot be used to make *men men*[5] which is a maize flour that serves as the staple food of the H'Mong.

H'Mong farmers prefer the traditional varieties for the rock pockets for several reasons. They actually give a better yield in the local conditions on soil (poor soil), climate (harsh), water resource (scarce water), household economic (very poor) than high yield varieties, and are more resistant to pests and drought. They do not require good soil and high inputs as HYVs, so applying animal manures provides adequate fertility. But the main reason these varieties of maize are preferred is that they can be used to make *men men*. An ordinary yellow variety with round grains and a growing time of 6 to 7 months is very commonly used.

Three plants of maize are usually grown in each rock pocket. At the first onset of heavy rains, the three plants are tied together to keep them from falling. When mature, the ears of maize hang downwards (called "lamp hanging corn" by the local people). The ears are protected by their drying husks from moisture and mold. A seeding rate of 3,000 plants per hectare (or 600 to 1,000 rocky pockets per hectare) is maximum. The rocky maize variety, however, produces large ears, giving an average yield of 1,000 to 1,200 kg per hectare as compared to the yield of 2,500 to 3,000 kg per hectare produced on normal hill slope fields. After harvesting, corn is stored on kitchen shelves for use as food and/or seed for the next crop. Maize seeds are selected from

5) *Men men* is a corn flour which is carefully prepared by lengthy steaming and then grinding of the kernels of corn. The dry corn flour is eaten together with vegetable soups or soybean sauce, or sometimes it is mixed into soup. The mixed soup, called *thang co*, is prepared using animal bones, meat and intestines.

large, long, and sturdy ears with unblemished kernels that have been hung from roof-eaves.

Farmers usually plant from the top of the field to the bottom in order to minimize effort in climbing the slope. They usually divide themselves into groups of four people: the leader (who is usually a strong man) uses the hoe to dig holes, the second person inserts the seeds, the third person applies fertilizer, and the last person fills the holes with dirt. Each hole receives from three to five seeds. When the maize reaches the height of a hand-span, the farmer will redistribute the plants in such a way that each hole has approximately the same number of plants. Each hole typically has two or three plants.

The H'Mong also sow *Muena Pru-rien*, called *dau meo*, or H'Mong bean in Vietnamese (*Mucuna cochinchinensis Merr*) in the maize holes. As the bean vines climb up the stalks of maize plants, the plants are enabled to withstand strong winds. There are two types of beans, one with green seeds and one with yellow seeds. The farmers usually mix both varieties of these beans before planting because when they gain a bumper harvest of the green seeded beans, they will have a bad harvest of yellow seeded beans; the cultivation of both bean varieties with maize provides a "lover" for the maize. Beans are also an important additional source of nutrition for the farm households.

Farmers also plant relay crops. In poor soil, farmers usually sow barley as a relay crop because it is a very tolerant plant, with undemanding soil requirements. French beans (*Phaseolus vulgaris L.*) are usually relayed with maize on rich soil fields. In July, when maize is ripening, farmers plow furrows, and then dig holes and plant barley or bean seeds. The barley seeds are sown mixed with decomposed compost. Maize is harvested in September and barley in December. Barley does not need to be weeded. French beans need to be weeded and tilled once in August. Like maize, barley is used to make *men men*. It must be ground and steamed three times. It is usually eaten with local cabbage mixed into soybean soup.

Rock pocket agriculture integrated with level fields and sloping fields is proof of the remarkable ability of these people to adapt to an environment with disadvantageous agricultural conditions. Their adaptations differ significantly and appropriately from those of other H'Mong farmers living in different regions. These cultural adaptations are necessary for survival. Intensive cultivation techniques, such as the application of decomposed compost, composting, aeration, winter plowing, intercropping, relay cropping, suitable agricultural implements, etc., indicate that the H'Mong have advanced technical ability in farming sloping land.

A Farming System in the Low Mountain Zone: Da Bac Tay Composite Swiddening

People who live in the low mountain zone have more favorable socioeconomic and ecological conditions than those living in the high and mid elevation mountains. In this case study I will describe the farming system of the Da Bac Tay people living in Tat

hamlet, Da Bac district, of Hoa Binh province.[6] They are well known for their practice of "composite swiddening" [Rambo 1998]. Composite swiddening is a unique type of agroecosystem that integrates permanent wet rice fields in the valley bottoms and rotating swidden plots on the hillslopes into a single household system of resource management.

Composite swiddening deserves special attention because (1) it is a stable adaptation that has persisted for generations in the mountain and valley zone of the highlands of Northern Vietnam; (2) it offers an indigenous model of relatively sustainable land use in montane mainland Southeast Asia. In contrast to pure swiddening systems, which often suffer rapid degradation, even collapse, in the face of increasing population pressure, composite systems are relatively robust; (3) it also offers considerable potential for intensification, and (4) it generates a high level of equitability among household incomes. Composite swiddening may thus offer an alternative production system for use in the mountainous tropics where pure swidden systems are producing excessive environmental degradation or are failing to meet the needs of expanding human populations.

A typical Da Bac Tay household manages a complex agroecosystem [*ibid*.; Rambo and Tran Duc Vien 2001]. Key subsystems include wet rice fields, home garden, fish pond, livestock, tree gardens, rice swiddens, and cassava, corn, and canna swiddens. Fallow swiddens and secondary forest are also exploited, especially for collecting wild products and grazing livestock. The distinctive characteristic of this type of agroecosystem is that swiddening comprises an integral component. It is not a gradually vanishing survival of an earlier, more primitive pure swiddening adaptation that is the process of being replaced by more advanced irrigated farming. Neither is swiddening present as a recent response to rapid population growth that has exceeded the carrying capacity of the wet rice fields and forced people to expand their farming onto the forested slopes. Instead, composite swiddeners such as the Tay have combined wet rice farming and swidden agriculture into a single integrated subsistence system for a very long time, certainly for generations and probably for centuries.

In the case of Tat hamlet, elderly informants reported that their parents had told them that they had employed both systems when they first began to settle the valley at

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6) The Tay of Tat hamlet are culturally and linguistically quite distinct from the main body of Tay. They belong to a smaller, geographically isolated Tay population of approximately 17,000 individuals found only in Hoa Binh province, primarily in Da Bac district. During the colonial period this population was referred to as Da Bac Tho and now is sometimes called Da Bac Tay. Some Vietnamese ethnologists believe that the Da Bac Tay are closely related to the White Thai but people in Tat hamlet who have visited Mai Chau, a White Thai community to the northwest near the border with Son La province, deny that their cultures are similar and say that they cannot understand the White Thai language [Rambo and Tran Duc Vien 2001].

least 100 years ago. At that time, the entire area was covered by primary forest and there was no scarcity of land on which to make paddyfields in the valley bottoms. One man recalled that in the mid-1950s, when he was a boy, there were only 7 households in the valley so there was plenty of land available for anyone who wanted to exploit it. The area of paddyfields was much smaller than it is now and good forest land was abundant and free for the taking. It would thus have been possible for households to have only cultivated paddyfields or only cleared swiddens, but none are reported to have done so. Evidently, there are survival advantages in maintaining a more diversified agroecosystem. Key components of the composite swidden agroecosystem are described as follows:

Paddies

The Tay have long experience in paddy rice cultivation. Most paddies (called *na* in Tay) are located in narrow valleys where water can be supplied around the year. Terraced paddies have been constructed on the hillsides around the valleys, but some steep slopes extend right down to the stream and terrace construction is not attempted there. The bunds of the terraced paddies range in height from 50 to 150 cm. Terrace bunds are built to store water for rice production; they are very narrow and almost vertical. Terraced paddies on hill slopes are divided into two categories. *Na nam* has an accessible water source all year round. *Na leng* paddies depend on rainwater and can be planted during the rainy season. During the winter, they are left to fallow or planted with subsidiary crops, if any.

Wet rice land is limited in the village, averaging 200 m^2 per person. Families with 5–7 members have 5–7 fields. The area for each field is quite small, usually from 40 to 300 m^2. These fields are irrigated by water coming down from the hills. The government recently constructed a concrete channel to supply water to the wet rice fields, but it only serves about half the area. Water is also led to the fields through bamboo pipes. Until recently, the farmers did not use plows and the fields were kept continuously flooded. But in the last few years, about half of the households have begun to use plows to prepare land and water is drained before plowing. Manure from animals and green manure are applied to the paddies, but the amount applied is very small, only about 2.0–3.0 tons/ha/crop, 3–4 times lower than in the delta. The cropping system is monoculture with rice. The rice displays little variety, in sharp contrast to the diversity of rice varieties used in swidden fields. Varieties are carefully chosen. Most varieties have been used over time and have great endurance. However, local varieties (such as *khau ma cai*, *khau khuong*, and *khau he*) are low yielding. New varieties (such as V 14 and CR 203, *chiem den*, Q2, Q 5) have been planted over a number of years and but have by now been degraded by cross-pollination. The yield, around 2.5–3.0 tons of grain/ha/crop of non-glutinous rice, is not high as in the delta because of lack of fertilizers and destruction of the rice by diseases and pests.

The Da Bac Tay work their paddies meticulously. Nursery paddies are plowed once and harrowed 3–4 times: the initial harrow to fell rice stubble, the second harrow to accompany reinforcing bunds, the third after fertilizing, and the fourth to sow. People often tie banana trunks to the harrow to flatten the soil before seeding. Seeds are soaked 2–3 days and covered to sprout before being sown in nurseries. Fertilizers are composted livestock manure, which has been covered with husk or straw and burned. The fertilizer allows rice seedlings to grow well and reduces weed infestation.

The Da Bac Tay usually plow once and harrow twice for the Spring crop. For the Autumn crop, the submerged field is not plowed but is harrowed 3–4 times until the soil is fine. Plowing and harrowing are done by men. Households usually participate in labor exchange because some families have buffaloes while others do not. Plowing and harrowing wet paddies are done by buffaloes. On a day agreed upon, 5–7 buffaloes are gathered at a designated field. Harrowed fields are usually left for one night to settle the mud before transplanting. Women and girls transplant during the following day to ensure that the plants take root. Paddies are usually weeded twice. The first weeding takes place 20–25 days following transplanting. The second weeding takes place 20–25 days following the first.

Rice paddies are fertilized with manure mixed with ash. Manure is applied once at harrowing and again during weeding. In addition to livestock manure, green manure is also used. Green manure, usually Lao grass (*Eupatorium odoratum*), is collected from the forest. Nowadays, the Tay also apply chemical fertilizers and pesticides.

Two rice crops are grown each year. The Spring crop is sown in nurseries in December, transplanted following the Tet holiday (usually late January–February), and harvested in April–May. The Autumn crop is sown in May or June, transplanted in late June or early July, and harvested in September–October. Paddy fields are fallow for a three-four month period from October to the end of January, and water flows through the fields during this time.

Continuous flooding of paddy fields has both potential advantages and potential disadvantages for soil fertility. The nitrogen mineralization rate is decreased by flooding, and denitrification losses are minimized by avoiding alternation between oxidized and reduced conditions, but leaching (percolation) and runoff (drainage) losses of dissolved nutrients may increase under continuous flooding.

Terraced paddy fields can decrease erosional losses by slowing runoff water and decreasing its kinetic energy, allowing silt to settle. However, we observed a situation in which siltation of downstream water courses appeared to be enhanced because runoff water drained freely from paddies during the harrowing operation.

Swiddens

Swidden cultivation plays an important role in the Tay farming system. Swiddens are usually cleared on narrow hillsides that have slopes of up to 45 degrees. Swiddens are

also found on steep ridges and peaks

Swidden areas consist of cultivated swidden fields and fallow fields, in which secondary forest is regenerating. As swidden fields in different stages of the rotation cycle are interspersed, swidden areas appear as a mosaic of rice, cassava, corn, canna, ginger, fallow (regenerating forest), and *Imperata* grass fields. Swidden areas stretch continuously in some places from the top to the foot of a hill, but are interspersed with protected forest areas in other areas. The protected forest would lie either on the top, in the middle, or at the bottom of the hill. In areas with good soils, after the forest is cut and burned, rice is grown for 2–3 years, followed by 2 years of cassava (1–2 harvests), and 3–4 years of fallow period. On poor soils, however, rice is grown for 2 years, followed by 2 years of cassava (1 harvest) and 4–7 years of fallow period. In areas near streams where the lands are relatively flat and soils are good and soft, corn is grown for 2–3 years followed by 2 years of cassava (1 harvest) and 3–5 years of fallow period. The length of the fallow period primarily depends on family size. In some areas where *Imperata* grass has taken over, the lands are left fallow and become grazing land. The grass is also used as a roofing material.

The hamlet cooperative is responsible for swidden field allocation to households. The area for swiddens is divided into two parts, with the stream running through the hamlet as the division line. Field allocation is done in such a way that each household has at least one field in each of the 2-swidden areas. Within the swidden area each household manages its own pattern of rotation between cultivated crops and fallow. Each household usually has 2–5 swiddens; 1 newly cleared and the others reclaimed. The fields are usually situated far from the hamlet because of the shortage of nearby good land. The fields average from 1–2 ha each.

The Tay have great experience in choosing land for swiddening. In the past when the area for swiddens was still large, they sought out good forest areas and pushed a knife into the soil. If dark soil stuck to the blade when it was drawn out, they knew that the soil was moist and could produce good rice. After locating the ideal plot, they clear trees to form borders, and then they plant a stake with their mark affirming ownership, which is respected by everyone in the community.

The clearing of a new swidden or re-clearing of an old one is begun in the end of March and the slash is allowed to dry during April. Clearing is done with machetes. The field is burned in early May. The burning is done on clear days at noon when the temperature is highest. The fire is begun on the highest point and spreads down the slope to the bottom of the swidden. Fire usually creates big winds that become whirlwinds, generating columns of smoke full of ash and dust. After the fire, practically all of the leaves and branches have burnt to ash. Large woody trees that did not burn are placed perpendicular to the slopes to prevent erosion. Some trees are made into fences or borders. Some tree trunks are carried to the houses for firewood. Clearing and burning is mostly done by the men of a household. The newly burned field is covered by a layer

of ash.

People begin to sow rice at the middle of May, which marks the beginning of the rainy season, a few days after burning. The men use thick wooden or bamboo dibble sticks, with one end pointed or hardened over a fire, to poke holes in the soil. The spacing of the holes depends upon the number of times the swidden has been cultivated, the quality of the soil, and degree of incline. In new swiddens there are usually 10–14 holes/m^2. Women and sometimes children follow, sowing 5 to 10 seeds per hole. The holes may or may not be partially filled with dirt. No fertilizer is applied. Planting in the swiddens is done with exchange labor. The number of people involved depends on the size of the plot, sometimes there are large groups of up to 20 or 30 individuals and work is completed within one morning or one day at most.

There are about 20 varieties of rice in the swidden fields, both glutinous and non-glutinous types. But mainly farmers plant 3 or 4 varieties in their fields. The different varieties have varying durations and therefore mature in sequence, dissipating labor demand at harvest. Several of the varieties (*khao kapi, khao hang ngua*, *khao khinh*) meet specialized needs.

In addition to rice, beans, melons, pumpkins, sesame, cucumbers, gourds, taro, and bananas are planted at the borders of swiddens or around huts that are built as guard towers at the top of swiddens. People plant local corn (*kale dam*, *kala luong*) into gaps where rice plants have died. The subsidiary crops are usually consumed on site, especially when the swidden is located far from home.

After rainfall, rice seedlings as well as weeds begin to grow. The crop is meticulously weeded, mostly by women using a small hand sickle (*ngheo*). It is also hand-hoed twice, generally at one month after planting and again at flowering. Weeds are usually worst during the first year of rice cultivation, following fallow. The worst weed is *Ageratum conyzoides*, a purple-flowered composite.

The rice harvest begins in October and extends for a period of over one month. Harvesting is performed by the household over a period of from two weeks to one month. A hand held blade (*hai dom*) is used to sever panicles from straw. The panicles are bound into sheafs (*cum*), which yield 2 handfuls of grain. Each *cum* weighs from 1.8 to 2.5 kg. The *cum* are dried on the swiddens before carried home in baskets or by shoulder poles. Places where rice matures first are harvested first; places where rice matures later are harvested later. Many varieties of rice, maturing at different times, are planted, depending on the varying niches. People can choose seed for the following harvest at the swidden site. They choose healthy stocks with even flowering and solid grains, and let these mature well.

The rice yield greatly depends upon weather and soil conditions but, if the first year, averages 700–800 kg/ha. In addition to irregular weather, other natural calamities, such as epidemics of birds and rats, occur, even people use a kind of trap to capture for both home consumption and sold, but they could not control the situation. The outbreak of

rats are directly related to the flowering cycle of the bamboo. Fortunately, the flowering, a catalyst for the destructive outbreak, occurs only once every 5–7 years.

Some families practice a form of agroforestry by planting seeds of *Melia azedarach* or *Styrax tonkinensis* trees together with the crops in their swiddens. These trees can reach 20 cm in diameter and be harvested in 7–10 years. Before burning the swidden, the people sow the Melia (it is short name from *Melia azedarach*, local name is *xoan*) seeds. When the swidden is burnt, the seeds are stimulated for an even and vigorous germination. This Melia provides many different benefits. Melia leaves are used as a green manure to fertilize rice, especially autumn rice; they also serve as an insecticide. The charcoal made from Melia wood was previously used as gunpowder, so it was a product to sell. The branches of Melia are also used as firewood.

In the weeding period, while one is looking after rice, one is also looking after Melia. A density of 1,000–1,500 plants per hectare is believed to be ideal for the Melia. Excess Melia is pruned and additional Melia may be planted. After yielding two to three annual crops of rice, the earth loses its fertility and grain cultivation is abandoned. But by this point, the Melia is already tall enough to continue growing. The swidden is left fallow, and normally bamboo (*nua*) also begins to sprout. After 7 to 8 years (sometimes 10), when the Melia trees have grown to a diameter of 20 to 30 cm, both the Melia and bamboo are harvested and sold. The cultivation cycle then begins again. Of course, during the fallow period, people can still obtain some income from this land by harvesting bamboo shoots. Usually, each hectare of fallow swidden can bring in up to 100 m^3 of wood. Using the current price (250,000/m^3) of Melia wood, which is more than two times the price of styrax (snowbell) trees, farmers can earn up to 12 million dong/ha after 8 years. If the field was only used as a rice swidden, the farmers would harvest 2 crops of rice, adding to 2 crops of cassava in maximum with a yielded of 5.5 tons of unhusked rice in equivalent, having a cash value of 5.5 million VND in totally in cultivated period (4 years) and then give fallow for 4 years more before turn back to next cycle.

In recent decades, the government has attempted to prohibit swidden farming. The Da Bac Tay have responded by finding ingenious ways to conceal from the authorities their continuing practice of swiddening. Local people use land classified as "*mixed garden*" land to clear swidden fields but still call the fields "mixed gardens" (*vuon tap*). Also, people pay agricultural taxes for mixed gardens. The local authorities know about this discrepancy, but they have so far not reacted to it. Furthermore, local people have also begun to use the term "*dry rice*" instead of "*swidden rice*" when they report to officials. Local people have in this way responded to increased government efforts to stop shifting cultivation. In addition, they have preserved forest along the road, where government officials can easily inspect conditions, but continued swiddening on more remote hill and mountain slopes. As a third strategy, they have increased efforts to find new areas for paddy rice and to develop new kinds of swidden crops such as canna, corn intercropped with canna, and ginger. But for the Tay, having rice swiddens remains

vitally important.

Tree Gardens

Some households have established tree gardens in the lower parts of hills located just above their houses or near streams. Households have tree gardens with areas between 140 m^2 and 4,000 m^2/person. Trees are grown both for cash sale and to meet subsistence construction needs. Species grown include: *Aleurites montana* for sale of the oil producing nut, *Melia azedarach* for timber, the Livistona palm (*Livistona cochinchinensis*, local name is *co*) for roofing, various species of bamboo (such as *Bambusa spinosa Roxb*, *Bambusa stenostachya Hack*, *Dendrocalamus patellaris Gamble*, *Neohouzeaua dullooa*) for construction, basketry, and food production, and *Eucalyptus* spp. for sale to the state for pulp and timber. Among these, Melia is most common.

Fruit trees are mostly absent from the tree garden areas. This may be because some species of fruit trees require deeper soil than that to be found on the hillslopes, or because they require better protection from pests immediately prior to harvest, or because farmers find it more convenient to separate the longer-term fruit trees from shorter-term harvest of most of the tree garden species, or some combination of the above.

Tree gardens are examples of long-term cropping systems, which minimize soil disturbance and erosion and runoff hazards. Buffer strips of tree gardens planted on middle and lower slopes adjacent to watercourses may help to ameliorate some of the off-site impacts of swidden cultivation on sloping land and protect the integrity of the Hoa Binh reservoir watershed. Rotational harvesting of different species within the tree garden buffer strips may help to provide protection during tree harvest periods.

Home Gardens

Almost all households have small home gardens located around their houses. They are made up of a variety of plants, and biodiversity is rather high, with a large number of fruit trees, vegetables, herbs, and ornamental species planted at various stages of the cropping cycle.

Fruit trees commonly include: jackfruit, guava, papaya, banana, lime, orange, pomelo, lychee, jujube, plum, and peach. Fruit trees are generally grown close to the house on flatter lands, but are often planted on slopes surrounding the house as well. Under the shade of the trees many medicinal species are found such as: *Zingiber zerumbel*, *Curcuma zedoaria*, *Amomum galangal*, *Amoniutti echinosphora*, *Acorus gramineus*, *Acorus calamus*, *Kaettiferia galatiga*, *Curcuma angustifolia*, *Eleutheritie sugaphylla*.

Most households also have small, bamboo fenced, vegetable gardens adjacent to their house on flatter land. Vegetable species found in homegardens include: chilies, garlic, onion, pumpkins, squash, eggplants, long beans, taro, sesame, edible colius, *ngot* (a leafy vegetable used in soup), and bamboo varieties for shoots. *Kangkong* is grown in fish ponds for human consumption and several other water vegetables are harvested for pig

feed.

Various ornamental tree and flower species (orchids, roses, portulaca, and some annual species) are planted around the houses on the side facing the road.

Fishponds

Only some households have fishponds. The area of fishponds is small, and they are still not intensively managed. Fingerings are not of good quality, so that farmers do not raise fish in winter season because most fish die from the cold. The ponds not only serve to supply fish for home consumption or for sale, but also store water for animals, human use, and irrigation.

The average area of the ponds is 200–500 m^2. Fishponds are usually situated close to the houses, but some villagers have constructed earthen weirs to create large fishponds close to the road in narrow valleys far from any household. Three species of carp are raised in the ponds, each occupying a unique niche. The grass carp feeds on higher plant vegetation, the silver carp feeds on plankton, and the common carp feeds on bottom detritus. Farmers harvest vegetation to feed the grass carp. Cassava leaves are a common feed, although weeds and aquatic vegetation are also fed to the grass carp. Livestock manure is sometimes added to the fishponds to stimulate plankton growth and, in a few cases, pig pens are constructed over the ponds.

Livestock

All households raise animals such as buffalo, cattle, pigs, chickens and so on, but the number is small. Buffalo are raised mostly to provide draft power. Cattle and pigs are raised for sale, for consumption on holidays (Tet), or at ceremonies (weddings and funerals). Chickens are kept for both home consumption and for sale. Buffalo are kept under houses and forage on grassy areas along the roadside and adjacent to forests and fields during the cropping seasons. A few households maintain fenced paddocks for buffalo but most households let their livestock forage freely in the forest and fallow swiddens.

The sub-components described above are managed as part of an integrated farming system. It is this integration that makes composite swiddening unique. Because all of the components interact with each other, if one of them is changed, then the others will be changed after that. This cultivation system, which has been very stable for the Da Bac Tay in Hoa Binh for many decades, is an ingenious adaptation these people have achieved in order to survive in difficult resource conditions. This cultivation system, like the cultivation system of the Dao, discussed below, is very similar to the Kebun-Talun rotational agroforesty system employed by some farmers in the mountains of Java, Indonesia.

A Farming Systems in the Mid-elevation Mountain Zone:
Red Dao Rice-Cinnamon Agroforestry

Another distinctive farming system has been developed by the Red Dao people who have lived in Van Yen district, Yen Bai province for the past 200–300 years. The Red Dao of Van Yen live at the foot of the Pu Luong mountain ridge, which lies on one side of the Red River. Van Yen is regarded as the third most humid portion of the Northern Mountain Region. The region always has high humidity, and the dry season is indistinct. The soil here is derived from mica and schist, with physical and chemical characteristics that suit the cinnamon tree (*Cinnamomum cassia*).

The Dao have developed a method of sustainable land use that is well adapted to the particular sloping region in which they live. It cannot be employed under different environmental conditions. Thus, the inhabitants of the Con Voi (Elephant) mountain range on the other side of Red River, are unable to adopt this practice. This method of cultivating cinnamon trees as part of an agroforestry system has become famous because it has earned a relatively high income for the Dao, while preserving the forest.

Cinnamomum cassia is an indigenous fast-growing tree that after 30 years reaches up to 55 cm in diameter. Its wood is useful for building material, fuelwood, pulp, and paper. In addition, the bark contains about 2 to 4 percent essential oil and the leaf 1.8 percent. This essential oil is valuable in medicine. The young cinnamon trees need shade of about 50 to 70 percent, so the Dao people cultivate it in the early years in the swidden fields interplanted with hill rice or cassava, where it thrives.

Cinnamon trees grow naturally in the forest, and have also been planted in house gardens for a long time. The Red Dao of Van Yen have an ancient practice in which cinnamon trees provide a dowry that women take with them when they go as brides to live in the husband's home. So a newly married young couple plant cinnamon trees at once in order to be able to provide dowry presents for their children in the future.

As I have described elsewhere [Tran Duc Vien 1993; Tran Duc Vien and Pham Chi Thanh 1996], the process of cinnamon tree production begins with choosing land, clearing, and burning. In the first year of the cultivation phase, rice is sown in the swidden. After the rice crop is harvested, cinnamon is planted. When the cinnamon seedlings are still young, they require shade which is provided by the rice stalks left in the swidden after the harvest. During the second year of cultivating the swidden, rice is again intercropped with the cinnamon. During the third and fourth years, cassava is planted. After 4 or 5 years, the cinnamon does not need shade anymore, and the trees now compete with annual crops, so intercropping is halted. When first planted, the cinnamon has a density of 3,000 to 4,000 trees per hectare. After 6 to 7 years, excess cinnamon is thinned so that from the 8 to the 10 year (when the trunk diameter is 15–17 cm) the density is reduced to 1,000–1,100 cinnamon trees per hectare.

This system requires a 30 to 40 year cycle with rice followed by cinnamon growing for 20 years until the trees are ready for harvest. Then, the field must be left in fallow for

10 to 20 years for the soil to regain its fertility. Assuming that the cycle is 39 years (20 years for planting cinnamon with rice and cassava in the first 3 years; followed by 19 years of fallow), we calculated the total value of the harvest from 2.5 tons of paddy (in the first 2 years), 10 to 15 tons of cassava (in 3 year), 20 kg of extracted cinnamon oil (from leaves and small branches when pruning in 8 year), 19–20 tons of cinnamon bark, and 200 m^2 of wood and branches (in the 20th year when harvesting). This generates an average annual income of over 4.5 million VND per hectare. In comparison, if the same plot was only used for growing swidden rice with rice in the first 2 years and cassava in the 3 year, it would produce only 16.5 tons or unhusked rice in equivalent (5 kg of fresh tuber of cassava equivalents to 1 kg of unhusked rice), with a total value of 16.5 million VND or 412,000 VND per year. These calculations do not include possible benefits from grazing cattle on the field during the fallow period. Comparative benefits and costs of the systems are shown in Tables 2 and 3.

According to data in tables 2 and 3, we have two projects: (1) project 1: rice-cinnamon agroforestry system, and project 2: rice swidden system. If we calculate in duration of 40 years with suppose that discount rate is 9.6 percent per year (equivalently 0.8 percent per month that is interest rate of loan which farmer can borrow from the Bank of Agriculture and Rural Development), we have NPV (net present value) of project 1 is 33,740.10 thousand VND and NPV of project 2 is 3,686.16 thousand VND.

Table 2 Benefits and Costs of the Rice-Cinnamon Agroforestry System*

(unit: '000 VND/ha)

Cropped Year	Income Source	Income	Expenditure	Net Benefit
1st (Rice+Cinnamon)	1.5 tons of unhusked rice	1,500	905	595
2nd (Rice+Cinnamon)	1.0 ton of unhusked rice	1,000	305	695
3rd (Cassava+Cinnamon)	10.0 tons of fresh tubers	3,000	1,000	2,000
4th–7th (Cinnamon only)	0	0	0	0
8th (Prune trees)	0.7 ton of bark	3,500	450	3,050
9th–19th	0	0	0	0
20th (harvest cinnamon bark/cut trees)	19 tons of bark; 20 kg of extracted cinnamon oil; 200 m^3 wood	158,900	6,190	152,710
21st–39th (fallow)	Firewood	8,800	5,000	3,800
Total		176,000	13,850	162,850

*with price in the 1993–94 period: 1,000 VND/kg of unhusked rice, and 200 VND/kg of fresh tuber cassava.

Table 3　Benefits and Costs of the Rice Swidden System*

(unit: '000 VND/ha)

Cropped Year	Income Source	Income	Expenditure	Net Benefit
1st (Rice only)	1.5 tons of unhusked rice	1,500	905	595
2nd (Rice only)	1.0 ton of unhusked rice	1,000	305	695
3rd (Cassava only)	10.0 tons of fresh tubers	3,000	1,000	2,000
Sub-total 1		5,500	2,210	3,290
4th–13th (fallow for 10 years)	0	0	0	0
Second cultivation cycle (3 years)	Ditto			
Sub-total 2		5,500	2,210	3,290
17th–26th (fallow)	0	0	0	0
The third cycle	Ditto			
Sub-total 3		5,500	2,210	3,290
30th–39th (fallow)	0	0	0	0
Total		16,500	6,630	9,870

*It assumed that the yields and prices of the swidden rice and cassava do not change over the period, and also that only rice and cassava are raised in the swiddens.

Although the net benefits of the rice-cinnamon system are much greater than those provided by the rice-only swidden system, the farmers must wait for 20 years before they receive most of the income. Thus, if it were possible to accurately discount the value of future income, then the benefits of the rice-cinnamon system would be considerably lower than is indicated by Table 2, although probably still much higher than those derived from only raising rice. This explains why the Dao of Van Yen have achieved a relatively high living standard, higher than their fellow farmers have in other upland areas.

The rice-cinnamon agroforestry system of this group of Dao people is very successful. It benefits both the people (grain, cash income, fuel wood, etc.) and the environment (by maintaining forest cover over a long period and preventing soil erosion). Many scientific and government delegations have visited to observe this swidden rice-cinnamon "model" developed by the Dao people. They have tried to understand this indigenous system because, despite investments of millions of VND over several decades in a series of large-scale government projects to develop cinnamon plantations in uplands from the North to the Central Highlands, little success has been achieved. Most government cinnamon plantations failed because they do not understand that successful is integrated into the culture of the Dao, in other hand they were on a larger scale and did not benefit from the moisture provided to the Dao fields by the surrounding forest. Also, because it was hoped that cinnamon would bring a lot of money to planters, government officials tried to plant cinnamon at elevations of less than 400 m asl. But under these

conditions, the trees were destroyed by disease [Hoang Xuan Ty 1998 cited in Jamieson *et al*. 1998: 14]. After many failures, the officials went back to learn more from Dao people. They eventually found out that they could not develop cinnamon on a wide scale in the uplands. The point that I want to emphasize here is that the local people in Van Yen who traditionally practiced shifting cultivation are now the leaders in maintaining the forests and protecting natural resources—the sources of prosperity and peace for them [Tran Duc Vien 1993].

Conclusion

The above cases illustrate three different farming systems employed by three different minority ethnic groups in different environmental zones in the NMR. These examples illustrate successful cultural adaptations to difficult environmental conditions in the mountains. These cases show that, in any situation, people find suitable methods to adapt to nature, to the environment in which they are living. The challenge is for outsiders such as us (researchers, policymakers, investors, development officials, etc.) to find methods to learn from the experience of the ethnic minorities and to apply their knowledge to the development process.

We should recognize, however, that indigenous knowledge is not static and that cultural adaptation is a continuing process. Steadily increasing population pressure and ever more intensive natural resource exploitation are making it imperative for people to adapt anew to nature. In the mountainous regions many additional farming systems have already evolved out of traditional cultivation methods. Along with swidden cultivation, some new models of land use have appeared in recent times due to cultural exchange with the low mountain zone peoples. These models include home gardens, tree gardens, forest farms, the VACR system (garden, fish pond, stables, and forest), enclosed grazing pasture, etc. These are manifestations of cultural adaptations in new situations.

In order to promote this process of re-adaptation to changing environmental conditions, however, as yet undiscovered local knowledge must be combined with a growing body of scientific knowledge on the use and management of natural resources. This urgent and very important task must involve researchers in the natural sciences, the social sciences, and the humanities. And, above all else, it must involve upland farmers themselves. If we wish to help them, we must emulate their holistic, experience-based approaches and come to a better appreciation of the capacity of these cultures to utilize their practical knowledge of local conditions to adapt to the complex and changing conditions of Vietnam's Northern Mountain Region.

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