This paper presents a preliminary description of the composite swiddening agroecosystem of the Tay minority people of the northwestern mountains of Vietnam. Composite swiddening is a unique type of agroecosystem that integrates permanent wet rice fields and rotating swidden plots into a single household resource system. The swiddening component is neither a survival from an earlier purely swidden-based system nor is it a recent innovation adopted in response to increased population density and consequent shortage of paddy land. Instead, it is a stable adaptation that has persisted for generations, perhaps even centuries, in the mountain and valley zone of the highlands of northwestern Vietnam.

The composite swidden system is worthy of attention because 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. They also offer considerable potential for intensification. 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 farming to meet the needs of expanding human populations.

This paper is based on information collected by a long-term study on the human ecology of the Da River watershed in the northwestern mountains of Vietnam. This research is part of a joint project on sustainable rural resource management and conservation of biodiversity in Vietnam being carried out by the East-West Center Program on Environment (ENV) and the Hanoi University Center for Natural Resources and Environmental Studies (CRES). The goals of this project are to find more sustainable ways to manage upland
ecosystems and conserve biological diversity in Vietnam’s extensive uplands. Our initial focus has been on describing the composite swidden agroecosystem of the Tay of Tat Hamlet, Tan Minh Village, Da Bac District, Hoa Binh Province. This paper presents some preliminary findings of this continuing study.¹

In this paper, I will briefly describe the Tay of Ban Tat and their social system, followed by a more extensive examination of their mode of adaptation to the mountain environment, with special attention to a detailed description of the structure and functioning of the “composite swiddening” agroecosystem.

The Tay of Ban Tat and their Social System

Referred to as Tho² in French ethnologies from the colonial period (e.g., Abadie 1924), the Tay speak a language belonging to the Tai language family that is widely spread across mainland Southeast Asia (Le Bar et al 1964:232). The Tay, who numbered 1,190,342 according to the 1989 census enumeration (Central - Census Steering Committee 1991:66) are concentrated in the provinces of Ha Tuyen, Cao Bang, Lang Son, Bac Thai, and Hoang Lien Son in the Viet Bac region of northern Vietnam³. A smaller, geographically isolated Tay population of approximately 17,000 individuals resides in Hoa Binh Province, primarily in Da Bac District. It is this somewhat distinctive outlier population, as represented by the people of Tat Hamlet, Tan Minh Village, that is described in this paper.

Tat Hamlet (Ban Tat) is one of six hamlets that make up Tan Minh Village, which is one of the 21 villages in Da Bac District, in Hoa Binh Province (Map 1). According to records of the hamlet cooperative, Tat Hamlet includes 69 households. In 1993 it had a total population of 389 people of which 184 were male, 205 female.

Tat Hamlet is located in the watershed of the Da River (referred to in Western geographies as the Black River). The Da River is the site of the Hoa Binh Dam, Vietnam’s largest hydropower project, which provides most of the country’s electricity. Flooding of the reservoir in the late 1980s forced relocation of 9,305 households or an estimated 52,000 people, mostly of the Muong ethnic minority, from their homes in the valley bottom. Many have resettled on steep slopes above the lake where their swidden fields are a major source of sediments flowing into the reservoir (Vu Quyet Thang 1991). Others have migrated into surrounding communities located on higher ground that were not flooded by the reservoir. Three of these households have recently settled in Tat Hamlet, further intensifying pressure on limited land resources there.

Production is almost entirely organized on a household basis. Although most household production is for subsistence purposes, and the trade in commodities very limited, the economy is already strongly market oriented. Farmers report a pressing need to obtain cash, particularly in recent years since the local government began to collect taxes in cash rather than paddy. Informants readily cite prices for different locally produce commodities including livestock, paddy, and fruit. It is lack of physical access to markets, and the scarcity of marketable commodities, rather than any sort of traditional “anti-market mentality” that limits participation in trade.

Within the household economy there is a clear but not wholly rigid sexual division of labor. Men do the land preparation in the fields. Both men and women carry manure from the houses to the paddies. Men are responsible for clearing and burning the swiddens. Men uproot rice seedlings from the nurseries and help to carry them to the paddyfields. Women transplant seedlings into to the paddies and plants seed in the swiddens using dibble sticks. Weeding is mainly a female responsibility. Harvesting of the rice is done primarily by the women while the men carry the grain from the fields to store in the houses. Threshing is done by the women who trample the bundles of rice with their feet to release the grain from the heads. Thanks to the water powered rice mills that are owned by almost every household, the women are freed of the necessity of spending several hours every day pounding paddy in a mortar and pestle, a task that falls heavily on women of many mountain minorities in Indochina.

Men hunt wild game in the forest. They cut bamboo poles and drag them to the road for sale to passing trucks. Bamboo shoots and wild vegetables are mainly collected by women. Women cut most of the firewood in the secondary forest and carry it to the houses but men bring down an occasional large log. Buffalo are tended by young men or boys but smaller livestock are cared for by women and girls. Most domestic tasks are done by females. Cooking, cleaning of the house and compound, and washing and mending of clothes are done by women and girls. Members of both sexes care for infants although toddlers are most often carried by their older sisters. Men weave baskets for household use and for sale. In the past, when cotton was grown in the swiddens, women wove cloth. Women are responsible for collection of produce of the home garden and marketing of the fruit. Except at peak labor demand times in harrowing the paddyfields, women probably have a considerably heavier work schedule then men. Collection of firewood is an especially heavy burden on women.
Some differentiation among households in terms of material wealth is evident, although, in contrast to the situation on among the Tay in the colonial period (Ban Dan Toc Tuyen Quang 1972, Vien Dan Toc Hoc 1978) there are today no truly wealthy households that are freed from the necessity of producing all of their own subsistence needs through their own manual labor. Better-off households have larger houses, always built off the ground on piles. They have more livestock. And they may own radios, bicycles, or even motorbikes. Most differentiation attributed to the different stages in the family cycle occupied by these households. Newly formed households and those of elderly widowed individuals tend to be noticeably poorer than the norm. They are more likely to live in small houses built in Kinh style on the ground. Households with several unmarried teenagers are likely to be relatively prosperous as a result of their large labor force. Families having mainly sons can have their resources depleted by the heavy demands of paying bride price. Four or five large pigs, plus a considerable quantity of rice, alcohol, and other consumption items, are needed to complete a single marriage contract.

The extent to which permanent systemic economic differentiation is occurring among households is uncertain. Given the relatively high equitability in access to agricultural land, the strong ethos of sharing productive resources with less fortunate kinsmen and neighbors, and the lack of other channels for accumulating wealth, it is unlikely that class formation is occurring within the local social system. Participation in administrative and political institutions may confer some competitive advantages, however, with well-connected families deriving some long-term gains from involvement of their members in official roles. Education may serve as a means of upward mobility for those willing to leave the hamlet but it provides little advantage to those who remain in residence. One woman (of Muong origin) who had ensured that all of her children completed high school and obtained jobs as teachers complained of the poverty of her family because of the low salaries paid by the government.

Helping to offset pressures toward differentiation is a strong ethos of sharing. Hunters who kill wild pig or deer are obliged to share the meat with their neighbors. Young farmers who have not yet accumulated sufficient capital to purchase their own buffalo are able to “borrow” animals from better endowed relatives or neighbors. Farmers who do not have sufficient land for their swiddens are able to approach those with larger plots to request the use of some of their extra land. Much of the work in the village is done with exchange labor. Paddy fields are harrowed by several buffalo at once, with groups of plowmen working the fields of each in turn. Transplanting is done by teams of up to a dozen women. Swiddens are planted by large groups of up to 50 or 60 individuals. When a household wants to install a new roof, their neighbors come bringing bundles of palm leaves to help do the job. Meals are provided to helpers when they plant the swiddens and put on roofs but not for work in the paddy fields.

The Natural Environment

The elevation of the valley floor at Ban Tat is approximately 300 m asl. Surrounding peaks reach an elevation of 800 to 950 m. Slopes of the mountains surrounding the settlement are quite steep, frequently exceeding 60 degrees). Numerous small streams flow down from small valleys cut into the slopes surrounding the village and join the northward flowing main stream. The climate is monsoonal with the rainy season extending from late April until September. Winter temperatures fall as low as 2 or 3 degrees Celsius, summer temperatures may exceed 40 degrees. Humidity is high year round.

Soils are generally thin, highly acid, and poor in nutrients. There is a great deal of site specific variability in soils because of differing parent material. Sandstone and schist are common, with areas of quartz and mica-bearing granite. No limestone karst occurs in the vicinity, of the hamlet. Soils are deeply weathered with depths of up to 5m observed in road cuts. Soil color varies from light grayish-brown to yellowish-brown to reddish-orange, suggesting varying stages in the weathering process and varying contents of iron and aluminum oxides. Upland soils have a fairly high clay content which is evident by the their shiny surfaces and their high degree of slickness when wet. These soils are extremely hard when dry, but soften considerably and can be cultivated easily when wet.

Although much of the territory of Ban Tat was covered by primary forest until the 1960s, today only tiny remnant patches survive on extremely steep and inaccessible peaks. Hill tops and ridge lines are covered with mature secondary forest with a slight degree of canopy differentiation. Most slopes are covered with swiddens or recently fallowed plots covered with grasses, herbs, and scattered patches of bamboo and small trees. Valley crotches and storm drainage courses have largely been left surrounded by woody vegetation and secondary forest, though in some cases these patches have been scorched by fires escaping from the swiddens. Near-slopes and hillocks in non-protected areas surrounding the hamlet have mostly been cleared and planted to cassava swiddens or tree gardens, with very little fallow land. In a few limited areas, Imperata covers the lower hillocks and isolated patches of Imperata occur even on distant hillslopes. The valley bottom is covered with wet rice fields.
Until a few years ago wild mammals were still quite abundant in the forest. Wild pig, several species of deer, and porcupines were hunted with considerable success as is indicated by the number of deer antlers and pigs jaws and tusks still displayed hanging from the houseposts. Other than the abundant night flying bats, no wild mammals were seen in the settlement area although the Tay say that a few wild otters survive there and raid the fish ponds for food. They are reported to be very difficult to trap. Small birds are quite common in the village, especially on the western edge of the settlement where houses are widely separated. In the morning and evening many different bird calls are heard and one quite often sees birds flying across the road. Only a few boys carry catapults so hunting pressure may be light. Swallows and swifts frequent the air over the paddy fields.

Wild animal populations have decreased because of excessive hunting pressure and probably also because of habitat loss, in particular the fragmentation of the forest into scattered islands atop the hills. Although the total area still under forest cover is quite large it is entirely in scattered bits and pieces of only a few hectares each. If the patches could be reconnected with strips of forest along the ridge lines, some more species might be able to survive.

The Tay Composite Swiddening Agroecosystem

For as far back as any informants can remember, The Tay of Tat Hamlet have been "composite swiddeners." The defining characteristic of composite swiddening is that households simultaneously manage both permanent wet rice fields in the valley bottoms, shifting swidden fields on the hillslopes, and exploit wild resources of the, forest. Similar composite systems are found among the Muong of northern Vietnam (Cuisinier 1948), the Shan of Burma and northern Thailand (Durrenberger 1981), the Hani of Xishuangbanna Prefecture in Southwestern China (Pei Shengji:pers comm), and the Ifugao (Dove 1983) of the Cordillera in the Philippines.5

The distinctive characteristic of this system is that swiddening comprises an integral component of the total system. 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 practiced both wet rice farming and swidden agriculture together as an integrated system of subsistence for a very long time, certainly for generations and probably for centuries. In the case of Ban Tat, elderly informants reported that their parents had told them that they had employed both systems when they first began to settle the valley at least one hundred years ago6. 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 53 year-old 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. Indeed, the household resource system of the Tay is notable for its incorporation of a wide range of subsystems. (Figure 1). Key subsystems include wet rice fields, home garden, fish pond, livestock, tree gardens, rice swiddens, and cassava swiddens. Fallow swiddens and secondary forest are also exploited but management of these land units is the responsibility of the cooperative. Table 1 shows land holdings of composite swidden subsystems by nine households in Tat hamlet.

Wet rice fields

The wet rice fields are built in a series of terraces rising like steps from the stream in the middle of the valley floor. Each terrace is quite small, covering an area of 30 to 70m$^2$. The 1 to 1.5 meter high bonds are almost vertical. The tops of the bunds are very narrow, only 20 or 30 cm wide, making walking on them a treacherous affair. Irrigation water enters the highest terraces from small streams flowing down of the hillslopes and spills down from the upper fields to the bottom level where excess water flows into the large stream running through the floor of the valley. The flow of water through the paddies is continuous.

Because the fields are kept continuously flooded, plowing is not usually required. Cultivation is done by buffalo-drawn harrows. Each field is harrowed 3 times before planting. As many as 6 buffalo will be used at once in the larger fields. Farmers from several households exchange their own labor and that of their buffalo to do this task. After the final harrowing, the rice seedlings are immediately transplanted by groups of women. The planting pattern is quite casual with little concern shown with placing the seedlings in straight rows.

Manure from the buffalo and cattle, night soil, and green manure are all used to fertilize the paddies. Recently,
some farmers have begun experimenting with the use of chemical fertilizers. Manure is collected from the
buffalo and cattle that are stabled at night underneath the house. It is stored in large woven bamboo bins until
needed and then carried to the fields in pack baskets by the women and children and with shoulder pole
baskets by the men. One farmer said that he used 300 kg of manure per crop for a field area of about 1,500
m$^2$. He said that this was a higher than average amount because his fields were close to his house. Farmers
say that they generally have adequate quantities of manure and that use of greater amounts would produce
excessive vegetative growth with lowered grain production.

Most farmers grow improved varieties of non-glutinous rice in the spring crop and traditional varieties of
glutinous rice in the summer crop. One farmer said that they preferred non-glutinous rice because a small
amount of grain cooks up into a large volume of rice. Yields are quite low, averaging around 2.5 tons per
hectare per crop. Because plots are so small, averaging 0.14 ha per household, families harvest an average
of only 650 kg of paddy per year.

**Home gardens**

Scattered around the house plot are a variety of trees that make up the home garden. Papaya, bananas,
pomelo, oranges, guava, and jackfruit are the most commonly planted species although no house has more
than 2 or 3 individuals of any one species. Clumps of tea plants and a shrub, the leaves of which are used to
make soup, are more numerous. Some houses also have a small bamboo-fenced enclosure where green
vegetables are grown protected from depredations of the free-ranging household livestock. Green onions are
sometimes planted in raised wooden troughs. Marigolds and other ornamental flowers are sometimes also
grown in the home garden.

**Fish ponds**

Located within a few meters of most houses are one or more small fish ponds with an average surface area of
about 100 m$^2$ and a depth of from 1 to 2 m. The ponds are filled with water flowing through bamboo pipe.
conduits from streams or springs on the hillslopes behind the house site. Carp of several species and tilapia
are the most commonly raised fish. They are fed cassava leaves, weeds, rice bran, and buffalo and pig
manure. Cultivation is not very intensive.

**Livestock**

Most households have at least one buffalo and several cattle. In some cases they are grazed in the swiddens
after harvest. Most are allowed to range freely in a valley that is reserved by the cooperative for use as a
pasture. After the swiddens are harvested livestock are allowed to free range there. Goats were raised some
years ago but were abandoned because of the destruction of vegetation that they caused.

Pigs of the local pot-bellied variety are kept in small numbers but are said to be vulnerable to disease. Pigs are
of great ritual importance as they are needed by the families of young men for bride payments. Some are free
ranging during the day while others are kept all of the time in small cages in the home gardens. They are fed
cassava roots from the swiddens close to the village.

A small number of chickens are kept by most households for feasts and for eggs. Ducks are also raised. Fowl
range freely around the houses during the day but are kept in special bamboo pens beside the house at night.

**Tree gardens**

Planted on the hill slope behind the house are patches of planted trees; palms (*Livistona cochinchinensis*),
Melia, *Aleurites montana* (candlenut), and bamboo are the most common tree garden species, usually planted
in pure stands. Few of the Aleurites trees bear nuts because of failure to select only female plants. Melia and
Aleurites are also planted in cassava swiddens where they gradually become the dominant species. Recently,
people have also begun planting Eucalyptus in old cassava swiddens as part of a PAM (World Food Program)
reforestation effort.

**Swiddens**

The Tay distinguish between two types of swiddens, those for cassava and those for rice. The cassava
swiddens are sited on the lower slopes of hills near the sandy and infertile to support rice cultivation. Two
varieties of cassava are grown, one with dense broad leaves and the other (banana cassava) with thin leaves.
The broad leaved variety is by far the most common although farmers say that the banana cassava has a better taste. Cassava roots are eaten as a substitute for rice. The roots are also fed to pigs and the leaves used for carp food. Fresh roots and dried chips are sold to the government. One ton of fresh roots sells for 150,000 dong.

Rice-swiddens are cleared when possible from secondary forest on soils thought to be of higher fertility. The Tay judge the fertility of swidden soil by sticking a knife into it. If soil sticks to the blade when it is pulled out, they consider the soil suitable for rice. If nothing sticks, it is only good for cassava.

The Tay swiddens display a low diversity of crop species. Some rice swiddens are almost pure monocultures. One quite large field located about 1 km from the hamlet was planted with 4 varieties of rice. The only other crop was some sesame which was planted scattered in a thin line along the bottom of the field. Swiddens located at a greater distance from the settlement are characterized by somewhat greater crop diversity. They may have cucurbits, squash and melons, rice beans (yard long beans), and maize plants intercropped with the rice. Most of these plants are grown for consumption on the spot when the Tay stay overnight in their field huts to protect their ripening crop from wild animals. Surplus production may be carried back to the village for consumption there. None of the Tay swiddens approximate the diverse polycultural swiddens of Geertz's (1963) ideal type, however. Certainly their architecture does not mimic the tropical rainforest with multiple layers of canopy. Instead they resemble a field of tall grass, except that they are much more open with considerable areas of soil exposed.

Most households cultivate at least two rice swidden plots at any one time. The average area cultivated each year is about 1.2 ha. Yields are less than 600 kg/ha.

**Fallow Swidden Fields**

In several actively cultivated swiddens, Melia seedlings were observed growing scattered among the rice plants. In some cases these plants are volunteers, with seeds probably dispersed by birds. In other cases they are deliberately planted. The seeds are dibbled into the field before burning so that the fire will cause germination. Melia and candlenut are also planted in the cassava swiddens. Few other trees were observed in the swiddens and no attempt appears to be made to protect coppicing stumps or to enrich the fallow with more trees than occur naturally.

Following the rice harvest, swiddens become open access pasture for cattle and buffalo from the hamlet. The effect of grazing on regeneration of secondary has not yet been studied. Several Tay remarked that efforts to improve management of the fallow period such as enrichment planting of leguminous trees would be made difficult by unregulated grazing.

**Forest**

Virtually no primary forest survives within walking distance of the hamlet although there are remnant patches on the highest mountains along the boundary with Vinh Phu Province to the north of Ban Tat. The tops of most hills and the channels of water courses are covered with well developed secondary forest. These areas are defined and protected by the cooperative. Individuals who clear swiddens in these protected areas are subject to fines and are also compelled to plant trees to speed reforestation of the plots.

Forests are an important source of resources to all households both for own consumption and for sale. Bamboo shoots are, an especially valuable commodity.

**Productivity of Composite Swiddening**

Although the Tay agroecosystem is a very complex one with multiple interacting components, it is two components, the paddyfields and the swiddens, that supply most of the calories consumed by the population. Each provides roughly half a typical Tay household. Information on productivity of the and labor inputs collected from 9 households is presented in Table 2.

The nine households had an average paddy holding of 0.14 ha (range: 0.07 to 0.18), divided into an average of 5.4 separate parcels (range: 2 to 8). Average parcel size was 0.03 ha. Because of the sloping terrain, each of the household's parcels is further divided by earthen bonds for terracing and flood water impoundment.

Paddy rice yields were low compared to those in the Red River delta. Average yield were 2.5t/ha/crop (range: 1.4 to 4.2) Each household harvested an average yields of 651 kg from wet land fields each year (range: 400
to 900). All households harvested 2 crops of paddy rice per year.

Estimated labor requirements (in person-hours) for the various agricultural operations (harrowing, transplanting, weeding, harvesting) were complete for only of the 9 households. To provide a better estimate for calculation of rice return (output) to labor expended (input), labor requirements for each of the operations were calculated on a per hectare basis so that the mean of all available responses from several households could then be calculated. An average of 0.95 kg of rice was produced for every person-hour of labor expended in wet rice cultivation.

The nine households had an average swidden rice land holding of 1.2 ha (range: 0.2 to 2.3), divided, on average, into 2 parcels. Average parcel size was 0.57 ha (range 0.2 to 1.1).

Swidden rice yields averaged 586 kg/ha. Each household harvested an average of 502 kg (range: 200 to 1000) of swidden rice. There is only one swidden rice crop per year.

Estimated labor requirements for the various agricultural operations (cutting and clearing, planting, weeding, harvesting) were incomplete for all households. Labor requirements for each of the operations were calculated on a per hectare basis so that means of all available responses from several households could then be calculated to provide an estimate of rice return to labor expended. An average of 0.88 kg of rice was produced for every person-hour of labor expended in swidden rice cultivation.

On average, households received about 1.3 times (range: 0.6 to 3.1) as much rice from their paddies as they did from their swiddens on a yearly basis. However, two of the six households (in which comparisons were possible) relied more heavily on swiddens than paddies to meet their rice needs.

Paddy rice productivity (per hectare/crop) was, on average, 4.2 times higher than swidden rice productivity (range: 1.5 to 10.2). Two paddy crops per year are possible on paddy lands, compared to only one crop per year in swidden fields. On a land area basis over the period of one year, rice yields are approximately 8.4, times higher from paddies than swiddens (range: 2.9 to 20.3).

Estimates for grain return per labor expended were quite similar for the wet rice (paddy) and dry rice (swidden) cultivation systems (0.95 and 0.88 kg, respectively). However, these estimates were obtained from very limited information on labor resource allocation. Better estimates of labor expenditures for each of the agronomic practices may reveal greater differences in relative efficiencies between the two cropping systems.

Although the yield per labor hour of paddies and swiddens is roughly comparable, the Tay say that they prefer cultivating paddies to swiddening. This reflects the fact that swiddening involves more arduous work, especially walking back and forth to the fields, some of which are located more than 2 hours walk from the village along trails that often are on slopes in excess of 60 degrees. During rainy periods the trails are extremely slippery. Even the sure footed Tay stay home when it rains hard.

Conclusions: Composite Swiddening and Mountain Area Development

Although, following in the tradition of Conklin and Geertz, some anthropologists continue to sing the praises of swidden agriculture as an ecologically and socially benign adaptive system, in my view this agricultural system is no longer viable in most parts of montane mainland Southeast Asia. This reflects the dramatic increase in population densities in the uplands, the result of both endogenous growth and in-migration of large numbers of lowlanders, and the incorporation of large tracts of forest into protected reserves that are off-limits to swiddeners. The consequent unfavorable shift in the people to land ratio has forced a dramatic shortening of the fallow cycle in most rotational swidden systems. Fields that a generation ago were cropped for but a single year and then fallowed for twenty years are now cropped for two or three years and then fallowed for no more than four years. Such intensification maintains production in the short term but results in greatly reduced yields and permanent environmental degradation once the fallow period falls below the minimum time necessary for adequate forest regeneration. Pure rotational swidden systems offer few possibilities for sustainable intensification so that there is an imperative to introduce alternative agricultural systems. Composite swidden systems offer one approach that can help pure swiddeners make the transition to more sustainable alternative modes of subsistence.

Composite swiddening-offers a number of advantages over pure swiddening. The wet rice field component of the system, although occupying only a small total area produces a relatively high and stable yield. Since households meet one-half of their grain requirement from their paddies, they can clear a significantly smaller area of swidden fields each year than would be the case if they had to rely exclusively on swiddens to meet
their consumption needs. Consequently, the carrying capacity of a given area is twice as great as it is when rotational swiddening is the primary mode of adaptation.

The paddies and the swiddens together create a favorable niche for livestock. Buffalo are essential to maintaining paddy field productivity, both as a source of traction and manure. They also offer one of the few viable cash crops in remote mountainous areas where poor transportation makes it difficult and expensive to carry most goods to market. The fallowed swiddens provide essential pasture for the livestock, allowing their maintenance with minimal additional human labor.

Ultimately, of course, composite swidden systems face the same fate as rotational systems, if population density increases beyond carrying capacity. This has already happened at Ban Tat. The fallow cycle has been reduced, forest regeneration is impossible, yields are falling, and environmental degradation is becoming evident. The response of the government authorities has been to prohibit clearing of swiddens but it is impossible to enforce this regulation since the people have no other source for the one-half of their calories that currently are raised in the swiddens. Finding ways to increase production in other components of the agroecoforestry system, notably the paddy fields, the home gardens, fish ponds, and livestock, is one partial solution. Accelerating the rate of regeneration of fallow swidden, so as to permit a more frequent rotation, is another solution. In the long-term, the Tay swiddens might evolve in the direction of the Talun-Kebun rotational agroforestry system of Java (Soemarwoto and Soemarwoto, 1984). There, a highly sustainable and very productive system of long fallow swiddening remains an important component of an agroecosystem that supports perhaps the highest population density of any, mountain area in the tropics.

Composite swiddening, as exemplified by the Tay of Ban Tat, is a type of agroecosystem that has not previously been well described in the literature. It offers another example of the very great diversity of human adaptations to the difficult environments of Southeast Asia’s uplands. Far from being a simple and primitive system, it represents a complex and highly evolved strategy for survival. Composite swiddening is thus an indigenous agricultural technology that is deserving of attention from researchers seeking solutions to the problems of development in montane mainland Southeast Asia.

ACKNOWLEDGEMENTS

This paper is primarily based on information collected as part of an on-going long-term study of the human ecology of minority ethnic groups in the Da River watershed. This project is a joint activity of the Program on Environment of the East-West Center (EWC) and the Hanoi University Center for Natural Resources and Environmental Studies (CRES). The author and Dr. Le Trong Cuc, CRES Director, are the co-principal investigators for this project which is funded by grants to the EWC from the John D. and Catherine T. MacArthur Foundation and to CRES from the MacArthur Foundation and the International Development Research Council. In addition to Dr. Cuc, I want to thank Keith Fahrney, Nghiem Phuong Tuyen, Tran Duc Vien, and Vy Ton for their help in organizing and carrying out this project. The officials of the Peoples Committees of Hoa Binh Province and Da Bac District have been most generous in the assistance they have provided to our research team. The people of Tat Hamlet have always done everything possible to assist us in our data collection efforts. Our most special thanks go to the late Mr. Xa Van Dau and Ns family, who have made us repeatedly welcome in their house during our field visits. Keith Fahrney has provided valuable assistance in preparing this paper, including drawing Figure 1, and preparing the analysis of productivity of the composite swiddening system.

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NOTES

1. Following a brief reconnaissance visit to the hamlet made by Le Trong Cuc, Tran Duc Vien, and the author in January 1992, CRES-EWC research teams have made six field trips to the hamlet, most recently in July 1995. This report is based on the author's observations during these visits supplemented with information collected by other team members, principally Le Trong Cuc, Nghiem Phuong Tuyen, and Tran Duc Vien of CRES, Diep Dinh Hoa of the Institute of Ethnology, Keith Fahney, and Vy Ton of the EWC, Karl Hutterer of the Burke Museum, Neil Jamieson of Winrock International, and Aran Patanothai and Patma Vityakon of Khon Kaen University.

2. In Vietnamese, "tho" means "earth, land, or ground" (Nguyen Dinh Hoa 1966:476). Several older informants in Ban Tat said that they had referred to themselves as Tho until the 1960s when they were instructed by government officials to Use Tay instead. Similarly, "Dzao" was substituted for "Man" and "H'mong" for "Miao" or "Meo." These changes were justified on the grounds that the old ethnonyms had pejorative connotations. People in Ban Tat do not think that this was true with regard to Tho and elderly people still employ this word in casual conversation when referring to traditional aspects of their culture. The term is also employed in a somewhat negative sense, however, to refer to individuals that are perceived as being old fashioned or behaving in a feudalistic manner.

3. Although they constitute the largest of Vietnam's more than 50 minority ethnic groups, the Tay are, from an ethnological standpoint, one of the least well known. In contrast to the "tribal Thai" of the northwestern mountains (McAlister 1967), and the "montagnards" of the Tay Nguyen plateau (Hickey 1993), the Tay were not a major focus of ethnological research during the French colonial era (Abadie (19241 offers perhaps the most detailed account). Only in 1992 was the first relatively comprehensive Vietnamese language ethnography of the Tay published by the Institute of Ethnology in Hanoi (Be Viet Dang et al 1992).

4. Most houses have a water powered rice mill. Water flowing through a bamboo pipeline from a stream on the hillslope behind the house powers the mill. It fills a trough on one end of a 3 m pole on a fulcrum. The weight of the water raises the pole. When the water spills out of the trough, the pole drops back driving a pounder on the other end into the mortar where it dehusks the paddy. A mill can husk about 5 kg per day.

5. Although there had been descriptions published of specific systems in which permanent wet rice fields were integrated with swiddens, home gardens, and tree gardens into complex agroecosystems (e.g., Rambo 1982), recognition that composite swiddening systems deserved recognition as a special and relatively widespread type of resource system in Southeast Asia was the product of a meeting of the Southeast Asian Universities Agroecosystem Network (SUAN) Task Group on Biodiversity in Swidden Agroecosystems held in Kunming, China, in January 1992. Although I am responsible for coining the term "composite swidden system," my colleagues in that meeting, notably Pei Shengji, Michael Dove, and Le Trong Cuc, provided the comparative perspective out of which the concept emerged.
6. The origins of the Tay of Da Bac District are somewhat obscure but informants in Ban Tat say that their ancestors migrated there from Son La approximately a century ago. Some Vietnamese ethnologists believe that the Tay of Da Bac are not true Tay but are instead closely related to the White Thai. (Chu Thai Son and Nguyen Chi Huyen 1974)

7. Keith Fahrney, an ENV Project Specialist who has participated in several field studies at Ban Tat, prepared the analysis of productivity reported in this section.

8. Presumably, those who continue to defend swiddening are thinking of rotational systems such as that described for the Hanunoo of Mindoro Island by Conklin (1957). The pioneering system associated with the Hmong of Indochina and the Iban of Borneo are much harder to hold up as models of ecologically sustainable indigenous technology.

Table 1: Land Holdings of Composite Swidden Subsystems by Nine Households in Tat Hamlet

<table>
<thead>
<tr>
<th>Land use and Holdings</th>
<th>Households interviewed</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>Average</th>
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<tbody>
<tr>
<td>Paddy fields</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Area (m²)</td>
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<td>770</td>
<td>1780</td>
<td>1600</td>
<td>1000</td>
<td>1530</td>
<td>1500</td>
<td>1600</td>
<td>900</td>
<td>1750</td>
<td>1381</td>
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<tr>
<td>Fields</td>
<td></td>
<td>2</td>
<td>6</td>
<td>6</td>
<td>8</td>
<td>5</td>
<td>6</td>
<td>2</td>
<td>7</td>
<td>6</td>
<td>5.4</td>
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<tr>
<td>Avg Field Size (m²)</td>
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<td>275</td>
<td>297</td>
<td>267</td>
<td>125</td>
<td>306</td>
<td>250</td>
<td>800</td>
<td>129</td>
<td>292</td>
<td>302</td>
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<td>Swidden Fields</td>
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<tr>
<td>Area (ha)</td>
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<td>1.45</td>
<td>2.34</td>
<td>0.78</td>
<td>0.65</td>
<td>1.30</td>
<td>2.21</td>
<td>0.21</td>
<td>0.39</td>
<td>1.56</td>
<td>1.21</td>
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<td>2</td>
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<tr>
<td>Avg Field Size (m²)</td>
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<td>0.78</td>
<td>0.39</td>
<td>0.32</td>
<td>0.65</td>
<td>1.10</td>
<td>0.21</td>
<td>0.39</td>
<td>0.78</td>
<td>0.57</td>
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<td>Tree Gardens</td>
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<td>0</td>
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<td>0</td>
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<td>3</td>
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<td>Home Gardens</td>
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<td>Area (m²)</td>
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<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>1.5</td>
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Table 2. Productivity and Labor Inputs from Paddy and Swidden Subsystems (Averages from nine households in Tat Hamlet).

<table>
<thead>
<tr>
<th>PADDY CULTIVATION</th>
<th>SWIDDEN CULTIVATION</th>
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<tbody>
<tr>
<td>Land Area (ha)</td>
<td>0.14</td>
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<tr>
<td></td>
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<tr>
<td>Activity</td>
<td>Rate (p-h/ha/crop)</td>
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<tr>
<td>-------------------------------</td>
<td>--------------------</td>
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<tr>
<td>Annual Yield (kg/hh)</td>
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<tr>
<td>Yield (t/ha/yr)</td>
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<td>Yield (t/ha/crop)</td>
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<tr>
<td>Total Labor (p-h/ha/crop)</td>
<td>2616</td>
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<tr>
<td>Harrowing</td>
<td>474</td>
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<tr>
<td>Transplanting</td>
<td>786</td>
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<tr>
<td>Weeding</td>
<td>387</td>
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<tr>
<td>Harvest</td>
<td>786</td>
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<tr>
<td>Labor Efficiency (kg/p-hr/crop)</td>
<td>0.95</td>
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<tr>
<td>Land Efficiency (kg/ha/yr)</td>
<td>4900</td>
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