A short history of land use changes and farming system differentiation in *Xuat Hoa* Commune, *Bac Kan* Province, *Viet Nam*

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Abstract

Xuat Hoa Commune, located in the mountainous province of *Bac Kan*, *Viet Nam*, was the subject of a diagnostic study on past agrarian dynamics and their impact on the current diversity of farming systems. We interviewed farmers and local development stakeholders in order to assess the role of socio-economic transformations as a driving force of agrarian dynamics. A farming system differentiation model was proposed, based on the ratio of units of labor force to number of mouths to feed in each household up to the early 1990s, and thereafter on the modality for allocation of ricefields. The differentiation model explains current diversity of farming systems in the light of recent economic and institutional transformations (including distribution of the means of production to farmers, land entitlements, and new governance systems). A chronological series of aerial photographs from 1954 to 1998 shows that land use changes have had a tremendous impact on the resource base, particularly in the form of deforestation. However, our field surveys suggest a reverse trend of relative forest recovery since the recent allocation of forestlands to households (1992) and associated government reforestation programs. Finally, an analysis of the production strategies of diverse farming households leads to concrete proposals for future development activities.

Keywords: farming systems, social change, rural development, farming system differentiation, mountain agriculture, northern *Viet Nam*

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1. Introduction

Land use in *Bac Kan* Province is diverse, and substantial geographic variability exists within a range of several kilometers. The Mountain Agrarian Systems Program (SAM) was initiated in this context to develop methodology to rapidly characterize the present diversity of the region's agricultural production systems, and past patterns of evolution (Castella et al., 1999). We selected six communes to encompass the diversity in agro-ecological conditions and degree of market integration found within *Bac Kan* Province. This monograph focuses on data from one of the six selected communes: *Xuat Hoa* Commune. A comparative analysis of the data obtained from these six communes in 1999 and 2000 allowed us to explain functional relations between local and regional scales (Castella et al., 2002). This kind of diagnosis aims to better orient development activities by basing them on a firm understanding of local dynamics. Generalizing these results to the provincial level will allow us to (i) evaluate the requirements for extrapolating research results to larger geographical areas and (ii) propose alternatives to currently unsustainable agricultural practices.

2. Methods

Our approach consisted of analyzing the evolution over time of farming systems, and relating it to changes in the biophysical and socioeconomic environments. This required the integration of many facets of a complex reality, which is why we have chosen a systems approach.

We studied land-use changes through the interpretation of a chronological series of aerial photographs from 1954, 1977, and 1998. The longitudinal study of more than forty years of changes helps to explain present-day land use and the features of the present farming systems.

We divided *Xuat Hoa* Commune into three separate homogenous zones to facilitate surveys and to avoid confusion between different agro-ecological and socioeconomic contexts. In each zone, the fieldwork had three phases:

- A series of interviews with local informants, to identify past land use dynamics.
- More-detailed surveys on recent differentiation and the current variety of production systems. From the results of this phase, we developed a preliminary typology to use as a basis for the third phase.
- Surveys of archetypal households representative of each category in the preliminary typology.

Table 1 shows the number of interviews in each phase. However, in this chapter we have presented mainly the results acquired from analyses of *Tày* villages. The *Tày* ethnic group has been at the root of agricultural changes in *Bac Kan* Province (Castella et al., 2002a).

We first present the transformations of the farming systems that led to the villages' current landscape. Then, we examine households' livelihood strategies and categorize family farms according to their production systems. Finally, we analyze the combinations of cropping and animal husbandry systems, which allows us to identify farmers' production constraints and prioritize future options for sustainable development.

Table 1: *Number of surveys in each of three homogeneous zones*

Dominant ethnic group	Number of villages	Number of individuals interviewed		
		Phase 1	Phase 2	Phase 3
Tày	7	5	22	29
Dao	1	2	16	12
Kinh	2	-	17	8
Total	10	7	55	49

3. Evolution of land use

3.1. The four stages of lowland transformation

The historical analysis of the studied area is presented in Figure 1. Two important points emerged from the analysis:

- *Xuat Hoa* Commune has been colonized and farmed in various ways for centuries. The landscape is shaped by humankind.
- Historical land use in the region was characterized by low labor productivity and inconsistent yields from rainfed farming. Therefore, the harvesting of forest products (wild yams, bamboo shoots, wild game) was an important factor in meeting the population's needs. This was possible because the area was once covered by forests.

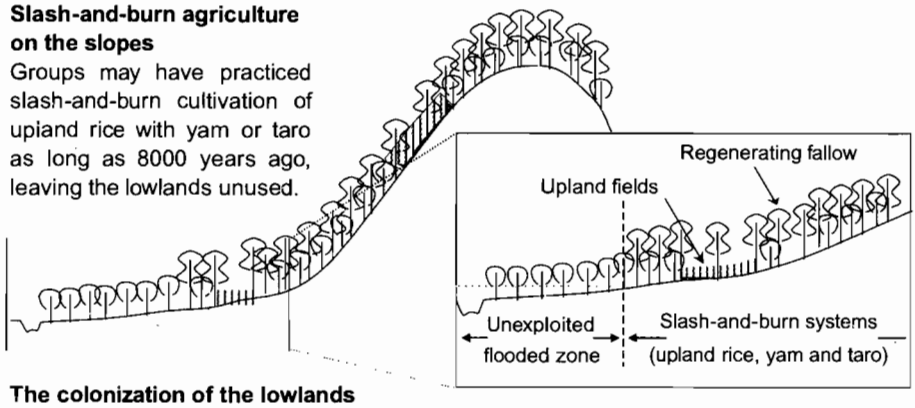
Land use in the middle of the twentieth century was characterized by a tiered ecosystem of lowlands and uplands, where the *Tày* and the *Dao*, respectively, practiced different agricultural systems. Figure 2 illustrates the interaction between land uses of the different landscape units. The 1954 land use map (Figure 3) shows the impact of the two systems on the landscape.

The *Tày* sedentary production system

In the western part of *Xuat Hoa*, agriculture was centered on lowland paddy fields. The lower slopes were farmed manually, whereas the flatland fields were cultivated with animal traction. The *Tày* system had a minimal impact on the forest. Land inequalities were based on the order in which families had settled the commune. The founding families owned the largest and most productive paddyfields. *Tày* farmers with fewer paddyfields worked the fields of the founding families in exchange for rice. The main determinant of households' production strategies was social access to irrigation water (Mellac, 2000).

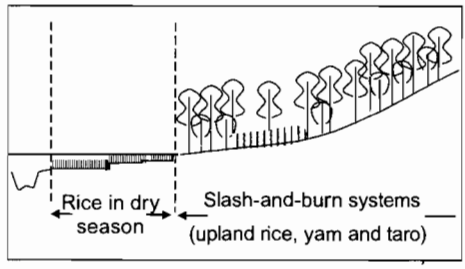
Slash-and-burn agriculture on the slopes

Groups may have practiced slash-and-burn cultivation of upland rice with yam or taro as long as 8000 years ago, leaving the lowlands unused.



The colonization of the lowlands

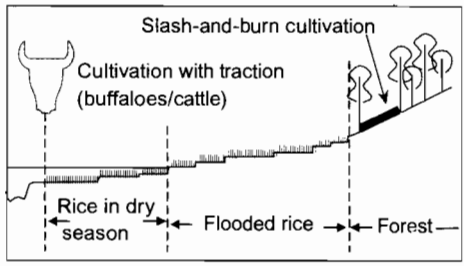
Migrants from China in the Neolithic period, ancestors of the *Tày* people, were likely the first cultivators of paddy rice in the lowlands. They also practiced slash-and-burn farming on the hillsides. Land preparation and the construction of bunds for water level control led to a progressive terracing of the lowlands.



Water control and terracing

Approximately two thousand years ago, Chinese invasions brought the animal-driven plow. Soil compaction from plowing minimized percolation in the coarse soils of the hillsides, which allowed the settlement of the terraced lower slopes.

Animal traction brought increased labor productivity, leading to an intensification of work on the rice fields and a decline in slash-and-burn farming.



Irrigation and ricefield expansion

By the middle of the twentieth century, irrigation systems that diverted water from rivers into paddy fields were well established in *Xuat Hoa* Commune. Improved water control allowed paddy fields to be developed farther away from water sources, leading to higher and more stable yields.

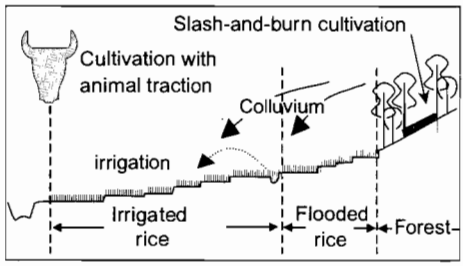


Figure 1: *History of land use and transformation of the cultivated ecosystems*

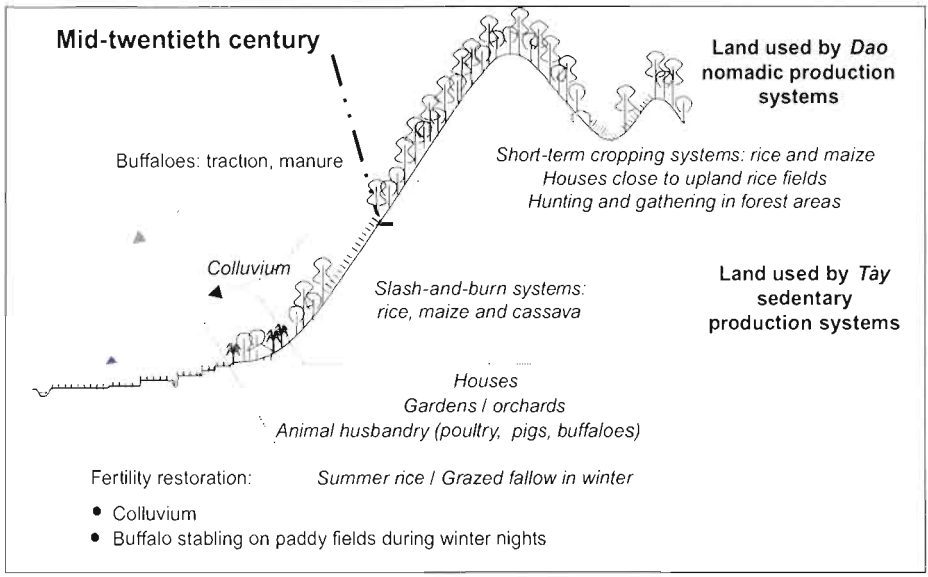


Figure 2: *Dual agrarian system based on Tày and Dao use of distinct landscape units.*

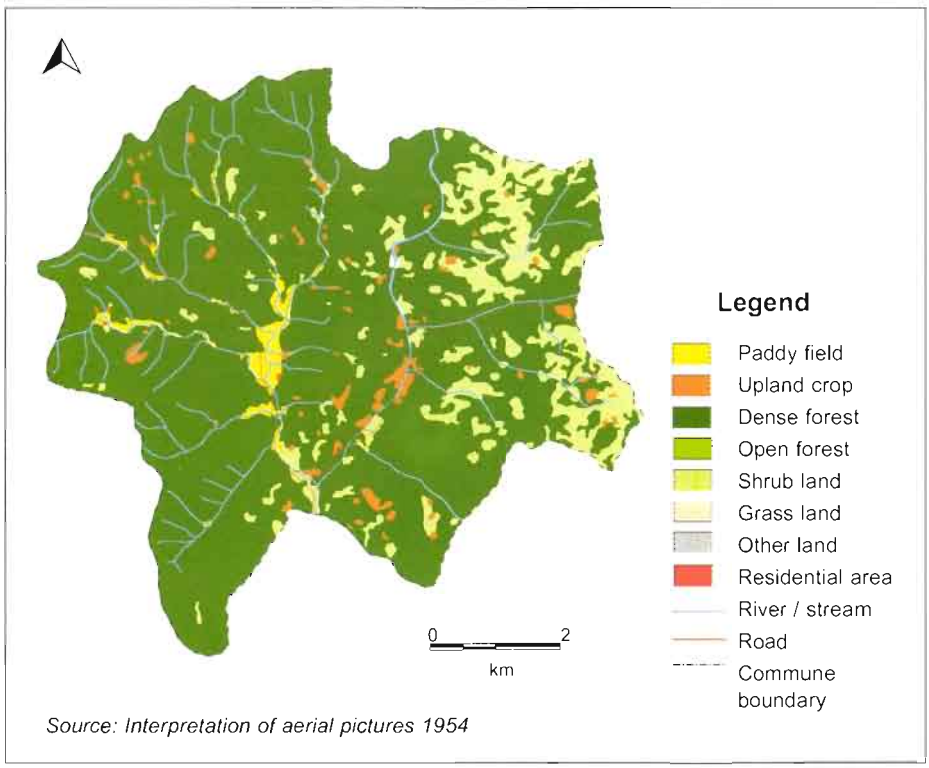


Figure 3: *Land use map of Xuat Hoa Commune, 1954.*

The rice cultivation system in the lowlands had the following characteristics:

- Monoculture: a single annual rice crop, followed by six months of grazed fallow;
- Land preparation (plowing and harrowing) with animal traction (buffaloes);
- Soil fertility restored by run-off bringing buffalo manure from the slopes;
- Generally satisfactory water control in the ricefields.

The *Dao* shifting cultivation system

Dao families lived in the eastern half of the commune, grouped in small hamlets. Settlements were located near the land that was being cultivated, so that it could be guarded against damage from wild animals. Every three years or so, when the swiddens became less productive, the *Dao* would move on, leaving the forest to regenerate. The impact of the *Dao* system on the forestland is unmistakable (i.e. patchwork of vegetation at diverse regeneration stages). By about 1940, the shifting cultivation system began to fail, as population density in the region had increased from 4 people/km² in 1990 to 15 people/km² (Piquet and Puvilland, 1992).

Two kinds of cropping systems were present on the slopes:

- Short-term cultivation on land cleared from forests, mainly practiced by nomadic farmers. Rainfed rice and maize monocultures would be planted annually for two to three successive years, then the field was abandoned and the forest allowed to regenerate. Soil fertility was restored by long fallow periods (15-30 years).
- Long-term cultivation on cleared land. After two or three years of cereal crops, land fertility was restored with a cycle of soybean followed by cassava.

Both systems relied entirely on human labor. The extent of each was limited by the labor requirement of weeding.

3.2. The agricultural cooperatives (1958 – 1981)

From about 1958 to 1981, the State actively encouraged agricultural cooperatives and collective production throughout the country. The cooperative period brought about substantial changes in land use and social organization. Between 1958 and 1962, the State resettled many traditionally-nomadic ethnic minorities. Within *Xuat Hoa* Commune, the resettlement program led to the creation of the *Dao* village of *Tan Cu*, allowing authorities to keep better track of the descendants of nomadic *Dao* families. Having joined the cooperatives, the *Dao* shifted from traditional slash-and-burn farming to intensive rice cultivation in irrigated valleys. The *Dao* community was now making use of the same ecosystem tier as the *Tày*, though with less paddy field area.

Gradually, the cooperative gained ownership of the means of production, though pigs, fowl, gardens, and ponds remained privately held. From 1958 to 1960,

mutual aid, already a common practice in both *Tày* and *Dao* communities, was systematized. Working collectively helped to overcome the limitation of seasonal peaks in labor requirements, allowing the expansion of cultivated land, particularly on the slopes. The new social policy reinforced community solidarity, resulting in better collective management of irrigation systems. The historical context of the post-war period and the propaganda of the time further facilitated the collectivization process.

Collectivization brought an agricultural revolution, with a shift to two rice crops per year in 1962. Other innovations of the Green Revolution (Box 1) were introduced in 1967. Collective agricultural activities were based in the lowlands while private farming was concentrated on the hillsides. Needy families grew upland rice, while others grew maize and manioc for pig raising (Figure 4). Collective work was remunerated on a labor point system. Laborers received approximately 70% of total paddy production for their work, and the remaining 30% went to the cooperative for administrative expenses, agricultural taxes and the like.

As the collective management system became more bureaucratized and inflexible, it created tensions among farmers for a number of reasons. Firstly, a proportion of production was being given to a growing number of administrative staff who were not directly productive. Meanwhile, as the population increased (augmented by immigration from delta regions), each individual's share of production declined. Secondly, though farmers were already poor, a part of their production was being diverted to support war efforts and help other areas hit by natural calamities (e.g. flooding, drought). Before long, cooperative activities were no longer able to meet families' basic needs, even with the addition of forest resources. To meet their growing needs, cooperatives transformed the hillsides around the lowlands into large swidden fields. The impact of swiddening on the landscape is dramatically apparent on the western half of Figure 5.

Box 1: *The Green Revolution: two stages in modification of rice cultivation systems*

First phase: rice double-cropping

- Increase in mineral uptake from soil, creating need for fertilization with manure;
- Innovations in animal husbandry, animal stabling to collect manure;
- Increased need for the Chinese plow;
- Irrigation becomes necessary => water was the limiting factor for the second crop, but farmers invested little in irrigation infrastructure during this phase.

Second phase: high-yielding varieties

- Introduction of high yielding rice varieties, which were also short cycle, more demanding of inorganic fertilizer, and more susceptible to insect pests and diseases;
- Increased pesticide use.

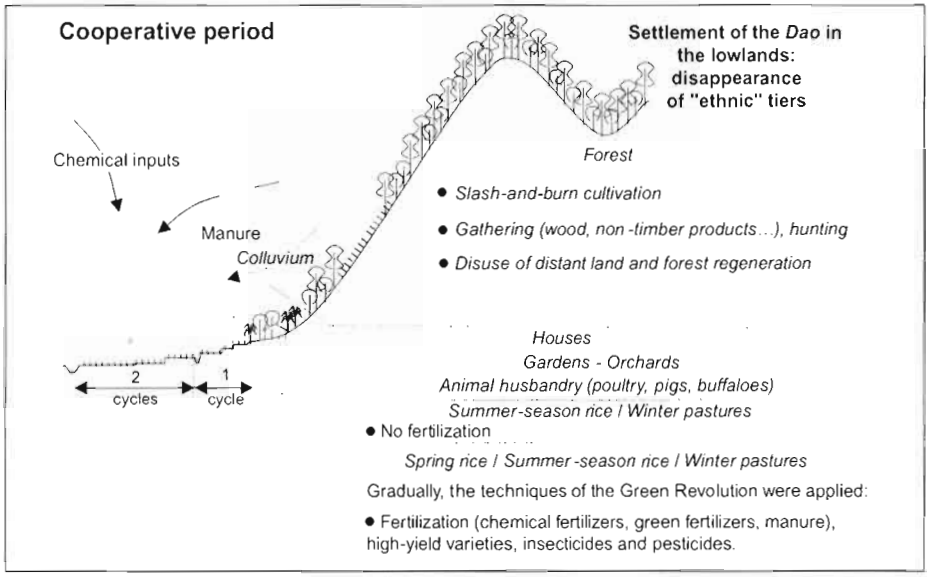


Figure 4: *Cultivated ecosystem land use in the cooperative period (1962-1982)*

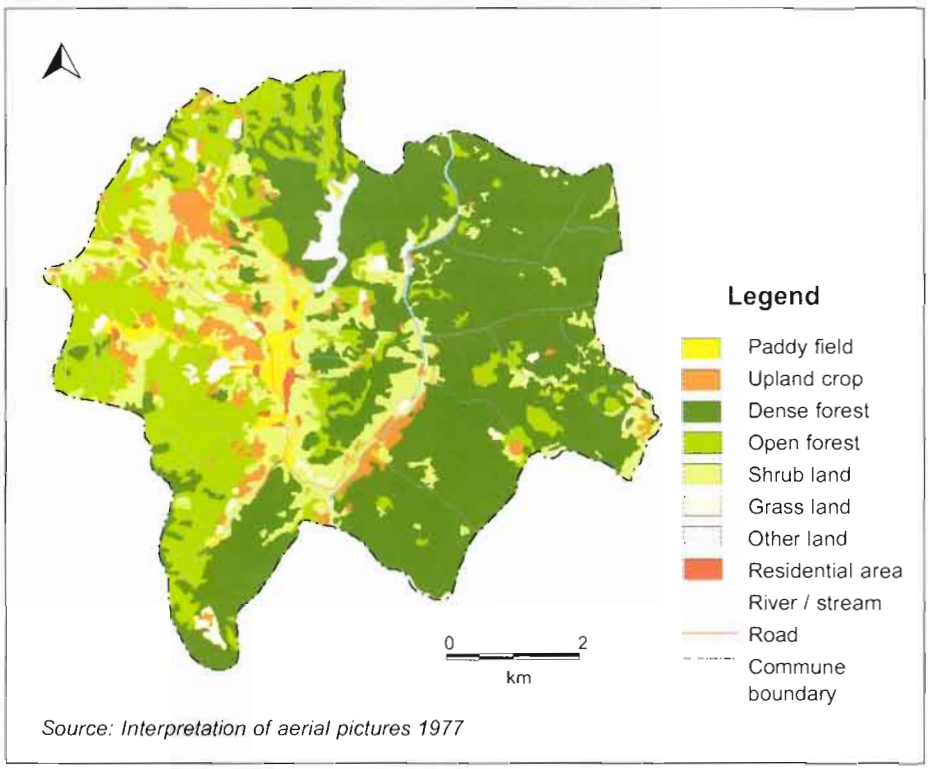


Figure 5: *Land use map of Xuat Hoa Commune, 1977*

Farmers were dividing their time between cooperative labor in the lowlands and private labor in forests and on swidden fields. Cooperative labor shifts were in the mornings and afternoons, so private work took place in the evenings, and occasionally in the early morning before the beginning of cooperative work. The rugged landscape restricted households to using only the gently sloping land nearest the villages, which allowed substantial forest regeneration to take place in the remote areas. By the end of the 1970s, forest cover had become dense again in the eastern part of the commune (Figure 5).

Toward the end of the 1970s, the disciplinary arm of the cooperative was weakening, faced with food shortages and increasing tensions along the Chinese border. The outbreak of war with China in 1979 further complicated matters for the cooperative administration. In the context of war, it was difficult for officials to outlaw slash-and-burn practices while the State itself was encouraging large-scale agriculture on massive swidden fields. Private swidden fields were multiplying as farmers maximized the profitability of their labor and land. At first, extensive private hillside cultivation was restricted to plots located far from villages, difficult to access and out of sight of authorities. With time, the practice became more and more open.

3.3. Progressive economic liberalization (1982-1995)

In 1981, the national "Decree 100" established limited private land-use rights. This began a series of reforms that eventually would lead to the dissolution of the cooperative system (Table 2). The rules of the cooperative seemed to be constantly changing. Farmers adapted their land-use systems to each new restructuring. Systems were selected based on the relative return of various crops, available capital, technical knowledge, and local regulations.

The new policies resulted in three stages of intensified ecosystem use:

1. Labor productivity was maximized by an expansion in the area of upland used. Upland area seemed inexhaustible, and plots were readily abandoned as soon as yields began to decrease.
2. By 1986, all clearable forestlands had been cleared. The community then moved to increase the productivity of available paddy lands, turning to two rice crops per year, chemical fertilizers, and increased animal husbandry (for manure).
3. Beginning in 1990, individual ownership first of paddy fields, and then of sloping lands in 1995, led to increased investment in labor and inputs (Figure 6).

The reforms had different impacts in different regions. In many areas, the changes prescribed by the new regulations had already taken place; the new policy only legitimized the unofficial system. For example, by 1986, although officially land was owned collectively, in reality *Xuat Hoa* Commune already had developed a system of private land-use rights very similar to that decreed by Resolution 10, the 1988 agricultural-reform policy.

The environmental impact of the period's land use systems was considerable. The unsustainable use of upland resources between 1982 and 1986 drained the commune's forest capital (Figure 7). Meanwhile, the changes in land use were accompanied by a notable household differentiation (discussed in Section 4, below). Disparities in capital accumulation and families' access to various types of land during this time largely determined the present-day household livelihood strategies.

3.4. The current landscape

Figure 6 shows the present-day land use in the studied region. The *lowlands* continue to be used exclusively for rice cultivation. Production has become intensified in terms of both labor (for weeding and application of manure) and capital (for chemical inputs and, in some cases, mechanization). Except where limited by the availability of water, farmers grow two rice crops per year.

The *lower slopes* continue to be used for vegetable gardens for family consumption and orchards.

Table 2: *Agrarian dynamics and policy reforms in Xuat Hoa Commune*

Dates and policies	Modification of organizational rules	Short-term consequences for agriculture	Ecological impact
1982 Decree 100	- Privatization of production activities, producers give fixed quota of rice to cooperative. - Privatization of buffaloes.	- Extensive shifting cultivation tapped upland resources - Gradual increase of herds (buffaloes / cattle)	- Rapid disappearance of old-growth forest - Erosion
1986 Adjusted contract	- Privatization of labor gains. - Land remains collective.	- Decrease of upland field area, temporary end of upland rice cultivation. - Switch to two rice crops per year where irrigation permitted.	- Forest entirely cleared. - Reduced soil fertility on sloping lands.
1990 Resolution 10	- *Tày* reclaim ancestral land. - Many households left out of paddy field distribution.	- Increased time and capital investments in the lowlands (paddy fields, gardens, etc.) - Migrations to the South - Slash-and-burn farming with short fallow periods by landless farmers	- Buffaloes begin to damage swidden fields, causing disputes, degrading forests, and becoming obstacles to the development of perennial crops.
1994 Upland allocations	- Gradual allocation of uplands (local rules based on size of swidden fields cleared in earlier periods)	- Substantial investment in plantations (orchards) - Agricultural diversification - Mechanization and large investment in paddy fields	- Relative regeneration of forest cover. - Rice intensification causes problems with pesticides

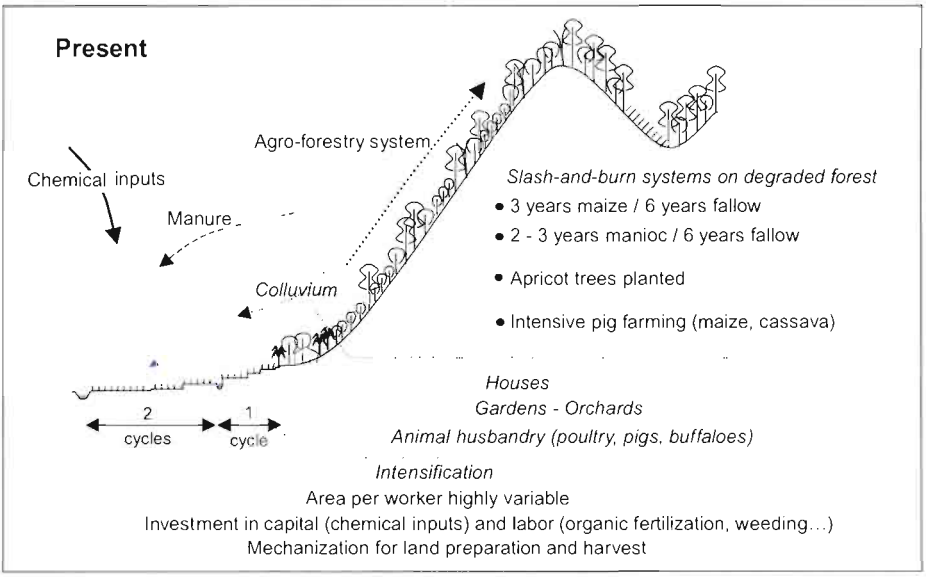


Figure 6: *Current land use in Xuat Hoa cultivated ecosystem*

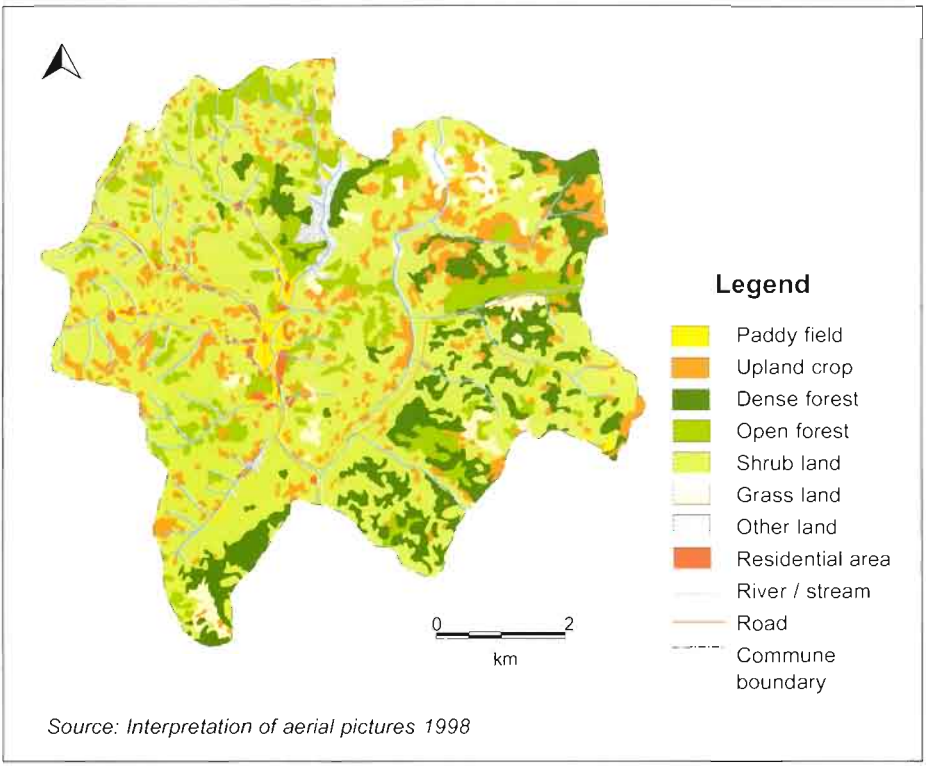


Figure 7: *Land use map of Xuat Hoa Commune, 1998*

The uplands are being used more and more intensively, but in a manner that nonetheless may be environmentally sustainable. Unsustainable slash-and-burn systems have given way to perennial plantations, assisted in the early 1990s by several government reforestation programs in *Bac Kan* Province. The first such program arrived in *Xuat Hoa* Commune in 1998, supported by the World Food Program (WFP). Plantations of *Manglieta*, a timber tree species, have since increased substantially in number and extent, covering approximately 2000 ha in 2001 (Figure 8). Farmers have several reasons to be interested in reforestation programs:

(i) They can clear young forests, which would otherwise be legally protected from cultivation. They can then grow several cycles of annual crops on the cleared plots before tree cover thickens; and

(ii) In their first three years of participation, they receive large rice subsidies. By the time the subsidies expire, the plantation itself should yield profits.

The history of the region during the 20th century can be summarized as a succession of four different kinds of land use (Figure 9, Figure 10, Box 2).

A. Before 1954, land use was not intensive. Lowland use consisted mainly of a single rice crop per year, characterized by extensive rice monoculture. Uplands were used for slash-and-burn agriculture with long fallow periods. The *Tày* occupied the lowlands, whereas the *Dao* lived in the uplands.

B. During the collective period (1960–1988), lowland rice production was intensified with the technology of the Green Revolution (Box 1). Cultivation of the hillsides was forbidden by local regulations, and the practice was restricted to a few small fields near the village. Some forest regeneration occurred in the eastern part of the commune (Figure 7).

C. In the late 1970's and early 1980's, agricultural production could not keep pace with the growing population of the region, while the hillsides continued to be under-exploited. The resource base was maintained but the food needs of people were not being met. This failure culminated in an abrupt return to traditional shifting cultivation practices and an uncontrolled rush to clear and appropriate as much upland area as possible. Within several years most of the forests in the commune had been cleared.

D. In the 1990's, sustainable land uses emerged, characterized by intensification of paddyland production and perennial plantations on the hillsides (Figure 6). However, not all families have been able to take part, due to the large capital investments required.

Intensification happened in two main ways: (i) land use modification in the lowlands (Green Revolution, new technology, mechanization), and (ii) permanent agro-forestry systems or expansion of maize area (associated with pig raising) in the uplands. Over the past 50 years, the region has seen an increase in labor productivity coupled with a decrease in per capita area of arable land.

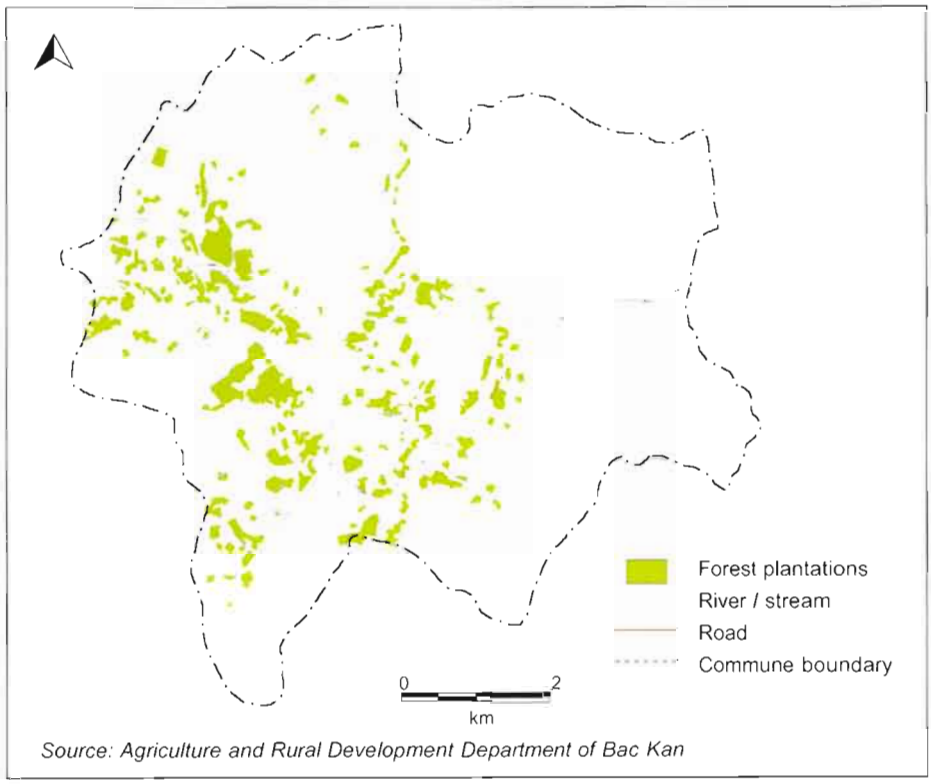


Figure 8: *Areas planted with Manglieta under World Food Program from 1998 to 2000*

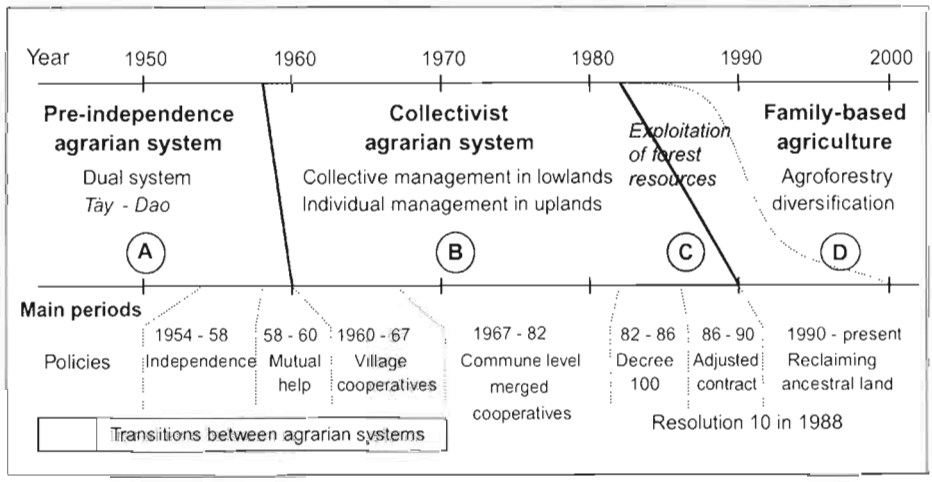


Figure 9: *Agrarian systems timeline*

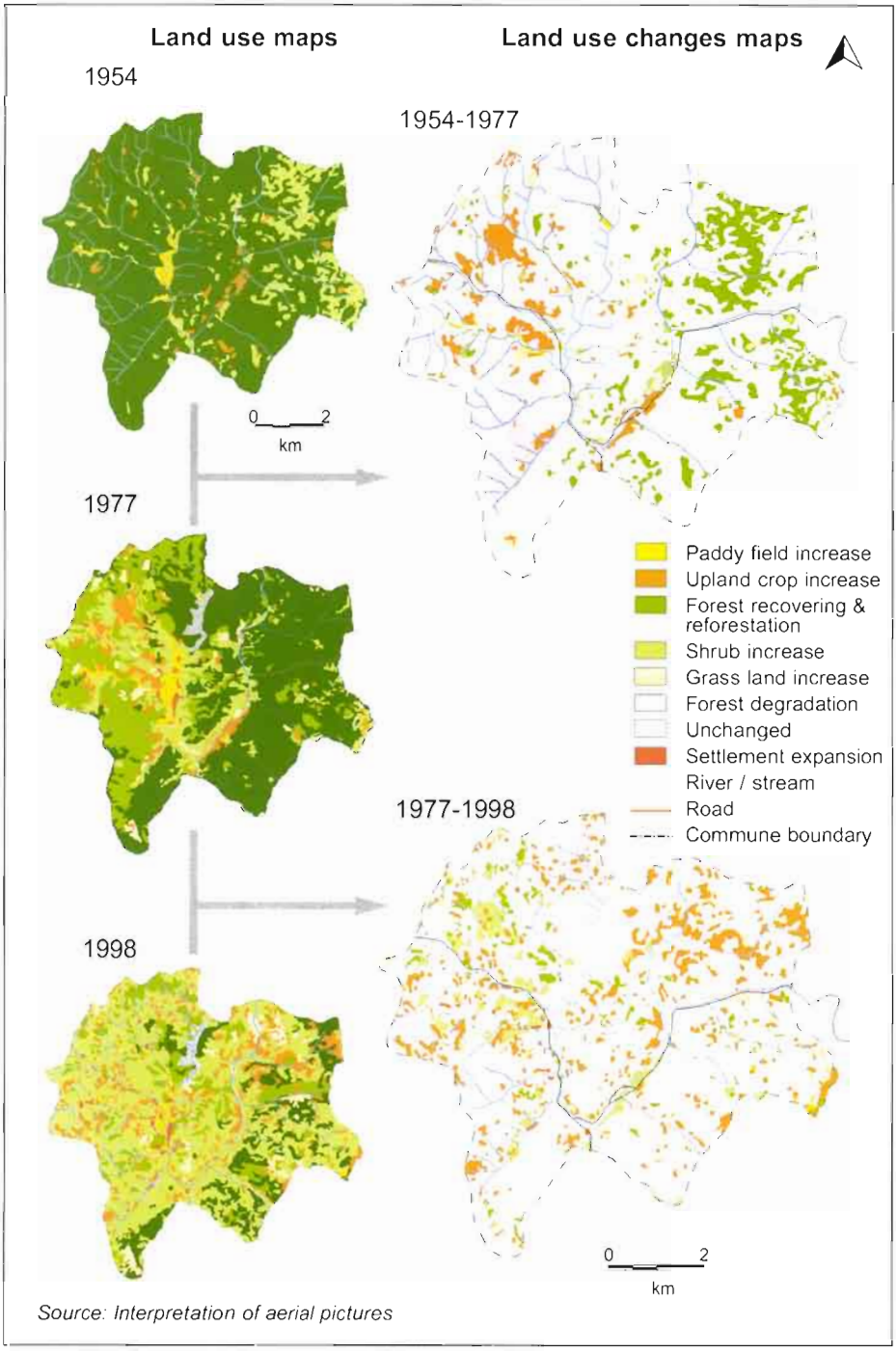


Figure 10: *Land use change map of Xuat Hoa Commune*

Box 2: *Agrarian transitions and ecological dynamics*

The graphs below were developed from a quantitative analysis of maps in Figures 3, 5, and 7 presented above.

Intense deforestation

Graph 1 demonstrates the severe reduction in forest cover that took place over the last fifty years. By 1998 only 15% of the 1954 forest cover remained, covering only 12% of the total commune area. Forest deterioration was even more marked than can be seen in Graph 1, as the steep reduction in forest quantity was combined with a substantial deterioration in forest quality. Over the period shown, the region's secondary forests were totally destroyed and replaced by degraded forests (Graph 3).

Slash-and-burn practices accused...

The agrarian history of *Xuat Hoa* Commune shows that the deforestation of the region had many causes (slash-and-burn practices, logging, etc.), across different time periods and regions. The increase of slash-and-burn practices (Graph 2) over the last 40 years has nonetheless played an undeniable role in deforestation.

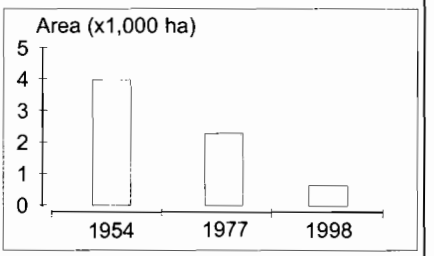
Fallow period reduction

We can see from Graph 3 that the impact of slash-and-burn practices on the state of forests was considerably higher in the 1977-1998 period than during the period before that. Shrub area increased at a faster rate than deforested area, indicating a reduced fallow period. The forest no longer had enough time to regenerate.

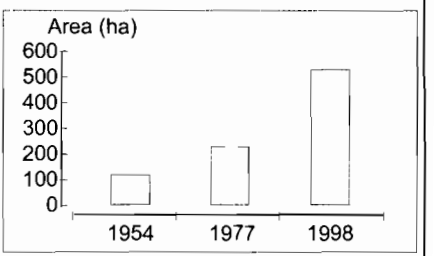
The tragedy of the commons

Collective management led to a sharp increase in the size of swidden fields. The increase in slash-and-burn practices in the following individualist period, combined with population densities considerably greater than in the previous 50 years, led to the exhaustion of forest resources.

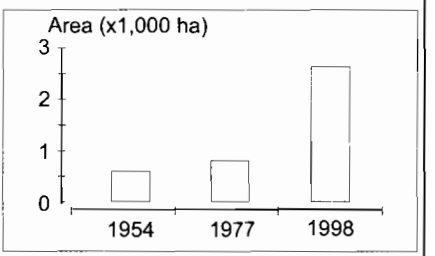
1. Decrease in forest area



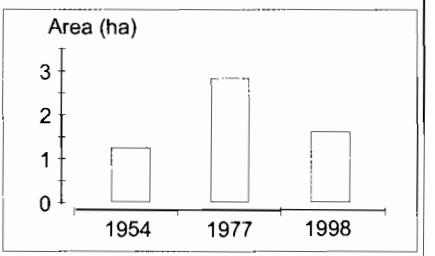
2. Increase in upland crop area



3. Increase in shrub area



4. Average area of upland crop fields



4. The farming system differentiation process and the diversity of current production systems

4.1. The driving forces of differentiation in the 1980s

When economic reforms began to take place in the 1980s, agricultural production systems were very homogeneous. In terms of explaining recent differentiation, we have taken pre-1980 differences among production systems to be negligible (Sadoulet, 1999). Whatever social differences that may have existed before collectivization (e.g., differences based on paddy areas, wealth, and farming skills) had been effectively leveled by the cooperative system. Starting around 1980, the reform and eventual dissolution of the cooperative system created new disparities, and allowed some old disparities to resurface.

Decree 100: the fallacy of a system that should have been equitable

Decree 100, passed in 1982, reorganized the distribution of lowland fields and the remuneration for paddy field labor as follows:

- Lowland area was allocated according to the number of individuals in each family, with the intention of giving each family enough land to feed themselves;
- Families owed a fixed quota of ricefield production to the cooperative, based on the size and quality of their ricefields. Any surpluses beyond this fixed amount could be retained.
- Cooperative labor (ricefield work, construction of irrigation systems, animal tending, etc.) was remunerated on a labor point system.

The system seemed simple and equitable: the households with the greatest food needs had the largest areas allocated to them. But the new policy only created new disparities:

- The high productivity of slash-and-burn practices discouraged families from investing any more effort than was obligatory in the paddy fields. Because of the cooperative's poor input delivery management, paddy yields remained low, attaining but rarely exceeding production quotas;
- Families with few laborers but many mouths to feed had a proportionately high ricefield surface area per laborer, sometimes more than the workers could handle, resulting in poor yields;
- An under-valuation of working time on the paddy fields led to a transfer of the fruits of labor from underprivileged households with small labor forces to those with sufficient labor to engage in other cooperative work that received a higher valuation.
- Unable to attain their paddy field quotas, labor-poor families could not take part in slash-and-burn cultivation, the most profitable work of that period.

For two or three years, many families were poorly paid for their obligatory paddy field work. It was at their expense that food security in the commune was attained.

Between 1982 and 1990, various practices allowed farmers to accumulate capital:

- High-yielding upland cultivation from 1982 to 1986. The potential for this practice soon vanished, as widespread slash-and-burn cultivation of upland rice, maize, and cassava soon exhausted soil fertility on sloping lands.
- Harvesting of high-value timber from 1982 to 1990, for those families with enough laborers to undertake the task.

Since 1990, unequal access to land and private property

In 1990, there was a spontaneous movement among the *Tày* to reclaim the paddy fields that had been collectivized in 1960. Families took back the paddy fields of their ancestors and distributed them amongst themselves, reproducing the land inequalities of the pre-independence system. Families who had joined the cooperatives in later years were deprived of the fields on which they had been working for years.

In 1994, the State initiated allocation of long-term rights to use upland. In 1995, individual households received stable titles for specific upland areas in *Xuat Hoa* Commune. The land allocation tended to give households the same areas that they were already cultivating, including fallow fields. Of course, households with large upland fields were those who had enjoyed labor surpluses during the Decree 100 period. The redistribution of uplands thus only entrenched the land-access inequalities that had already developed.

The roots of the present-day social disparities seen in *Xuat Hoa* Commune can therefore be found in the 1980s (Figure 11). The driving forces of the differentiation process fit into three categories:

(i) The inequality of the "Decree 100" system according to the households' relative abundance of labor force in comparison with the number of mouths to feed;

(ii) Private profits from unsustainable forest use and other private activities (opportunities for which depended on labor surpluses during the Decree 100 time period); and

(iii) Since the early 1990s, the movement to reclaim ancestral lowlands. The size of paddy fields inherited from ancestors relative to the number of descendants among which it was shared, influenced households' production strategies.

4.2. Current livelihood strategies defined by access to the means of production

The range of options in cropping and animal husbandry systems

Xuat Hoa households' livelihood strategies consist of one or more crop or livestock production system, sometimes combined with non-farm income. We can

classify the activities of *Xuat Hoa* households into categories of agricultural production systems, with each category defined by combinations of cropping and animal husbandry systems. For instance, when a household grows rice in the lowlands, maize and apricots on the slopes, and raises pigs for sale and buffaloes for land preparation, one can identify three interrelated production systems: (i) a rice production system comprising rice cultivation and buffalo raising; (ii) a pig production system including maize cultivation for feed; and (iii) an apricot tree cultivation system.

We find in *Xuat Hoa* three principal rice-based production systems:

- Rice cultivation including buffalo raising for draft power;
- Mechanized rice cultivation, allowing the farmer to rent plowing services to other households;
- Manual rice cultivation, with mutual aid.

The main systems observed on the hillsides are:

- Maize cultivation for sale;
- Maize cultivation for pig farming, combined with the purchase of supplementary feed;
- Apricot tree cultivation, intercropped with maize for two to three years;
- *Manglieta* timber plantation, subsidized by the World Food Program.

Profitability of production systems

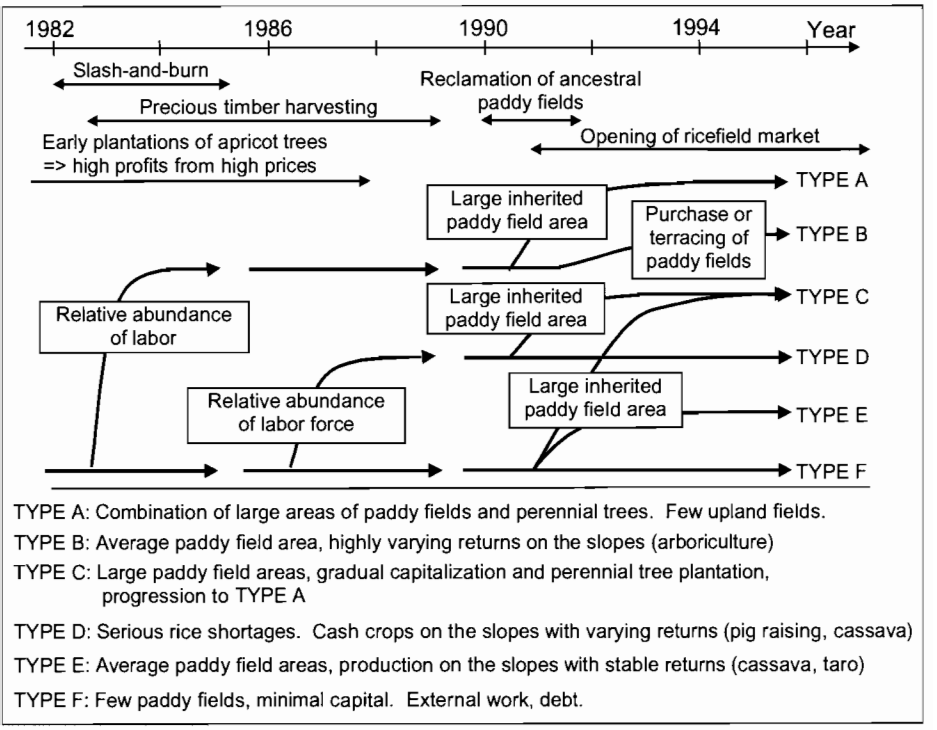
Table 3 shows the profitability of the different production systems in *Xuat Hoa* Commune. Figure 12 compares the profits of the different production systems per unit area of production and per day of labor.

Rice, the staple food of most *Xuat Hoa* families, continues to be of strategic importance, with relatively stable yields although only generating an average income of 20,000 VN Dong / working day. Although the maize-pig system offers high profits, the lower initial investment for growing rice makes it a more feasible investment. Pig farming is most commonly practiced by households that lack paddy fields but have access to capital.

Cassava and maize cultivation systems are even less profitable than rice per unit of land area but their labor requirements are comparable to other systems (Figure 12).

Taro is a special case, with very high profitability per unit of land and relatively high profitability per unit of labor. Like all vegetable products, though, the market demand is small, and taro requires non-acidic soil conditions.

Perennial trees (apricot trees, *Manglieta*) are very profitable with respect to labor, but require large land areas and offer unstable returns. The market for fruit is uncertain, and the market for *Manglieta* timber is unknown to farmers as this tree is a new arrival in the region.



TYPE A: Combination of large areas of paddy fields and perennial trees. Few upland fields.

TYPE B: Average paddy field area, highly varying returns on the slopes (arboriculture)

TYPE C: Large paddy field areas, gradual capitalization and perennial tree plantation, progression to TYPE A

TYPE D: Serious rice shortages. Cash crops on the slopes with varying returns (pig raising, cassava)

TYPE E: Average paddy field areas, production on the slopes with stable returns (cassava, taro)

TYPE F: Few paddy fields, minimal capital. External work, debt.

Figure 11: *The differentiation process of production systems and the current typology.*

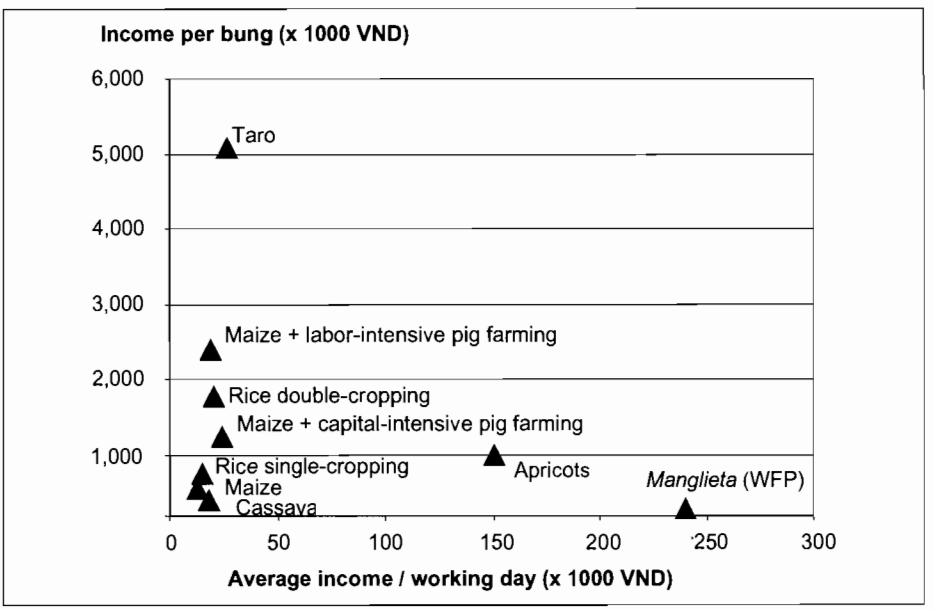


Figure 12: *Income per working time and income per unit of land of elementary production systems (1 bung = 1,000 m²)*

Table 3: *Relative profits and requirements of production systems*

	Profits (thousands of VN Dong)		Capital needs (thousands of VN Dong)		Labor requirements	
Production System	Per working day	Per 1000 m^2 cultivated	Rotated capital per 1000 m^2 cultivated (e.g. inputs, hired labor)	Initial investment required per 1000 m^2	Maximum area per laborer (m^2) (larger areas indicate lower labor requirement)	Peak labor requirements
rice + buffalo	20	1,700	250	1,500	1,200	March and June-July
rice + hand tractor	21	2,100	250	1,000	1,200	
rice (hired labor)	15	1,300	600	7,000	2,000	
maize for sale	13	120	-	-	2,500	July
maize for pigs	19	2,300	120	-	1,500	
maize for pigs with additional feed	23	1,140	450	-	2,000	
apricots	150	900	-	-	6,000	March-April
Manglieta	220	48	-	- subsidized WFP	> 10,000	none

Timing of peak labor requirements

There are two peaks of labor requirements: from March to April, and from June to July. At the moment of planting a given crop and then during each peak period, the most important factor in farmers' decision-making is the marginal income per working day (Table 4). Between March and April, rice production is the highest priority, both because it is profitable and because it ensures the household's food security. Maize and apricots are second priority. Rice and maize are rarely produced by the same household on large areas because of their concurrent labor peaks.

Between June and July, labor is divided between maize and rice cultivation. If time is insufficient, families do not plant a second maize cycle. For households with small ricefield areas, the high profitability of the maize-pig system makes it a common choice.

4.3. A typology of household livelihood strategies.

Table 5 displays the elementary production systems available to farmers, along with their advantages and disadvantages. Farmers' decisions about the amount of land and labor to devote to each elementary production system are based on:

(i) farmers' access to production means,

(ii) the relative profitability of elementary production systems, and

(iii) the timing of competing peaks of labor requirements.

Table 4: *Marginal income of a working day during labor peaks*

Period	apricots	rice double-cropping	maize + labor-intensive pig farming	maize + capital-intensive pig farming	maize for sale
March - April	150,000	120,000	88,000	90,000	78,000
June - July	-	74,000	135,000	60,000	47,000

Remark: The marginal income of a working day is equal to the ratio of the income per ha to the working time per ha during the labor peak period.

Table 5: *Factors explaining the production combinations observed in Xuat Hoa Commune*

Production systems	Advantages	Constraints
Rice + buffalo	- food security - buffalo care maximizes labor force use (employing both children and the elderly)	- limited by available paddy field area
Rice + hand tractor	- food security - good return on investment	- large areas required to ensure investment profitability
Rice (hired labor)	- eases pressure on family labor force during labor peaks	- low return on labor - food security less assured
Maize for sale	- no investment required	- very low profitability - minimal available area and low return per unit of land
Maize + pigs	- return on labor comparable to rice fields	- labor required in July, at the same time as in the paddy fields
Maize + pigs with with additional feed	- substantial return on labor - regular work throughout year	- important initial investment - low return on labor during July peak labor demand compared to rice
Apricots	- potentially profitable	- unstable income
Manglieta (WFP)	- profitable with respect to labor - allows the clearing of new land for maize	- very low profitability per hectare

Farmers' combinations of these elementary production systems result in a set of household livelihood strategies that can be used to characterize the household types in the study area. As shown in Figure 13, current household livelihood strategies are largely defined by lowland access and accumulated capital (mostly during the 1980s, at the expense of the forest). These are important elements to take into account when examining the current situation of upland agriculture and orienting future development activities.

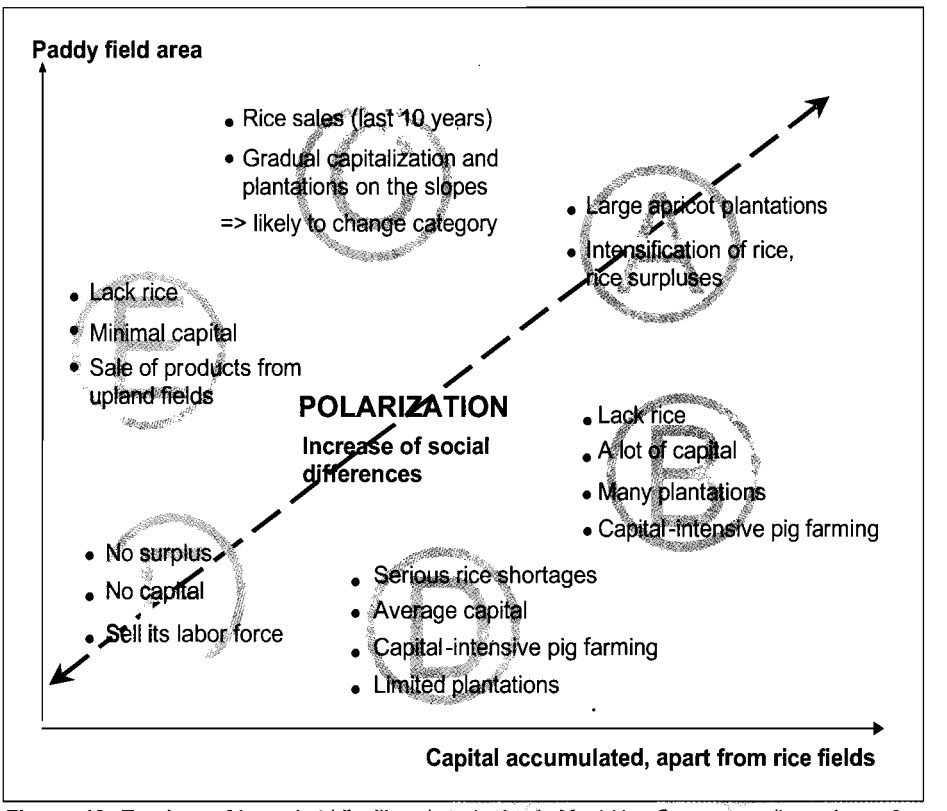


Figure 13: *Typology of household livelihood strategies in Xuat Hoa Commune: dimensions of polarization*

5. Conclusions

The historical background of the extremely heterogeneous mountainous region of northern *Viet Nam* needs to be considered when planning policy modifications or development interventions. By the end of the 1980s, the *doi moi* reforms had affected different households differently, according to the initial characteristics of the households. Whereas policies before 1980 tended to level the differences among households, policies since 1980 actually have accentuated those differences. Farmers do not react to institutional changes in a vacuum. In the future, as in the past (since 1980), different households will be obliged to develop livelihood strategies along different pathways. An understanding of the interactions between household characteristics and the historical and institutional context in which they develop their livelihood strategies is crucial for policy-makers and development practitioners.

Contribution of the study in scientific terms

During the political transformations of the past 50 years, *Xuat Hoa* Commune systematically reinterpreted national policies at the local level. Indeed, this is representative of *Bac Kan* Province as a whole. The need to reinterpret at local level likely came about from the differences among the ecosystems in which policies had to be implemented. It is unrealistic to expect policies developed in the context of the delta region to solve problems in the markedly different and highly heterogeneous mountainous region (Sikor and Dao Minh Truong, 2000; Le Trong Cuc and Rambo, 2001).

The study of *Xuat Hoa* Commune has revealed the existence of a dramatic process of household differentiation that began with the decollectivization process. Our diagnostic work led us to define a set of indicators that have become the basis of a comparative study of the differentiation process in various research sites within *Bac Kan*. These indicators (see Figures 12 and 13) have been integrated into a multi-agent computer model (named SAMBA), which has allowed us to validate them and evaluate their relative importance in past dynamics (Castella et al., 2000). The results, which provide a thorough understanding of local realities, will lead to concrete recommendations for better collective management of the local resources (Castella et al., 2000).

Contribution of the study to development

Diagnostic studies implemented in *Bac Kan* Province (*Cho Don* District) in the early 1990s, the peak period of slash-and-burn agriculture, predicted a major environmental crisis in the province (Piquet and Puvilland, 1992). Farmers avoided the crisis by turning to new systems of intensive upland cultivation that seem more sustainable than previous systems. Land allocations were undoubtedly the main cause of this change in production systems.

Intensive agricultural systems often require more capital (e.g. maize/pigs) and/or generate unstable returns on initial labor investments (plantations of perennial trees, paddy field construction). These limitations exclude certain households from the development process (e.g., households with insufficient investment capital or which cannot bear the risk of unstable returns). These households often have little recourse beyond turning to less sustainable practices on the hillsides. It is these farmers who currently are in need of technical and organizational support to ensure the ecological and economic sustainability of their farming systems.

Some unresolved problems

Intensive but sustainable systems of upland farming with small initial investments need to be developed for struggling farmers who lack the means to invest in perennial trees (Husson et al., 2001).

Cattle and buffalo herds in the region are rapidly decreasing in size because of increased difficulties in pasturing. Conflicts are increasing over free-grazing and its resultant damages to crops, plantations, and forests. Further research is needed on new methods of cattle management (Eguienta et al., 2002). In light of the need to shift to more intensive crop systems on the slopes, it seems relevant to study the introduction of cattle husbandry in perennial plantations that include plants for upland feed production.

In *Xuat Hoa* Commune, private fruit tree plantations have been expanding, and fruit production has become an essential part of the revenue of many households. However, the future market for fruit is uncertain, as the apricot market has been in decline for the last five years. A study of the evolution of the market for perennial cash crops would be helpful in orienting the decisions of future producers.

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