




**Vietnam Agricultural Science Institute**
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# Report on Participatory Rural Environmental Management in the Northern Upland Areas

# (Moc Chau district, Son La province)

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# PART 1: RESEARCH OBJECTIVES

1. Assessing the present situation of the rural mountainous regions' environments;
2. Studying the community awareness of the environmental issues;
3. Studying the mechanisms and methods of rural environment management;
4. Working with farmers to identify necessary measures and action plans for solving the environmental problems;
5. Drawing recommendations on building policies and institutional regulations to manage and improve the environment, based on the results of participatory environment assessment and analyses.

# PART 2: RESEARCH METHODOLOGY

The research methodology includes:

2.1. ***Selection of the research sites***: The bases for identification of the research sites were available statistical data, related documents, ecological and socio-economic characteristics of the regions.

2.2. ***Collecting of baseline data***: Baseline data were extracted from related documents and data from local authority offices at different levels.

2.3. ***Investigating based on the topographical transect***: Investigation was conducted along the typical local topography transect focusing on the change of this transect with time.

2.4. ***Investigating the process of changing production patterns***: Data were collected in relation with the history of production and development process.

2.5. ***Rapid rural appraisal (RRA)***: RRA was used to investigate and assess the household economic and production situation, as well as the pressure on environment.

2.6. ***Participatory rural appraisal (PRA)***

The assessments aimed at identification of

**Problems that rural communities are facing with:*

- Causes to the environment problems;

- Responses from the communities on the environment problems;

- Readiness from the local people to participate in enhancement of the role of the local communities in the rural environment management;

- Capacity of local communities to approach new environment policies and conditions for the local communities to accept and fulfil new environment policies;

- Expectation of local communities from environment management;

- Knowledge and awareness of local people of legislation, rules and community behaviour.

* *Methods at the community level.*

* Methods of implementation:

- Organise meetings to discuss the rural mountainous regions' environment problems.

- Assess collected ideas and comments from the communities.

2.7. ***Venn's diagram***: Venn diagram was used to describe the roles of different players in environment management at community and village levels.

2.8. ***Processing the collected information and data***: using some computer software such as IRRSTAT, EXCEL, etc.

2.9. ***Diagramming***: Diagrams were set up to describe the impacts of production activities on the environment.

2.10. ***Experts***: Experts were employed to analyse the collected information and data.

2.11. ***Seminars and workshops*** were organised for discussion on the research progress and results.

# PART 3: RESEARCH RESULTS

## 3.1. GENERAL INTRODUCTION

### 3.1.1. Natural and socio-economic conditions in Moc Chau District.

❖ **Natural conditions:**

Moc Chau is a mountainous district of Son La Province located along the National Highway No6, 120km from Son La town to the East and 200km from Hanoi to the Northwest. Moc Chau lies on $20^0$40" and $21^0$07" North latitudes and $104^0$26" and $105^0$05" East longitudes.

Western border of Moc Chau is adjacent to Thanh Hoa Province and the Lao People's Democratic Republic.

Eastern border of the District is adjacent to Hoa Binh Province.

Western and North-western borders are adjacent to Yen Chau District, Son La Province.

Northern border is adjacent to Da River and Phu Yen District, Son La Province.

There are 7 main natural springs in Moc Chau: Sap, Bang, Giang, Khua, Vin, Tan and Quanh Springs. The first six springs run to the Da River. The last one rises from Lao and runs through Long Sap and Xuan Nha communes to join the Ma River with its length of 40km. In addition, there are several small springs and creeks in the District which often flood in rainy seasons.

Moc Chau town locates on Moc Chau Highland at 930m to 979m above the sea level. However, the District is not a flat area. The lowest area is at Quy Huong Commune (300m above the sea level), and the highest area is Pha Luong Peak (1889m above the sea level). Moc Chau's terrain is inclined on the Southwest - Northeast direction and is divided by limestone mountains to create many small valleys.

❖ **Potential use of lands**

The use of lands in Moc Chau District up to date is summarised in Table 1.

**Table 1. Land use in Moc Chau District and plan for the future**
**(Unit: hectare)**

| **Type of lands** | **1995** | **1997** | **2000** | **2005** |
|---|---|---|---|---|
| Total area of lands | 202,513 | 202,513 | 202,513 | 202,513 |
| I. Agricultural land area | 32,532 | 33,915 | 32,228 | 33,765 |
| 1. Annual crops | 26,108 | 27,137 | 24,557 | 25,233 |
| a. Paddy fields | | 1,601 | | 1,751 |
| b. Sloping land fields | | 22,763 | | 20,775 |
| c. Other annual crops | | 2,772 | | 2,707 |
| 2. Mixed gardens | | 2,815 | | |
| 3. Land area for perennial trees | | 2,646 | | 5,902 |
| 4.Land area for animal fodder crops | | 1,208 | 936 | 1,500 |
| 5. Water surface area | | 109 | 15 | 125 |
| II. Forest lands | 38,869 | 51,336 | 67,682 | 99,378 |
| 1. Natural forests | 37,500 | 48,436 | 60,269 | 89,288 |
| 2. Planted forests | 1,369 | 2,900 | 7,413 | 10,090 |
| III. Land for special use | 4,030 | 4,076 | 4,446 | 4,983 |
| IV. Residential areas | 158 | 840 | 1,143 | 1,210 |
| V. Unused lands | 126,288 | 112,337 | 96,954 | 63,177 |
| 1. Flat lands | 500 | 411 | | |
| 2. Mountains and hills | 124,907 | 111,045 | 85,973 | 54,667 |
| 3. Rivers and streams | | | 1,096 | 1,096 |
| 4. Rocky mountains without forests | | | 2,469 | |

**Figure 1. Land use in 2000**

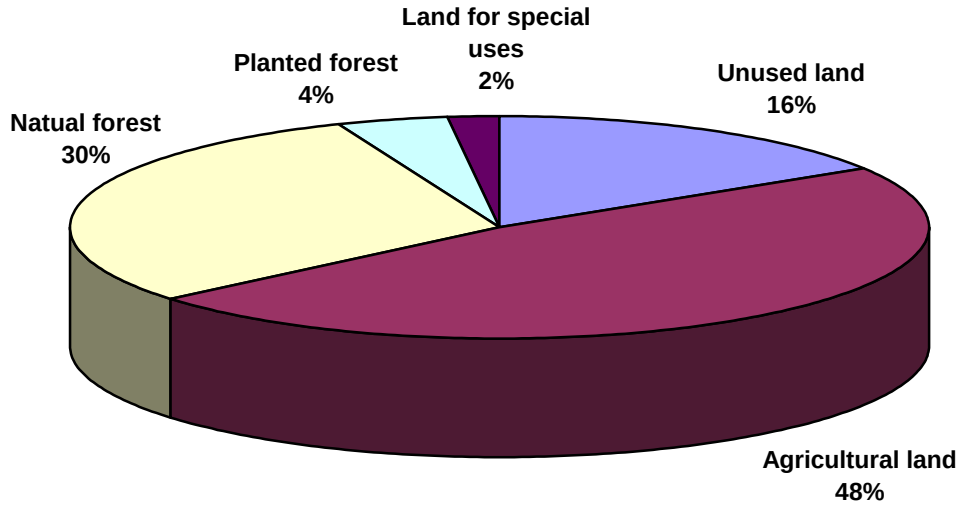
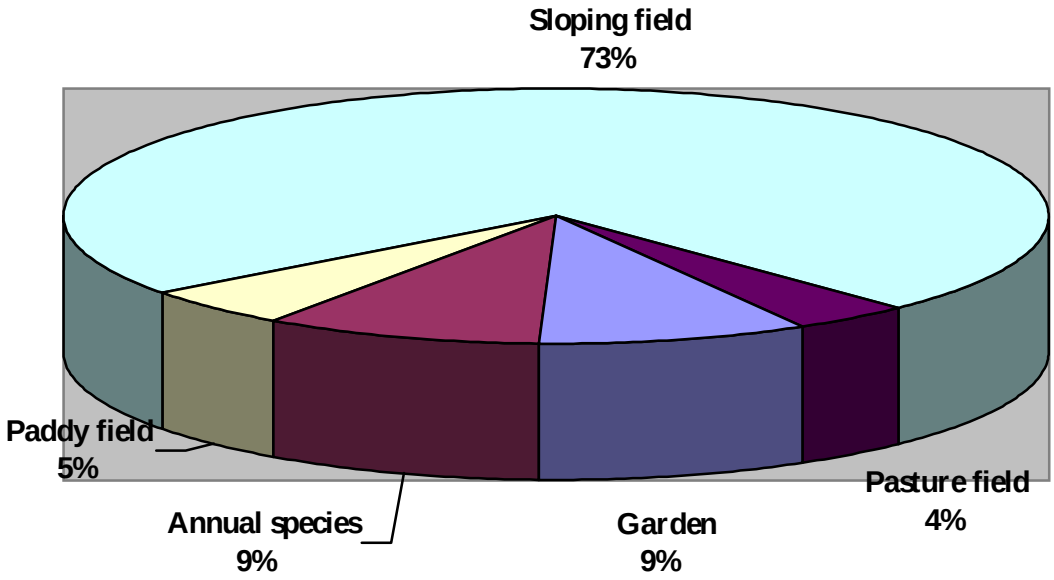


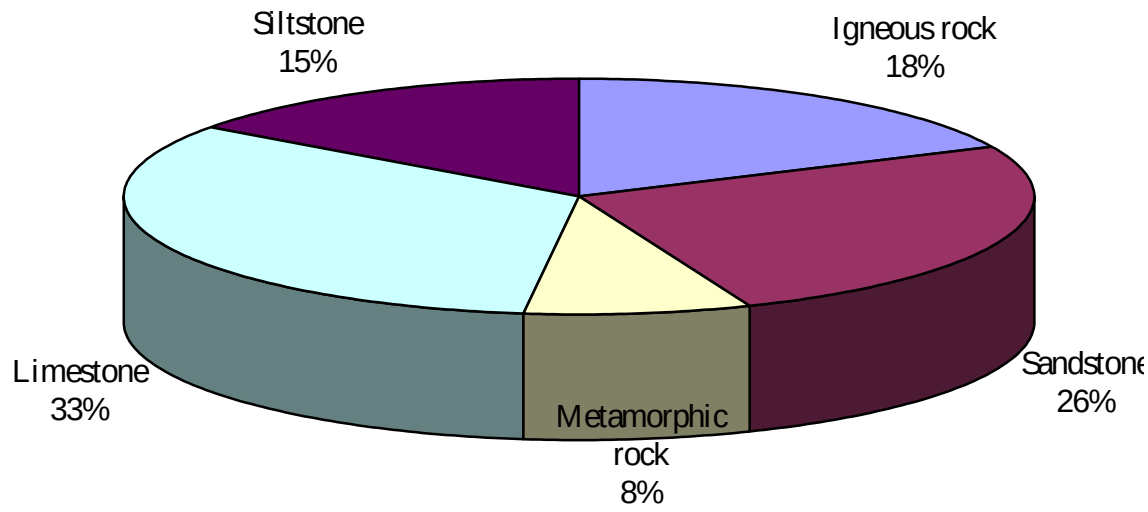

**Figure 2. Land use in 2000**




***Source: Moc Chau Department of Statistics.***

In 2000, the agricultural land area was 32288 ha consisting of 73% hill-side land, 5% paddy field, 4% pasture field and the rest for fruit trees and other perennial crop species (Figure 2). Forest land area is 67682 ha and unused land area is 96954ha.

**Figure 3. Soil types in Moc Chau**




***Source: Moc Chau Department of Statistics***

The soil types in Moc Chau are shown in Figure 3. Soils samples have been analysed to identify their chemical and physical properties. The results show that the soils are not acidic (or little acidic) although the land is sloping. The soils have been formed in thick layers with high concentrations of silt, Ca, Mg, and easily-decayed substances. These characteristics are simply a result of 25.6% of the land in the district being originated from limestone. The soil properties analysis for Moc Chau Highland and Bac Ha District are summarised in Figures 4 and 5.

**Figure 4. Amount of exchanged calcium (Ca) in soil (me/100g soil)**

**Moc Chau (Chieng Hac, Na Muong, Muong Sang)**

**Bac Ha (Lau Thi Ngai, Nam Mon, Nam Luc)**

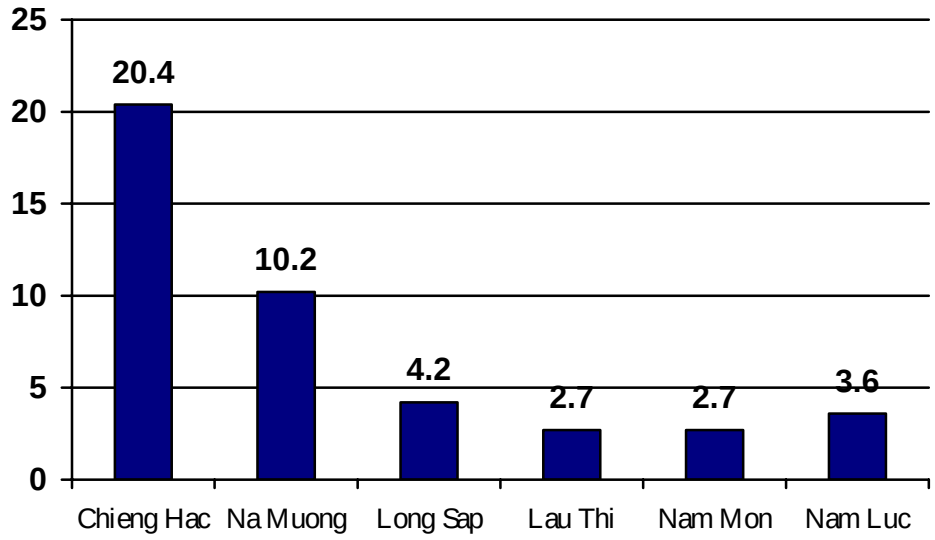
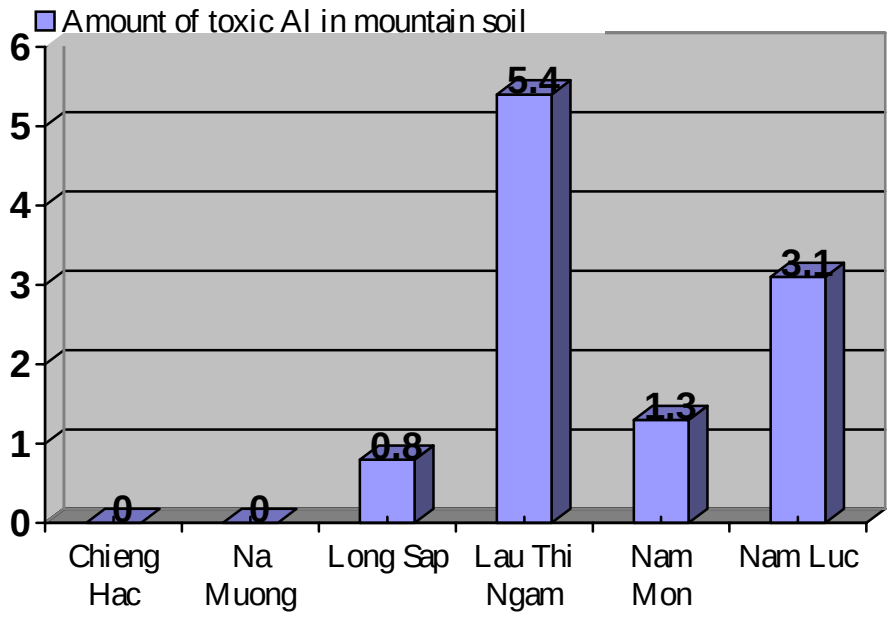



**Figure 5. Amount of toxic aluminium (Al) in soil (me/100g soil)**

**Moc Chau (Chieng Hac, Na Muong, Muong Sang)**

**Bac Ha (Lau Thi Ngai, Nam Mon, Nam Luc)**



❖ **Climatic conditions**

Climate in Moc Chau is colder than that in the plain regions with the same latitude. The average annual temperature is $20^0$C, the average maximum monthly temperature is $23.8^0$C and the average minimum monthly temperature is $16.2^0$C. The average monthly temperature difference between days and nights is $7.6^0$C.

The average monthly air humidity is 83.2%. The average maximum and minimum monthly humidity is 96.3% and 70% respectively.

The average annually sunny hours are 1849. The month with the largest amount of sunny hours is May with 5.7hours/day and the month with the smallest amount of sunny hours is February with 4.5hours/day.

The average annual number of days with hoarfrost is 5days.

Hot and dry south-western wind occurs annually in March and April. Cold North-eastern wind occurs from October to February.

Moc Chau climate is typical for the North-west region of Vietnam which is different from other regions in North Vietnam. The annual rainfall here is smaller but more intensive in rainy months. This clearly defines wet and dry seasons. The number of annual sunny hours in this region is also higher than in other regions in North Vietnam, especially in spring.

❖ **Socio-economic situation**

**Social situation:**

Until 31 December 2000, the district's population was 131480 of which 66435 were female and 65045 were male. The agricultural labour force is 49109.

Five main ethnic groups in Moc Chau are Thai, Kinh, Muong, H'Mong, Dao. Table 2 shows the percentage of each ethnic group constituting the population of the District.

**Table 2. Population of each ethnic group in Moc Chau**

| No | Ethnic group | 1996 | 1998 | 1999 | 2000 | 2001 |
|---|---|---|---|---|---|---|
| 1 | Thai | 44,120 | 43,803 | 43,443 | 43,714 | 44,193 |
| 2 | Kinh | 35,299 | 38,064 | 38,838 | 38,787 | 38,799 |
| 3 | Muong | 20,604 | 20,158 | 20,336 | 20,966 | 21,163 |
| 4 | H'Mong | 14,143 | 17,630 | 18,008 | 18,919 | 19,516 |
| 5 | Dao | 8,704 | 7,819 | 7,921 | 8,123 | 8,208 |
| 6 | Sinh Mun | 913 | 522 | 511 | 531 | 531 |
| 7 | Kho Mu | 342 | 356 | 363 | 372 | 384 |
| 8 | Others | 76 | 43 | 42 | 68 | 67 |
| ***Total*** | | **126,197** | **130,393** | **131,461** | **133,480** | **134,862** |

***Source: Moc Chau Department of Statistics***

As can be seen, 33.25% of Moc Chau population are Thai, 29.5% are Kinh, 15.95% are Muong, 14.39% are H'Mong and 6.18% are Dao.

**Economic situation**

In 2000, Moc Chau's GDP was 285.06 Billion VND with a growth rate of 4.3% compared to that in 1999.

The GDP structure includes 68.9% in the agro-forestry sector, 18.1% in the industrial and construction sector, 13% in tourism, services and other sectors. The annual income per capita was 154USD.

Total food production was 40,502 tonnes, of which paddy rice amounted to 9,300 tonnes. The annual food production per capita was 300kg.

The percentage of poor household was 20.1%.

The main income for Moc Chau is from agro-forestry production with the average in 3 years from 1997 to 1999 being 83.4% of the total production.

### 3.1.2. Scenario of agricultural production in Moc Chau District

❖ **Cropping systems in Moc Chau in 1990-2002**

Maize planting area increased rapidly from 4685 ha in 1996 to 11259 ha in 2001. This is due to:

+ The introduction of new hybrid maize varieties with high yield and short growth duration. Farmers can plant two maize crops per year. The area under Summer-Autumn maize production increased from 20 ha in 1990 to 585 ha in 1996 and 3500 ha in 2002.

+ The corn market is highly stable, and the corn price is consistently high year-round and tends to rise at the end of a year.

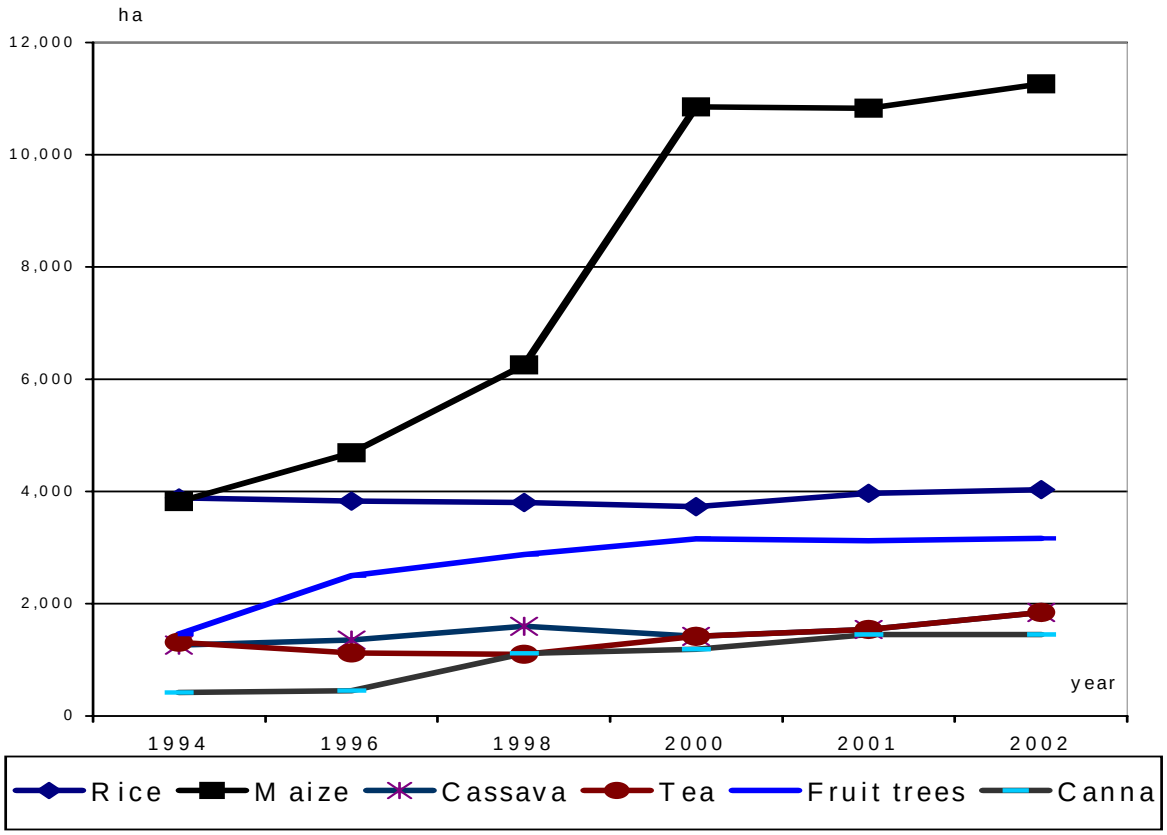
+ The profit from maize production per a unit land area is higher than that of other crops, thus maize is cultivated as a market-oriented sole crop.

+ The maize production is suitable to farmers' investment capacity.

The land area for upland rice cultivation decreased sharply from 3100 ha in 1990 to 1540 ha in 2002, and the yield of upland rice also decreased. Land area for irrigated rice cultivation remained unchanged. However, with the improvement of the irrigation system and the application of new technology, wet rice productivity in the Winter and Summer seasons has increased consistently satisfying 50% of rice demand in the District.

The land area for fruit trees (mainly plum) was increased in the period of 1990 - 2000. In recent years, the profit from plum has fallen sharply due to low productivity and the drop in plum prices from 4000VND per kg to 500VND per kg.

**Figure 6. Land areas for main crops in Moc Chau**




Areas under cassava and canna were increased at low rates over the years but still played an important role in the crops structure of the District.

Tea was given a high priority for development as it contributed highest economic return. The land area for tea cultivation was 1840 ha in 2002. However, it is clear that the tea price is not stable.

Figure 7 shows that:

+ Rice yield increased especially in winter season from 1.96tonnes/ha in 1990 to 5.9tonnes/ha in 2002. This indicates that the cultivating skills of farmers have improved.

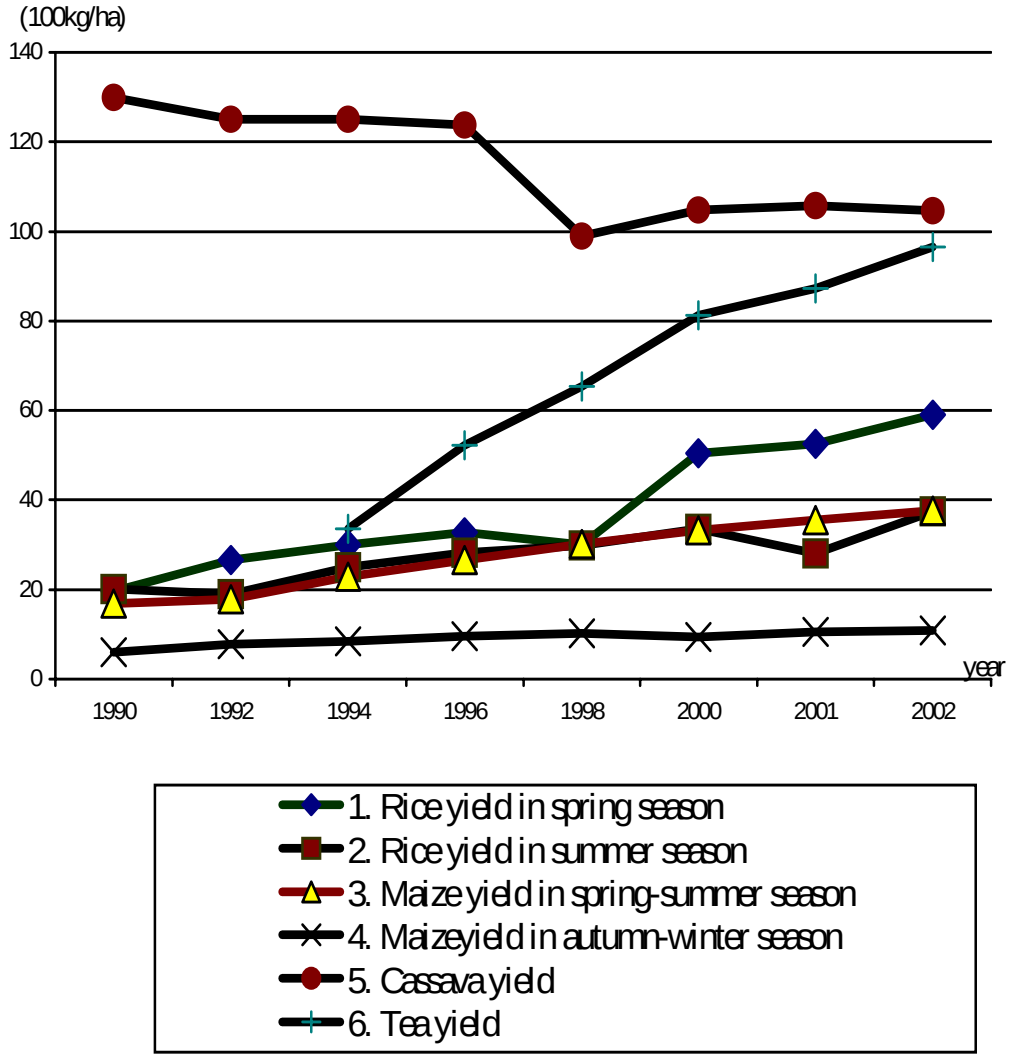
+ Maize productivity increased steadily due to the use of fertiliser and the introduction of new hybrid varieties. The maize productivity in Spring-Summer seasons soared from 1.69tonnes/ha in 1990 to 3.76tonnes/ha in 2002. The maize productivity in Autumn-Winter seasons is much less than the spring-summer season

but the maize price is 1.5 to 2 times higher. Therefore, maize is still the favourite crop of the farmers.

+ Due to the priority for investment, tea productivity has increased rapidly from 3.36tonnes/ha in 1994 to 9.66tonnes/ha in 2002. Moc Chau Tea Company has a plan of replacing existing tea varieties with new ones which have lower productivity yet higher quality.

+ The cassava yield was decreased due to the fact that cassava mono-cropping on sloping land causes soil degradation.

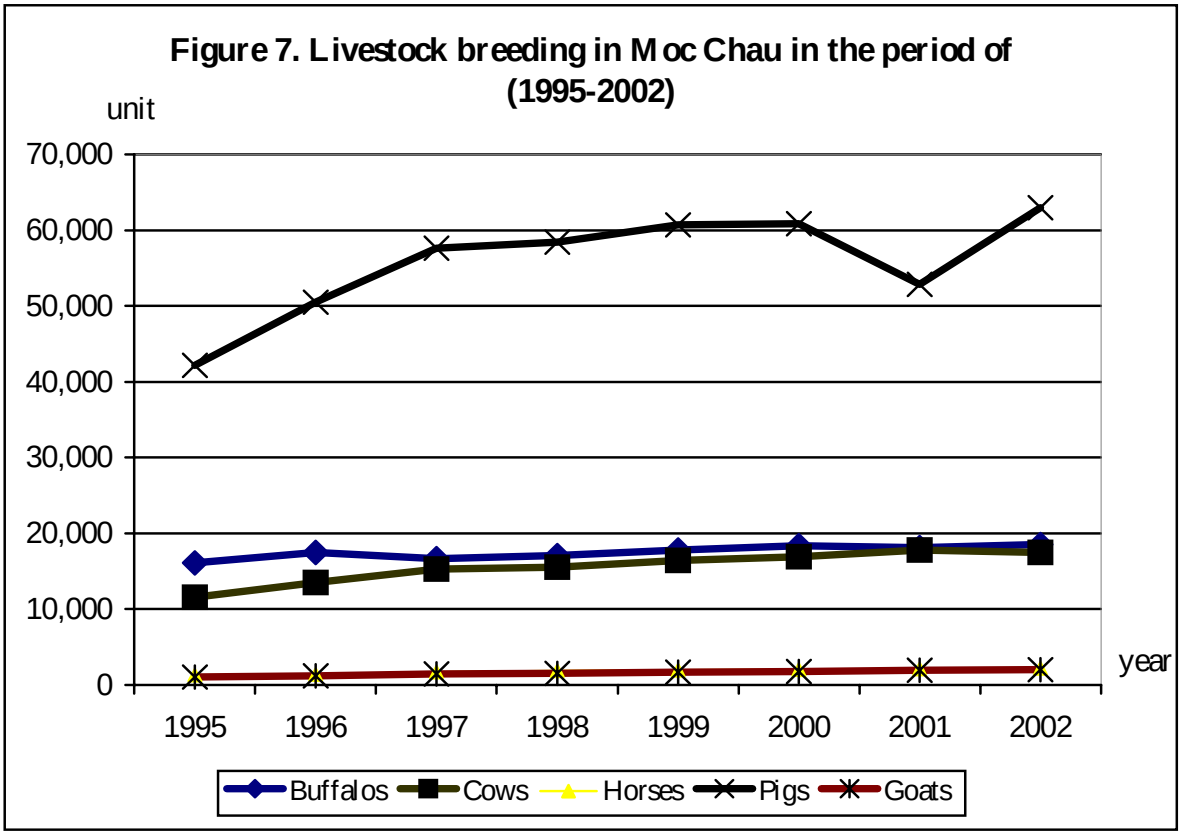
**Figure 7: Yields of the main crops in Moc Chau in the period of 1990-2002**




***Source: Moc Chau Department of Statistics***

❖ **Livestock breeding in Moc Chau in the period of 1995-2002**

Thanks to the advantages of the soil and climatic conditions, Moc Chau has more than 35000 cows and buffaloes. Moc Chau Milk Company possesses 2270 cows with the milk production of more than 4000 tonnes in 2002. In the future, the District will focus on developing pigs breeding to meet the demand of meat in the district and also for the national domestic market. The number of cattle will be kept constant at approximately 40000.




## 3.1.3. General assessment

❖ **Advantages**

Moc Chau has a high potential use of agricultural land with suitable climatic and soil conditions for food crops such as maize, upland rice, vegetables and for cattle breeding, especially cows.

A high priority is given to development of tea, mulberry and dairy cattle to create more goods for domestic and overseas markets.

Kinh is a major ethnic group in Moc Chau (29.5% of the total population).This encourages cultural exchange between the ethnic groups and introduces new methods of production.

Moc Chau's economy is gradually becoming stronger with encouraged investment and increases in agricultural productivity.

❖ **Disadvantages:**

There is a complicated topography with small plain area and 50% of lands are sloping, mostly of more than $25^0$. Lands for agriculture are mostly upland with small and scattered lands suitable for wet rice cultivation. This creates difficulties for planning and constructing public works for agricultural production.

The relative difference of altitudes between the communes in the district results in the differences in temperature, rainfall and soil properties, etc. Thus the guidance on production and the introduction of new technology are more difficult to implement.

Drought and hoarfrost often occur And severe flooding occurs in the rainy season. In the dry season, potable water is very limited for remote rural areas.

The percentage of poor households is high (20.1% in 2000). Social evils (drug addiction) have been increasing drastically concurrently with the existing depraved customs which slow down the socio-economic development of the District.

### 3.1.4. Existing problems for mountainous rural communities

- ❖ Poor infrastructures.
- ❖ Lack of internal and external investments.
- ❖ Degradation of the environment.
- ❖ Poverty.
- ❖ Low level of literacy.
- ❖ Being isolated.
- ❖ Lack of new and advanced technology.
- ❖ Complicated topography.
- ❖ Poor healthcare and educational service systems.

**Degradation of mountainous rural environment and natural resources**

- ❖ Loss of forest area, exhaustion of the forestry resources.
- ❖ Soil erosion on sloping lands.
- ❖ Exhaustion of water resources.
- ❖ Environment pollution.
- ❖ Degradation of biodiversity.

## 3.2. ECOLOGICAL ZONING AND RESEARCH SITE SELECTION

### 3.2.1. Ecological zoning

Moc Chau's topography can be divided into 3 main zones with their own characteristics.

+ Zone of high terrain: includes communes and towns on the sides of National Highway $N^0$6 and adjacent to Moc Chau Collective Farm, Moc Chau Town, Muong Sang, etc.

+ Zone of low terrain: includes communes adjacent to Da River such as Na Muong, Quy Huong, Tan Hop, Quang Minh, Muong Te, Song Khua, Suoi Bang, etc.

+ Zone of medium terrain: includes Chieng Khoa, Xuan Nha, Hua Pang, etc.

### 3.2.2. Research site selection

Based on topographical characteristics and traffic conditions, Moc Chau can be divided into 3 zones which are different from those mentioned-above.

+ Zone adjacent to Da River: This is the lowest region in the district. Its terrain is hilly and heavily sectioned with steep slopes. The terrain is mainly covered by a protective forest that makes it very difficult to access.

+ Zone adjacent to National Highway $N^0$6: This is the zone of high terrain lying on Moc Chau Highland. The terrain is even and flat that allows easy traffic access. The forests here have been exploited to exhaustion. This zone has the biggest potential for economic development in the District in terms of both crop cultivation and livestock breeding.

+ Border zone: This zone is a medium high terrain which is slightly sectioned. The traffic system here is so poor that it is very difficult to access. Forests in this zone are abundant and mainly categorized as specific-use forests .

From the above discussion, three communes were selected as research sites including Na Muong Commune (Lakeside zone), Chieng Hac Commune (National Highway $N^0$6 adjacent zone) and Team $N^0$70 of Moc Chau Milk Company. From these locations, recommendations for the participatory rural environment management in mountainous areas will be introduced.

### 3.2.3. General characteristics of the three research sites

❖ **Natural conditions**

**Table 3. Land areas**

| **Type of land** | **Na Muong** (ha) | **Chieng Hac** (ha) | **Muong Sang** (ha) |
|---|---|---|---|
| **Total area of land** | 4,276 | 10,650 | 9,832 |
| **Agricultural land area** | 1,324 | 2,594 | 934 |
| Land area for wet rice cultivation | 33.50 | 120.3 | 195 |
| Land area for dry-land annual crops | 1,119 | 1,242 | 450 |
| Land area for mixed gardens | 119.5 | 346 | 117 |
| Land area for perennial trees | 52.1 | | 204 |
| **Land area for forestry** | 1,957 | 1,649 | 6,749 |
| Natural forest area | 1,605 | 1,620 | 1,096 |
| Planted forest area | 352.7 | 29.2 | 204 |

❖ **Social situation**

In Chieng Hac Commune, the percentage of poor households is relatively low. Only 4.7% of the total households has monthly income of less than 80,000VND per capita. Meanwhile, those figures for households with monthly income of between

80,000VND and 150,000VND per capita and between 150,000VND and 300,000VND per capita are 49.1% and 35.6%, respectively. Rich households share 10.6% of the total households with monthly income of greater than 300,000VND per capita. There are 2 primary schools, one secondary school, 1 kindergarten and 1 medical centre in the commune. The medical staff include 3 nurses and 1 orderly. Each village has one nurse on duty. Although Chieng Hac situates next to National Highway $N^0$6, the traffic system is still very poor due to dissected terrain. Roads are mainly unpaved creating difficulties for traffic and transportation, especially in rainy seasons. There are 22 automobiles, 7 tractors and more than 600 motorcycles in the Commune.

**Table 4. Populations in the Communes and their compositions**

| **N⁰** | **Commune** | **Ethnic groups (persons)** | | | | | | **Total** |
|---|---|---|---|---|---|---|---|---|
| | | Thai | Kinh | Dao | Muong | H'Mong | Sinh mun | |
| 1 | Na Muong | 788 | 478 | 775 | 1642 | 0 | 0 | **3683** |
| 2 | Chieng Hac | 2691 | 1756 | 0 | 37 | 1274 | 521 | **6279** |
| 3 | Nuong Sang | 2911 | 1632 | 1 | 258 | 0 | 0 | **4811** |

Na Muong is a poor commune of Moc Chau District. The percentage of poor households amounts to 16.83% which is relatively high. There is 1 primary-secondary school 1 kindergarten and 1 medical centre in Na Muong. The medical staff comprises 5 nurses, and 1 medical orderly. Besides, each village has 1 nurse on duty. Na Muong is within the Da River flood area. The trans-provincial road passes the Commune and the water ways make transportation very much easier in the dry season. Automobiles can access each village on the inter-village roads system.

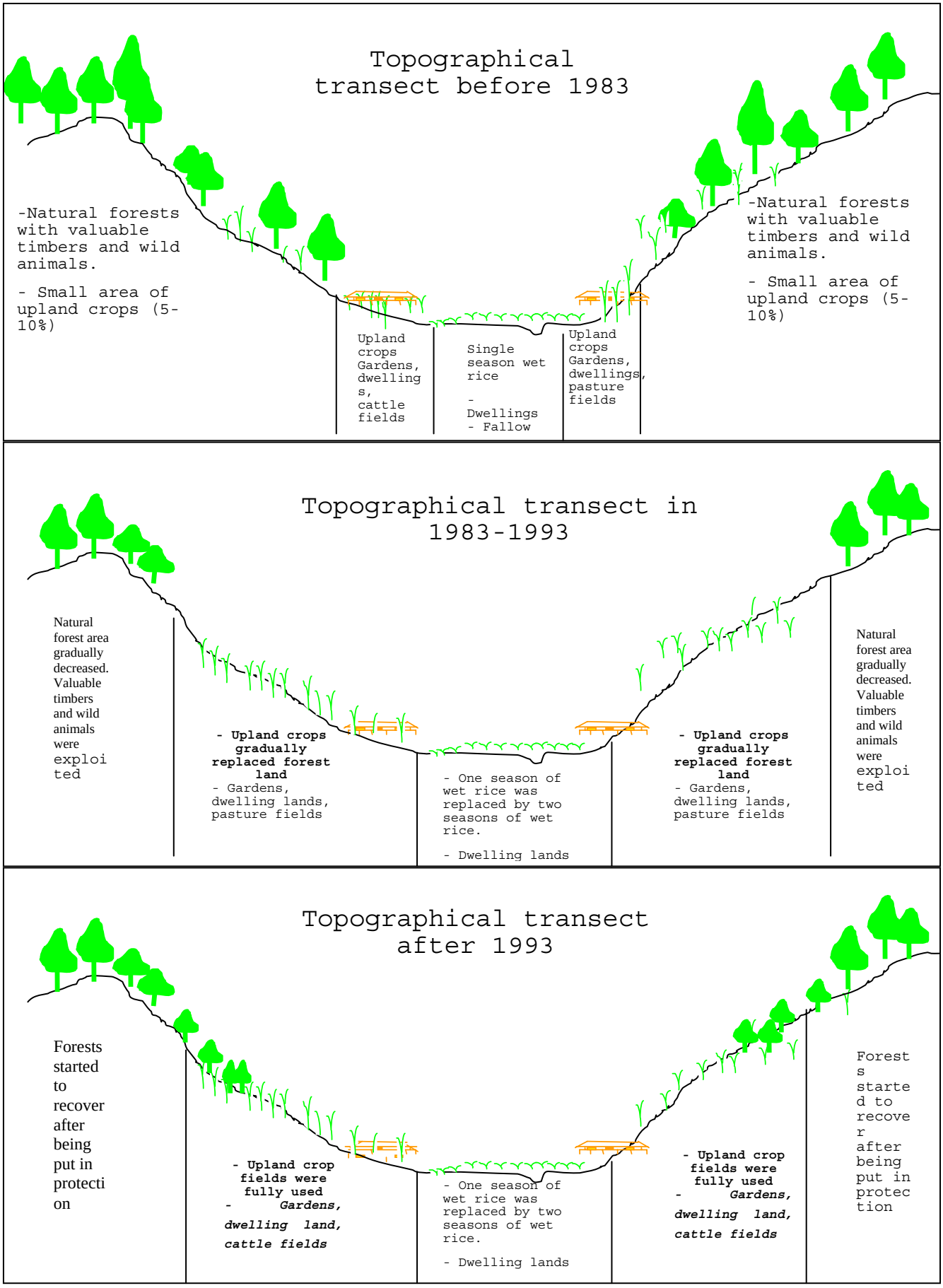
Muong Sang is on the Vietnam-Lao border and the traffic system is reasonably good. There is 1 kindergarten, 1 primary school, 1 secondary school and a 4 bed medical centre. The medical staff includes 4 nurses, 1 medical orderly. One nurse is one duty at each village.

**Table 5. The changing process from forest lands to sloping upland crop fields in Na Muong, Chieng Hac and Muoong Sang**

| Period | Change of forests | Change of upland sloping fields |
|---|---|---|
| Before 1965 | The area of forest covered more than 40% the land area. This was the period of recovery after the heroic war against French colonists. Forests started to be exploited. | The area of upland fields was small. People made a living by slash-and-burn method and growing upland rice and maize. Maize productivity was 1.5 tonnes per ha per season. Cycle of fallow was 5 to 7 years. Food production was for human consumption and livestock breeding. |
| From 1965 to 1983 | The resettlement program encouraged people from low-land regions move to uplands. Forest cover reduced to only 20 and 30% of land. | The area under upland crops increased sharply. Upland rice and maize were still the main crops but old varieties were used that gave low productivity. Cycle of fallow was 5 to 7 years. Food production was for human consumption and livestock breeding. |
| From 1983 to 1993 | Due to poor management of forests after the collapse of cooperatives and the food crisis, forests were overexploited. Forest coverage decreased to 10-15%. | The area under upland crops was nearly fixed. Maize cultivation gradually replaced upland rice cultivation. New maize varieties such as Q2 and TSB2 were introduced thus maize yield increased to 2-3.5 tonnes per ha per season. |

| | | |
|---|---|---|
| | | Cycle of fallow was decreased to 3 - 4 years. Food production was partly for goods exchange, the rest was for human consumption and for livestock breeding. |
| From 1993 to present | After the implementation of the policy of forest land allocation to households for management and protection, forest recovered quickly to cover more than 20% of land. | Upland crop area remained unchanged. Maize cultivation totally replaced upland rice cultivation. Hybrid maize varieties gave higher yield at 4.5-5.5 tonnes per ha. Land was fully exploited without fallow period. 100% of agro-products were sold. |

**Figure 8. Typical topographical transects in research regions in each period**



**Development history of cattle breeding at Moc Chau Cows Raising Company**

The company was established in 1958 with the main tasks of raising cows and milk processing. Currently, the Company possesses 1968 ha of land of which 1022 ha are for agriculture and 950ha are pasture fields.

**Table 6. History of the development of livestock breeding at Moc Chau Cow Raising Company**

| **Year** | **1990** | **1992** | **1994** | **1996** | **1998** | **2000** | **2002** |
|---|---|---|---|---|---|---|---|
| Number of cow heads | 1369 | 1253 | 1353 | 1458 | 1480 | 1453 | 2270 |
| Number of mother cows | 723 | 750 | 852 | 897 | 839 | 818 | 1276 |
| Milk production (tones/year) | 1582 | 1362 | 2133 | 2114 | 2003 | 2959 | 4959 |

***Source: Technological Department, Moc Chau Cows Raising Company.***

The Company implemented a new scheme in which each staff member received a limited number of cows for their own care and protection. The roles of the departments in the Company are to control the quality of milk, introduce new cultivation and animal raising techniques, and methods of milk preservation. There are 504 households of 600 staff participating in this scheme. Each household raises averagely 4 to 5 cows. The percentage of households with more than 15 cows accounts for 15-17%. The Company also signed contracts with other households in the region to buy cow milk.

## 3.3. ASSESSMENT OF ENVIRONMENT DEGRADATION IN MOC CHAU BY LOCAL COMMUNITIES

### 3.3.1. Pressures on the environment

In the recent years, food production in mountainous regions including Moc Chau has changed from self-sufficient to more market-oriented with more commercial products. However, this process and the overexploitation of natural resources to meet

increasing demands of local people have greatly changed the landscape environment in the mountain rural areas, which by nature is already very fragile.

The main process occurring in the mountainous regions in general and in the research areas in particular was the expansion of cultivated land at the expense of forest cover area.

On sloping lands, the comparatively stable forest ecology system has been changed to much less stable shifting cultivation pattern making sloping land vulnerable to soil erosion. This is the major cause of degradation of the mountainous environment.

The production development process has put great pressures on the environment by different ways and at different levels overtime. The pressures at the research area can be described as follows:

❖ **Pressures on the environment**

1. Pressure from food demand;
2. Pressure from need for agricultural products;
3. Pressure from the need to increase income;
4. Pressure from intensive agricultural production.

❖ **Spatial distribution of pressures**

| |
|---|
| **Forest**<br>Pressure from income increasing needs: timber exploitation |
| **Used to be forest zone**<br>Pressure from food demand<br>Pressure from need for agricultural products (such as hybrid maize) |
| **Upland crops fields**<br>Pressure from food demand<br>Pressure from need for agricultural products (such as hybrid maize, plum, canna) |
| **Valley wet fields**<br>Pressure from intensive agricultural production (hybrid rice, fertiliser, pesticide) |

❖ **Scenario of pressure in time and pressure intensity**

| |
|---|
| 1975 - 1983<br>***Cooperative-run land management and agricultural production***<br>- Pressure from food demand: food demand was high but the level of this pressure was low because farmers were under cooperative control.<br>- There was no pressure from increasing income (not allowed)<br>- There was no pressure from tradable agricultural goods (not possible). |
| 1984 – 1993<br>***Period of changing ownership from cooperatives to households***<br>- Pressure from food demand: extremely high because of free labour force and poor forest management.<br>- Pressure from increasing income: timber and forest products were intensively exploited. The pressure level was high due to poor forest management.<br>- Pressure from agricultural goods: was not very obvious and at a low level. |
| 1996 – 2002<br>**Households controlled land resources and the production**<br>- Pressure from foods was not high since 60% of rice could be locally produced. The deficit could be filled by purchasing in the market.<br>- Pressure from increasing income: exploitation of timber and other forest products was banned. There were not enough pasture fields.<br>- Pressure from agricultural goods: at high level because hybrid maize gave a higher yield and corn was easily sold. Local labour force was not enough so that there appeared the need for hiring labour from other regions.<br>- Pressure from intensive farming: valley fields. |

❖ **Pressures on the environment in the period when cooperatives controlled land and managed the production (1975-1983)**

In this period, the production belonged to cooperatives. Cooperatives managed all production activities. Products were redistributed based on labour contribution (labour days) and household members (including people who were out of or not yet in the labour age).

Pressure from food demand: In this period, the demand of foods was high due to the pressure from population growth and low productivity. However, the pressure on the environment was not significant thanks to cooperative's policies of tight management of production and labour.

**Forest**: Forest area remained large with rich resources. There was low pressure except from local people's activities of minor exploitation to meet their everyday needs. Thus, the forest still held its balance (less threat on the ecological system). The pressure from food demand did not affect the forest environment.

**Invasion of forest land area:** Due to very large areas of forests and limited labour time for reclaiming forest lands (only out of the working hours in cooperatives), the invasion area of forest land for food crops was comparatively small (shifting cultivation fields), especially in favourable places like with fertile soil and gentle slopes. The reclaimed land was used for a short time, followed by a long fallow period. Therefore, forest coverage remained high. Pressure from food demand on this area was negligible.

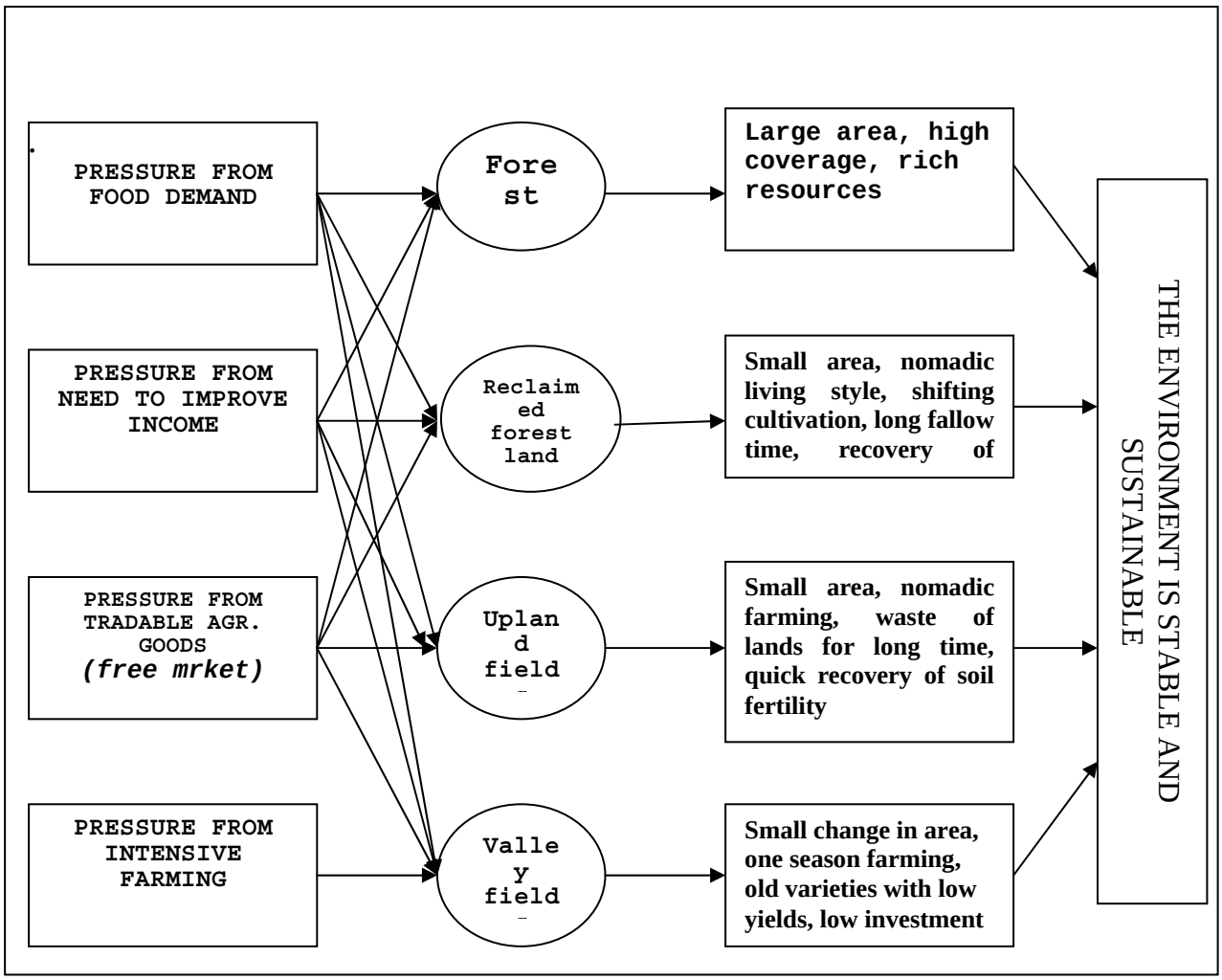
**Upland crop fields** occupied only small areas of which a part belonged to cooperatives for food production. Hence, the use of upland was very well planned. The other parts were in possession of local people for seasonal cultivation. It could be said that the food demand did not impose a great pressure on the environment.

**Valley fields** were totally controlled by cooperatives. Local varieties of crops with low yields were used in food production. Intensive farming was not of prime importance. The agricultural production had not imposed any pressure on the environment.

- There was no pressure for tradable agricultural products. In fact, the people at that time did not know about markets. Main products were delivered from the government to the cooperatives. Therefore, the pressure for tradable agricultural products did not exist.
- There was no pressure to increase income. However, the demand for foods had increased sharply especially at the end of this period. The cooperatives did not allow people to satisfy their needs by themselves.

- There was no pressure from intensive farming on the environment. Low investment for agricultural production meant less impact on the environment.
- **Summary:** In this period, the food demand was high due to high population growth rate. However, the pressures on the environment were minimal. The environment had still maintained its balance and stability. Locally, people faced many difficulties, and especially the shortage of food which occurred everywhere.

❖ **Pressures on the environment in the period when cooperatives controlled land and managed the agricultural production (1975-1983)**



❖ **Pressure on the environment in the period of changing ownership from cooperatives to households (1984-1993)**

Due to the increasing food demand, unsuitable methods of production and management had been replaced by more suitable ones. Land and production management did not cope with the increasing demand for increased production. Therefore, the improvement was made by changing the ownership from cooperatives to households. This created a new atmosphere for the production environment in the region. The leadership role of cooperatives had been reduced. Farmers became free to decide their own production plans. The pressure on the environment in this period was of a different level and different characteristics compared to previously.

***Pressure from food demand***

- In this period, food demand was very high and could not be met.

+ Valley fields with small areas were used to cultivate one crop of wet rice. New crop varieties and technologies were not yet introduced. Old varieties with low yields and poor cultivation methods were still popular among farmers. Furthermore, cooperative ownership did not encourage initiatives and dedication from the farmers. Rice production only met 15% of food demand of the region. It was obvious that the area of valley fields had to be extended.

+ Shifting cultivation was not capable providing sufficient food for the local people. The fallow cycle had to be reduced. Extensive farming and low yield varieties were dominant. Newly developed cultivation techniques were not introduced. Other crops such as fruit trees, tea, mulberry and canna, etc. played a minor part in household income. Food production from sloping land cultivation was not enough for local consumption. Government aid was vital.

+ Other economic activities were mainly self-sufficient.

- Livestock breeding could only satisfy local demand. Food shortage and malnutrition were very common.

- The explosion from production activities to meet the food demand had put pressure on the environment. Land and forest were under very poor management. Farmers had the freedom to work on their own.

- **Pressure on forests**: The forest area shrunk rapidly. The reclaimed forest land was use for cultivation of short cycle food crops. In 1990-1993, the forest coverage was only 10% of the total area and located mostly on the remote mountainous areas. The pressure on the forest was very high.
- **Pressure on reclaimed forest land and upland crop fields**: The reclaimed forest land was completely used for agricultural production. The area for short cycle food crops was gradually expanded. Fallow land was reclaimed to increase the agricultural production area. The land use efficiency in this period was higher than that of the previous period.
- **Pressure on valley fields**: This pressure was negligible since the food demand was mainly satisfied by upland cultivation.

***Pressure from the need to improve income***

In the previous period, this pressure was not a problem due to the strict management of production and redistribution of goods by cooperatives. Private production activities were not allowed. After the new policy was introduced, the need to improve incomes of households became clear. The main income was from exploitation of timber and other forest resources using the local labour force. The level of exploitation became more severe due to the poor forest management. The forest resources were rapidly degraded. Most of the resources were exported to other regions. The need to improve income had directly put a very high pressure on the forests.

In other areas, the need to improve income had a modest effect since production was only to meet the local demand.

***Pressure from tradable agricultural products***

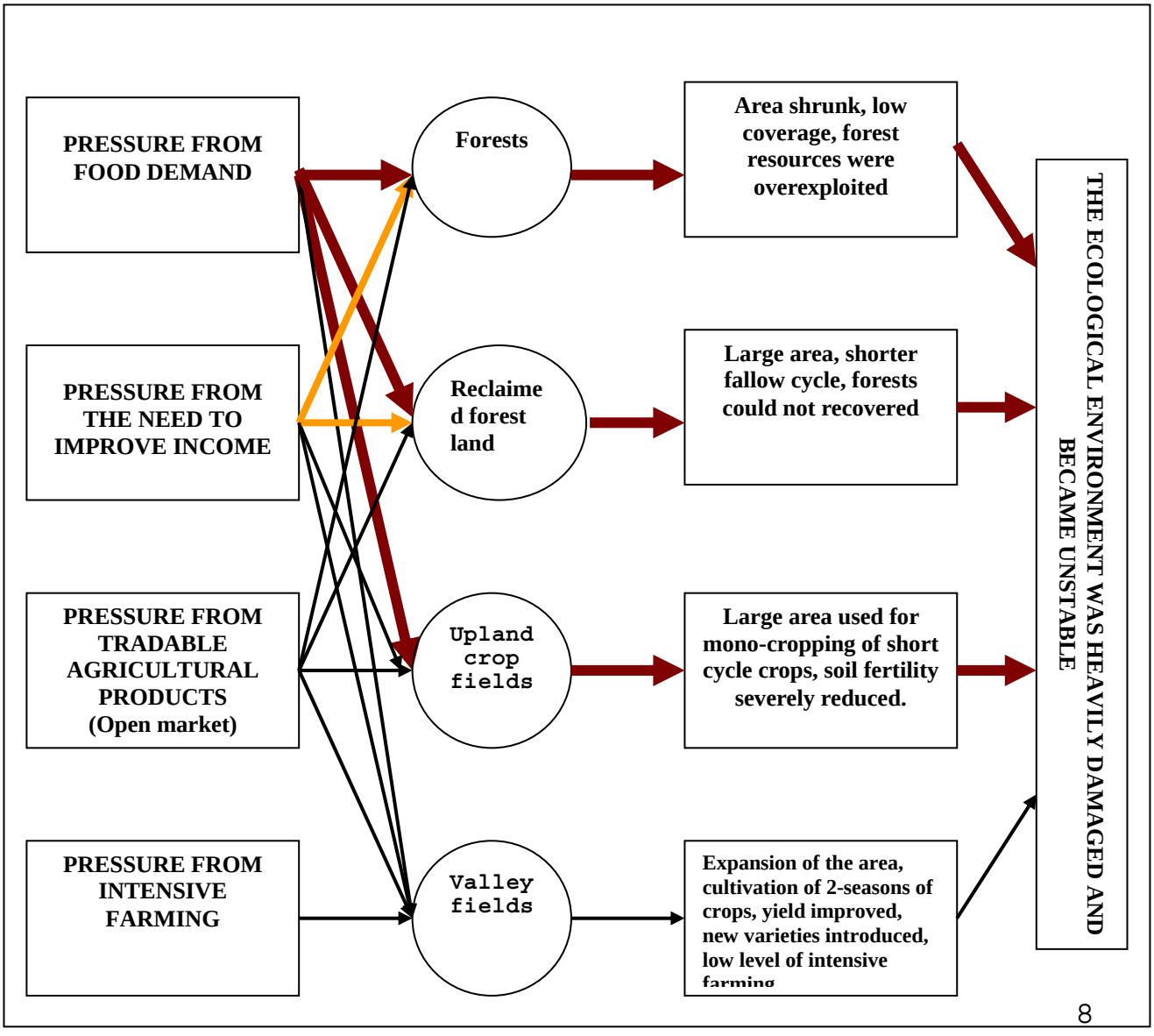
When food demand was satisfied then the surplus would be tradable. However, when the amount of surplus was not much then the pressure on the environment was not severe.

***Pressure from intensive farming***

In this period, the main production was extensive farming. Intensive farming was only used for cultivation of irrigated rice in the valley field but only at low levels. The pressure from intensive farming on the environment was not apparent.

In summary, for 20 years, the food demand had changed the sustainable forest ecological system to the unstable upland cultivation ecological system. The pressure from the need to improve income on forest resources was more apparent and at increasing intensity. Tradable agricultural products had appeared but their impact on the environment was only at minor scale.

- **Pressure on the environment in the period of changing ownership from cooperatives to households (1984-1993)**



❖ **Pressures on the environment in the period of households' full control of land and production decision making (1994-2003)**

Due to the pressure from food demand in the previous periods, farming land was fully expanded. The environment had been heavily damaged by human activities. After a long time of poor management of lands and forests, the rich natural resources area with high biodiversity was transformed to a low fertility soil area with poor natural resources.

When the food demand was fully satisfied and people's everyday life was very much improved, there other needs. The local people's view of agricultural production was very different from the past. For example, in the past, the yield was calculated by the amount of food per a unit land area or the amount of food per capita; presently, the yield was calculated by the amount of cash per unit land area or the amount of millions of VND per capita. New requirements arose when farmers are able to control of their land and labour:

- Change of cropping patterns for markets.
- Need for new crops varieties with high value.
- Need for newly developed cultivation techniques.
- Need for investment including capital, labour and input materials.
- Establishment of large production zone.
- Need for improved infrastructure.

The pressures on the environment were different from the previous periods in terms of nature and intensity.

***Pressure from food demand***

Irrigated rice cultivation on valley fields gave higher efficiency. Mono-wet rice cropping was replaced by double rice patterns yearly. New varieties of rice suitable to the local ecology were introduced to the region. Investment for agricultural production had been increased. Fertilisers were used in almost all areas of cultivated land. New varieties of crops were replacing the local ones. Pesticides were widely applied for rice cultivation, especially in the summer season. Rice yield and production were increased

sharply. This guaranteed the stability of the regional food reserve. To date, the rice production had satisfied approximately 60% of the local demand. The deficit was easily filled up by purchasing in the markets. Therefore, the pressure from food demand had decreased in the region.

***Pressure from the need to improve income***

Due to tight forest management, timber and forest resources exploitation were totally banned. The pressure from the need of improve income had a less impact on the forest.

There were not enough pasture fields because lands were privatised. Large cow and pig farms were setup causing other problems to the environment such as solid waste, waste water, and bad odour, etc. causing big problems to public health.

Other economic activities include small production businesses (to process corn, canna, etc.), service, trading sector and small mechanical businesses. These businesses had given a significant contribution to the economic development of the region. Some households' incomes had improved with less impact on the environment.

***Pressure from tradable agricultural products***

When the demand for foods were satisfied thanks to rapid development of irrigated rice cultivation and the expansion of upland crop fields, methods of cultivation had been changed rapidly. Hybrid maize varieties were introduced that gave very high yields. Maize had shown a high competitiveness over other crops and this caused the change in crops structure in the uplands.

The land area for maize cultivation had been increased significantly. Maize replaced upland rice and cassava. Maize cultivation resulted in a shortened fallow period, changing shifting fields into that of maize mono-culture.

Maize production was not only enough for local demand but also for export to other regions. It was estimated that more than 90% of maize production was for export.

Intensive maize cultivation has become increasingly dominant and fertilisers are widely used. Currently, maize is the most important crop for the region that provides main incomes to locals farmers.

Other crops with high market value were also expanded:

+ Plum used to be the most profitable crops for the region, especially in temperate areas. However, plum supply had largely exceeded demand thus lowering the plum price. So, the plum growing area has been gradually reduced.

+ Canna was also a valuable crop in the region. However, the growing area for this crop was limited due to the fact that the area of soil suitable for growing canna was not large. Furthermore, canna was not a single crop. It must be cultivated alternatively with other crops after being planted for 1 to 2 years.

+ Tea production was heavily dependent on the post-harvest processing technology. The tea growing area depended on this, and on demand for tea. The tea growing areas was mainly active on collective farms in the period of 1960 - 1970.

In this period, the pressure from tradable agricultural products had been at a higher level. New pressures on the environment had appeared.

Agricultural land was expanded especially in remote areas where abundant land resources were still available for maize cultivation. Local people still reclaimed land from the forests (mostly natural recovered forests). However, this matter was quickly changed by the policy of giving households the right to take care of and protect the forests.

Hybrid maize was successfully cultivated in the sloping land, thus making full use of lands. Maize had been the main source of income for the local people.

+ Maize growing area increased to maintain the income source for the local people. The off season time was made shorter so farmers could cultivate maize all year round. In some areas, maize was grown in 2 seasons of the year.

+ More capital was invested to maintain and increase maize production. The labour force in the region was fully employed. Labour from other regions was also employed to support maize cultivation in the region. The amounts and types of fertilisers were also increased.

+ Maize had replaced other crops such as upland rice, tea, cassava and plum. The area under maize cultivation was the largest and maize also gave the highest economic return to farmers.

Investment for intensive cultivation of wet rice was also increased. Wet rice was cultivated 2 seasons in a year. Fertilisers and pesticides were widely applied.

Heavy investment was placed for resource exploitation. Investment included improved seeds, fertilisers, pesticides and labour. Employing outside labour was very common among local households.

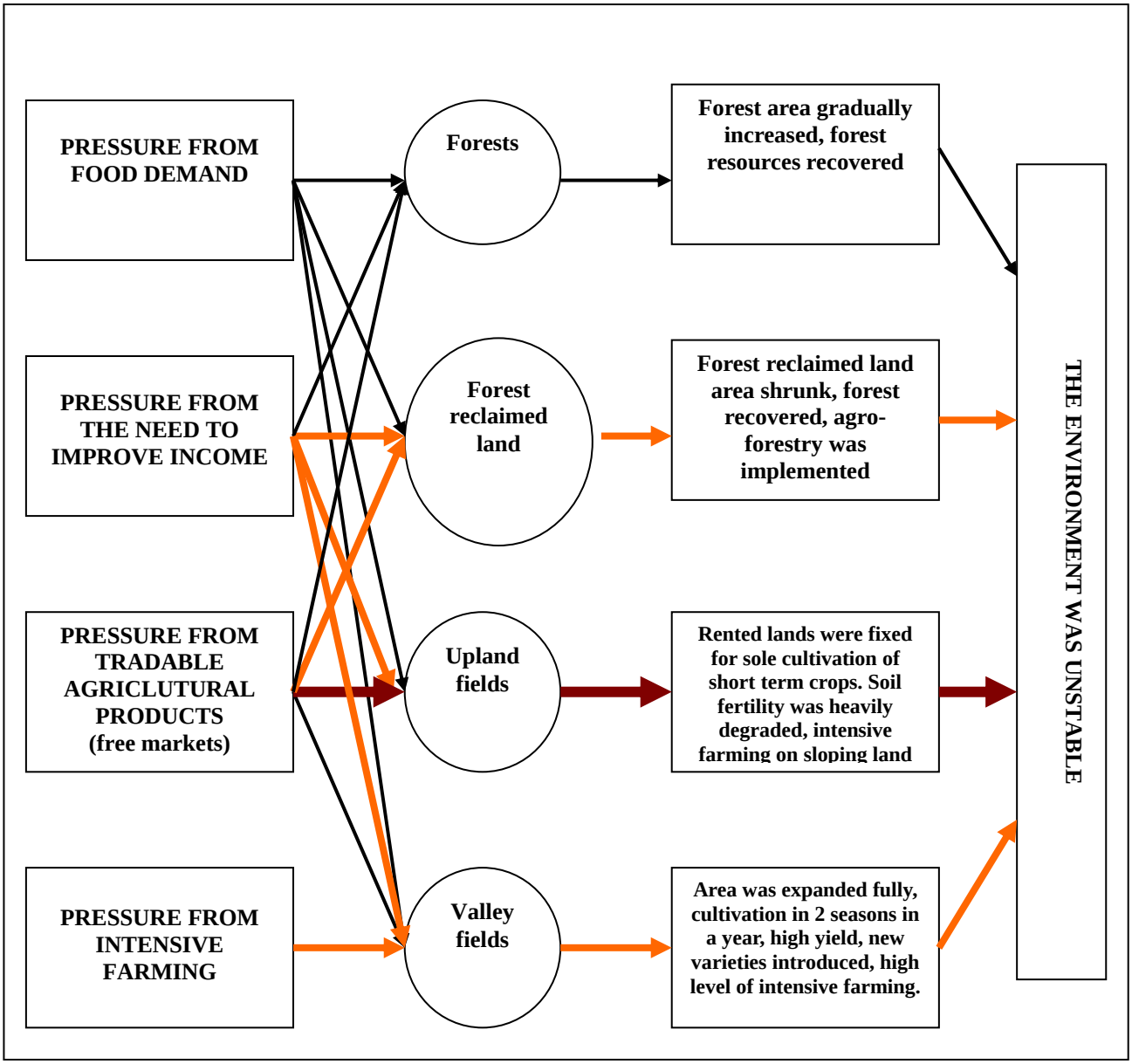
The need for improving income had put pressure on almost all areas at an increasing level. This pressure on upland fields was the largest. Overexploitation of land had made the soil heavily degraded.

**Pressure from intensive farming**

Investment on intensive cultivation of wet rice was also increased. Wet rice was cultivated 2 seasons yearly. Fertilisers and pesticides of various kinds were widely applied to maintain and raise the maize production. The intensive use of these agro-chemicals had somewhat negatively impacted to the living environment of the local communities.

**Summary:** Farming activities in this period had been very intensive. The change from self-sufficient production system to market-oriented production system had a significant impact on the local environment. However, it must be noted that the region's economy had been at high growth rate, and the standard living of the local people had been significantly improved.

❖ **Pressures on the environment in the period that household had full control of lands (1994-2003).**



### 3.3.2.Environmental problems that face local communities

| Pa Phang Village | Ke Teo Village | So Luon | Team 70 |
|---|---|---|---|
| 1. Land degradation due to soil erosion. Using fertilizers was a must.<br><br>2. Pesticides were increasingly used for irrigated rice cultivation. Pesticide sprayers' health was threatened. | 1. Severe degradation of soil. Some land areas lost production capacity.<br><br>2. Residential environment seemed to be polluted due to high population density, livestock breeding development, and lack of wastewater and waste treatment systems, cattle rearing near the village. | 1. Severe degradation of soil in upland fields. Maize yield decreased.<br><br>2. Water sources were not regularly available: too much water in rainy season while no water in dry season. | 1. Residential environment was severely degraded: cow dung releases, bad smell of cow shelter, washing water.<br><br>2. Soil became poorer due to growing fodder crops. |
| 3. Residential environment seemed to be polluted due to high population density, livestock breeding development, and lacks of wastewater and waste treatment systems. | 3. Forest resources degraded as area shrunk, low timber quality, wildlife disappearance. | 3. Forest resources degraded as area shrunk, low timber quality, wildlife disappearance. | 3. Ground-water level is lower, there were signs of water pollution from infiltrated wastewater. |

| Pa Phang Village | Ke Teo Village | So Luon | Team 70 |
|---|---|---|---|
| 4. Forest resources degraded as area shrunk, low timber quality, wildlife disappearance.<br><br>5. Water sources were not regularly available: too much water in rainy season while no water in dry season. | 4. Water sources were not regularly available: too much water in rainy season while no water in dry season | | |

### 3.3.3. Main causes to the environment problems

| | Pa PhangVillage | Ke Teo Village | So Luon Village | Team 70 |
|---|---|---|---|---|
| Poor soil conditions | - Continuous cultivation of maize.<br>- Growing new maize varieties made the soil poorer. | - Large sloping land, continuous cultivation.<br>- Double cropping patterns practiced yearly.<br>- Ploughing on very steep land area | - Long and continuous cultivation.<br>- Ploughing on very steep land area | - Under long and continuous exploitation.<br>- Low soil fertility. |
| Pesticides | - New rice varieties are very vulnerable to pests and need large amounts of pesticides.<br>- Lack of safe working equipment.<br>- Lacks of knowledge on the pesticides. | | | |
| Residential environment polluted | - Development of livestock breeding.<br>- Livestock breeding areas close to residential area,<br>- Not enough pasture.<br>- Lack of waste treatment and drainage system. | - Development of livestock breeding.<br>- Livestock breeding area close to living area.<br>- Not enough pasture.<br>- Lack of waste treatment and drainage system. | | - Increase in number of cows.<br>- No wastewater treatment and drainage system.<br>- Workers work and live at the same place. |

| | Pa PhangVillage | Ke Teo Village | So Luon Village | Team 70 |
|---|---|---|---|---|
| Degradation of forest resources | - Expansion of cultivating land.<br>- Timber and other forest resources were overexploited. | - Expansion of cultivating land.<br>- Timber and other resources were overexploited. | - Expansion of cultivating land.<br>- Timber and other resources were overexploited. | |
| Water sources | - Loss of forest.<br>- Accumulated stream deposits | - Loss of forest.<br>- Accumulated stream deposits | - Loss of forest.<br>- Accumulated stream deposits | - Loss of forest.<br>- Solid waste |

### 3.3.4. Difficulties that the local communities face in environmental management

| Pa PhangVillage | Ke Teo Village | So Luon Village | Team 70 |
|---|---|---|---|
| - Lack of capital investment to purchase fertiliser.<br><br>- Shortage of labour force.<br><br>- Lack of substitution crops for maize<br><br>- Lack of suitable cultivation techniques to protect the soils.<br><br>- Lack of appropriate policies to encourage participatory forest management and development. | - Shortage of lands<br><br>- Lack of substitution crops for maize.<br><br>- Lack of capital investment to develop livestock breeding sector and to purchase fertilisers.<br><br>- Lack of suitable cultivation techniques to protect the soils.<br><br>- Lack of appropriate policies to encourage participatory forest management and development. | - Poor infrastructure resulted to limitation for trading.<br><br>- Lack of capital investment.<br><br>- Lack of substitution crops for maize<br><br>- Lack of appropriate policies to encourage participatory forest management and development. | - Lack of investment to build the waste treatment system.<br><br>- Lack of investment for intensive farming on pasture fields.<br><br>- Limited knowledge on health and work safety. |

### 3.3.5. Expectations of local communities from environment management

| Pa PhangVillage | Ke Teo Village | So Luon Village | Team 70 |
|---|---|---|---|
| - Capital investment for agricultural production, especially for maize.<br><br>- Substitution crops for maize which have high yield and can protect the soils.<br><br>- Suitable soil protection techniques.<br><br>- Appropriate policies that increase the benefits for those who are protecting the forests and helping the recovery of forests. | - More lands for livestock breeding and cultivation.<br><br>- Capital assistance to promote livestock breeding, intensive farming and tree planting for timber.<br><br>- Appropriate policies that increase the benefits for those who are protecting the forests and helping the recovery of forests. | - Improvement of the roads system for good trading.<br><br>- Substitution crops for maize.<br><br>- Capital assistance to invest in agricultural production.<br><br>- Appropriate policies that increase the benefits for those who are protecting the forests and helping the recovery of forests. | - Capital for building waste treatment system.<br><br>- Improvement of local health care system.<br><br>- Techniques to protect and improve impoverished soils. |

### 3.3.6. Roles of the local communities in environment management

| | Pa PhangVillage | Ke Teo Village | So Luon Village | Team 70 |
|---|---|---|---|---|
| Land resources | - Focusing on intensive farming on upland to maintain yields and to protect the soils.<br>- Practicing soil protection techniques. | - Using fallow for some time.<br>- Implementing alternative farming.<br>- Changing crop structure (plant more fruit trees, and forest trees). | - Increasing intensive farming on upland fields to maintain crop yields and to protect the soil.<br>- Changing crop structure (plant more fruit trees and forest trees). | - Mixed farming.<br>- Alternative farming. |
| Pesticides | - Following suggested instructions.<br>- Protecting labourers from harm. | | | |
| Residential environment | - Moving cattle out of residential area.<br>- Setting up simple sewage drainage systems.<br>- Keeping residential area clean and hygienic | - Moving cattle out of living area.<br>- Setting up simple drainage systems.<br>- Keeping residential area clean and hygienic. | - Moving cattle out of living area.<br>- Keeping residential area clean and hygienic | - Building new and durable cattle breeding facilities.<br>- Constructing septic tanks for wastewater.<br>- Discharging wastewater to pastures.<br>- Keeping cattle breeding facilities clean and hygienic.<br>- Setting up clean water supplying system.<br>- Supplying safety equipment. |

| | **Pa PhangVillage** | **Ke Teo Village** | **So Luon Village** | **Team 70** |
|---|---|---|---|---|
| Forest resources | - Protecting the allocated forest areas.<br>- Planting more trees annually.<br>- Exploiting a specified amount of timber. | - Protecting the allocated forest areas.<br>- Planting more trees annually.<br>- Exploiting a specified amount of timber.<br>- Protecting the primitive forests. | - Protecting the allocated forest areas.<br>- Planting more trees annually.<br>- Exploiting a specified amount of timber. | |
| Water resources | - Using clean water from water tanks provided by Program 135).<br>- Improving the irrigation system. | - - Using clean water from water tanks provided by Program 135). | - Using clean water from water tanks provided by Program 135).<br>- Improving the irrigation system. | |

## 3.4. THE PRESENT ENVIRONMENTAL SITUATION IN MOC CHAU DISTRICT

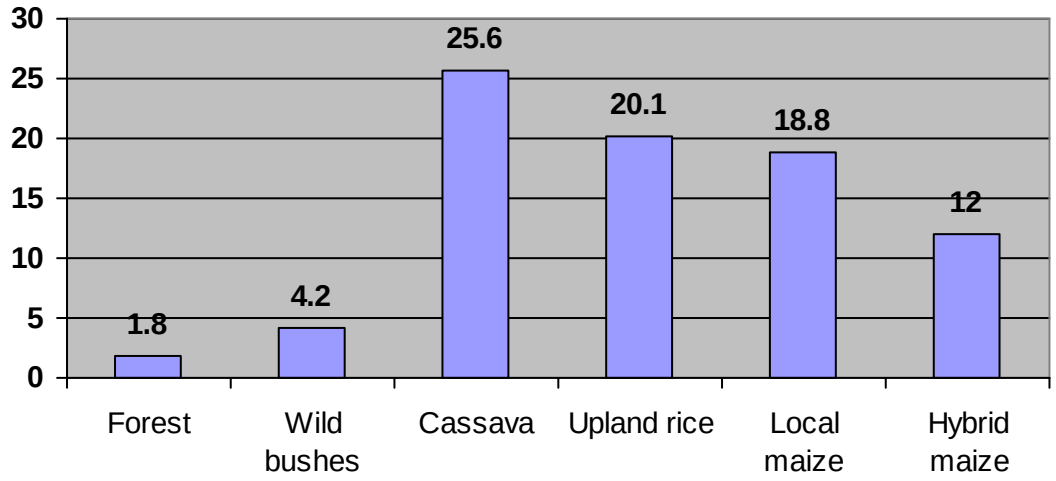
### 3.4.1. Degradation of sloping lands

Maize was the major crop in Moc Chau crops structure. In 2002, maize growing land area was 11259 ha, occupying 34.46% of the total agricultural land. This figure was 2.4 times and 3.7 times higher than those in 1996 (4685ha) and in 1990 (3045ha). The Summer-Autumn maize growing area increased significantly from 20 ha in 1990 to 585ha in 1996 and to 3500 ha in 2002. Most of the maize growing areas were on sloping land of $10^0$ - $35^0$. The mono-culture of maize on sloping land without protection measures has reduced the quality of the soils. This was described using the following criteria:

❖ **Degradation of soils**

Crops cultivation in Moc Chau had been greatly dependent on the rainwater, thus the cultivation season was normally from March when rainy season starts. At this time, the degree of tree coverage on land was approximately zero. Furthermore, fields were ploughed by using buffaloes, ploughing machines and by manpower. These activities had increased the erosion of soil. According to Rambo and Terry (1998), 130 tonnes of surface soil were depleted per ha per year when the sloping degree was $27^0$. However, the amount of eroded soil also depended on the land use. Research at Da Bac District, Hoa Binh Province by a team of researchers at Hanoi University of Agriculture had shown the same results.

Figure 9. **Amounts of eroded soils (tones per ha per year)**




***Source: Journal of Agricultural Technology No 2 - 2003, Hanoi University of Agriculture***

According the survey conducted by our research team at Pa Phang, Chieng Hac, So Luon and Muong Sang on people at ages of 30 and over, 60% of responses revealed that the surface soils on their lands had been eroded up to 40cm to 50cm depth; 32% of responses said that the figure was 20cm to 30cm after 10 years of maize cultivation; only 3 people said that their lands had not suffered from erosion as the lands were in the valley with low slopes ($4^0$ to $8^0$). In Na Muong and Ke Teo Villages, maize was cultivated in 2 seasons per year for 4-5 years. Farmers worried that in the next 5 to 7 years, their lands could not be used for maize cultivation.

❖ **Degradation of soil chemical and physical properties**

Local people said that in early years after reclaiming from the forests, the soils had black-brownish colour containing many rotten tree roots, and no gravels. Soils were very easily ploughed. Presently, soil colour is red-brownish and is not easy to plough. Gravels appeared in soils with sizes ranged from 1to 2cm and bigger.

Before 1995, maize was planted in the mid-March when brief but hot and dry westerly wind came early. However, since then, this type of wind occurred over a longer time. In addition, soils had been so heavily degraded that the sown seeds

germinate only when it rains. Thus, the maize growing time had to be postponed to April.

❖ **Degradation of soil fertility**

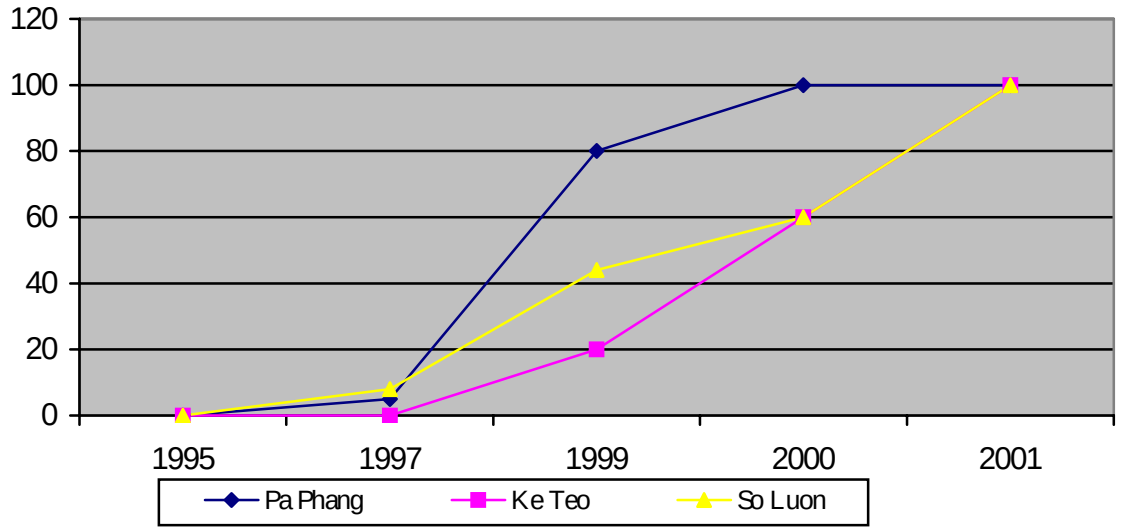
After 10 years of maize cultivation, the surface soil had been eroded on average by 20cm to 30cm in depth. If an assumption that the soil specific weight was 1-1.2 $kg/dm^3$, the percentages of N, $P_2O_5$, $K_20$ in soil were 0.1%, 0.05% and 0.05%, respectively was made, after 10 years, the total amount of eroded soil was 2000 tonnes to 3600 tonnes, and the amounts of wasted nutrients would be: 2.0 tonnes to 3.6 tonnes of N (equivalent to 4.35 tonnes to 7.83 tonnes of urea), 1.0 tonnes to 1.8 tonnes of $P_2O_5$ (equivalent to 5.56 tonnes to 10 tonnes of super phosphorous), 1.0 tonne to 1.8 tonnes of $K_2O$ (equivalent to 2.0 tonnes to 3.6 tonnes of potassium sulphate). This analysis showed that farmers must apply fertilisers heavily.

Before 1995, local farmers never used fertilisers for crop cultivation (except at the Kinh households) as soil conditions were good and local crop varieties were used. After high yield maize varieties (such as $TSB_2$ and Mexico) were introduced to replace the local varieties, there was no demand for fertiliser as new varieties still gave higher yield. Then, hybrid maize varieties such as Bioseed 9698, LVN10, DK888 and DK999, etc. were introduced making maize production very stable. However, this stability could not exist for long and maize yields decreased sharply, forcing farmers to use more fertilisers.

A survey conducted in Pa Phang - Chieng Hac, Ke Teo - Na Muong, So Luon - Muong Sang showed that most of the households started applying fertilisers from 1997 onwards.

The amount of fertilisers used varied greatly, depending on farmers economic situation and knowledge of fertilisers.

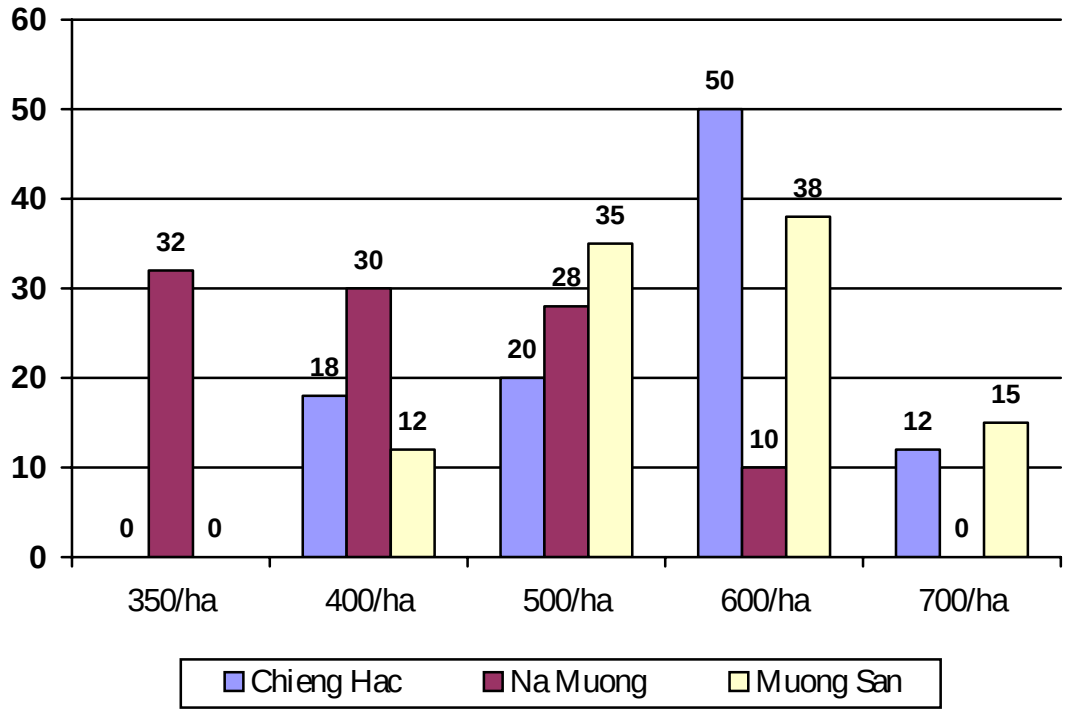
**Figure 10. Percentage of households using fertilisers for maize cultivation**




***Source: Farm Households survey***

Results from the survey showed that farmers did recognise the importance of using fertilisers and 100% of households reported that without using fertilisers, maize yields had decreased by 40% to 60% in the first year and by 50% to 70% in the second year compared to the situation when fertilisers were used. Unfortunately the fertilisers used for maize cultivation did not contain potassium, an element which maize needs to grow.

**Figure 11. Percentages of fertilisers used for maize cultivation at different scales in 3 communes in Moc Chau (Urea : Super phosphate = 1:2)**




***Source: Households survey***

❖ **Trend to increase labour investment**

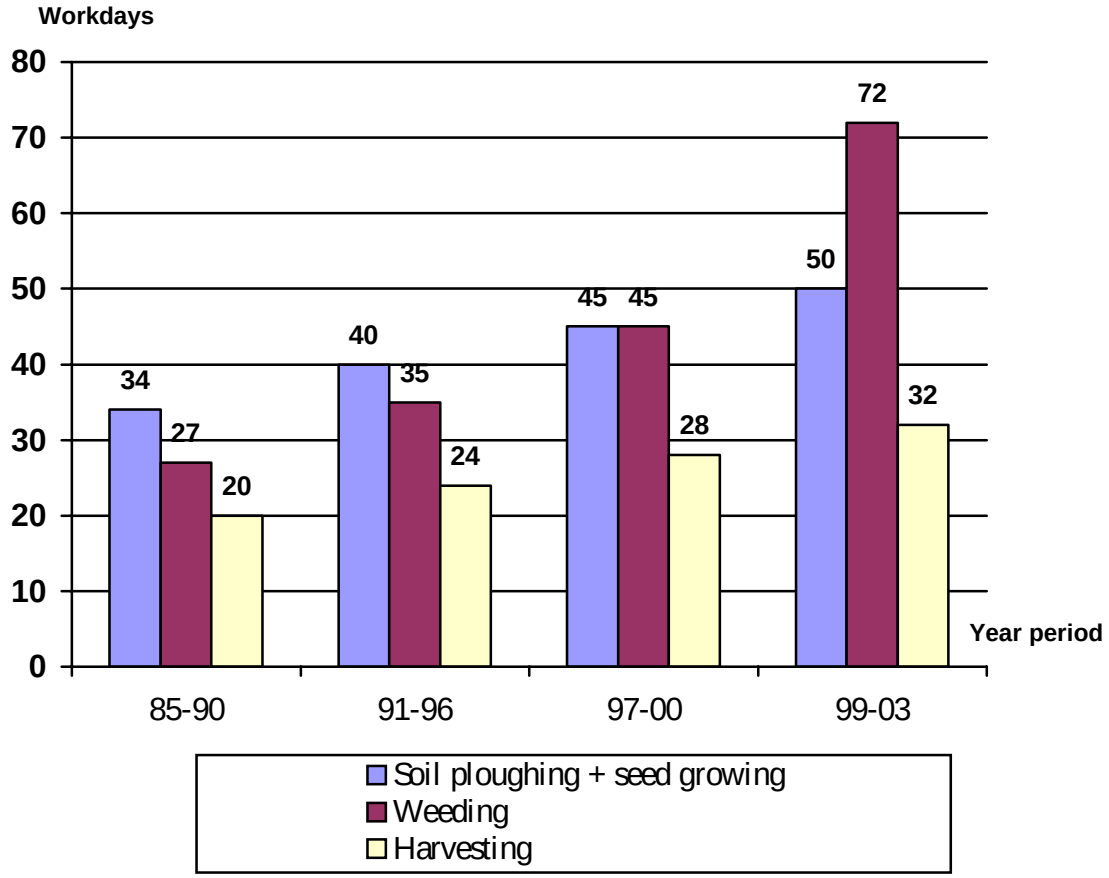
Due to the erosion of good surface soil, the soil became harder and drier. More human and animal labour was utilised for ploughing work.

In the past, local maize varieties had tall plants with large leaf angles, thus the distance between plants was large. In opposition, new maize varieties had shorter plants with more erect leaves, thus the distance between plants can be reduced. This required more labour for sowing.

When soil conditions were good and soil moisture was high, maize had a short growing time, with little growth of weeds. After years of cultivation, soil was degraded that led to long growing time in maize. Weeds had a chance to grow faster than the maize, and more labour was required for weeding. Local people revealed that weeds

in the fields had to be cleared twice a year, and approximately 200- 300 working days per growing season were required for each household.

**Figure12. Required labour for maize cultivation**




### 3.4.2. Degradation of forest resources

The north-western region of Vietnam used to have rich forest resources. The total land area of 4.62 millions of hectares used to be covered by natural forests. Recently, because of the pressures from fast growing population, nomadic living and shifting cultivation, and the policies from the local government allowing people to exploit forest resources, there are 4 million hectares of bare lands and hills. The forest coverage was 85% in 1945, 20.9% in 1965, 10.6% in 1985 and 6-7% in 1993. The consequence was frequent natural disasters such as flooding, droughts, hoarfrost, hot and dry westerly winds, etc.. Moc Chau was in this region and suffered the same problems. When free market economy was introduced, agricultural production

changed from rice cultivation for self-supply to market oriented maize cultivation. Uplands were totally used for maize cultivation. The following changes took place:

❖ **Reduction of forest protection capacity and exhaustion of water resources.**

Protective forests were used to protect the water resources, to control soil erosion, to regulate the climate and to protect the environment. According to the Decision $N^0$ 278 of the Prime Minister issued on 11 July 1975, the exploitation of forest land for cultivation was specified in Table 7.

**Table 7. Specifications in Decision $N^0$ 278**

| Slope | | Soil thickness (cm) | Methods of utilization |
|---|---|---|---|
| In degrees | In percentage | | |
| <15 | < 27 | >35 | Cultivation on terraced fields |
| 15 - 18 | 27 - 33 | .>35 | Cultivation on terrace fields along contours |
| 18 - 25 | 33 - 47 | >35 | Practicing agro-forestry, using as a cattle field, planted industrial trees, perennial trees and fruit trees |
| > 25 | > 47 | For all soil thickness | Forestry practices |

It is apparent that farming practices in the whole country hardly comply with the above requirements. In fact, the Da River Lake flood-prone zone in Moc Chau has greatly violated the above requirements, followed by the highland border zone and the zone adjacent to the Da River.

Investigation in the protective capacity of forests in Na Muong Commune showed that early season rainwater could flush the soil and sand to the local streams that made the water very muddy. In rainy season, the water flow in the streams was very turbulent; water level rose and fell quickly. More sediment was deposited on the stream bed and that made for shallow flows.

The same situation happened in So Luon and Muong Sang villages. Local people reported that before 1980, the commune had 30ha of 2 season rice fields, but now there are only 6 ha of 2-season rice fields. Water was not sufficient for other the

150ha of lands. Therefore this land was used for one-season rice in Summer and short time crops in Winter.

❖ **Degradation of forest biodiversity**

There were more than 7000 plant species in Vietnam forests of which 2300 species were used for foods, medicine, fodder, timber, and other products. The fauna system included 273 mammal species, 773 bird species, 180 reptile species, 80 amphibian species, hundreds of fish species and thousands of invertebrate species (Le Van Khoa, Tran Thi Lanh). However, many species are now either extinct or being endangered. Overexploitation of forest resources in Moc Chau had reduced the biodiversity at three levels: species diversity, inter-species (genetic) diversity and diversity of eco-systems.

Local people in Pa Phang and Chieng Hac Villages said that flora was very rich 20 years earlier with many valuable timber species such as dinh huong, lat hoa, and nghien which could not be found today. Local maize and rice varieties were gradually replaced by hybrid varieties. The fauna system in the region had been severely damaged. Wild animals such as tigers, leopards, bears, deer and wild boar have disappeared in the last 20 years. Only small animal species such as rodent and bird species are still present.

The fauna and flora systems in Na Muong and Muong Sang communes were in better conditions than those in other areas.

Forests in Na Muong are categorized as protected forests and are currently very well protected. Local people said that the forests were heavily exploited during the period of 1980 - 1989 thus valuable timber species such as sau, cho, dinh etc. were endangered and only small trees existed. Since 1970 wild animals have disappeared due to over-hunting. Only small animal species such as wild boar, monkeys, squirrels, foxes etc. are still present.

The forests in Muong Sang played a very important role in national security and defence. In the past, due to poor roads system, the forests were exploited on a small scale. However, the amount of woods was very limited. Farmers had to travel 3km to 5 km for wood. Wild animals disappeared due to over-hunting.

### 3.4.3. Impact of animal breeding on the environment and public health

Livestock breeding in the region was on a small scale and very scattered putting small impacts on the environment and public health. However, it is important to note that:

- Cattle breeding facilities were small and close to farmers living areas. Furthermore, waste and wastewater treatment facilities were not built. Therefore, the farmers had to suffer with polluted air and water.

- Since there were not any waste and wastewater facilities available, the farmers had to dump the waste on the pasture fields. This was the underlying cause of environmental pollution when the livestock breeding scale reached a high level.

## 3.5. Roles of different players and factors in local environmental management

**Figure 12: Roles of different players and factors in environment management in a Thai community in Pa Phang village, Chieng Hac commune**

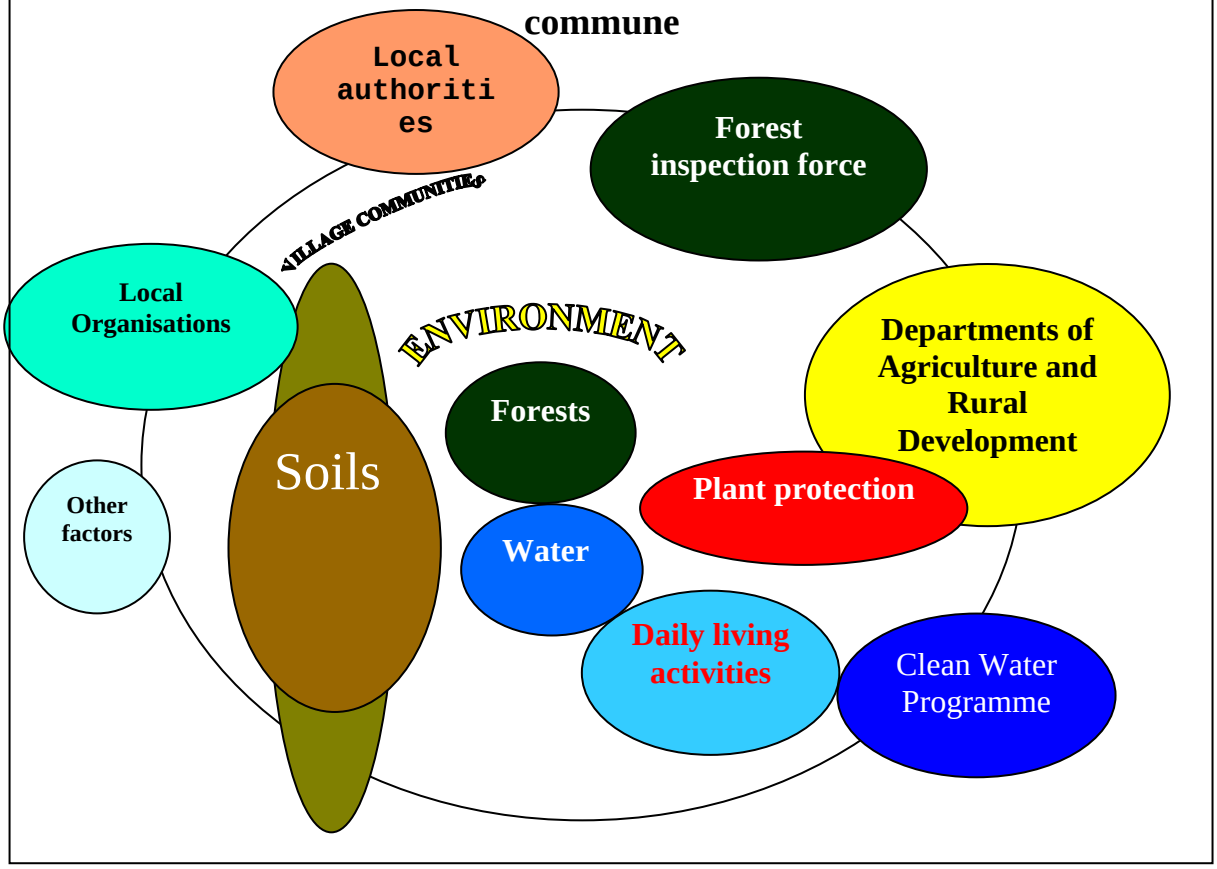


**Figure 13: Roles of different players and factors in environment management in a Thai community in So Luon village, Muong Sang commune**

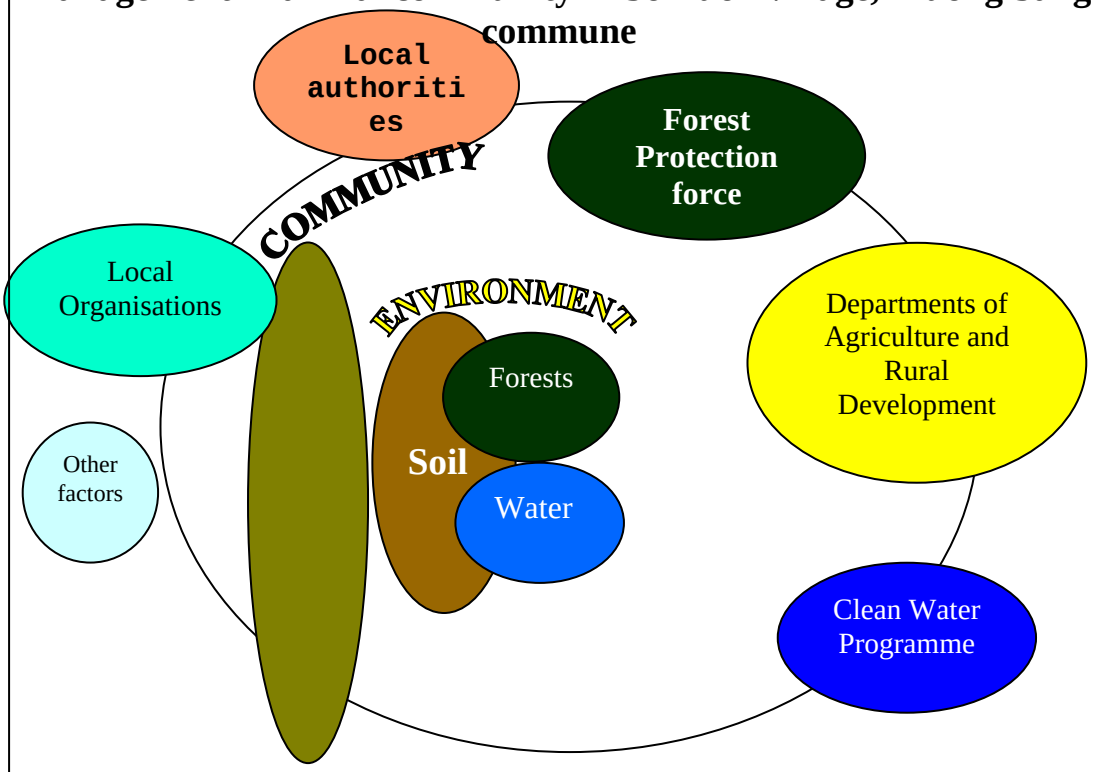



**Figure 14: Roles of different players and factors in environment management in a Thai community in Ke Teo village, Na Muong commune**

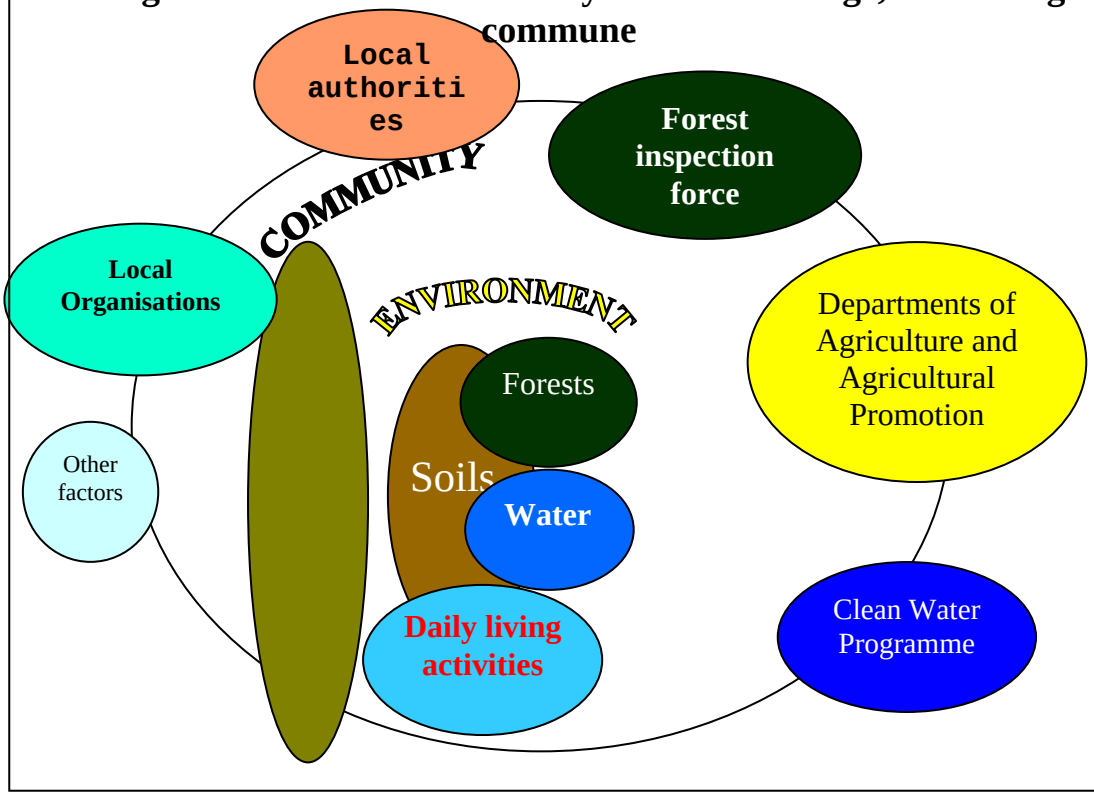
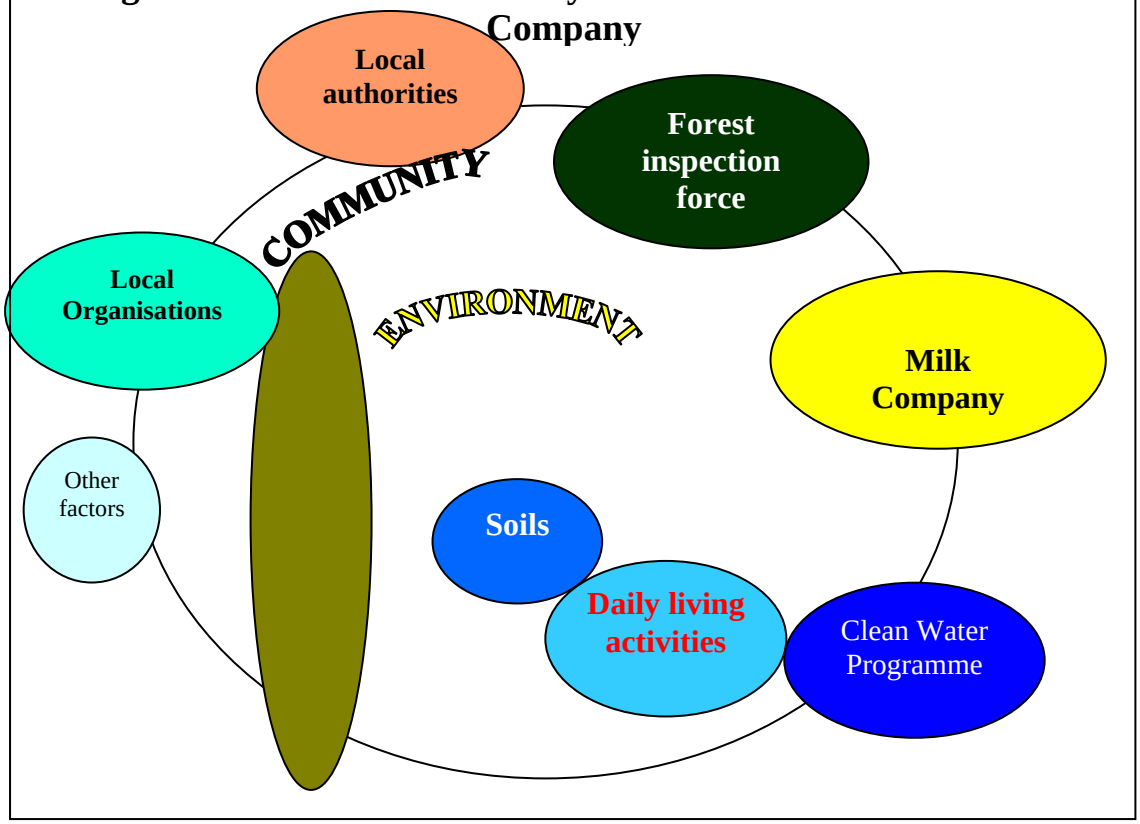


**Figure 15. Roles of different players and factors in environment management in a Kinh community at Team N$^0$70 - Moc Chau Milk Company**




The village communities at the three communes had different environmental problems. specific factors affecting environmental management had the following characteristics:

- The roles of the local authority and professional bodies in agricultural activities were very important to the environment management in the region. The interaction between these bodies and farmers was represented by a number of activities such as disseminating technical knowledge, supplying equipment and materials for agricultural production, production management, etc. In the milk cow raising community, the role of the Milk Company was more essential because the Company also supervised the milk quality and managed the milk production.

- The role of the Forest Inspection Force and its network was of great significance for environmental management, especially for land use planning and forest resources management.

- The clean water supply programme brought about significant benefits for the local people and the environment.

- The role of the local authorities was less significant to the environmental management. It was limited to only disseminating information on the new policies to the local people.

- Local mass organisations made almost no contribution to the environmental management in the region.

- Other factors such as external labour, services providers, governmental and non-governmental organisations, etc. had been gradually playing a more and more important role in the environmental management in the region. For example, external labour in Pa Phang put more pressure on land use there.

## 3.6. Local communities' solutions to improve the environment

Findings from our field assessment showed that the environmental problems were very complicated. Participation from the whole society, especially the local communities, is essential to draw feasible solutions for addressing these problems. The following measures have been drawn up after analysing the responses from local communities and authorities:

### 3.6.1. Measures for effective and sustainable land use

❖ ***Awareness***

- Local people and officials have been aware of the degradation of land resources (especially the sloping lands). They are worrying that in the near future, their lives will be threatened as land areas have quickly shrunken and soil quality has been very much reduced. In addition, the fast growing population has put heavy pressure on the limited land resources. The need for new measures to improve the environment has been a great concern for the whole nation, all the members of which must actively work together to seek solutions for a better future.

❖ ***Increasing intensive farming***

Most of the local farmers believe that the increased usage of fertilisers (especially for maize) helps to maintain high crop yields and to limit the degradation of land resources. Many farmers thought that without fertilisers maize would give no crop. A question came up as to what the farmers would do in the future if fertilisers could not help to increase crop yields. Local authority officials suggested that measures should be drawn quickly to prevent the problem from happening.

❖ ***Applying advanced methods of cultivation***

Making terraced fields, setting up hedge rows in the fields to prevent soil erosion, using cover crops, implementing intercropping, relay cropping, crop rotation, etc. are effective alternatives for more sustainable farming. Currently, local farmers are urgently looking for new cultivation methods which are suitable to their customs and conditions to improve the soil conditions. This problem has been a great concern of the local authority officials. Leaders of Na Muong Commune said that without necessary measures in the next 5 to 10 years, crops could not be cultivated on their lands. One recommendation is to set up more new models of sustainable cultivation on sloping lands so that farmers can learn from them.

❖ ***Changing cropping patterns for more sustainable land use***

A recommendation is to introduce new crop species (especially perennial trees) to replace the short duration food crops on sloping lands, aimed at limiting land degradation. Local people have totally agreed to this solution with a condition that the introduction of the new crop species must ensure the future economic efficiency and long term development. The choice of new species is dependent on the views of the local people, but none were expressed. Perhaps this will be done with the assistance of experts and the results of the field performance of new crop species under actual conditions of the region.

❖ ***Exploiting the full potential of valley lands to reduce the pressure on sloping lands***

In the regions where land areas for irrigated rice cultivation are large, farmers have been recognising the important role of paddy rice production in their total income. Some people said that if they had enough lands for wet rice cultivation, they would stop cultivate food crops on sloping lands as rice production is very stable and of high economic efficiency. However, valley land areas in this region can hardly be further expanded to increase their economic efficiency. The farmers also start to worry about the impacts of using pesticides on human, aquatic animals, and the water sources.

❖ ***Promotion of training for farmers and transfer of new cultivation techniques***

It was recommended that village-based agricultural extension clubs should be established in collaboration with other organisations to diffuse the information on improved agricultural techniques.

### 3.6.2. Measures for better forest management and development

Local people are fully aware of the forest degradation in quality and area. However, only few of them can understand the potential challenges of this scenario. These are the retired government officials and local staff who have been working for a long time at various levels. Not many people recognised the impacts of forest loss on the climate change (for example, the appearance of more hoarfrost and drier climate), especially the regulation of water in rivers and streams. Therefore, the points of view on development and management of forest resources are different in different communities.

❖ ***Natural forest regeneration through forest projection for special care and protection***

Most of the local people have agreed to this solution. However, the issues of projection planning and benefits of the foresters are still under discussion.

❖ ***Planting forest with market orientation***

This solution was supported by high income households and the local government. However, the choice of specific tree species is still a question.

❖ ***Applying better methods of forest management and protection***

Many people said that better methods of forest management and protection were urgently needed such as establishing local forest protection forces and increasing awareness of local people. Local leaders recommended that rights and responsibility of direct and indirect forest workers must be clearly defined. Improvement of equipment and human resources for the professional forest protection forces is equally important.

### 3.6.3. Measures for improvement of living environment

According to the local community assessments, the problems from livestock breeding and crop product processing wastes have little impact on the environment. The only people that recognised the important impact of these problems are those directly involved in the production and who have direct contact with bad odour of the wastes, the increasing amount of insects (mosquitoes), polluted water and unhygienic living conditions that have greatly affected their health. These people have suggested that they should be supported to set up waste and wastewater treatment systems and be provided with some initial capital to equip themselves with protective facilities. Other farmers and local government officials have also understood the impact of the problems on the environment and public health.

***Overall comments and suggested solutions***

- The shrinkage of forest lands due to the expansion of agricultural lands (to cultivate hybrid maize) was rapid, because the forest lands with high fertility can help farmers increase maize yields with less investment in fertilisers and labour for weeding.

- The degradation of uplands was due to continuous cultivation. The main reasons for this are: (a) most of uplands were used to cultivate annual crops (upland rice in the past and currently hybrid maize); (b) uplands in Moc Chau have been used

without the fallow cycle, so there was no chance for recovering the soil fertility; (c) upland fields are mostly located on slopes of greater than $25^0$. If preventive measures are not practiced, the soils could become unsuitable for crops cultivation.

- Pollution of water sources was a problem, resulted from intensive cultivation in valley fields. The area for wet rice cultivation in valleys is only 5% of the agricultural land in Moc Chau, but it was the main source of rice production for local people. The local farmers have invested capital to purchase fertilisers and pesticides and to set up small irrigation systems for intensive cultivation of new varieties of rice. As the fields are close to the streams, water pollution is unavoidable.

- The degradation of the local biodiversity is easily noticeable as valuable timber species, medical herbs, wild animals and local crops have disappeared from the region.

Based on the responses from local communities and experience in other regions, the following solutions are suggested:

**1. Appropriate land use planning.** For land use planning, lands must be classified based on slope and soil properties. Farmers are not encouraged to cultivate short cycle crops such as maize, upland rice, cassava, etc. on upland fields with slopes of more than $25^0$. Reforestation should be conducted on bare hills to protect the soil and water sources.

**2. Inventory of invaded forest lands and reinforcement of the forest protection force.** Appropriate policies must be issued for the best use of these lands and solutions must be implemented to create alternative incomes to farmers in these areas rather than planting hybrid maize.

**3. Issuing policies to ensure sufficient benefits from forestry (planted forest, community forest, allocated forest).** This will encourage the farmers to engage themselves on forest protection and development.

**4. Introducing new perennial crop species** (industrial and fruit trees) to the annual crop areas in sloping lands to create higher values than maize: The farmers have

agreed on this solution. However, the identification of suitable crops species is still a big question.

5**. Training and providing guidance to farmers on** the new cultivation techniques on sloping land to limit the problem of soil erosion.

**6. Projection of community pastures** to promote cattle breeding, replacing hybrid maize cultivation.

**7. Intensive farming on valley fields** must be combined with reasonable use of mineral fertilizers. In addition, pesticides must be used as directed. It is advisable to establish groups to forecast potential pest outbreaks and to guide the agro-chemical application in more effective ways.

# APPENDIX I

## Soil classification in Moc Chau

| No | Soil type | Area (ha) | Percentage (%) |
|---|---|---|---|
| **1** | Light yellow feralitic soil on limestone | 44,552.8 | 22.0 |
| **2** | Reddish yellow feralitic soil on siltstone | 22,047.0 | 10.9 |
| **3** | Yellow red feralitic soil on metamorphic rocks | 10,733.2 | 5.3 |
| **4** | Yellow feralitic soil on acidic igneous rocks | 26,526.7 | 13.1 |
| **5** | Light yellow feralitic soil on sandstone | 38,882.5 | 19.2 |
| **6** | Reddish brown soil on limestone | 7,290.5 | 3.6 |
| **7** | Reddish yellow feralitic soil on metamorphic rocks | 1,012.6 | 0.5 |
| **8** | Yellow red soil on siltstone | 1,012.6 | 0.5 |
| **9** | Yellow soil on acidic igneous rocks | 1,012.6 | 0.5 |
| **10** | Light yellow on sandstone | 1,012.6 | 0.5 |
| **11** | Soil on purple sandstone | 1,012.6 | 0.5 |
| **12** | Soil on sloping land | 1,601.0 | 0.5 |
| | ***Total*** | ***156,696.7*** | ***100.0*** |

*Source: Moc Chau Department of Statistics*

# APPENDIX II

## Climatic characteristics in Moc Chau

| Climatic criteria | Month | | | | | | | | | | | | Year |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | |
| Average temp. ($^0$c) | 11.8 | 13.3 | 16.8 | 20.2 | 22.5 | 23 | 23.1 | 22.4 | 21.2 | 18.9 | 15.7 | 12.8 | 18.5 |
| Average max temp. ($^0$c) | 16.8 | 18.6 | 22.6 | 26.2 | 27.8 | 27.5 | 27.6 | 26.7 | 25.5 | 23.3 | 20.2 | 17.9 | 23.4 |
| Average min temp. ($^0$c) | 8.8 | 10.1 | 13.4 | 16.6 | 19 | 20.2 | 20.2 | 19.8 | 18.4 | 15.9 | 12.7 | 9.6 | 15.4 |
| Average temp. variation ($^0$c) | 8 | 8.5 | 9.2 | 9.6 | 8.8 | 7.3 | 7.4 | 6.9 | 7.1 | 7.4 | 7.5 | 8.3 | 8 |
| Rainfall (mm) | 235 | 235 | 235.4 | 235.4 | 1340 | 1340 | 1340 | 1340 | 1340 | 235 | 235 | 235.4 | 787 |
| Sunny hours | 137 | 125.3 | 154.2 | 171.6 | 204.4 | 156.8 | 176.6 | 153.2 | 161.1 | 161.1 | 14.8 | 156.9 | 190.5 |
| Air humidity (%) | 87 | 86 | 84 | 82 | 82 | 85 | 86 | 88 | 87 | 86 | 86 | 85 | 85 |

*Source: Son La Department of Meteorology*

# APPENDIX III

## Crop Areas, Production and Yields in Moc Chau ( 1990-2002)

| Crops | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1.** Whole year rice area (ha) | 4,865 | 4,910 | 4,397 | 4,374 | 3,885 | 3,893 | 3,824 | 4,192 | 3,802 | 3,500 | 3,731 | 3,971 | 4,030 |
| - Annual rice production (tones) | 5,942 | 4,677 | 5,327 | 6,979 | 6,721 | 7,567 | 7,623 | 9,123 | 5,614 | 8,103 | 9,260 | 9,198 | 12,113 |
| * Upland rice area (ha) | 3,100 | 3,150 | 2,600 | 2,600 | 2,050 | 2,000 | 1,944 | 2,279 | 2,184 | 1,606 | 1,644 | 1,636 | 1,540 |
| - Yield (100kg/ha) | 7.8 | 4.1 | 6.2 | 9.8 | 9.5 | 9.6 | 10.8 | 8.4 | 3.6 | 9.4 | 9.0 | 8.4 | 10.2 |
| * Winter-Spring rice area (ha) | 365 | 400 | 392 | 364 | 385 | 424 | 450 | 434 | 422 | 398 | 465 | 527 | 558 |
| - Yield (100kg/ha) | 19,6 | 22,1 | 26,6 | 31,3 | 30,0 | 31,0 | 32,8 | 30,0 | 30,0 | 48,5 | 50,4 | 52,5 | 59,0 |
| * Summer rice area (ha) | 1,400 | 1,360 | 1,405 | 1,410 | 1,450 | 1,469 | 1,430 | 1,479 | 1,196 | 1,496 | 1,622 | 1,808 | 1,932 |
| - Yield (100kg/ha) | 20.1 | 18.5 | 19.0 | 17.6 | 25.0 | 29.5 | 28.2 | 39.9 | 29.9 | 31.1 | 33.5 | 28.1 | 37.5 |
| **2.** Maize (ha) | 3,045 | 3,252 | 3,350 | 3,552 | 3,820 | 4,637 | 4,685 | 5,672 | 6,253 | 9,742 | 10,851 | 10,830 | 11,259 |
| - Annual production (tonnes) | 5,037 | 6,266 | 5,861 | 6,291 | 8,338 | 12,186 | 11,720 | 10,276 | 17,569 | 26,212 | 31,061 | 29,660 | 34,909 |
| * Spring-summer maize (ha) | 3,025 | 3,200 | 3,250 | 3,250 | 3,300 | 4,107 | 4,100 | 4,540 | 4,883 | 7,580 | 8,079 | 7,830 | 7,759 |
| - Yield (100kg/ha) | 16.9 | 19.6 | 17.8 | 20.4 | 22.9 | 27.5 | 26.6 | 18.2 | 30.2 | 31.1 | 33.3 | 35.6 | 37.6 |
| * Summer-autumn maize (ha) | 20,0 | 52,0 | 100 | 302 | 520 | 530 | 585 | 1.132 | 1370 | 2.162 | 2.772 | 3.000 | 3.500 |
| - Yield (100kg/ha) | 6.0 | 7.5 | 7.8 | 7.9 | 8.4 | 10.8 | 9.6 | 6.3 | 10.3 | 11.2 | 9.4 | 10.6 | 10.9 |

| **Crops** | **1990** | **1991** | **1992** | **1993** | **1994** | **1995** | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **3.** Soy bean area (ha) | 215 | 220 | 175 | 265 | 277 | 346 | 378 | 187 | 300 | 172 | 133 | 279 | 366 |
| - Yield (100kg/ha) | 6.0 | 7.5 | 7.8 | 7.9 | 8.4 | 10.8 | 9.6 | 6.3 | 10.3 | 11.2 | 9.4 | 10.6 | 10.9 |
| **4.** Vegetables (ha) | | | | | 70.6 | 91.3 | 81.2 | 75.9 | 105.5 | 234 | 232.9 | 230 | 230 |
| - Annual production (tones) | | | | | 1,500 | 1,560 | 1,300 | 1,264 | 1,980 | 3,312 | 3,428 | 3,450 | 3,450 |
| **5.** Cassava (ha) | 1,130 | 1,200 | 1,230 | 1,250 | 1,265 | 1,350 | 1,350 | 1,443 | 1,596 | 1,501 | 1,419 | 1,543 | 1,843 |
| - Yield (100kg/ha) | 130 | 125 | 125 | 125 | 125 | 123.8 | 123.8 | 109 | 98.9 | 92.2 | 104.8 | 105.8 | 104.7 |
| **6.** Tea (ha) | | | | | 1.312 | 1.178 | 1.124 | 1.051 | 1.099 | 1.239 | 1.419 | 1.543 | 1.843 |
| - Yield (100kg/ha) | | | | | 33.6 | 41.6 | 52.2 | 63.5 | 65.4 | 73.7 | 81.2 | 87.3 | 96.6 |
| **7.** Mulberry (ha) | | | | | 661.8 | 455.6 | 342 | 180 | 177 | 152.1 | | 254.6 | 301.7 |
| - Annual leaf production (tones) | | | | | 2,093 | 1,563 | 1,386 | 741.7 | 653 | 1,120 | | 1,680 | 2,314 |
| **9.** Fruit trees (ha) | | | | | 1,455 | 2,127 | 2,496 | 2,794 | 2,873 | 3,015 | 3,156 | 3,122 | 3,165 |
| - Annual production (tones) | | | | | 7,222 | 10,041 | 11,058 | 13,378 | 8,693 | 19,307 | 13,943 | 20,312 | 22,361 |
| **10.** Canna (ha) | 392 | 450 | 455 | 420 | 422 | 440 | 450 | 1156 | 1111 | 1306 | 1185 | 1450 | 1450 |
| - Yield (100kg/ha) | 245 | 240 | 240.8 | 240 | 240 | 235 | 235 | 210 | 140 | 96.1 | 112 | 220 | 225 |

# APPENDIX IV

## Livestock breeding in Moc Chau ( 1995 - 2002 )

| Type | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
|---|---|---|---|---|---|---|---|---|
| Buffaloes | 16.130 | 17.446 | 16.693 | 17.057 | 17.834 | 18.370 | 18.100 | 18.500 |
| Cows | 11.536 | 13.510 | 15.313 | 15.539 | 16.453 | 16.913 | 17.785 | 17.500 |
| Horses | 1.307 | 1.337 | 1.664 | 1.861 | 1.967 | 2.026 | 2.090 | 2.150 |
| Pigs | 42.125 | 50.460 | 57.609 | 58.388 | 60.730 | 60.850 | 52.874 | 63.000 |
| Goats | 1.037 | 1.220 | 1.431 | 1.568 | 1.690 | 1.810 | 1.940 | 2.000 |
| Poultry | 352.000 | 335.000 | 368.000 | 326.000 | 346.000 | 346.000 | 306.000 | 380.000 |

# APPENDIX V

## Percentages of farm households using fertilisers

| Year | Pa Phang | Ke Teo | So Luon |
|---|---|---|---|
| | (%) | (%) | (%) |
| 1995 | 0.00 | 0.00 | 0.00 |
| 1997 | 5.00 | 0.00 | 8.00 |
| 1999 | 80.00 | 20.00 | 44.00 |
| 2000 | 100.00 | 60.00 | 60.00 |
| 2001 | 100.00 | 100.00 | 100.00 |

# APPENDIX VI

## Households' level of investment in fertilisers in 2003

| Amount of fertilisers (kg/ha) | Pa Phang (%) | Ke Teo (%) | So Luon (%) |
|---|---|---|---|
| 50urea + 300super phos. | 0.00 | 32.00 | 0.00 |
| 100urea + 300super phos. | 18.00 | 30.00 | 12.00 |
| 100urea + 500super phos. | 20.00 | 28.00 | 35.00 |
| 150urea + 300super phos. | 50.00 | 10.00 | 38.00 |
| >150ur[a] + 500super phos. | 12.00 | 0.00 | 15.00 |

# APPENDIX VII

## Workdays for maize cultivation

| No | Period | Workdays /ha | | | | | Total |
|---|---|---|---|---|---|---|---|
| | | Ploughing | Sowing | Weeding | Applying fertilizers | Harvesting | |
| 1 | Before1990 | 20 | 14 | 27 | 0 | 20 | 81 |
| 2 | 1991 - 1996 | 24 | 16 | 35 | 0 | 24 | 99 |
| 3 | 1997 - 1999 | 27 | 18 | 40 | 5 | 28 | 118 |
| 4 | 2000 - 2003 | 30 | 20 | 45 | 27 | 32 | 154 |