PRELIMINARY ASSESSMENT OF PRESENT AND
POTENTIAL LAND USE SYSTEM IN DAK PHOI COMMUNE,
DAK LAK PROVINCE

Short-term Mission Report

by

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1. INTRODUCTION

The project on Sustainable Management of the Lower Mekong Basin is a cooperation project between the Mekong River Commission Secretariat and the Federal Republic of Germany. It is implemented by the German Agency for Technical Cooperation (GTZ) in collaboration with national organizations in Vietnam, Cambodia, Laos, and Thailand.

The long-term objective of this project is 'to jointly promote measures for the rehabilitation and sustainable management of natural resources in the Lower Mekong Basin' (Mekong River Commission Secretariat, 1996).

According to activity 2 of the project operational plan (Misa and Hoang, 1996), the project will identify and establish 3 pilot areas in the riparian countries and initiate programs by November 1997.

The project staff have selected two villages of Dak Phoi Commune, Lak District, Dak Lak Province, Vietnam as the first pilot area. The selection of Buon Jie Yuck and Buon Dung was based on the following criteria:

- situated in the Mekong Basin;
- representative for the problems existing in the region in the field of management of natural resources;
- area dominated by special use/protection forest, production/plantation forest, or bare/waste land;
- farming systems dominated by shifting cultivation;
- low crop productivity;
- low income;
- poor infrastructural development;
- mainly inhabited by people belonging to an ethnic minority group;
- development potential for social forestry and agroforestry;
- grassroots and official willingness to get involved in sustainable resource development.
- target group and pilot area should be expandable;
- provide for replication in similar socio-physical environment;
- accessible in both the dry and wet season;
- existence of handicraft/cottage industries;

The present report aims to assist the project with the development of the selected pilot site in Dak Lak province by ‘providing technical expertise in the fields of agricultural production of upland crops; soil and water conservation; and identification, selection and introduction of agroforestry-based land use systems and their economic and ecological viability’ (Annex 1: Terms of Reference). The report targets the national staff of the project and counterpart personnel of organizations responsible for natural resource management and avoids the use of technical jargon as much as possible.

Firstly, a brief analysis of the physical environment of the pilot site is presented. The following chapter introduces the present land use systems. Next, some suggestions are offered on how these land use systems could be improved. The final chapter outlines key recommendations that may be useful to elaborate yearly plans of operation at the village level.

This report is a working document that should be improved as more detailed information of the pilot site becomes available. It is based on a five day visit to the pilot area and does not claim to be comprehensive.

2. ANALYSIS OF THE PHYSICAL ENVIRONMENT
Dak Phoi is one of the 9 communes of Lak district, Dak Lak Province. An overview of the physical and socio-economic environment of this district has been given by Ksor (1996). Dak Phoi is located in the south of Lak district, 8 km south-east from Lien Son, the district capital. It is bordered by Krong Bong District in the East, Dak Nue Commune in the West, Krong No Commune in the South, and Dak Lieng Commune in the North.

The commune consists of 11 villages with a total population of 3821 persons of which 3770 (98%) belong to ethnic minority groups. The vast majority of households are M’ong, but IG installation Group6% are Tay and 2% Kinh. There are on average 5.5 persons per household. Population growth rate is very high (estimated at 3.5%), and this is not likely to change soon because, for various reasons, family planning is not much practised. Although it is not yet a pressing problem given the current population density of 27 persons/km², on the long term, the rapid population growth will become the main threat to sustainable natural resource management.

The pilot site is situated in the buffer zone of Chu Yang Sin Nature Reserve, about 20 km from the crest of Chu Yang Sin mountain. Dak Phoi is the last permanent settlement on the south-west border of the nature reserve. Chu Yang Sin is of outstanding global conservation importance, showing levels of endemism unparalleled in the region. The area has been classified as one of the world’s 211 centers of bird endemism. Evidence of endemism amongst plants was provided by the discovery of 69 endemic species during a field study conducted by Eames and Nguyen Cu (1994). Besides, the nature reserve, lying in the watershed of the Mekong, also has great economic importance because of its high hydrological value. The Mekong Delta supports one of the most densely populated agrarian-based societies in the world. The nature of this agricultural expansion has been largely in accordance with the great seasonal variations in rainfall and water flow of the Mekong. Upstream developments, however, could easily upset this delicate balance and cause devastating floods or unparalleled droughts (Miller et al., 1996). Its biodiversity and hydrological functions provide ample justification for Chu Yang Sin area to be preserved. In this respect, the project can play a significant role by removing the threat posed by shifting cultivators living at the fringe of the reserve. The challenge is to develop permanent farming systems that are sufficiently profitable that shifting cultivation is given up voluntarily. Conservation must go together with improvement of the quality of life of the local population.

The different villages of Dak Phoi commune are spread in a valley that is 7 km long and 3 to 5 km wide (Annex 2: Map of Dak Phoi). The valley has two small rivers, the Dak Phoi and the Dak Lieng, and is found at an altitude of 450 m asl. The two villages that have been visited, Buon Jie Yuck and Buon Dung are at the end of the valley. They are surrounded by hills with moderately steep slopes (usually from 15 to 25 percent) that rise up to 700 - 1000 m asl. The area belongs to the watershed of the Krong Ana river, which flows into the Dak Krong No river. The Dak Krong No goes west then north before joining the Srepok river which drains into the Mekong Basin in Cambodia.

The pilot site has a typical monomodal tropical monsoon climate. Average annual rainfall is 1800 mm. The rainy season usually lasts from late April to mid November and accounts for about 90% of the total precipitation. From July to September, rainfall intensity can be very high, so that severe erosion can take place on bare or partly protected soils. The period during which rainfall is higher than evaporation is normally five to six months. The long dry season is the main climatic factor limiting agricultural productivity. The temperature does not fluctuate much and averages 23 °C. Frost does not occur. The region is spared from devastating typhoons, but wind speed can be fairly high during the dry season. This could influence the flowering of some perennial crops.

The soils in the area are mainly derived from granitic rocks. The dominant soil group on the moderately steep slopes according to the Vietnamese soil classification is that of the Yellow-red soils derived from acid magmatic rocks. The internationally recognized FAO-UNESCO system classifies these soils as Haplic and Ferric Acrisols. They are strongly weathered, acid soils characterized by a low cation exchange capacity (<24 cmol (+)/kg clay), a low base saturation (<50 %), and a clay content that increases in the deeper soil horizons (argic B-horizon). The prolonged weathering and advanced soil formation have led to a dominance of low activity clays (mainly kaolinite) and a general paucity of plant nutrients. Aluminum toxicity, strong phosphorus sorption, slaking/crusting and high sensitivity to erosion pose severe limitations to permanent cropping.

The soils in the valleys are formed from colluvial material eroded from the surrounding hills. They have the same parent material and similar chemical and physical properties as the soils on the slopes. Because they are almost flat, soil erosion threats are less severe but not absent. Severe sheet erosion has been found on Haplic Acrisols in Tay Ninh and Song Be province on areas with slopes of less than 2%.

On the steepest slopes, the soils can be very shallow and interspersed with many large blocks of granite. Such soils, classified by the FAO/Unesco system as Leptosols, are not suitable for agriculture, including agro-forestry. They should be left under forest or grassland.
Partly due to the rather harsh physical environment, most inhabitants of Dak Phoi are subsistence farmers with a very low standard of living. The GDP of Dak Lak province in 1995 was less than 110 US$, compared with 294 US$ for Dak Lak province. According to a recent survey conducted by the Lak Agriculture and Rural Development Department, 18% of the households in Dak Phoi have a medium income (average consumption of 240 kg of rice/capita/year), 27% is poor (200 kg rice/capita/year) and 55% is very poor (<200 kg rice/capita/year). In national terms, the people in the area are considered highly disadvantaged with food shortages during several months of the year due to the low agricultural productivity.

Education and health services are very poorly developed, which indirectly influences the potential for agricultural development. People frequently suffer from diseases such as malaria, cholera, and dysentery preventing from doing physical labor. The high illiteracy rate may hamper extension efforts and the introduction of farming systems requiring good management skills. Although it is important to look into these issues, they fall outside the scope of this report.

3. PRESENT LAND USE SYSTEMS

In the course of this preliminary assessment, it has not been possible to analyze the existing farming systems in Buon Dung and Buon Jie Yuck in great detail. The description of the present land use systems is mainly based on interviews with the village headmen and other farmers, on official statistics, and on transect walks. Obviously, the local systems need to be studied in more depth using a variety of tools such as participatory rural appraisal (PRA) techniques.

The total area of Dak Phoi is 14130 ha of which 12700 ha (90%) is classified as forestry land. There are 1300 ha of agricultural land, giving an average of 1.83 ha per household. The land use statistics for Buon Dung and Buon Jie Yuck could not yet be obtained, but field observation confirmed that also in these two villages agricultural land only occupied a minor part of the total area.

A reconnaissance map with a rough delineation of the different land use types (boundaries have not been checked) and some photographs of the area are found in Annex 2 and Annex 3, respectively.

The dominant land use system on the slopes is secondary bamboo forest of which, seasonally, a patch of 20-50 ha is cleared for shifting cultivation. Surprisingly, the valley is not yet fully developed for agriculture. Only in the immediate vicinity of the villages, permanent agriculture is practised. Coffee is grown in small homegardens. Adjacent to the residential area, there are some paddy fields and a modest area used for cultivation of vegetables, maize, cassava, sugarcane and other upland crops. Further away towards the hills, the land is covered by grass (Imperata cylindrica) and shrubs. These grasslands are used to obtain material for roof thatching and to cut fodder for animals. Before entering the village, one passes a cashew nut plantation, belonging to Lak Forestry State Farm, that is badly neglected.

In general, the existing cropping systems do not seem to be very highly evolved: traditional, long-duration varieties are used; few external inputs are applied; there is no mechanization and little crop diversification. As a results, crop yields are very low.

3.1 Upland rice

Upland rice is the main source of food and income in both villages. It is grown according to a traditional shifting cultivation system on foothills with moderately steep slopes (usually <20 %) at 1 to 3 hours walking distance from the village (forest on the hills closer to the village is protected). The main shifting cultivation areas are found along smaller streams. The M'nong used to have settlements in these areas which had to be abandoned during the war.

Traditionally, the village headman selects a suitable piece of land for shifting cultivation. Because they are aware that primary forest cannot be encroached any more, the village headmen claimed that, nowadays, only secondary forest is used for shifting cultivation, even though they know the productivity of such land is lower. Our preliminary observations confirm this. This is an important point in deciding whether the present slash-and-burn systems are ecologically sustainable and, therefore, needs to be more carefully checked.

Preparation of the land usually starts in late February or early March. Long, sturdy knives are used to cut all above-ground biomass. Depending on the type of vegetation, this takes from 80 to 160 labor days/ha. Each household can decide how big their cultivation area should be, but, according to the information received, this
normally would be less than 0.5 ha. The slashed fields are burned towards the end of the dry season.

Early in the rainy season, a traditional, 6-month, glutinous rice variety is sown after a small hole is made in the soil with a pointed stick. No fertilizers are applied. Weeding is done by hoe, two to three times per season. The yield varies from 500 to 900 kg rice/ha on a good piece of land.

The fields are abandoned after only one year of cultivation due to weed pressure and declining soil fertility. They revert back to a dense bamboo forest within two years. The fallow period is about ten years. Last year, immediately after the rice harvest, farmers of Buon Dung have planted Acacia Mangium on their shifting cultivation fields as part of the 327 program. Acacia seedlings are provided free by the Forestry State Farm. The villagers are paid 18 US$/ha for planting, and 4 US$/ha for the next two years for maintenance. They have agreed with the local authorities not to practise shifting cultivation on lands planted with Acacia. Therefore, the land previously allocated for shifting cultivation decreases through reforestation. It is unlikely that reforestation will stop villagers from practising shifting cultivation unless it is accompanied by introduction of profitable farming systems in the valley and on the lower slopes; otherwise planting of forests actually can encourage shifting cultivators to explore new areas in natural forest.

Because the occupation period is short and is followed by a fairly long regeneration period and only secondary forests are cut, the present shifting cultivation system in Buon Dung and Buon Jie Yuck seems to be ecologically sustainable. No symptoms of soil degradation could be found. The surface horizon of the soils used for upland rice cultivation was fairly thick (15 cm) and dark colored, suggesting that erosion and removal of organic matter is limited. With external inputs out of reach, the existing system probably makes the best use of the limited possibilities of the soils of the area. However, it is foreseeable that, with increasing population pressure, primary forests will be encroached, steeper slopes will be cultivated or the fallow period will be shortened. Eventually, continuation of shifting cultivation practices will result in a loss of biodiversity, soil erosion, and nutrient mining. Now that underutilized land in the valley and on the foothills close to the villages is still relatively abundant, an effort should be made to develop sustainable permanent farming systems for these areas, so that there is no incentive for villagers to practice shifting cultivation.

Besides, the concept of sustainability also has an economic dimension. Sustainable cropping systems should provide farmers with their basic needs and ensure an acceptable standard of living. The productivity of the upland rice system is very low. Farmers have to sell part of their harvest to buy essential commodities. The remaining part covers their personal needs for maximum 7 to 8 months per year. Because shifting cultivation cannot provide sufficient staple food, there is an urgent need to introduce more productive systems.

3.2 Wetland rice

There are only a few hectares of wetland rice in both Buon Dung (7 ha) and Buon Jie Yuck (2 ha?). The wetland rice system is essentially of a low input/low output type. Seeds of a local variety are raised in a seedbed that is not fertilized. Consequently, the seedlings used for transplanting look stunted and frail. Only one or two plantlets are used per hill, so that too few panicle-bearing tillers develop. Weeding is done by hand when required. Annually, two paddy crops can be grown. Expansion of the paddy fields seems to be hampered by a limited water supply during the dry season. Because traditional varieties are used with insufficient fertilization, paddy yields in the two pilot villages barely exceed 1 t/ha.

The present system does not cause any environmental degradation. Paddy cultivation is extremely sustainable as long as the fields are carefully leveled, puddled and bunded. This is nicely illustrated in some areas in China where wetland rice has been continuously cultivated on very steep, terraced slopes for hundreds of years.

3.3 Coffee

Most households established a small homegarden of coffee (average size of 0.15 ha) one or two years ago when world coffee prices were very high and a coffee mania swept Dak Lak province. The few assets they had were invested to buy coffee seedlings and some fertilizer.

Although it is too early to know what the exact yields will be, the coffee plants in the area do not have a healthy appearance. They probably suffer from drought as well as from nutrient deficiencies (nitrogen and potassium). Money to install irrigation or to obtain sufficient fertilizer or organic manure is lacking. It can be said that the present poor coffee plants occupy areas that are needed for crops that can generate cash or reduce food deficiencies during the year.

3.4 Maize
The village headmen mentioned that, next to rice, maize is the most important upland crop. But not much information on the total area cultivated or on the management practices could be obtained. Inspection of a small patch of young maize grown just outside the residential area indicated that traditional, low-yielding varieties are used. The plants were stunted and showed symptoms of nitrogen and phosphorus deficiency. Too many plants were sown in one hill. The yields may not even reach 1 t/ha.

### 3.5 Cassava

Small plots of cassava are cultivated to bridge the period when no rice is available. Farmers use a sweet (low cyanide) variety that is very tall and has a low yield (about 8 t/ha). Because it is known that cassava is a very sturdy plant, it receives no external inputs and very little attention.

Cassava roots cannot be preserved for a long time (maximum 2-3 days). Farmers, therefore, will only harvest the amount required for immediate consumption. Fortunately, unlike most other crops, the harvest period of cassava is extremely flexible, ranging from 4 to 24 months after planting. Cassava roots are an excellent source of carbohydrates, but they are very poor in proteins. Besides eating cassava during periods of food scarcity, soft leaves, mushrooms and other products from the forest have to be collected to maintain a balanced diet.

### 3.6 Vegetables

The cultivation of vegetables is not very popular, probably because most vegetables are quite sensitive to pests and diseases and because many kinds of leaves and roots (pennyworth, amaranth, wild cassava) can be collected with less effort from the forest. Still some vegetables are grown in the homegarden and on small pieces of land very close to the river. The most common vegetables are cabbage and spinach. These vegetables need less attention and are quite robust. Cultivation of vegetables is not an important land use system.

### 3.7 Livestock

The livestock situation has not been investigated in great detail, but seems to differ markedly between Buon Dung and Buon Jie Yuck. In the former village, rearing livestock is an important activity and is claimed to be the second most important source of income (after rice). There are a total of 45 cattle, 150 pigs, and more than 300 chicken for 63 households. The latter village is poorer and has much less livestock, only 10 cattle for 33 households. Most of the chicken and pigs they had before died from a variety of diseases.

In Dak Phoi, animals have a function similar to a savings account in a more monetary society. The death of most livestock in Buon Jie Yuck makes it difficult for the villagers to buy rice when they have run out or to pay for medical treatment when they are sick.

### 3.8 Forest and forest land

It was mentioned that, according to the official statistics, 90 % of the land in Dak Phoi commune is classified as forest land. Forest land has been divided as special use forest (6627 ha), production forest (410 ha), and barren land/tree savanna (5639 ha). At this stage, it is not entirely clear on what basis a certain piece of land is assigned a certain forest function. It seems that land with a similar vegetation and actual use in a similar physical environment can very well be classified as a different forest land use group. To add confusion, no clear distinction is made between planned and existing forest land! Before a new forest land use plan is prepared for the area, there is a need to clearly define the different terms currently in use to classify forest land and to prepare unambiguous criteria for each forest type. Virtually no primary forest is left in the immediate neighborhood of Dak Phoi. On the crest of a few mountains, some natural forest remains, but undoubtedly, even there the valuable timber trees have been removed. Only well inside Chu Yang Sin nature reserve, virgin forests are found. The natural vegetation of the area has been broadly classified as lowland semi-evergreen forest and tropical lower montane evergreen forest (Mackinnon and Mackinnon, 1986). It is dominated by Dipterocarpus species such as *D. alatus*, *D. costatus*, *D. intricatus*, and *D. obtusifolius* (Eames and Nguyen Cu, 1994).

After primary forests are cleared, the fallow land usually is very quickly covered by bamboo. The frequent use of fire as a tool in shifting cultivation prevents the regeneration of evergreen forest and promotes the growth of a fire climax dominated by bamboo. Most land in Dak Phoi, whether classified as special use forest, production forest, or barren land, is in fact occupied by secondary bamboo forest with here and there patches of other vegetation. Secondary forests are a source of timber and rattan for making furniture and the construction of
houses, but are mainly used to gather fuelwood. Other secondary products from the forests are bamboo
shoots, mushrooms, medicinal plants, and leaves which are collected by women in periods when food is
scarce or when somebody is ill. These products are for household consumption and are not sold. Men go
hunting in the forest to provide extra meat when they do no have work in the field or when they are not busy
making baskets.

In the pilot area, the total surface of forest plantations (excluding cashew) is only 190 ha, but it is rapidly
expanding. There is an active program to replace bamboo with *Acacia Mangium*. *Pinus kesiya* is an important
species in production forests. It is tolerant to fire and has a good natural regeneration. In the valley, a cashew
plantation of 220 ha was established, but this has not been very successful and the plantation presents itself in
a badly neglected state.

The Lak forest state farm is responsible for the management of all forest land. They prepare and implement
operational plans for production forests and are charged with the protection of special use forests. The forest
state farm also supervises various government programs aimed at regreening of bare lands (*327 Program*)
and at development of the uplands (*Fixed Cultivation and Sedentarisation Program*). Unfortunately, there
was no opportunity to meet the people from the Lak Forest State Farm during the short period of field work.
Obviously, the project would need to develop a close relation with the state organizations that implement the
various natural resource management programs.

Forest protection and related programs aim at the development of the uplands, the control of shifting
cultivation, and the sustainable management of forest land. Farmers receive a small amount of money (4
US$/ha/year) to assist in the protection of forests. At present, it appears that only the forests surrounding the
villages are protected. As a result, these areas are no longer logged and cleared. However, this does not stop
the villagers from practising shifting cultivation but merely encourages them to walk deeper into the forest
where government programs are not implemented and there is no control. This is a trend which needs to be
stopped immediately because it threatens more valuable forests as the people will move from newly protected
secondary forest into virgin primary forest areas. It would appear that current government interventions to
protect natural resources would benefit from some rethinking to prevent reaching the opposite of the stated
objectives.

### 3.9 Preliminary problem analysis

It is premature to make a comprehensive problem analysis based on the incomplete data available at this
stage. But a broad picture emerges that socio-economic problems beset subsistence farming at Dak Phoi more
than ecological and technical constraints. Options to overcome technical problems are presented in the next
chapter. It is beyond the scope of this report to deal with economic issues in detail. But more productive and
environment-friendly farming systems cannot be introduced unless the following limitations have been
addressed.

#### 3.9.1 Land tenure systems

Farmers who do not own their land, or at least have assured access to it, are not likely to adopt sustainable
farming systems and conservation measures which will cost them time, money, and effort. It is not feasible to
work on sustainable management of natural resources if no stable land tenure systems are in place.

It is essential to start immediately with a participatory land use planning and land allocation exercise in the pilot
area. The methodology tested and implemented by the Vietnam-German Social Forestry Development Project
Song Da is recommended. The major steps include (a) setting up a steering committee and working group; (b)
conducting a PRA; (c) preparation of a detailed present land use map; (d) development of a land use plan; (e)
solving of conflicts; and (f) allocation of land. This whole process is time-consuming and expensive: an average
3 ha per labor day can be allocated at an estimated cost of 2 US$/ha (SDPF, 1996).

#### 3.9.2 Credit

To improve the quality of life of the population in Dak Phoi commune, introduction of more intensive farming
systems seems inevitable. Such systems need capital investment for the purchase of improved seeds,
fertilizers, agrochemicals, and better tools. A flexible credit system has to be worked out with the farmers and
existing formal credit institutions that is simple, does not require much collateral, and has a reasonable interest
rate. Several development organizations such as FOS and Enfants et Development have worked in Vietnam
with minorities and disadvantaged farmers’ groups on this aspect. In addition, the existing government
programs could provide cooperation in this field.
3.9.3 Extension

Common problems with extension in Vietnam which also seem to apply in Lak district include: insufficient extension staff, officers from urban areas, use of prescriptive messages, little experience with upland agriculture, lack of facilities (transport, books), poor salaries.

The project should promote, through training and field exercises, a more interactive form of extension whereby extension officers become facilitators to encourage farmers to discuss and suggest solutions to their own problems. This approach has been tried, with fixed success, by a Community Forestry Project implemented by Care International in Ha Bac Province in Northern Vietnam (Neave and Bui Ngoc Quang, 1994).

3.9.4 Infrastructure and markets

Because subsistence farming is practised, so far no formal market structures have been established in the area. Fortunately, the pilot site is easily accessible in both seasons (this actually was a selection criterion) and is less than 60 km from Buon Ma Thuot (with 200000 inhabitants a sizeable market). There is thus a potential to produce cash crops that can be sold in the province capital, but it will take an effort to put all the logistics in place.

With the exception of coffee, the cultivation of industrial crops is limited by the absence of processing facilities. The distance to the closest factory for rubber and sugarcane is 50 km and 70 km, respectively. For cashew nut, tea or cassava, there are not yet any processing facilities in Dak Lak province. Unless the project is willing to assist in setting up small processing units, industrial crops should not be introduced.

4. POTENTIAL LAND USE SYSTEMS

The intention of this chapter is to suggest land use systems for Dak Phoi commune that should provide stable and high income, without environmental degradation. The emphasis is on annual and perennial cropping systems. Other forms of land use, forests and grasslands, are only briefly touched upon and should receive more attention in other project reports.

The list of options is not exhaustive and subjective, although it is based on studying successful farming systems in areas with similar physical environments in South Vietnam. At this stage, introduction of advanced or capital-intensive technology is unwarranted. Good implementation of a few simple measures should be sufficient to drastically increase the productivity of the existing cropping systems. Each potential land use system is briefly introduced and its suitability for the pilot site is assessed. Highly suitable systems are well adapted to the physical as well as the socio-economic environment. Suitable systems need modification of the environment, but at a level that the farmers should be able to handle. Investments of capital, labor, land, management skills and other scarce resources to establish marginally suitable systems are very high.

Active participation of farmers in selecting interventions and adapting them to the local conditions is of vital importance. No technology should be introduced without the consent and enthusiastic support of the local community. But it is equally important to reach agreement with farmers that minimum requirements for sustainable upland agriculture are (a) soil erosion control, (b) soil fertility maintenance, and (c) crop rotation and diversification. The project should not support activities that violate these important principles.

4.1 Soil erosion control

When crops are grown on a slope, soil erosion control measures are essential. This is certainly the case for the pilot area because the soils are very sensitive to erosion due to their weak structure; the individual elements collapse under the impact of heavy tropical rain, particularly where the organic matter content of the surface horizon is low. Under protective natural forest, Acrisols have a porous surface soil which permits adequate infiltration of water. If the forest is cleared, the surface soil will lose part of its organic matter and slake, with crusting, surface runoff during rain showers, and devastating erosion as a result.

The most critical step to control soil erosion is to reduce the velocity of run-off water. This is done most effectively by sowing the crops along the contour lines and by introduction of stone or vegetative barriers. Barriers should be established at fixed vertical distances. As a rule of thumb, the vertical fall between barriers should be 1 m on slopes >15 % and 0.75 m on slopes <15%. Stone barriers may be too costly in terms of capital and labor to be applicable in Dak Phoi. A multitude of plant species have been proposed in the literature...
as being suitable to form a vegetative barrier, including various leguminous shrubs and grasses.

Before soil conservation measures are implemented, ideally, a trial has to be established in collaboration with farmers in which many erosion control methods are demonstrated. Farmers should judge for themselves which technology they prefer. Unfortunately, proper establishment of such a trial takes time (at least two years). A demonstration trial with more than 20 erosion control methods has been laid out in Bac Thai province with support from the CIAT Asian Cassava Program. The majority of the farmers who visited the site thought that vegetative barriers with Vetiver grass was the most suitable and effective erosion control method. With support of the royal family, Vetiver grass has been strongly promoted in Thailand. The Thai have a lot of experience with Vetiver that could be useful for Vietnam.

Vetiver grass (*Vetiveria zizanioides* L. Nash) has the following characteristics that make it very suitable for soil and water conservation (Greenfield, 1988):

- easy to propagate and establish as a hedge;
- adapted to a wide range of soil and climatic conditions;
- forms a dense, permanent hedge in less than one year;
- requires minimal maintenance;
- does not spread into alleys due to absence of rhizomes or seeds;
- tolerant to fire and overgrazing;
- resistant to most insects and diseases;
- does not attract rats or snakes due to its sharp leaves and aromatic roots;
- occupies less space than other vegetative barriers;
- drought and flood tolerant;
- competes less with crops than other grasses and leguminous hedgerows;
- compatible with any crop;

The disadvantages of Vetiver include:

- few economic uses (unpalatable to livestock except young leaves)
- vegetative propagation, more work to establish than through seeds;
- little contribution to soil fertility improvement.

An alternative that is also attractive to farmers is a vegetative barrier with native grass and weeds. It is very easy to establish and quite effective. The main disadvantage is that the vegetative barrier can severely increase weed pressure in the field if grasses and weeds are allowed to produce seeds.

The use of hedgerows with leguminous shrubs has been advocated by many organizations. It is claimed that these hedgerows control erosion, provide fodder, fuelwood and mulch, and improve the fertility of the soil by nitrogen fixation and by recycling of nutrients leached beyond the root zone of annual crop. Adoption by farmers has not been commensurate with the promotion effort. Thus may be due to one or more of the following reasons:

- strong competition between hedgerows and crops for light, water, and nutrients: in Vietnam, leguminous hedgerows that produce a lot of biomass may be too competitive for water during the early and late rainy season.
- if nitrogen is fixed at all (the acid pH of most upland soils does not favor nitrogen fixation), only a small percentage seems to end up in the harvested crop; the bulk may be lost due to denitrification and leaching;
- a lot of labor is required for maintenance;
- many legumes are sensitive to pest and diseases;
- hedgerows, being less effective to control erosion barrier than grasses, require a double row, so that much cultivation space is lost.

Soil conservation work requires large capital and labor investments. Because this yields off-site and downstream benefits for the society in general, it would be unfair to expect the small farmers in the uplands to bear the full cost themselves. Few people question that the government has a duty to assist with the installation of irrigation schemes for lowland agriculture. Similarly, some incentives should be given to promote the establishment of sustainable agricultural systems in the uplands. Incentives can vary from cash subsidies and exemption from tax on income to the provision of technical assistance or security of land tenure. The project could be a mediator between the farmers and the local government to identify the most suitable form of incentives.
4.2 Soil fertility maintenance

Although a number of low input systems have been suggested for the acid soils of the tropics as a transition technology between shifting and continuous cultivation (Sanchez and Benites, 1987), it is more than doubtful whether any low input system can lead to productive land use on a sustainable basis, especially when land is scarce.

Many upland soils in South East Asia are so deficient in primary nutrients that economic yields cannot be produced for a long time unless nutrients are added to the soil. The soils of the project site are no exception. Without fertilization, nutrients are quickly depleted, yields and income are reduced, and soil is degraded. If nutrients removed by the crop are not replaced, farmers are soon trapped in a vicious cycle of low yields, low income and low inputs.

If sedentary farming is to be taken up on Acrisols, preservation of the surface soil with its all-important organic matter is imperative. Organic matter not only supplies the bulk of nutrients to the crop through mineralization but also influences water and nutrient holding capacity and aggregate stability. Application of organic manure or mulching is recommended but it is not often feasible for field crops. Green manures can contribute to organic matter build-up, but agricultural land in the pilot area may be too scarce to set aside plots for the production of green manures. If the main crop and the green manure crop are grown simultaneously in the same field, care should be taken to avoid excessive competition. In South Vietnam, cover crops have been experimentally introduced in the main upland cropping systems. It was found that the yields of the several upland crops decreased with 30 to 40% in the presence of cover crops. Due to the long dry season, it would seem that permanent cover crops may only be useful in well established perennial systems like rubber or cashew nut. Inorganic fertilization will help to maintain soil organic matter because fertilized crops not only have higher yields but also leave more crop residues.

4.3 Intensification and diversification

In Vietnam, many fields can be found on which a certain upland crop such as maize, cassava, and sugarcane continuously has been grown for decades. Crop rotation and diversification, however, is one of the keys to the successful development of sustainable upland agriculture. It reduces the build-up of pests and diseases and makes farmers less dependent on market fluctuations. Especially resource-poor farmers should not put all their eggs in one basket, but spread the risk by cultivation of several crops.

Annual upland agriculture can only compete with lowland cultivation when two stable harvests per year can be obtained. Varieties that take 5 to 6 months to mature have to be replaced by improved cultivars that are ready for harvest in 3 to 4 months so that a second crop can be sown in relay or immediately after the first harvest. Vietnamese farmers have to make maximum use of the small plot of land that is allocated to them. More intensive farming will not only increase farmer's income but also reduce erosion because the soil is covered for a longer time during the rainy season.

4.4 Highly suitable land use systems

4.4.1 Cashew (Anacardium occidentale L.)

Cashew is probably the most neglected of the major crops in Vietnam. Although its annual export revenue well exceeds 100 million US$, the crop has received very little attention from state organizations responsible for agriculture and rural development. Nevertheless, cashew cultivation is very popular in newly opened upland areas because it is a low-risk crop requiring little capital, labor (except for harvesting), and management capability to secure a reasonable income. At present, average yields of mature cashew in the former Song Be Province, which is adjacent to Dak Lak, are 700-800 kg of nuts/ha, providing a gross income (total income - all costs except family labor) of 400-500 US$/ha. It should be noted that it takes up to 7 years for a tree to reach its maximal productivity and that during the harvest period (2 - 3 months), someone has to pick up the fallen nuts every other day. The price of the nuts fluctuate with world market demand. The price can be high when the trees are planted, but may have severely dropped by the time the first nuts are harvested.

However, it was found that cashew cultivation in several parts of South Vietnam is not ecologically sustainable. The fertility level of the soil declines under cashew because, usually, no or few fertilizers are applied (resulting in decrease of soil organic matter content and bases). There is also some physical degradation (increase in bulk density, lower infiltration rate) due to a decrease of soil organic matter in the topsoil. Rampant soil erosion has been observed in many cashew plantations in the Eastern Region of South Vietnam. These three problems may be rectified by balanced fertilization (about 3 kg 16-16-8 NPK fertilizer/mature tree/year or an equivalent amount of available nutrients in organic form), sowing of a cover crop (such as Cassia rotundifolia,
Centrosema pubescens, or Calopogonium mucunoides), and Vetiver barriers, respectively.

The profitability of cashew in Vietnam could be further increased by the following measures:

- **good disease and insect control:** Anthracnose and Oidium are two important fungal diseases that may severely reduce the yield if left untreated. Proper and timely spraying of fungicides will control these diseases. The main insect pests for cashew in Vietnam are Heliopeltis, Alcides. Control is possible with insecticides or by introduction of natural enemies of these insects.
- **introduction of improved varieties:** there are no improved cashew varieties in Vietnam. Some selection work will have to be done. Awaiting the results of a breeding program, healthy nuts or material for vegetative propagation have to be selected from a vigorous, high-yielding tree.
- **adapted cultivation technique:** in Vietnam, optimal plant density of 100 mature trees/ha often is not respected. Regular weeding of the young trees is required.
- **valorization of by-products:** the cashew apple and cashew nut shell liquid are not or not well commercialized. In countries such as Brazil, by-products provide 50 % of the income.

In Dak Phoi, cashew trees have been planted in the valley by the Forestry State Farm. This cashew plantation has not been well maintained and a poor variety has been planted. The yields must be extremely low. Unfortunately, this bad example may deter farmers from planting cashew on their land.

The lower slopes of the hills surrounding the pilot site could be planted to cashew, replacing the protected bamboo forest. Due to the rather poor chemical properties of the soils, some fertilization will be essential if new cashew is planted. On sloping lands, soil conservation measures are required. Shallow or compacted soils, and badly drained lands are not suitable for cashew cultivation. The first three to four years after planting, cashew should be intercropped with an annual crop such as upland rice, groundnut, or soybean to provide income for the farmers.

If no high-yielding trees are found in Dak Lak, nuts or material for vegetative propagation can be obtained from adjacent provinces such as Tay Ninh or the former Song Be province. If sufficient farmers are interested in growing cashew, eventually a small processing facility could be established in the commune. This would give added value to the product and provide employment. When the cashew area is small, processing has to be done elsewhere and a reliable and sincere trader has to be found.

### 4.4.2 Cassava

Cassava is an important food security crop for communities where rice is lacking for part of the year. Besides, it is emerging as a major industrial crop in South Vietnam for the animal feed and starch industry.

There are a lot of prejudices about cassava. It is claimed that the crop chemically and physically degrades the soil. Although it is true that the traditional cassava cropping system as practised in Vietnam (no fertilization, no intercropping or crop rotation) leads to severe soil degradation, this does not have to be so.

It has been convincingly shown that cassava does not remove a higher amount of nutrients from the soil than most other crops. But because this plant has a very efficient nutrient uptake system, it manages to grow fairly well even in very poor soils. Cassava will continue to mine soil nutrients until their concentration has dropped to extremely low levels. In the absence of fertilization, long-term cassava cultivation completely exhausts a soil, and because it is considered a low-value crop, it is rarely fertilized.

The production potential of a soil grown to cassava can be perfectly maintained if the important principle to replenish the soil with nutrients extracted by the crop is adhered to. In other words, do not grow cassava (or any other crop, for that matter) unless you are prepared to apply organic and/or inorganic fertilizers to compensate for the nutrients that have been taken up.

One of the real problems with cassava is that it takes about three months to form a closed canopy. During this time, severe soil erosion and structural degradation can take place, especially when the crop is grown on a steep slope. It is essential that cassava is intercropped for the first three months after planting. A number of experiments have been done by the Institute of Agricultural Science of South Vietnam (I.A.S.) which showed that groundnut and soybean are the most promising intercrops. When permanent cover crops were sown between the cassava rows, the yields severely dropped, probably because there was an intense competition for water during the dry season.

If cassava is cultivated for food, it is important to select a variety with a low cyanide content, a so-called sweet variety. The only improved sweet cassava variety introduced in Vietnam is Rayong 2, locally known as KM95.
Under proper management, this variety can yield 20 t fresh roots/ha (the current average in Vietnam is 8 t/ha).

Stakes of this variety are not yet commercially available, but small amounts could be obtained from I.A.S. Obviously, one has to verify that the quality characteristics of KM95 (such as taste, appearance, color, preservation time) meet the requirements of the farmers in Dak Phoi before it is introduced.

Cultivation of bitter cassava may be an interesting option provided there is a demand for animal feed, starch, noodles or other cassava-based products. A village-scale processing facility should then be established. Several communes in Dong Nai Province and Tay Ninh Province have cassava cottage industries that have been doing quite well, although more recently a number of large cassava plants have been constructed that will provide fierce competition.

The most promising improved variety that should do well under local conditions is KM94. If the intention is to sell the roots, it should be noted that the price for fresh roots can be very volatile, fluctuating from less than 15 US$/ton to more than 45 US$/ton. If the supply of roots is well matched with the processing capacity and the price remains stable, the net profit from cassava can reach 450 US$/ha, equaling the average income from intensive wetland rice cultivation. Cassava cultivation is not profitable when the price for roots drops below 30 US$/ton.

Improved sweet and bitter cassava varieties should be grown in deep, well drained soils at a density of 1 x 1m. Recommended fertilizer application is 60 kg N/ha, 60 kg P₂O₅/ha, 90 kg K₂O/ha in two split doses. Stem cuttings of about 15 cm length should be planted vertically either at the beginning or towards the end of the rainy season. Simultaneously, the intercrop (groundnut or soybean) should be sown. The fields should be regularly weeded until the plants are three months old. Cassava is ready for harvesting about 10-12 months after planting. In case money is required earlier, part of the field could be harvested as early as 6 months after planting.

The advantages of cassava are:

- low risk (high tolerance to drought, pests, diseases and soil stress);
- low investment;
- cheap source of carbohydrates;
- many industrial uses (animal feed, noodles, starch, mono sodium glutamate);
- flexible harvesting time (from 6 to 24 months after planting);
- reasonable income.

4.4.3 Pearl millet (Pennisetum typhoides)

Pearl millet is a crop that is relatively unknown in Vietnam. Nevertheless, it has a number of characteristics that are very interesting. It is a fast-growing crop that develops a very deep rooting system. The finely branched rooting system helps the plant to absorb any water that remains in the soil after the rains have stopped. Pearl millet, therefore, is a drought-tolerant crop that is well suited to be grown at the start or the end of the rainy season when the risk to grow more drought-sensitive crops is too high. This allows the cultivation of two crops per rainy season in areas where usually only one crop was grown. In addition, pearl millet does not require very good soils, high fertilizer applications nor frequent weeding.

A field trial was established in an high elevation area (>1000 m) with sloping lands in Lam Dong province. The main crop, hybrid maize, occupied the land for the greater part of the rainy season per year. The aim of the trial was to intensify the existing cropping system by introduction of a second crop. This would increase the income of the farmer, decrease soil erosion during the months the land used to be left fallow, and reduce the build-up of weeds. Six rotations were tested: maize followed by fallow, cover crop (Centrosema pubescens), soybean, groundnut, upland rice, or pearl millet. The maize-pearl millet rotation provided by far the highest yield (> 2 t grains/ha) and income. Its profuse biomass production effectively reduced soil erosion and should help to build up the soil organic matter content.

Because the crop is not known, farmers would need to be shown what to do with the seeds. In semi-arid or arid regions, pearl millet is well appreciated for human consumption, the production of beer, or sometimes as animal feed. If pearl millet would be grown for commercial purposes, It is difficult to predict how profitable this would be. In the beginning, profit may be very modest due to the low value of the seeds.

4.4.4 Forest

Compilation of recommendations for forest management will be left for specialists. Here, only a few broad
suggestions are given.

The principal goal in forest management should be the strict protection of the remaining primary forests. The forest state farms and other responsible agencies should devote the scarce financial and human resources to enforce the ban on logging and shifting cultivation in forest with a high biodiversity and hydrological value. If necessary, villagers should be paid to assist in this conservation effort.

Traditionally, the responsibility for all aspects of natural resource management rested with the village head man, who inherited this position from his father. He decided which land can be used for shifting cultivation, and how long the fallow periods should be. However, because the authorities have made shifting cultivation illegal, his authority on natural resource issues is waning. Individual households are now starting to make their own decisions. Because they have less experience and there is less social control, the decision to ban shifting cultivation may actually lead to more environmental degradation. The authorities should invite the people to actively take part in planning which areas are to be protected. They should make maximum use of the indigenous knowledge.

It is pointless to spend money to protect degraded areas where human utilization of resources is high and likely to increase as the population grows. Now that land pressure is not yet very strong, it should be feasible to prevent encroachment of virgin forest areas by allocating secondary or degraded forest land close to the residential areas for agricultural or agro-forestry purposes.

The area in the valley occupied by the cashew plantation and by grasslands should be allocated to the farmers so that more productive land use systems can be established. On the other hand, the effort to plant forest species to replace bamboo on land classified as production forest or barren land may be expanded. Natural bamboo forest is very good for soil conservation purposes, but economically speaking, it is not very valuable.

4.5 Suitable land use systems

4.5.1 Upland rice

Since 1990, the CIRAD-ISA project on Improvement of Upland Cropping Systems has been very active in testing improved dry rice varieties and better management techniques for the uplands of Vietnam. They have released several high-yielding upland rice varieties which are now already grown on an estimated 6000 ha (Godon, 1996). The most performing modern rices recommended for the Central Highlands are LC90-4 (120 days) and IRAT 144 (100 days). Under good management, these varieties yield 2.5 - 3 t rice/ha. Improved rice varieties require good land preparation, moderate fertilization (something like 60 kg N/ha, 60 kg P₂O₅/ha, 30 kg K₂O/ha), and regular weeding. Besides the much higher yield, the short growing cycle of modern rice allows for a second crop, such as cowpea, mungbean, soybean, or groundnut, to be established during the same rainy season.

It should be noted that these modern rices, unlike the traditional long-duration cultivars, are not glutinous and fetch a lower market price than the sticky varieties. Before efforts are done to replace traditional rice varieties with high-yielding ones, it has to be to confirmed that minority people are prepared to eat rice with a different taste and consistency.

Upland rice should no longer be grown in a traditional shifting cultivation system but rather as an intercrop with young rubber or cashew on the foothills surrounding the villages. Once the rubber or cashew canopy is closed, upland rice cultivation should be discontinued. As the income from perennial systems is higher than that of upland rice, the farmer should be able to buy rice or obtain it from his paddy field.

4.5.2 Wetland rice

Farmers in the Red River Delta, the Mekong Delta, and many other areas in Vietnam have mastered the technique of growing wetland rice extremely well. A large number of improved varieties, and detailed recommendations on land preparation, fertilization, weed, pest and disease control are available for all agro-ecological zones. All that is needed to improve the existing cultivation of wetland rice in Dak Phoi are some adaptive trials in which several modern varieties are screened and a few fertilizer treatments are compared. Such trials could be handled by farmers themselves in collaboration with the district agricultural authorities, who have good experience with wetland rice cultivation.

It should be investigated whether the total area of wetland rice can be increased by expanding the irrigation system. If this is difficult, part of the Imperata grassland could be developed into an area for rainfed rice
cultivation (rice grown under flooded conditions but solely dependent on rainfall as source of water) during the rainy season. To get rid of Imperata, the land should be plowed repeatedly by buffalo or tractor. Alternatively, Imperata can be controlled by twice spraying of a systemic herbicide (such as glyphosate). Control by manual land preparation and hand weeding is very labor intensive. Once Imperata has disappeared, the fields should be leveled, bunded, and puddled. This is only possible when several households agree to join hands.

4.5.3 Hybrid maize

At present, the average maize yield in Vietnam is only 2 t/ha. The main reasons for the low productivity are the use of unimproved, traditional varieties and low fertilizer inputs. Although hybrid maize varieties have been introduced in Vietnam less than a decade ago, they are already becoming quite popular in many parts of the country including Dak Lak province. With these improved varieties, yields exceeding 12 t/ha have been obtained on farmers’ fields. The primary question now is not how to further improve the productivity of maize, but rather how to extend the existing hybrid maize technology to more remote areas such as Dak Phoi. In China, hybrid maize has been successfully introduced on more than 20 million hectare; the national average maize yield now exceeds 5 t/ha.

In Dak Phoi, hybrid maize could be grown in the valley as well on the hills surrounding the villages, provided the soil is sufficiently deep and soil conservation measures are in place. Varieties that have been doing well under conditions similar to those of the pilot area include DK888 and LVN-10.

Disadvantages of hybrid maize are:

- sensitivity to nutrient deficiencies mainly phosphorus and nitrogen;
- demand for good land preparation and frequent weeding;
- high price of hybrid seeds that need to be bought each year.

At higher altitudes, maize takes a few weeks longer to mature than the 90-95 days normally required. As such, the remaining period of the wet season may be too short to establish a second crop. This issue could be solved by relay cropping: about three weeks before the harvest, the lower maize leaves are removed by hand and the second crop is sown. Alternatively, a short-duration crop such as cowpea (55-60 days) or a drought-tolerant crop such as pearl millet could be planted.

In spite of the fairly high investment, cultivation of hybrid maize should be quite profitable. Assuming a yield of 5 t/ha can be obtained under good management, a gross profit of 400 US $/ha can be obtained.

4.5.4 Rubber

The government of Vietnam is very keen to expand the area under rubber from the current 300000 ha to about 800000 ha in the year 2010. It is planned that most of the expansion would take place in the Central Highlands. The World Bank is now preparing a feasibility study for a major small-holder rubber project in the area. A first phase of this project may commence early 1998. It is recommended that the project collaborates with this effort.

However, planting of rubber by small-holders in the pilot area should not wait for the World Bank project. The experience of other projects, such as the GTZ project on development of improved rubber in East Pasaman, West Sumatra, Indonesia should be useful. According to this project, the key factors for development of successful small-holder rubber plantations are:

- sound technical approach incorporating (a) soil amelioration by application of one ton rock phosphate/ha; (b) contour planting of trees and intercrops; and (c) use of improved planting material.
- involvement of farmers in adapting the technology to their own requirements and adding their own ideas and experience.
- involvement of pioneer farmers in the extension web. Experienced farmers are able to instruct and educate other farmers using their own experience and new found knowledge.

The slopes in Dak Phoi should be quite suitable to establish a rubber-based cropping system. Good poly-clonal planting material should be obtained from the Rubber Research Institute or from the General rubber Company. The one-time application of 1 ton thermophosphate is considered an essential investment to saturate the high phosphorus fixation capacity of the soils. Rubber trees should be planted at a density of 7 meters between contours and 3 meters between plants within contours and fertilized with 100-200 kg urea/ha and 50-100 kg KCl/ha. During the first three years rubber can be intercropped with upland rice or pulses.
The initial cost of planting material and fertilizer is approximately 200 US$/ha. Rubber should not be planted if the farmer is not able or willing to make these investments. It also has to be checked whether the World Bank project or some other organization will assist with the installation of a rubber factory in the region.

4.5.5 Soybean/Mungbean/Groundnut

The physical conditions in Dak Phoi valley may allow two short-duration annual crops to be grown per year. Pulses such as groundnut, soybean, and mungbean should do well in rotation or in relay with upland rice or maize. They could also be grown as an intercrop in cassava, young rubber and cashew.

Although, in Vietnam, the average yield and profitability of pulses in rainfed conditions is rather low (500 - 600 kg/ha earning 200-250 US$/ha), they are a source of high quality food and help to maintain the fertility of the soil.

There are many varieties of soybean, groundnut, and mungbean with different management techniques. Selection of the variety and the management techniques will depend on the use (food/oil/animal feed), the month of establishment (early/late rainy season), the available period for growing (long/short duration crops), and the cropping arrangement (intercrop, rotation, relay). Improved seed material and detailed technical recommendations are available at the IAS

4.5.6 Livestock

Small livestock, especially chicken and pigs, can generate an important part of the cash income of farm households. There seems to be a certain potential for livestock development in Dak Phoi. This should be the topic of a separate report that should focus on veterinary services, production of feed and fodder, clear designation of grazing areas, and pasture development.

4.6 Marginally suitable land use systems

4.6.1 Coffee

Some farmers in Dak Lak province obtain coffee yields that are among the highest in the world (>5 t green beans/ha). Coffee cultivation expertise is abundantly available in the province. The extension services of the district should acquaint the farmers of the pilot area with this expertise.

Even with good extension, on the short term, productive coffee cultivation in Dak Phoi requires more investments for good irrigation facilities and adequate amounts of fertilizers (organic or inorganic) and agro-chemicals. This calls for flexible credit schemes. Before farmers make these extra investments, they should consider that during periods with exceptionally high coffee prices (1994-1995), every grower will benefit. But when world market prices crash (1996-1997), only the fittest will survive. The villagers of Dak Phoi are not well equipped to take on the battle with big coffee growers on the fertile soils of Buon Ma Thuot.

On the long term, the sustainability of coffee cultivation may be threatened by:

- lack of water for irrigation (falling groundwater table);
- declining yields in older coffee (importance of proper pruning not well realized);
- build-up of diseases and pests (coffee rust);
- high nutrient losses from excessive fertilization (environmental pollution);
- bad coffee quality; and
- volatile world market prices.

Due to the rather poor soils and the high investment and risk, the pilot area ly marginally suitable for coffee cultivation. Expansion of coffee homegardens in the area should be discouraged or at least supplemented by other crops.

4.6.2 Fruit trees

Although on the medium to long term, introduction of fruit trees could be envisaged, at present, this may not be a such a good option because, like coffee, it requires high capital investment, good planting material, and strong management skills. Once the project gains the trust of farmers by introducing proven and simple technology, something more risky such as fruit trees may be tried.
It should be noted the conditions in Dak Phoi are not very suitable for fruit trees. In order to obtain a good yield, most fruit trees need to be irrigated during the dry season. This would be very difficult on sloping lands, unless a farmer is prepared to spend a lot of capital or labor to install an irrigation system or carry water to the orchard. The conditions in the valley are not very appropriate because the soils are quite sandy and poor. Basaltic soils found on the Dak Lak plateau are much more suitable for fruit production because they have excellent physical properties and the prevailing nutrient deficiencies (mainly nitrogen and phosphorus, and probably, magnesium) can easily be rectified by application of fertilizers. Although most of these lands are now occupied by coffee, some farmers may decide to try their luck with fruits if the coffee prices remain as low as today. Unless market demand is large enough to accommodate all producers, farmers in Dak Phoi may find it difficult to compete with those who have access to better land.

4.6.3 Tea

The potential for tea cultivation in the pilot area is not very high. The main limiting factor is the uneven distribution of rainfall. Tea shrubs are not well adapted to areas that have a dry season of more than three months. They are also very sensible to drying winds, so that windbreaks need to be installed.

Tea cultivation at small-holders’ scale should only be undertaken by farmers with excellent management skills because it is not so easy i.e. to establish a nursery or to efficiently organize picking of the leaves and pruning of the bushes.

Lack of a processing facility is another important constraint. To successfully operate a small factory, at least 100 to 200 ha of tea has to be planted. The factory should be in the immediate neighborhood of the plantation because tea leaves need to be processed within 6 hours of picking.

4.6.4 Vegetables

Vegetable cultivation for household consumption can continue to be practised on plots close to the river. In order to have a more balanced diet throughout the year, efforts should be done to expand the vegetable area on irrigated land. It is recommended to focus on sturdy vegetables such as beans, cabbages, pumpkin, onions, and carrots. Once the farmers are familiar with these crops, more sensitive vegetables such as tomatoes or salad could be tried.

Large-scale, intensive, market-oriented vegetable cultivation requires very high investments for irrigation, seeds, fertilization, and agro-chemicals. In addition, a lot of labor is needed (a farmer can maintain maximum 0.3 ha of vegetables) as well as good farming and commercial skills. Probably, the risks are too high for most farmers in Dak Phoi to get involved in this specialized land use type.

5. RECOMMENDATIONS

Farmers in Dak Phoi face many constraints, including a physical environment with limited possibilities for agriculture, lack of capital, and poorly developed health and educational services, resulting in unproductive cropping systems. However, more productive and environment-friendly land use systems can be developed through better utilization of underutilized resources such as land and labor.

The principal recommendations of this report are as follows:

1. It should be investigated how big the region is for which the pilot area is representative. This should be done by extensive terrain work and by studying air photographs. In case there are large areas that face different or more acute problems in natural resource management, additional pilot areas should be selected.

2. The project emphasizes participatory and self-help approaches. Before starting the implementation phase, all parties involved in the project should be made familiar with or reminded of these concepts:

   - the farmers should realize that the project is there only to create favorable conditions, to give an initial push, or to suggest options for sustainable natural resource management; it is their own responsibility to make things happen;
- the project staff should not introduce activities without the consent and the enthusiastic support of the local community. In order to get to know the local environment and to develop a strong relationship with the target group, the project should start with a participatory rural appraisal. But PRA is not a goal on its own. Some projects spend far too much effort on it, so that insufficient time is left for action.

- the local authorities should be willing to make maximum use of indigenous knowledge in land use planning and be prepared to reallocate land that is currently underutilized to individual households or farmer groups;

- the donor agencies should provide a time frame that is compatible with the chosen strategy; participatory land use planning and development of suitable technology takes time.

3 There are too many constraints in the pilot area to work on all of them simultaneously. The project should select with the farmers a limited number of key issues for interventions that are likely to yield large dividends. No time should be wasted with irrelevant red herrings!

4 Even though the staff of local institutions should be involved as much as possible with the implementation of the program, the project staff needs to be expanded to coordinate the different activities.

5 In order to introduce more productive and environment-friendly farming systems, stable land tenure systems, flexible credit schemes, interactive extension, and suitable market structures should be in place.

6 The project should start immediately with a participatory land use planning and land allocation process. This will require setting up a steering committee in which all parties, farmers, local authorities, and project staff are represented. A detailed present land use map should be compiled by the committee. The next step would be the preparation of a land use plan. Before this could be done, the terms used in forest land classification should be defined and criteria for each class should be developed. Underutilized areas should be assigned a more productive and permanent land use. It should be discussed with farmers which technology options suggested in this report may be useful to address the existing constraints. In general, the valley should be developed for high-value annual and perennial crops: vegetables, wetland rice, coffee, and maize. On the slopes around the valley, perennial crops such as rubber and cashew could be established. Shifting cultivation areas should be given up voluntarily and turned into production forests. Primary natural forests should be strictly protected. Once agreement is reached on a land use plan, the process should end with allocation of land and handing over of land use certificates.

7 At this stage, technology to be introduced should be simple and effective. It should include erosion control, soil fertility maintenance and crop rotation and diversification. The project should not really be involved with development of technical options but rather with the adaptation of proven technology to the local environment. Adaptation trials that have few treatments and large plots should be established. Farmers have to be involved in measuring success or failure, in monitoring differences between treatments, and in modifying treatments. The same trial should be replicated in different farmers’ fields to enable statistical analysis. Trials that are left completely under the control of farmers may not give very reproducible and easily interpretable results, especially when farmers are not familiar with on-farm experimentation.

8 The ecological and socio-economic sustainability of the introduced land use systems should be regularly evaluated by measuring key indicators such as sediment load in the rivers, soil organic matter content, cation exchange capacity, infiltration rate, bulk density, farmer’s income, or number of months with food shortages.

REFERENCES


