Integrated Management of Upland Agriculture for Sustainable Development in the Central Highlands of Vietnam

A Proposal of a bilateral to be submitted to the Belgian Administration for Development Cooperation

1. Country: Vietnam
2. Project title: Integrated Management of Upland Agriculture for Sustainable Development in the Central Highlands of Vietnam
3. Short title: Vietnam-Belgium Upland Agriculture Project
4. Project goal: To slow down land degradation and improve agricultural productivity in the Central Highlands of Vietnam through an integration of better nutrient management, diversification of agricultural production and proper land use planning.
5. Target area: The Central Highland region of Vietnam (55569 km²) consisting of the provinces Lam Dong, Dac Lac, Gia Lai and Kon Tum.
6. Target group: Resource-poor farmers who practice unsustainable agriculture, especially Viet immigrants and members of ethnic minorities.
7. Project duration: 4 years
   Proposed starting date: 1 January
   finishing date: 31 December 1999
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16. Contribution offered by Vietnam: 9,320,000 BEF.
I. PROBLEM ANALYSIS

In spite of major recent developments in the industrial and service sectors, Vietnam remains a predominantly rural society with the mass of its population dependent on agriculture and related activities: more than 60% of the workforce is still employed in agriculture, generating 30% of the gross domestic product and 52% of the export earnings of the country (General Statistical Office, 1994). The Government of Vietnam is committed to the view that development is only meaningful if the rural masses, constituting 80% of the population can achieve higher incomes and a better life. Success in the agricultural sector is therefore crucial to the realization of Vietnam's national goals.

During the last 15 years, considerable progress has been made in agricultural productivity. With an average growth of agricultural production of 4.5%, the country has rapidly changed from a food importer to an exporter of about 2 million tonnes of rice per year. However, it is often overlooked that these remarkable achievements have been realized at the expense of a massive degradation of the country's major ecosystems.

Due to war damage, shifting cultivation, agricultural encroachment, and excessive logging, forest cover shrank from 44% of the total national land area in 1943 to 23% today. Deforested lands have been cultivated on a large scale without appropriate soil conservation measures and with minimum inputs. When severe land degradation resulted in low yields, fields were abandoned. Barren lands now cover more than twice the land under cultivation (UNDP, 1994). In large parts of Vietnam, especially in the uplands, the rural population is caught in a downward spiral leading to poverty: soil erosion, nutrient mining, bad land preparation, lack of farmer experience, lack of improved varieties, insufficient diversification and intensification, and high weed pressure cause a decrease in yield; this results in income reduction; lack of funds for essential inputs brings about further land degradation more poverty and unemployment. According to a survey undertaken by the World Bank in 1993, 57% of the rural population in Vietnam falls under the poverty line compared to 26% in urban areas. In 1994, the GDP per capita in Vietnam amounted to only 200 US$, ranking 150th of 173 countries.

To break this vicious cycle of low income, low inputs, low yields, it is essential to prevent further land degradation and to improve agricultural productivity. As demonstrated in the problem tree (Figure 1), land degradation is the core problem that will be addressed in this project. Three major interventions are proposed to tackle this key problem: improved nutrient management, diversification of agricultural production, and proper land use planning.

The first important tool to slow down land degradation and to improve the productivity in the uplands is integrated nutrient management. At the outset, it must be acknowledged that agriculture in the target area is characterized by an almost complete absence of soil fertility monitoring. Consequently, no significant scientific support in terms of fertilizer use or nutrient management can be forwarded to the farmers. Apart from the intrinsic and purely agronomical need for fertilizer recommendations, it can be stipulated that an increased fertilizer use may turn out to be detrimental to the environment if not accompanied by proper guidelines and by ways of monitoring, the soil fertility changes. Over the past ten years, some agricultural research activities including breeding programmes on maize, upland rice, soybean, mungbean, peanut, and cassava, as well as some fertilizer trials have been carried out in areas adjacent to the project region. This information will be useful to develop integrated nutrient management trials, but its regional coverage is far from complete due to the limited resources of the responsible institutes.
A second direction to improve the current farming systems in the uplands is to pay more attention to diversification and intensification of the agricultural production. The focal point of agricultural policies over the last 25 years, at provincial as well as district level, has been the need to become self-sufficient in food production. Self-sufficiency at the local level was an essential step of the country's defence strategy. Given its historical association with, and dependence on, rice cultivation, it was logical that self-sufficiency in food requirements should be based on an increase in paddy. Other food crops (cassava, maize, and sweet potato) were only resorted to whenever there were rice shortages. Rice cultivation has been extended even in areas where it is ill-adapted to the type of agricultural system in place because strategic considerations invariably prevailed over those of economic profitability and environmental concerns. In the Central Highlands, for instance, rice was cultivated at the expense of much more profitable industrial crops such as coffee, tea, or mulberry. With the achievement of self-sufficiency in rice, more emphasis is being put on diversification of the agricultural production. So far, diversification has a modest scientific foundation in Vietnam and the selection of crops is based on vague principles. Such a situation may lead to suboptimal choices which often result in soil erosion and land degradation. In the target regions, forested areas cover still 62% of the land but they are threatened by such practices. A more rational way of recommending a more diverse cropping pattern, therefore, seems urgent. Such recommendations will, apart from assigning the most suitable crops for a given situation, also include advice on land preparation, selection of tolerant high-yielding varieties, weed control, crop rotations, and soil conservation measures. On the latter issues, a large body of information exists from various parts of the world with similar problems, but it needs to be validated in the present area. Diversification through integration of crops and livestock is another promising way to increase the profitability of farming systems in the uplands. Intensifying animal husbandry and dairy production in the Eastern region and the Central Highlands of South Vietnam is the goal of two other bilateral project proposals between Vietnam and Belgium. Given the fact that almost no information exists on land suitability for the major crops in the uplands, this equally holds for fodder crops. As such, the present intervention will provide essential information to back-up any initiative aiming at increased livestock production. More livestock, in turn, will lead to an easier access to organic waste products which are welcome products to increase the fertility of the soils.

Development of a better data base on current land use, allied to a geographical information system that will enable changes in land, agricultural, and socioeconomic conditions to be more effectively monitored than at present is the third indispensable step if one endeavours to slow down land degradation. Such a database would allow the identification of the most serious land problems facing the nation and would enable priority for support to be given accordingly. Discriminatory use of land, targeting research and development activities, and assisting farmers in the management of farms all require comprehensive information on soil and water resources. In order to develop a database and geographical information system on land use, reliable information has to be obtained on soils, climate, geomorphology, geology, hydrology, and socio-economics.

Since 1980, systematic soil surveys have been done in all provinces and economic regions of Vietnam. Maps have been
prepared at a 1/100,000 and at a 1/250,000 scale at provincial and regional level, respectively. The existing soil maps, however, were compiled using the Vietnamese soil classification system. Contrary to most contemporary soil classification systems, the Vietnamese system uses soil genesis as the principal basis for classifying soils, making the soil map a less effective tool for soil management decisions. Besides, the system has only 2 levels of classification, and no precise criteria and key to define and separate the different soil groups. In order to facilitate the exchange of soil-related information and experience with the international agricultural community, it would be very useful to convert the existing soil survey information in Vietnam into the internationally widely accepted FAO/Unesco soil classification system. In 1994, the Dong Nai provincial authority has approved and sponsored a pilot project to convert the existing soil map into the FAO/Unesco system. The proposed project would build on this experience and assist to resolve the conversion problems which have been encountered.

Recently, an attempt to evaluate the land resources of the Central Highlands was undertaken. The existing land evaluation studies provide a useful basis for the proposed project. The value of these studies, however, can be enhanced by utilizing, in addition to the traditional methodology, more modern tools including crop growth models, weather simulators, advanced techniques of air photo interpretation and satellite data analysis, updated socio-economic statistics, and, of course, the comprehensive data on soil erosion and crop responses to be generated by the proposed project.

In 1993, an Integrated Resources Mapping Center (I.R.M.C.) was established at sub-N.I.A.P.P. with sponsorship of the International Mekong Center to apply GIS technology in evaluating the natural resources of Vietnam. A Committee and UNEP/GRID. The goal of this database on the biophysical and socio-economic environment of South Vietnam is in the initial stage of development. The considerable experience of the Institute of Land Management of the K.U.Leuven in building up an elaborate GIS for natural resources management will be very relevant to upgrade and expand the GIS of sub-N.I.A.P.P.

II. PARTICIPATION ANALYSIS

II.1 Target area

The project targets the Central Highlands which comprise the provinces Kon Tum, Gia Lai, Dac Lac and Lam Dong and cover an area of 55569 km². This region is by far the most forested area of the country with an estimated coverage of 62% in 1993. Preservation of the forest and the introduction of conservation measures is crucial in this area as many rivers in the Central and Eastern part of South Vietnam are originating in the Central Highlands. At present, population density averages only 52 persons/km² for a total of 1.9 million inhabitants.

But the government strongly encourages immigration from more populous provinces throughout Vietnam and attaches a very high priority to the sustainable development of this region. In order to develop the Central Highlands of Vietnam in a sustainable way it is essential that the massive inflow of people into the region is accompanied with integrated nutrient management, diversification and intensification of the existing farming systems and proper land use planning. If not, one risks to turn many more hectares of valuable soils into barren lands. The fight against environmental degradation should begin now because erosion is becoming widespread due to an absence of proper cultivation methods and due to uncontrolled slash-and-burn practices.

In summary, the Central Highlands have been selected as the target area for the following reasons:

• high priority of the Vietnamese government to develop the region;
• acute threat of environmental degradation;
• economic backwardness;
• rapid increase in population density (up to 100% in the last decade in some areas);
• strong reliance on agriculture or forestry; and
• good potential for increase of agricultural productivity;
• absence of a comprehensive land evaluation system.

II.2 Target group

All farmers in the project area should benefit from a scientifically-based land use planning, from integrated nutrient management strategies and from agricultural diversification and intensification. The project target groups, however, are new settlers, minorities and destitute farmers who use low input-technology. At present, both Vietnamese immigrants in settlement schemes of the government as well as ethnic minorities practice unsustainable farming systems. The former group often lacks necessary farming experience and is not covered by extension officers introducing and promoting farming methods. The latter group practices traditional slash-and-burn agriculture which does not match any longer with the current
land pressure

Poverty is a serious problem in the region: about one fifth of the population, mainly members of nomadic ethnic groups earn less than US $ 40 annually and suffer illiteracy rates as high as 60 %. As much as 7 % of the inhabitants of the Central Highlands are infected with leprosy It is hoped that the introduction of productive and environment-friendly farming systems will help these people to improve their living conditions.

II.3 Participating institutions

The Vietnamese counterpart institutions in this project, the National Institute for Agricultural Planning and Projection (N.I.A.P.P.), the Institute of Agricultural Science of South Vietnam (I.A.S.), and the Center for Soil and Fertilizer Research and Techno-Transfer in South Vietnam (C.S.F.), which is part of the National Institute of Soils and Fertilizers (N.I.S.F.), are amongst the most important agricultural institutions of the country.

The N.I.A.P.P. has a national mandate to undertake soil surveys and prepare soil and land use maps. For many years, the staff of N.I.A.P.P. has been involved in such studies. In the course of the project, the Vietnamese counterparts will be thoroughly familiarized with the principles and methodology of the FAO/Unesco soil classification system, the F.A.O land evaluation framework, and geographical information systems. Some essential equipment for such studies is already available at the above institutes. Additional equipment will be provided by the project. With the acquired experience and facilities, Vietnamese specialists will be able to engage in future survey and mapping activities on a more detailed scale.

The N.I.S.F. has a staff of 300 people and has 6 departments and 4 stations covering all aspects of soil science: soil genesis, soil biology, soil chemistry, soil physics, soil fertility, and soil reclamation. The inclusion of the N.I.S.F. as a partner in the proposed project will take available the vast experience of its staff as well as a rich soil database. It will also ensure that the activities of the project will be taken over without interruption by the institute once the Belgian contribution has been terminated.

As the objectives of the project are strikingly resembling the long-term goals of the I.A.S., it may be expected that the activities of the project will be taken over without interruption by the institute once the Belgian contribution has been terminated.

The Belgian partner in the collaboration would be the Catholic University of Louvain ('Katholieke University Leuven'), represented by the Laboratory of Soil Fertility and Soil Biology and the Institute for Land and Water Management. The Laboratory of Soil Fertility and Soil Biology has a long-standing tradition in soil fertility research in tropical and temperate areas. Research has been focusing on the bio-availability of crop nutrients or (radio)contaminants with respect to their transfer from soils to plants. In Europe recent activities have been addressing the mapping of phosphate-saturated soils together with a fundamental study on the physico chemistry of phosphate in these soils, the prediction of nitrogen losses from soils through biological denitrification, the soil-to-plant transfer of radiocesium and the bioavailability of cadmium. In the tropics, more than 15 years experience in biological nitrogen fixation has accumulated together with more recent activities related to iron toxicity in paddy rice, sloping land agriculture, the use of rock phosphate in paddy rice and soil organic matter dynamics. As such, a large body of information on soil fertility issues in the tropics has been created and applied in the respective target areas. The Institute for Land and Water Management offers a comprehensive capacity in land use and soil survey techniques and has demonstrated its excellence in this area. The institute has access to GIS and has pioneered its application in soil data bases. People from the institute are regularly consulted by policy makers in Europe dealing with planning of the natural resources and for environmental questions related to the vulnerability of specific ecosystems towards given environmental constraints. This expertise has also been frequently put to good use in tropical contexts where members of the institute are figuring as consultants for international organisations such as F.A.O., I.A.E.A., and World Bank.

As a whole, both partners combine a range of expertises essential in achieving the goal of this project.

III. OBJECTIVE ANALYSIS

The objectives of the project are obtained by inversion of the problem tree are formulated in the objective tree (Figure 2). The objectives are discussed in more detail in the intervention logic (chapter IV) and in the “purposes” and the “intermediate
IV. INTERVENTION LOGIC

4.1 Purpose #1: Improved nutrient management

Activities in this intervention serve the purpose of designing improved nutrient management systems for the most significant crops in the Central Highlands. This purpose will be met by several activities to be executed in the following sequence.

4.1.1 Assessing soil fertility status in representative ecosystems.

At the outset, an indicative survey of the soil fertility status will be carried out in the target region, focusing on the most representative cropping systems. Hereto, surface samples will be taken in an adequate number of fields within a given homogeneous soil type and land uses. These surface samples will be analyzed for organic carbon, total nitrogen, cation exchange capacity, exchangeable bases, and acidity, pH, and available phosphorus. It is anticipated that changes in these parameters when related to the cropping history will yield clues with respect to the question whether the cropping pattern is depleting or sustaining soil fertility. In other words, this exercise will indicate which soil parameters to look for when attempting to judge a cropping system on its effect on soil fertility.

4.1.2 Nutrient management trials on selected sites

Based on the results of 4.1.1 and the activities listed under purpose 2, a selection will be made of the more representative crops in a given area and improvements suggested according to the predominant soil constraints to crop production. At present there is a serious lack of knowledge on crop response parameters to environmental (soil) constraints. These parameters are needed to feed the models which are used in quantitative land evaluation. The existing land evaluation schemes in Vietnam are at present borrowing response parameters from literature what in most cases had led to unsatisfactory results.

With this tear of the proposed project, an attempt is made to generate crop response data, under Vietnamese conditions, for
the most commonly grown crops and varieties. In the first place, during the field surveys, information will be collected on biophysical factors which may limit the suitability of the land for crop production. Examples of such factors are depth of the soil profile, soil workability, slope of the land, oxygen availability to roots, and flood hazards.

Apart from these rather informal surveys a more formal area sampling will be conducted in the target area on rice, maize, cassava, soybean, pasture, coffee, tea, mulberry and cashew. This area sampling includes the systematic and detailed study of 2-3 sites for each crop. On one site, crop performance is monitored on a farmers’ field in presence or in absence of a cropping of resistant crops such as sorghum or pearl millet can be grown at the start or the end of the rainy season); and iv) to provide a better balanced diet to farmers. Multiple cropping systems that have been successful in comparable environments in other countries will be introduced and evaluated in the Central Highlands of Vietnam.

As an example, four possible field trials are suggested below. In other sites of the target area, selection of cropping systems and treatments will be done on the same basis or using similar lines of thinking. It is envisaged to establish a total of about 20 long-term field trials.

4.1.2.1 Coffee-based cropping systems in Buon Ma Thuot, Dac Lac

Plantation crops such as coffee and tea are becoming increasingly popular in the highlands, but fertilizer recommendations for optimum production of these crops are absent. Treatments will be laid out with different doses and kinds of inorganic as well as organic fertilizers. Under different environmental conditions (soil type, slope, etc.), it will be determined which management practices lead to a productive and sustainable cropping system.

4.1.2.2 Maize-based cropping systems in Da Loan, Lam Dong

Monocropping with maize is a widely occurring cropping pattern on the sloping lands of South Vietnam, potentially leading to land degradation through acidification and erosion. In the area concerned, maize is growing on highly weathered, nutrient-poor, acidic Oxisols and sometimes Nitisols. Sod constraints impeding a sustained production of maize in this way are P-fixation, acidity and low base saturation. Treatments are therefore concentrating on NPK additions, and on rotating maize with soybean and sorghum in order to add organic nitrogen and organic matter through the residues.

4.1.2.3 Cashew-based cropping systems in Duc Lieu, Song Be

Perennial crops like cashew entail a risk of soil loss during the years of establishment. In the highlands this is unacceptable in view of the generally sloping fields. Most often a recent cashew plantation is combined with upland rice before the trees attain complete canopy closure which does not seem the ideal combination in terms of erosion protection. Therefore, the treatments here will include some leguminous intercrops as an alternative to upland rice.

4.1.2.4 Mulberry-based systems in Bao Loc, Lam Dong

Mulberry is an important cash crop in this province and is increasingly planted, mainly on sloping land. As the crop is quite intensive, dramatic amounts of inputs (fertilizers, agrochemicals) are applied without any consideration or possibility to monitor the impact on the environment. Further, the crop is regularly pruned so that the soils often are subject to runoff and erosion. Therefore, treatments focus on an improved and rational fertilizer advice and on protecting the exposed soil before canopy closure with cover crops.

4.2 Purpose #2: Diversification and intensification of agricultural production

Soil fertility issues as explicated in the previous intervention should not feed the impression that these are the only causes leading to land degradation as shown in the problem tree (Figure 1). In this intervention, attention will be paid to the introduction of multiple cropping systems, inclusion of improved varieties, application of soil conservation measures, control of weeds, proper land preparation, and to studies on animal feed production ensuring a proper integration of livestock in the target area.

4.2.1 Multiple cropping system

Being used to successfully grow lowland rice on the same land year after year, Vietnamese farmers do not seem to value very highly the advantages offered by multiple cropping systems. Even in the uplands, they tend to practice mono-cropping with minim31 inputs until the yield of the crop declines so much that they have to abandon the land. Agriculture productivity and farmers’ income in the uplands can be drastically improved by introducing adapted crop rotations. Growing more or more diverse crops on the same land will help i) to reduce erosion because the soil remains covered during the entire rainy season; ii) to limit build-up of pests and weeds; iii) to better utilize scarce water resources (drought-resistant crops such as sorghum or pearl millet can be grown at the start or the end of the rainy season); and iv) to provide a better balanced diet to farmers. Multiple cropping systems that have been successful in comparable environments in other countries will be introduced to and evaluated in the Central Highlands of Vietnam.
4.2.2 Improved varieties

As part of the general objective of prevention of land degradation, yield increases are of central importance for preventing farmers from abandoning their land in a premature stage, in turn leading to excessive land degradation. More efficient or more tolerant varieties are crucial in this context. Therefore, it is logical to also include them in this proposal. The I.A.S. has developed quite a number of improved varieties of, amongst others, cassava, peanut, maize and cowpea. Wherever these species are used in the previous intervention, the improved varieties will be used and compared with the conventional ones.

4.2.3 Soil conservation measures

On sloping land, erosion is one of the major soil constraints to a sustained agriculture production. As many of the solutions are known and have been tested successfully in other countries, and in view of the widespread neglect of this issue in the highlands of Vietnam, a number of demonstration trials will be laid out. Apart from the obvious recommendation to plant along the contour lines, other treatments like tied ridging, trash lines and grass strips will be implemented and their effect on erosion control demonstrated.

4.2.4 Control of weeds

Under upland conditions, weeding probably is the most time-consuming activity of the farmer. A number of well-known practices such as mulching, growing of cover crops, crop rotations, and zero- or minimum tillage have proven to be effective to control weeds. Wherever weed pressure is conceived by the farmers in the target area as a major constraint, trials with a few simple treatments to validate different weed control measures under local conditions will be laid out.

4.2.5 Potential for animal feedstuffs production

Because the climatic conditions are more suitable than in the lowlands, the Central Highlands have a good potential to develop intensive animal husbandry. At present, about 10% of the arable land in this region are pastures. However, as these pastures have not been improved, their stocking density is very low. An essential activity for interventions aimed at slowing down land degradation and increasing agricultural productivity in the Central Highlands is to look at the potential of the land for growing animal feedstuffs. Therefore, in this intervention, attention will be given to the inclusion of fodder crops in a more diversified cropping system and to the improvement of existing pastures. This will ensure that sufficient fodder is available for intensive animal husbandry, while the manures produced will undoubtedly be useful in enhancing the soil fertility status of the degraded soils in this area.

4.3 Purpose #3: Improved land use planning

Through this intervention, tools will be made available allowing planning of land use to be done on a rational basis using up-to-date methodologies. The essential task is one of land evaluation which would identify suitabilities for each given agro-ecological zone for a particular use, from annual and perennial crops to animal husbandry and forestry. The task itself breaks down into several subtasks as explicated below:

4.3.1 Conservation and improvement of the existing soil maps

The existing soil maps of the study region based on the Vietnamese soil classification (1/250,000 scale) will be improved and will be converted into the internationally accepted FAO/Unesco soil classification system. The following steps will be involved:

- Collection of existing data and maps on soils, geology, geomorphology, climate, etc.
- Study of the existing soil profile descriptions in order to make correlations between the Vietnamese and FAO/Unesco soil classification system.
- Analysis of air photographs to identify areas suitable for field verification of the proposed correlations and for in-depth-study of soil groups for which no suitable conversions can be made.
- Performance of field surveys along transects: soil's will be thoroughly described and analyzed.
- Preparation of a draft regional soil map at 1/250,000 scale.
- Discussion on the draft map with Vietnamese pedologists.
- Modification of the map.
- Publishing of the map and legend.

Due to the large project area, a minimum of two groups of surveyors, consisting each of about 5-6 surveyors, will needed for the field verifications. Because there are wide variations in complexity of soil and accessibility of the terrain, no good estimate can be made of the area that can be surveyed per month team. As a rough approximation, about 1000 km² should be
surveyed per team per month. The methodology will be established in a first phase in small test areas. The total area for mapping will be demarcated upon the outcome of the tests and will be a function of the financial means of the project. Continuous soil survey work will be done the first three years of the project. After that ad-hoc field surveys will be important for further verification to solve problems which certainly will pop up when assessing the database in the GIS environment.

4.3.2 Improvement of existing soil suitability maps in a GIS environment

The results of the nutrient management trials (4.1.2) will be a set of customised crop response parameters which will then be fed into the GIS system to produce the soil suitability maps. The methodology proposed by the 'Framework for land evaluation' (FAO, 1976), will be followed to publish the land suitability maps. Furthermore, the use of mechanistic models to simulate crop growth on key test sites will be explored i) to pinpoint the magnitude of certain crop growth constraints; and ii) to find ways to develop a model-based GIS for quantitative land evaluation. This GIS will be able to analyse alternative land use scenarios, which will be assessed by means of linear programming techniques towards a preset goal. Apart from the maximisation of profits for the farmers, alternative scenarios will be explored in view of sustainability of the system.

4.3.3 Evaluation of the sustainability of alternative farming system in the target area

Nowadays, policy makers and planners are not only interested in the present suitability of a piece of land for a certain use. They also require information whether permanent or progressive deterioration of the suitability of the land in question is foreseen over a reasonably lengthy period of time. Therefore, in 1993, the FAO proposed an international 'Framework for Evaluating Sustainable Land Management (FESLM)'. This framework is designed as a structured, logical pathway for making decisions on whether or not a carefully defined form of land management is likely to prove sustainable in a defined situation over a defined period of time. The main difference with traditional land evaluation studies is that, besides identification of factors that determine present land suitability, trends of change in the local environment have to be exposed. By recognizing and explaining the causes of these trends in the past, the pattern of future change and its effect on sustainability has to be projected. There is also a much greater emphasis on social and economic factors that may limit the fitness of a certain land use. Because the latter factors are very variable in time and space, evaluation of sustainable land management should be made for a defined kind of land use and should relate to specific land sites and to a defined time frame.

The project will attempt to undertake a few such multi-disciplinary evaluations for sustainable land management. Three representative test areas, each of 1000 ha, will be selected on the basis of the 1:250,000 scale improved soil map, for an in-depth study of sustainability aspects. They will represent some of the most important land utilisation types of the project area. Detailed studies (at a scale of 1:5000) will be conducted at these sites to inventarise the soils, relief and land use. Special attention will be paid in these studies to the occurrence of sudden erosion phenomena which are quite common in the Vietnamese landscape. The factors which underlie these processes are not fully understood. A holistic approach will be followed in this study to unravel the intervening factors. Time series of aerial stereo pairs will provide clues on time trends and pinpoint key factors which trigger the occurrence of these devastating gullies. Special attention will be paid to: i) dynamics of land use by studying time series of aerial photo's; ii) characterisation of the studied hydrological catchments. This characterisation will not only take soil and land use into account. Other information layers are also of crucial importance e.g. lateral organisation patterns such as road infrastructure, lay-out of farming systems and urban areas; and iii) characteristics of the farming system with special attention for crop phenology degree of mechanisation, crop rotation and transport patterns.

4.3.4 Extension

The philosophy and methodology of the FAO/Unesco soil classification system, the Framework for Evaluating Sustainable Land Management, and GIS will be introduced to the local authorities and scientific community via workshops, training courses and (university) lectures.

The workshop will cover the following subjects:

- Correlation between the Vietnamese soil classification system and the FAO/Unesco system;
- GIS technology;
- Quantitative land evaluation;
- Land evaluation for sustainability;
- Recommendations for sustainable land use systems.

At regular intervals, farmers will be invited to inspect the demonstration trials and offer their comments. Future trials will try to accommodate their remarks. More formal efforts to extend the research findings to the farmers will be undertaken the last two years of the project. With the help of video clips and extension brochures, the most important results will be presented to a selected group of farmers. The recommendations on sustainable land management will be transferred to the farmers on a larger scale with the assistance of agricultural extension services of the provinces and the district and with the help of Non Governmental Organizations.
### V. PROJECT PLANNING MATRIX

<table>
<thead>
<tr>
<th>LOGICAL FRAMEWORK 1</th>
<th>INTERVENTION</th>
<th>OVI</th>
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| GOAL                | Land degradation slowed down and agricultural productivity increased | * Deforestation reduced  
|                     |              | * Area of degraded land stabilised  
|                     |              | * Total agricultural production increased | Area statistics  
|                     |              |                          | Agricultural statistics | * Assistance of local institutions to extend project recommendations  
|                     |              |                          |                          | * Land ownership transferred to farmers  
|                     |              |                          |                          | * Post-harvest losses controlled  
|                     |              |                          |                          | * Minimum prices for agricultural products guaranteed |
| PURPOSE 1 | NUTRIENT MANAGEMENT IMPROVED | * Soil fertility status improved  
|          |              | * Higher yield | * Project report on soil fertility status every year  
|          |              |                          | * Fertilizer sales figures  
|          |              |                          | * Agricultural statistics | * Fertilizer prices stable  
|          |              |                          |                          | * Credit available |
| INTERMEDIATE RESULTS | 1.1 Nutrient availability status monitored | 1.1 One year from the starting date, nutrient status monitored in the entire region.  
|          | 1.2 Nutrient management recommendations for different farming systems formulated | 1.2 Recommendations formulated and extended to 1000 farmers before the end of the project  
|          | 1.3 Research capability in nutrient management of Vietnamese staff improved | 1.3 20 Vietnamese staff trained in analytical techniques and soil fertility research. | 1.1 First project report on soil fertility status  
|          |                          |                          | 1.2 Leaflets with fertilizer advise for common crops.  
|          |                          |                          | 1.3 Training reports and annual project reports |

<table>
<thead>
<tr>
<th>LOGICAL FRAMEWORK 2</th>
<th>INTERVENTION</th>
<th>OVI</th>
<th>SOURCES OF VERIFICATION</th>
<th>ASSUMPTIONS</th>
</tr>
</thead>
</table>
| GOAL                | Land degradation slowed down and agricultural productivity increased | * Deforestation reduced  
|                     |              | * Area of degraded land stabilised  
|                     |              | * Total agricultural production increased | Area statistics  
|                     |              |                          | Agricultural statistics | * Assistance of local institutions to extend project recommendations  
|                     |              |                          |                          | * Land ownership transferred to farmers  
|                     |              |                          |                          | * Post-harvest losses controlled  
|                     |              |                          |                          | * Minimum prices for agricultural products guaranteed |
| PURPOSE 2 | AGRICULTURAL DIVERSIFICATION AND INTENSIFICATION INCREASED | * Total cropped area divided over more crops  
|          |              | * Increased livestock numbers | Statistics on agricultural production  
|          |              |                          | Transport and marketing systems improved |
| INTERMEDIATE RESULTS | 2.1 Recommendations for more diverse and more intensive  
|          | 2.2 Integration of crops and livestock improved | 2.1 Before the end of the project, recommendations for more diversified cropping systems formulated and extended to 1000 farmers | 2.1 Brochure with guidelines for more diverse cropping published through the project  
|          |                          |                          | 2.1 Assistance obtained to multiply and distribute improved varieties  
<p>|          |                          |                          | 2.2 Belgian-Vietnamese bilateral projects |</p>
<table>
<thead>
<tr>
<th>LOGICAL FRAMEWORK 3</th>
<th>INTERVENTION</th>
<th>OVI</th>
<th>SOURCES OF VERIFICATION</th>
<th>ASSUMPTIONS</th>
</tr>
</thead>
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<td></td>
<td></td>
<td></td>
<td>* Minimum prices for agricultural products guaranteed</td>
</tr>
<tr>
<td>PURPOSE 3</td>
<td>LAND USE PLANNING IMPROVED</td>
<td>Scientifically sound plans based on a more detailed database</td>
<td>Plans published by N.I.A.P.P.</td>
<td>Essential data on climate, geomorphology, socio-economics, etc., available to project.</td>
</tr>
<tr>
<td>INTERMEDIATE RESULTS</td>
<td>3.1 Existing soil maps converted and improved</td>
<td>3.1 FAO system soil maps at 1:250000 published by the end of the project</td>
<td>3.1 Soil maps available from N.I.A.P.P. in a GIS format.</td>
<td>Official permissions obtained to survey everywhere in the Central Highlands.</td>
</tr>
<tr>
<td></td>
<td>3.2 Recommendations for land use in Central Highlands formulated</td>
<td>3.2 Land use recommendation published and extended to 1000 farmers by the end of the project</td>
<td>3.2 Soil suitability maps and land use recommendations published through the project.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.3 Surveying and GIS capabilities of Vietnamese staff improved</td>
<td>3.3 18 Vietnamese staffs trained in soil survey and GIS</td>
<td>3.3 Training reports and project reports.</td>
<td></td>
</tr>
</tbody>
</table>