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REPOSA RESEARCH PRIORITIES AND WORK PLAN 1997-1998

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Conclusions of the meeting between the delegation from Wageningen and the Costa Rica field team,

8-15 December, 1996, Guápiles, Costa Rica.

December 1996, Guápiles, Costa Rica

Preface

From 8-15 December 1996, a delegation from Wageningen Agricultural University visited REPOSA in Guápiles, Costa Rica, with the following objectives:

- Evaluate the progress of REPOSA during 1996
- Fine-tune research priorities and activities
- Define outreach activities
- Define student involvement
- Evaluate management aspects

The delegation consisted of B. Boerrigter (Office of International Relations), J.Bouma (Soil Science and Geology), L.O. Fresco (Agronomy), A. Kuyvenhoven (Development Economics), and M.K. van Ittersum (Theoretical Production Ecology). The Costa Rica field team consisted of B.A.M. Bouman, S. Efdé, H.G.P. Jansen and A. Nieuwenhuyse.

This report documents the results of the discussions among delegation and field team members *vis-a-vis* the objectives mentioned above. After a brief introduction in Chapter 1, Chapter 2 of this report summarizes the state-of-the-art in REPOSA as at the end of 1996. Chapter 3 presents a summary of the conceptual framework and updated objectives, and constitutes the major guideline for the coming years. Chapter 4 presents major research issues as agreed upon by the Costa Rica field team and the members of the delegation. These research issues will be 'tackled' by the various players in REPOSA and the Wageningen VF program: the Costa Rica field team, M.Sc and Ph.D students, researchers in Wageningen from participating departments, and researchers from so-called 'related' projects (Knowledge Centre Wageningen). Because of limited time and manpower available (especially within the field team), priorities were set and a number of topics were selected to form the backbone of the work plan for 1997-1998. This workplan is presented in Chapter 5, with emphasis on the activities of the Costa Rica field team. Chapter 6 is dedicated to a discussion of outreach activities that will be undertaken in the form of workshops and courses. Finally, Chapter 7 lists objectives of (graduate) student research, in agreement with the prioritization of research issues as delineated in Chapter 5.

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1. INTRODUCTION

As REPOSA is now embarking on its final two years of work, emphasis will be placed on further refinement of the methodologies together with stakeholders in Costa Rica, and on outreach of the approaches developed thus far:

1. The continuing refinement of the methodology and its application at various scales in a number of different areas. The methodology consists of four elements ranging from land use projections, to defining exploratory options and policy models. Attention is also paid to developing decision support (DSS) models at the farm level.
2. Initiating an interactive process with stakeholders in Costa Rica to determine possible scenarios and land use evaluation needs that will further guide methodology development. Additionally, this includes an 'awareness' phase among stakeholders of the potentials of the developed methodologies in land use policy evaluation exercises.
3. Development of training materials and organization of international workshops to disseminate the concepts and tools of the developed methodologies. Target groups include NARSs, CGIAR Centres, NGOs, and researchers from Advanced Research Institutes.

Agricultural policies and economic incentives can be important tools to achieve a more sustainable use of natural resources. Policies are defined by national or regional governments, but the ultimate decision on how to use agricultural land is made on individual farms. Different farms may respond differently to certain policies or incentives. These differences in responses are related to differences between farms in bio-physical possibilities, in socio-economic conditions, and in objectives and preferences of persons managing the farm. Since policy makers need information about the trade-offs between socio-economic, ecological and agricultural objectives, they need to be able to evaluate alternative land use policy options from various perspectives, requiring analytical methods which simultaneously take account of socio-economic, edaphic and agronomic factors. Consequently, from 1991/92 onwards, REPOSA has been spending major efforts and resources in the continuous development and refinement of a multidisciplinary methodology which can assist policy makers in evaluating alternative land use options while allowing for improved analysis of the aggregate effects of alternative policies at the (sub)regional or national level.

2. STATE-OF-THE-ART IN REPOSA

The position of the program as of December 1996 is described below, more or less according to Figure 1 of Chapter 5.

A. *CLUE*

With the appointment of a Ph.D candidate in the Department of Agronomy of WAU, work has started on the further elaboration, validation and extension of the CLUE-CR model. Research focuses on modelling human drivers (both demographic and socio-economic) and biophysical constraints of regional land cover and use in an integrated and multi-scale effort. Special attention is given to national demand determining factors, yield fluctuations, and the integration of census data and satellite imagery.

B1. *Agro-exploratory models for the Atlantic Zone*

Options for land use in the Atlantic Zone (AZ) have been explored using an IMGLP model in which quantitative information on land use is confronted with social objectives. A single-period and a multi-period linear programming (LP) model, each with eight objective functions, are available in OMP. The single-period model is operational and a number of scenarios have been generated. The multi-period model (four periods of 5 years each) is not fully operational yet. The multi-period model takes into account that perennial crops have a longer cropping cycle than annuals; perennial crops can be grown during one or more periods. The effect of uncertainty in economic conditions (prices) and technical coefficients (related to nitrogen and pesticides) was investigated by running the model for "optimistic", "average" and "pessimistic" values.

In addition, aggregation issues related to explorative land use studies have been investigated. Land evaluation (soil and climatic data), quantification of input-output combinations, integration of information in LP models and generating scenarios have been operationalized at different aggregation levels.

B2a. *USTED 1995 (AZ)*

- APSTs data are available for dual purpose, milk and beef cattle systems, but these have not yet been fully operationalized in the model
- Work on pasture LUSTs has been started
- An economic evaluation of alternative ways to increase beef production is available
- The sensitivity of USTED regarding a number of assumptions relating to farm typology, labor market specification and prices, in terms of aggregation bias caused, has been carried out
- Even though transport cost models have been estimated for the AZ (and subsequently used in publications involving the use of USTED at the county level), the definition of economic sub-regions for the entire zone has not yet been executed
- A book on marketing of agricultural commodities is available in the CATIE Technical Series, in both English and Spanish
- A book on soils in the AZ is available in the CATIE Technical Series
- Work on the new version of the MODUS software is in progress
- A simplified version of the regional model for the AZ is available

B2b. *USTED 1996 (AZ)*

- Demand models are available for 24 aggregated food categories, and some of the results were used in the simplified version of the AZ model (results of the demand models are valid for Guanacaste as well)
- Work on incorporating risk in the LP model has been started
- Work on the development of a methodology for the incorporation of soil erosion aspects into LP models is in progress

B3. *Guanacaste*

Regarding soil map/land evaluation:

- The soil map is available in digitized format, and work on extending and updating the GIS data base continues according to schedule
- Collection of weather data was initiated
- A land evaluation study was initiated but not yet completed

Regarding LUSTs and APSTs:

- Data collection was initiated through a literature survey, farm-level data were generated for two tree species (teak and melina), whereas data for mango and coffee had been collected in 1995
- Some LUSTs were generated for rice, sugarcane, and orange
- Some work organic farming has been carried out by a student but has not led to useful input/output data
- Work on sustainability indicators is limited to erosion measurements by a Ph.D student

C. *Policy model*

Work on the UNA/DLV project started in March 1996 with input from UNA (three researchers) and Wageningen (Department of Development Economics). The project aims at the development of a methodology for policy-oriented appraisal of alternative scenarios of sustainable land use and food security at farm and regional level. This work involves the analysis of trade-offs between technical options and socio-economic objectives, comparison of agro-technical options to improve land use systems and technologies with the objectives and constraints of different types of agricultural households, and identification of suitable policy instruments to induce adjustment towards more sustainable land use systems.
A detailed work plan is available. In addition, data collection on land use in the AZ has been initiated. Meanwhile, research has started on farmers' decision making processes regarding time allocation.

For 1997, expected output include the development of various farm type models (small- and medium-sized farm households, haciendas, and banana plantations), and an analysis of partial and aggregate response to various policy measures.

D. *Decision support systems*

This work was officially initiated on June 1 1996, even though preparations commenced in January 1996. A detailed soil map of the farm is available in digitized format. Yield monitoring has also started and will be correlated to input use and soil characteristics.

E. *Related projects*

E1. *Land use and emission of greenhouse gasses*

From the Wageningen side, this project mainly involves the Ph.D. research of Roel Plant. The main research objective is the development of a statistical modelling framework to predict effects of land use change on nitrous oxide (N_2O) emissions. The framework incorporates various layers of the USTED GIS, and the small-scale mechanistic simulation model DNDC (DeNitrification and DeComposition). Ecosystems of interest include primary/secondary forest, pasture, and banana plantations. As at the end of 1996, the following elements had received attention: 1) development of spatial scaling techniques, and 2) adaptation of the DNDC model to the selected Costa Rican ecosystem types. Ongoing collaboration with the University of Wyoming focuses on the development of the GIS-based statistical modelling framework. The Wyoming group is working on a similar land use/trace gas project which, however, will consider a larger area and more ecosystem types.

E2. *Landscape turnover rates*

This project has entered its final stage. Several papers have been submitted to international geological journals. The analysis of field data is finished with the exception for some soil samples which need to be analyzed at a laboratory at the university of Utrecht. Soil samples of a chronostratigraphical terrace sequence are currently being analyzed for 10Be content. The aim of this research is to apply the contents of this cosmogene isotope as a tracer for the age of the terraces.

E3. *Soil formation in volcanic soils*

Work in 1996 focused on soil formation on andesitic ash deposits in the perhumid zone; liverwort growth and volcanic ash deposition on recent and esitic slope deposits of the Arenal volcano; surface mineral transformation at unvegetated andesitic slopes of the Arenal volcano; soil formation on ignimbrites in Guanacaste; and aggregation and allophane grain size of andisols in the AZ.

F. *Workshops*

A three-day USTED workshop was held for 20 participants during June 11-13 1996. Seventeen participants came from Costa Rican institutions including the National Production Council (CNP), the Ministry of Agriculture and Livestock (MAG), the National University (UNA), the Interamerican Institute for Cooperation in Agriculture (IICA), the National Geographic Institute (IGN), the Commission on Land Use Planning (COT), the Ministry of Planning (MIDEPLAN), the University of Costa Rica (UCR), the School for Agriculture in the Humid Tropics (EARTH), the National Banana Corporation (CORBANA), and the Center for Research and Education in Tropical Agriculture (CATIE). In addition, two researchers from Guatemala and one from Nicaragua also participated. The first day of the course was largely devoted to lectures in which the instructors familiarized the participants with the most important aspects of the USTED methodology. The main aim of the second and the third day was to obtain hands-on experience with all stages of the USTED methodology through a practical example in which the participants had to operationalize the USTED methodology using a farm-level case study which was especially designed for the course. The afternoon of the third day of the course also included discussions with some experienced authorities regarding the potential applications of the USTED methodology at the policy-making level.

3. CONCEPTUAL FRAMEWORK AND UPDATED OBJECTIVES

REPOSA aims at providing operational methodologies to analyze and evaluate alternative land use scenarios for sustainable land use at the farm, regional and national levels in Costa Rica. Different types of questions by stakeholders and policy makers receive consideration and methodologies are based on these questions. Four major types of approaches are considered. A more detailed description is provided in the February 1996 report:

A. The projection of future land use.
Type of question: What will be the likely land use changes if trends in land use are extrapolated to the (near) future?

B. Exploration of options for land use (B1: long time horizon, very open; B2: shorter time horizon, less open)
Type of question: What are the options for land use for the medium to long term when optimizing for objectives related to income, employment, environmental quality and risk, and what are the tradeoffs between these objectives?

C. Policy instruments for sustainable land use options.
Type of question: What are effective policy instruments to induce changes in land use to achieve certain desired objectives at the farm and regional levels?

D. Optimizing production systems at the farm level.
Type of question: how can management strategies at the farm level be modified to reduce costs while at the same time improving environmental quality?

A central issue discussed at length was the justification and the relevance of the type of research being done in view of the termination of REPOSA by January 1, 1999. Following the research outline agreed upon during the previous visit in February 1996, it was decided that clearly defined and realistic goals for the different research lines are needed, including specific ways of implementation. This requires a careful shifting, prioritization and selection of activities, in view of the limited time and expertise available. This shifting, prioritization and selection will be presented later in this report (Chapter 5).

The overall criteria for success of REPOSA include the following:

1. The generation of interdisciplinary methodologies for assessing sustainable land use at different space and time scales. These methodologies should be of a high scientific standard, as evidenced by publications in international scientific journals, and they should be presented in courses and workshops to an international scientific audience. Also, the developed expertise should be reflected in the educational program at Wageningen Agricultural University.

2. Procedures and tools developed in by REPOSA should be extended to stakeholders in the region through interactive workshops and other forms of communication. The underlying philosophy should influence current institutional thinking about land use evaluation and analysis and, ideally, (part of) the methodologies developed should be institutionalized. However, institutional limitations may preclude the latter objective from being realized. The focus is primarily on two types of stakeholders:
(a): Farmers or farm managers. The objective is to have an operational decision support system in place for managing nutrients and biocides in banana farms to the effect that costs are reduced while environmental pollution is avoided, or reduced at a minimal trade-off in terms of income reduction (or, perhaps, no income reduction at all or even an increase in income).
(b): Regional and national land use evaluation officials and policy makers. The desire is to reach the point that the methodology (covering, in principle, the entire range of approaches A to D) is being

applied by land use evaluation officials in planning agencies or user groups, preferably in close cooperation with other policy makers in related fields (National Resource Management Agencies, Foreign Trade, Finance).

4. MAJOR ISSUES FOR THE FINAL PHASE OF THE RESEARCH PROGRAM

4.1. Involvement of stakeholders for scenario development

4.1.1. Interaction with stakeholders

A major objective of REPOSA is the extension of the developed land use evaluation methodologies and the explicit recognition of their usefulness by local stakeholders, be it farmers, farm managers, or regional and national planners. As a minimum, these parties should experience the benefits of interaction among disciplines; ideally, the developed methodologies should become an integral part of their day-to-day activities. Irrespective of the latter objective ever being realized, more attention should be paid to the direct involvement of local stakeholders in defining land use scenarios and in executing alternative model runs. Adoption of the developed methodologies can only be expected if this involvement is being realized. Working in an interactive mode would be most helpful to facilitate this process; attention should therefore be paid to developing user-friendly interfaces of the models being used, be it decision support systems at the farm level (methodology D) or USTED (methodology B) for regional planning.

Methodology D (farm level decision support systems) is made operational at the REBUSCA farm where contact is maintained with the owner. Student work, under the supervision of Jetse Stoorvogel, is contributing towards development of a Decision Support System. This work will be continued as an associated project which, however, will not be replicated on other farms in Costa Rica. On the other hand, in a related project, similar work will be conducted on banana farms in Ecuador.

Interaction at the (regional and/or national) planning level will be operationalized by organizing a local group of cooperators ('user group') representing various agencies (see suggestions offered by the Dutch Embassy; Appendix 3). Potential cooperators may have to be approached on an individual basis and may include specialists from Natural Resource Management Agencies and agencies dealing with external trade and finance. The project coordinator, Hans Jansen, is asked to give high priority to this activity. The user group is expected to participate in formulating relevant policy questions relating to land use scenarios for both the AZ and Guanacaste. REPOSA will interact with the group by presenting demonstrations of the methodology on the basis of which group members can give their feedback and present their ideas and opinions. The expectation is that, through interactively experiencing the land use evaluation methodologies, members of the user group will promote their active use - and the ways of thinking the various methods represent- in their respective organizations.

4.1.2. Mode of operation

Given the main objective of incorporation of modern computer-guided land use evaluation methodologies in actual decision making processes, to be achieved through the generation of enthusiasm among land use evaluation officers and policy makers, the following mode of operation is proposed:

1. Generation of a minimum data set of the region under consideration, which allows a demonstration of the feasibility of the methodology. Conceivably such a minimum data set includes information on soils, climate, land use, economic driving forces and, possibly, some exploratory exercises according to the B1/B2 procedure. The concept of a minimum demonstration data set needs further definition and elaboration. Question to be answered: what are the minimum datasets for the various diciplines?
2. Inviting a number of individuals involved in natural resource management (or otherwise involved in policy aspects of land use evaluation) which are considered to be full participants, through an

interactive procedure, in the process of definition and analysis of land use scenarios. Using demonstrations, as defined under (1), the user group will define scenarios that are of particular interest to the region under consideration. First, the regional focus will be placed in a national and international context. Subsequently, the question will be raised which land use scenarios are considered most relevant.

3. Using these scenarios, additional requirements in terms of data and model development will be identified, on the basis of discussions based on the outcomes of alternative model runs. In this way, the results obtained can be considered as a joint product, with data gathering efforts and model selection procedures truly "demand driven" while at the same time efficient in terms of both time and financial costs.

4.2. Sustainability and its operationalization

4.2.1. Aspects of sustainability

Sustainability has socio-economic, technical and environmental dimensions. Operationalizing sustainability is equivalent to finding compromises between these objectives, as they are acceptable to the various interest groups and stakeholders. This requires normative weighing of the various objectives, *i.e.*, trade-offs among objectives should be made transparent.

Current objectives in the USTED methodology (B2 type) include the following:

- Maximization of regional economic surplus
- Minimization of regional nutrient shortage
- Minimization of regional biocide index

Minimization of regional nutrient shortage is not an unambiguous indicator for ecological aspects of sustainability, since, in theory, a low value for this objective might imply that half of the area has a nutrient surplus, while the other half is being mined. This issue bears a clear relationship to the definition of alternative LUSTs (see section 4.3): inclusion of non-stable (*i.e.*, not in equilibrium) LUSTs is not feasible in a static modelling approach such as LP.

Which alternative or additional socio-economic and ecological aspects of sustainability should be included in the USTED methodology?

Options related to current indicators
A number of alternative and additional indicators can be identified that are more or less related to the objectives currently used in USTED. Some of these are already used by Janette Bessembinder in her B1-type model.

Socio-economic:

- Agricultural employment
- Equity of income among farmers, farm types and sub-regions

Ecological:

- Loss of nutrients per ha
- Loss of nutrients per $ surplus
- Biocide index per ha
- Biocide index per $ surplus
- Soil organic matter (see below)
- Bio-diversity (see below)

Short term damage to human beings due to the use of biocides has been studied and quantified. However, a full quantification of damage to the environment due to nutrient losses or biocide emission is currently not feasible. In addition to insufficient knowledge regarding the behavior of these substances to assess their concentrations across space and in time, damage of particular emissions or concentrations seems to be 'perception-driven'.

Farm structure (*i.e.*, farm size as well as on- and off-farm employment possibilities) is changing rapidly in the AZ. Current methodologies, however, cannot cope with this phenomenon. It is suggested to run USTED without any farm structure constraints.

Options not related to current indicators
Sustainability aspects currently included in the various models - nutrient balances and biocides - are relatively limited indicators of ecological sustainability. Attempts to use soil compaction have not proven successful, while the extent to which erosion is relevant and can be quantified in time remains to be seen. Two suggestions were made to explore additional indicators: soil organic carbon (SOC) and biodiversity.

Regarding soil organic carbon (SOC), data exist from Ed Veldkamp's Ph.D thesis on SOC decrease in the AZ after deforestation and conversion to pasture, allowing an assessment of SOC 'costs' as a result of changes in land use. However, currently no data are available on SOC under continuous annual cropping, palm heart, and banana. On the other hand, SOC data for banana could possibly be obtained from older plantations (Chiquita, Valle de Estrella), while similar data for annual crops and palm heart might be derived from the literature. Still, potential difficulties are threefold: first, overall SOC levels in soils in both the AZ and Guanacaste are relatively high; second, decreases are difficult to measure if they are limited over time; third, a temporary increase in SOC levels immediately after land use change has to be taken into account. Possibly, a curve of SOC decline can be constructed for the main land uses and even linked to a TCG. In any case, the idea is to only illustrate the use of this indicator while avoiding a full quantification of the effects of SOC decreases on yield (even though this would be preferable). Since data will definitely not cover all crops, classes for annuals, perennials and banana may have to be constructed.

Biodiversity as a sustainability indicator is only relevant at the regional level. Hence, it cannot be incorporated in USTED in the same way as nutrient balances which are attributed to each LUST/APST. As a regional indicator, biodiversity could be assessed as an outcome of various scenarios, and it can also be included in regional models such as a qualitative land evaluation, GOAL and (perhaps) CLUE. Rather than on an assessment of species diversity and losses, the focus would be on a measure of the (decline of) areas under climax habitats (*i.e.*, more or less undisturbed ecosystems). Through various known relations on area and species diversity (*e.g.*, Wilson's law: a 50% reduction in area implies 10% less species), biodiversity reduction as a result of changes in land use could be 'guesstimated', taking into account absolute areas, spatial distribution and shape of natural areas (existence of buffer zones etc). Reference can be made to the work by Janzen *et al.* for Guanacaste.

Finally, the potential of land for ecotourism should be taken into account in land evaluation, through an assessment of land qualities such as undisturbed habitats of the four (?) major types: montane forest, lowland rain forest, lowland dry forest, and mangrove/coastal forest. In combination with an assessment of the available infrastructure (roads, lodges, tourist accommodation) as well as location (accessibility and proximity to coastal resorts), the question of which types of land have potential for ecotourism can be addressed (along lines of FAO Framework for qualitative land evaluation). Furthermore, it may be attempted to qualify the effects of pro-biodiversity and pro-ecotourism measures in terms of costs of abandoning agricultural land (production losses) or potential of ecotourism to generate income and employment.

4.2.2 Scale dependency

Sustainability can be considered at different levels of scale, *i.e.*, field, farm, regional, and higher levels. The relationship between sustainability and scale is a central but complicated issue, the analysis of which differs by discipline. Theoretically, the process studied determines the appropriate scale - this is true for economists as well as for agronomists. In practical modelling exercises, however, data availability often determines the scale level of study. Furthermore, interdisciplinary questions lead to cross-cutting of scales. As a result of these practical matters, aggregation biases occur that need to be quantified. A definition of optimal scales (*i.e.*, with minimum error) may be an important methodological goal. An additional issue is the problem of so-called 'hot spots', *i.e.*, extreme heterogenities that may cause peak values (*e.g.*, biocide load) that even though not detectable at higher scale levels, may be very relevant at lower scale levels.

In LP models, sustainability is operationalized at the field level by identifying stable (*e.g.*, equilibrium for nutrient pools) LUSTs that are more or less efficient in relation to sustainability objectives (economic, technical and environmental). When stable and efficient LUSTs are identified for the field level, farm and regional objectives as identified under the first section (Paragraph 4.2.1) are good indicators of sustainability at higher scale levels. A comparison of objectives defined per ha (*e.g.*, nitrogen loss per ha) with objectives defined per $ surplus may be indicative of trade-offs that exist among sustainability objectives defined at various scale levels.

4.2.3 Time dimension

In addition to the issue of scale, analyzing sustainability requires proper definition of the time scale involved, *i.e.*, different aspects of sustainability become relevant at different time horizons. Short term (in general less than 25 years, though still important beyond this time frame) and long term (in general more than 15 years, and related to events with a lower frequency) aspects of sustainability can be distinguished.

Short term
Input-output relations as they are defined in LUSTs may need adjustments through time as a result of changes in bio-physical conditions as indicated by sustainability indicators. For example, crop yields may decline through time as a result of nutrient losses (*e.g.*, related to soil erosion) or diseases. The main issue relates to the incorporation of such "dynamic" LUSTs into the USTED methodology (and the LP model in particular). The work of Marijke Kuiper and Janette Bessembinder may be of some help in this respect. There is, however, a serious risk of an exploding (too many variables and related constraints) LP model. One possible solution is to define LUSTs that are stable, at least in relation to rather short term processes such as nitrogen losses, or to define a fixed sequence of LUSTs.

Long term
In some related projects (N_2O emissions, Landscape turnover rates, Soil formation and Erosion), long term aspects of sustainability are being studied. Results and implications of these studies should be discussed in the light of results of the various modelling exercises (A, B1, B2, C and D type). In Paragraph 5.1.8, suggestions are presented for better linkage between these related projects and REPOSA.

4.2.4 Risk dimension

Operationalization of sustainability should explicitly address differences in risk perception among stakeholders. Conventionally, researchers distinguish between bio-physical risk and economic risk which are typically translated into yield risk and price risk, respectively. Yield and price risks might have different implications for consumers and producers, *e.g.*, a low yield might be associated with a high price and as such has negative implications for consumers. Research in REPOSA only addresses risk as far as relevant for producers.

Definition and operationalization of yield risk depend on the time and spatial scale considered, *e.g.*, annual yield fluctuations versus much more long-term inundation risk, or locally low yields versus an overall shortfall in supply. Price risk is typically translated into (annual) price variation. In cases where both sources of risk need to be considered, their co-variance becomes important.

Inclusion of risk aspects is most informative for stakeholders, particularly so when the effects of variation in economic and ecological variables are made transparent in terms of objectives and in terms of the associated land use (*e.g.*, through a Monte Carlo approach). A more stochastic approach, using ranges of economic and ecological variables, only results in information on average objective values and their standard deviation and gives no information on consequences for the type of land use.

4.3 Methodology to define APSTs and LUSTs

4.3.1. Quantification of Technical Coefficients (TC)

The calculation of technical coefficients of actual and alternative LUSTs and APSTs is a central component of the USTED methodology. These technical coefficients are inputs to LP models (written in the OMP language) which are used to optimize land use towards pre-set goals and constraints. Technical coefficients are derived from a combination of static descriptions (field surveys), modelling and basic agronomic insights (expert knowledge). Until now, technical coefficients in the USTED methodology have been calculated with the MODUS software. Main inputs for MODUS are price, amount and timing of inputs of LUSTs and APSTs (*e.g.*, price, quantity and application of nutrients, price, quantity and timing of labor, etc.). Yield levels associated with the amount and timing of the various combinations of inputs are not calculated by MODUS, but are to be supplied by the user. Thus, in MODUS, input-output relations have not been formalized in a model or subroutine. Nutrient balances are formalized by NUTBAL. Thus far, LUSTs and APSTs described (calculated) in USTED (using the MODUS software) have been largely based on field surveys and expert knowledge. In this paragraph, this approach will be called the 'USTED' approach. The strong point of the USTED approach is its correspondence with actual farmer practices in the description of LUSTs and APSTs (easily identifiable for stakeholders), the incorporation of nutrient balances (NUTBAL), biocide indices, discounting in time, and the treatment of labor. The weak point of the USTED approach is the fact that the derivation of the alternative input-output relations (or efficiencies) has not been made explicit nor documented, and is therefore not reproducible. Thus, TCs are merely 'calculated', not 'generated'. Moreover, at least until now, the module for calculating nutrient balances (NUTBAL) is 'hard-encoded' in the MODUS software, and not open for adaptation to other environments than the AZ.

In other studies using LP techniques (*e.g.*, PSS-Mali, EC, AZ-Bessembinder and different farming systems in the Netherlands, and in the DLV studies), a different approach was developed for the generation of TCs. In these studies, TCs are 'generated' by explicitizing input-output relations. Moreover, input-output relations of alternative LUSTs are cast in a theoretical framework, in which efficiencies are explicitly formulated in relation to pre-defined production orientations denominated technical, economic, and ecological. This approach will henceforth be called the 'TCG approach'. The strong point of the TCG method consists of its explicit theoretical cadre and the explicit formulation of input-output relations. This approach, a so called target-oriented approach, is also in accordance with the discontinuous nature of technology sets caused by synergism/interactions between inputs. The approach enables identification of input-output combinations that are stable in time (*e.g.*, no mining or accumulation of nutrients), which may be considered a pre-requisite when using a static modelling technique like LP.

4.3.2 Actual and alternative LUSTs and APSTs

Two types of LUSTs (and APSTs) can be distinguished: actual LUSTs and alternative LUSTs.

- Actual LUSTs are based on current input-output combinations as applied by farmers. As such, the efficiencies found implicitly reflect farmers production orientations (actual farmer typology). In quantifying actual LUSTs, 'average' farmers or 'best' farmers can be used as a standard.
- Alternative LUSTs are LUSTs with crops and/or input-output relations as yet not practiced by farmers in the area under consideration. In the TCG approach input-output relations of alternative LUSTs are cast in a theoretical framework, in which efficiencies are explicitly formulated in relation to production orientations such as technical, economic or ecological. Depending on the area under consideration, farmers may actually practice according to any of the theoretical production orientations (*e.g.*, economic) - and then actual LUSTs fall in this category - or not - and then the theoretical LUSTs are alternative LUSTs. In the USTED approach, alternative LUSTs have been formulated based on agronomic insights and by taking actual LUSTs as a starting point. Thus, ranges of input-output relations have been created that make-up a range of input-output combinations from 'low' to 'high/potential'. An example of a set of LUSTs (USTED approach) is given in Appendix II for maize.

4.3.3 Further developments: the best of MODUS and TCG

The aim and time horizon of the study determine which type of LUSTs should be included. Explorative studies of a very open nature (B1 type) and a time horizon of some 25 years require inclusion of alternative LUSTs that are efficient in terms of the objectives to be optimized in the model. Because of the relatively long time horizon, only production orientations of a rather theoretical nature can be used. Less open explorative studies (B2) with a time horizon of, say, less than 10 years, may consider actual LUSTs in addition to alternative LUSTs. In both types of studies, it is appropriate to define alternative LUSTs in such a way that the entire technology set is considered and that the most efficient (related to objectives to be optimized) set of inputs is identified. In policy instrument studies (C type), both actual and alternative LUSTs are considered.

For the AZ the B1, B2 and C type models use alternative LUSTs; while the B1 and C type models use the TCG approach, B2 type models (USTED) use the USTED approach (with MODUS as main tool for quantification of technical coefficients). The immediate problem for further elaboration of B2 type models (USTED) is (1) the unreproducibility of describing alternative input-output relations with MODUS, and the (2) 'closed' software (*e.g.*, NUTBAL for calculating nutrient balances is difficult to adapt). These problems exist both for 'finalizing' the B2 studies in the AZ and for initiating B2 studies in Guanacaste. Moreover, for a proper comparison of the different tools/models (see Paragraph 4.4), it is a prerequisite that they have a set of LUSTs quantified with the same approach and that they consider similar land use types. Problem (2) will be solved in January 1997, with the release of MODUS 3.0, where formal relationships that characterize LUSTs are made explicit, namely NUTBAL and the biocide index. As to problem (1), it was already suggested in 1995 by Don Jansen (NJAS, 43(1), p. 44) that *"To overcome this problem, formally described reasonings in expert systems could be used for generating LUSTs."* Therefore, it is proposed here to develop a 'LUST generator' with elements of the TCG approach. Involvement of Huib Hengsdijk in developing a TCG for the UNA-DLV project in the AZ, offers a good opportunity for REPOSA in this respect. The following elements of a work program should be addressed:

1. Making input-output relations explicit (entire technology set).
2. Study whether such relationships can be added in the form of a 'LUST generator' to MODUS 3.0.
3. Develop alternative LUSTs and APST (for existing and for new crops).

This work should be developed for the AZ, and lead to methods/software that are applicable to Guanacaste as well. The work should be executed in close collaboration with the Costa Rica field team.

IICA - CIDIA

4.4 Comparing methodologies

The aim will be to demonstrate differences in approaches as well as complementarities and overlap between a set of models and methodologies in land use planning as developed in REPOSA. This will not be carried out as a theoretical exercise. Rather, data from national (Costa Rica), regional and finca level will be used to quantify differences in assumptions, data sets and outcomes. More specifically, the comparison will concentrate on:

- Types of questions addressed
- Temporal and spatial scale/resolution
- Implicit and explicit assumptions
- Types of inputs (data)
- Boundary conditions
- Types of outputs
- Possible model validation
- Compatibility with other models

The comparison will be illustrated with examples/studied already carried out (*e.g.*, GOAL-type models, DLV and USTED models for the Atlantic zone, CLUE Costa Rica), and by studies to be carried out or completed in 1997 (*e.g.*, the proposed AB-DLO contribution as related project (Paragraph 5.1.3), the down scaling work with CLUE). It is foreseen that early 1998, most materials will have been compiled to initiate the comparative analysis.

4.5 Ecological farming and functions of rural areas

Ecological research issues can be addressed at two spatial levels, *i.e.*, that of the region and at the farm/field level.

Regional. Ecological functions of rural areas can be incorporated in the open, qualitative land use explorations of the B1 type. Ecological functions mainly relate to national parks and eco-tourism (*e.g.*, private parks and jungle for tourism). These non-agricultural functions can be analyzed and compared in relation to agricultural functions (see also Paragraph 4.2). A student will initiate this research theme.

Farm/field. Two approaches can be followed:

1. In the B2 methodology, ecological LUSTs can be designed that can be incorporated in scenario analyses using the USTED methodology. Given the relative scarcity of information on ecological farming, the construction of such LUSTs should concentrate on two crops for which data are potentially available: mango in Guanacaste and banana in the AZ. Some existing LUSTs as described earlier by Don Jansen might also be earmarked as ecological, *e.g.*, LUSTs for maize and cassave with zero or minimal external inputs. It is noted, however, that ecological farming started only relatively recently in Costa Rica, complicating a thorough analysis and description of ecological farm inputs and outputs (see also the next topic discussed below).
2. It is proposed to initiate an associated project aimed at a thorough study of ecological farming possibilities. In this study, on-farm research should be combined with a D-type modelling approach to study dynamics of nutrients, crop protection agents etc., and to enhance ecological farming using methods of prototyping and systems analysis such as simulation modelling, DSS, and LP. AB-DLO will be contacted to participate in this research because of its relevance to an already existing DLO

program. In terms of time horizon, the proposed project is expected to continue beyond REPOSA (VF) in Costa Rica.

4.6 Economic aspects

4.6.1 UNA/DLV

See Chapter 2, part C.

4.6.2 Updating price data

The existing price data sets refer mostly to 1990/91 and need to be updated towards prices of 1996. This work is already ongoing and mainly involves the collection and storage of both primary and secondary price data information, to arrive at a consistent data set.

4.6.3 Demand aspects

This work focuses on three main elements. First, continuation of the incorporation of demand aspects into B2 type models on the basis of already estimated demand elasticities (for the moment assuming unity supply elasticities). Second, exploration of the need for more specific estimation of demand elasticities for individual products. Third, exploration of the possibilities to estimate supply elasticities, taking into account cost differentials between regions.

4.6.4 Labor market

With increasing scale level (*e.g.*, that of the AZ as a whole), models of the B2-type require proper modelling of the labor market. The consequences of various assumptions regarding the labor market in terms of aggregation bias were made explicit in a modelling exercise for the county of Guácimo. Proper treatment of the labor market requires modelling labor influx and outflux to and from the region under consideration, as well as intra-regional labor movements (*i.e.*, labor movements between sub-regions). It is proposed that this research is initiated by a student as part of his/her thesis work.

4.6.5 Marketing and marketing-related research

In additon to transport cost models for the Guanacaste area, it is proposed to develop a spatial equilibrium model (SIM) for Costa Rica. First, data requirements and availability will be investigated. Second, with the help of the Department of Marketing and Marketing Research of WAU (Aad van Tilburg), a conceptual SIM will be developed and estimated with Costa Rican data.

5. RESEARCH PLAN FOR THE PERIOD 1997-1998

5.1 Overall time schedule

An updated Time schedule of REPOSA activities is given in Figure 1. This time-schedule includes activities of all players in REPOSA and the relevant part of the VF program (*i.e.*, Costa Rica field team, graduate and Ph.D students, staff members of associated departments of WAU, CATIE and MAG, consultants). Moreover, activities of so-called 'related' projects are indicated (these projects do not directly fall in the scope of REPOSA, but may contribute to/benefit from REPOSA on areas of mutual interest).

5.1.1 A: Land use projections

At the national and regional levels, work on land use projections with CLUE continues with main focus in Wageningen ('CLUE-group'). Details of this approach were given in Paragraphs 2.8, 3.1, 4.1.1 and 4.2.1. of the February '96 REPOSA report, and are updated in Chapter 2 of this report For both CLUE and REPOSA, it would be desirable to have a recent land use map of the Guanacaste area, focusing on land use types that are relatively subject to change (*e.g.*, teak). This information could be derived from satellite data. It was agreed that an effort would be made to investigate the availability and suitability of remote sensing data for this purpose. However, considering the expected outcome, it was also agreed that such activity does not justify a major time investment on the part of the Costa Rica field team (eligible student activity, see Chapter 7).

5.1.2. Model comparison

See Paragraph 4.4.

UPDATED TIME SCHEDULE

Approach	Who	1996	1997	1998
A:Land use projection (CLUE)	KK/J.Schoorl	----------	----------	----------
B1:Exploratory options (very open)				
GOAL AZ	JeBes/MvI	----------	----------	
Qual.L.E. (includes ec.aspects)	team	----------	----------	
Zonation	AB-DLO/BB		----------	
B2:Exploratory options (less open)				
USTED:				
LUSTs and APSTs	team	----------	----------	--------?
Operalization	team/RobS	----------	----------	----------
MODUS 3.0	JS	----------	------	
Sustainability indicators	team		----------	--------?
Economic aspects	team/RobS	----------	----------	--------?
USTED manual	JS/RobS/HJ		----------	
STAKEHOLDERS/SCENARIOS	team		----------	----------
C:Policy model (DLV/UNA)	RR/PR	----------	----------	
D:Decision sup.systems farm level	JS	----------	----------	
MODEL COMPARISON	team			----------
RELATED PROJECTS				
- N_2O emission	Roel Plant	----------	----------	----------
- landscape turnover	JJvanDijke	----------	----------	
- soil formation	SoilS&Geology	----------	----------	----------
- erosion	EvanLoon		----------	----------
WORKSHOPS, TRAINING	team	-----	-----	----- ----

Abreviations: KK: Kasper Kok, JSchoorl: Jeroen Schoorl, JeBes: Janette Bessembinder, MvI: Martin van Ittersum, team: Bas Bouman, Stella Efdé, Hans Jansen, André Nieuwenhuyse, BB: Bas Bouman, AN: André Nieuwenhuyse, RobS: Rob Schipper, JS: Jetse Stoorvogel, HJ: Hans Jansen, RR: Ruerd Ruben, PR: Peter Roebeling.

? The end of this activity depends on interaction with stakeholders

Figure 1. Updated time schedule REPOSA and related VF activities.

5.1.3. B1: Exploring land-use options (very open)

GOAL
The GOAL-type of study for the AZ will be concluded with a dissertation in mid-1997 by J. Bessembinder. The multi-period model will be completed and its results will be compared with results of the single-period model. Effects of uncertainty in technical and economic coefficients have been analyzed for the single period model and will be compared with those in the multi-period model. Finally, results of these exercises and their implications will be dicussed within the framework of 'exploring future land use options'.

Qualitative land evaluation
At the national and regional levels, a methodology should be developed for qualitative land evaluation (quick screening of bio-physical possibilities). It was suggested to use the 'Plantgro' (developed by Clive Hackett; CSIRO) software to derive qualitative indicators (on scale from 1-9) of suitability of crops and trees in response to the physical environment (soil, weather). The output of this software is a list of crops and trees that are potentially suitable for cultivation in given agro-ecological environments, plus indications of limiting factors. The scale at which this could be executed include national (Costa Rica), and regional (Guanacaste, AZ). The resulting land use options could then be analyzed *vis-a-vis* other requirements, *e.g.*, with B2 methods (USTED). These results could be an important input for discussion with the stakeholders (Paragraph 4.1).

Zonation study.
AB-DLO world-food studies typically use crop growth models for large spatial units, using broad (average/uncertain) input data and quite general models, the results of which are often subject to severe criticism. It is therefore suggested to perform a scaling study for typical agro-ecological zones to quantify effects of averaging and uncertainty in input data on simulation results, and to derive the validity of the approach, and, where possible, correction factors. Costa Rica can be used as a case study for this zonation study. Steps to undertake: use crop models (rice, pasture) with detailed spatial and temporal input for regions (*e.g.*, Guanacaste or AZ) and for Costa Rica; quantify simulated yields and water needs using these detailed data, and aggregate to broader units (yield distribution functions). Compare results with world food study results for same area = > derive correcting factors when possible; make statements as to the validity of world food study results (of course: validity restricted for specific agro-ecological environment of Cost Rica). Input data for the study can be derived from the CLUE Costa Rica national data base, and from GIS data for AZ and/or Guanacaste.

5.1.4. B2: Exploring land use options (less open)

Main emphasis will be placed on further development and refining of the USTED methodology through an interactive process with stakeholders in Costa Rica. The man issues for the updated workplan can be found in Chapter 4. In 1997, main emphasis will be put on 'finalizing' USTED for the AZ. The results should be used to initiate discussion with stakeholders (Paragraph 4.1). Work for Guanacaste in 1997 remains limited to further data collection and preparation. In 1998, a minimum set-up of USTED (data and models) will be made to continue discussion with stakeholders. Based on the outcome of the discussions, further developments/refinements of USTED for Guanacaste will follow in the second half of 1998.

Work on USTED in 1997 (AZ) focuses on a number of key issues:

LUSTs and APSTs.
See Paragraph 4.3. The construction of alternative LUSTs will include ecological LUSTs (Paragraph 4.5).

Operationalization
Time will be spent on integrating newly developed elements of USTED and on developing, checking and running the models.

MODUS 3.0
A new version of MODUS (vs. 3.0) will be released (action J. Stoorvogel) at the end of January 1997. It is noted that this release is crucial for further development of the USTED methodology in both the AZ and Guanacaste.

Sustainability indicators
See Paragraph 4.2.

Economic aspects.
See Paragraph 4.6.

Manual
The anticipated outreach activities require that complete documentation of USTED is available by September 1997 (Tools Workshop at CIP; Paragraph 6.1, Annex 1).

5.1.5. C: Policy models

See Paragraph 4.6.1.

5.1.6. D: Decision Support Systems Bananas

The work on the REBUSCA finca continues as planned, see Paragraphs 3.4 and 4.1.4 of the February '96 report.

5.1.7. Stakeholders/scenarios

See Paragraph 4.1.2.

5.1.8 Related projects

N_2O emission in the Atlantic Zone (Roel Plant).
A direct output of this research which has great potential for REPOSA, is the incorporation of N_2O emissions as a sustainability indicator (comparable to the use of biocide index). For different land uses or groups of land uses, Roel Plant should be able to provide REPOSA with an estimation of N_2O emissions, which, after incorporation in USTED, could be used for the estimations of total N_2O emission in the AZ under various scenarios. Roel Plant should be contacted as soon as possible to discuss how this topic could be worked out.

Landscape turnover rates (Jan Jaap van Dijke)
No clear link between the current work of Jan Jaap van Dijke and the focus of REPOSA exists. As Jan Jaap van Dijke is already in the final phase of his research (*i.e.*, writing thesis), there are no options left to tackle additional research issues.

Soil formation in volcanic soils (Peter Buurman, Ed Meijer, Toine Jongmans)
A possible link between the work of the REPOSA team and this research project can be the behavior of trace elements in volcanic soils. Evidence is accumulating that soil mining of micro-nutrients (such as zinc) might contribute to yield declines as observed in many parts of the world. Therefore, the availability of micro-nutrients for plants on relatively long time scales (involving weathering processes) could be useful as additional sustainability indicator. Nevertheless, to be useful to REPOSA, research of this related project should address more specifically the availability to plants of micro-nutrients in the long run. It is noted that the focus on volcanic soils of this related project limits wide applicability in both the AZ and Guanacaste.

Erosion in Guanacaste (Emiel van Loon)
From January 1997 onward, Emiel van Loon will carry out fieldwork for his Ph.D. research in the Horizontes protected area in Guanacaste. So far, it is not exactly clear to the field team what this field work involves, so it is difficult to assess to what extent this work can be incorporated in REPOSA. On the other hand, susceptibility to erosion of land units, under certain land uses, would be an interesting sustainability parameter in the USTED methodology. Incorporation of such a new sustainability parameter might benefit from the presence of Emiel in Costa Rica. This would mean that susceptibility to erosion, and possibly the quantification of erosion, should also be ascertained for other land units in Guanacaste, in addition to Horizontes.

5.1.9. Workshops, training

See Chapter 6.

5.2 Research priorities Costa Rica team

Because of limited time and manpower available within the field team in Costa Rica, priorities were set and a number of topics were selected to form the backbone of the work plan for 1997-1998. Total labor availability of the field team was calculated as follows:

1. Labor time available per team member:
- 11 months (12 months/year minus 4 weeks holidays, home-leave, 'illness-reservation'). Note that no time is reserved for 'unforeseen'.

2. Subtract fixed overheads per team member:
- Student supervision: 1 month
- Article/report writing: 1 month
- Seminar visits, conferences: 0.5 month
- Various tasks: (Bouman: hard- and software maintenance: 1.5 month; Nieuwenhuyse: multi-purpose: 1.5 month; Jansen: 3.5 project management)

3. Months per team member net available for research and outreach activities on yearly basis:
- Bas Bouman: 7
- Andre Nieuwenhuyse: 7
- Stella Efdé: in 1997: 2; in 1998: - (it was proposed that Stella Efdé continues work on REPOSA in Wageningen)
- Hans Jansen: 5

4. Total months net available for research and outreach activities:
- 1997: 21
- 1998: 19.

Based on the available time for research and outreach, the following time-schedule was agreed upon for the field team in 1997 and 1998.

1997

Approach	Activity	Detailed activity	Time input (months)
B1	Qual land evaluation.	Guanacaste only: Plantgro and biodiversity	1
B1	Zonation study	AB-DLO support	0.5
B2	Stakeholders	Organization	1.5
	1. Finish USTED for AZ: to bring 80% to 95%! 2. Further data collection and preparation Guanacaste	LUST & APST (new crops, ecol. crops, field work)	4
		MODUS - TCG generator	2
		Sustainability indicator: N_2O only	0.5
		Demand completing	2
		Risk completing	1
		Zonation	2
		Programming (OMP, MODUS, modules; integration)	1.5
		USTED manual	2
Workshops		6.1. Tools CIP sept. 97	1
		6.2 USTED workshop preparation	2
		Time total	21

1998

Approach	Activity	Detailed activity	Time input (months)
B2	Finish minimum set-up of USTED for Guanacaste for interaction with Stakeholders	All activities needed	6
	Stakeholder interaction	Stakeholders plus runs with USTED for both AZ (detailed, finished model!) and for Guanacaste (minimum set-up); discussions, etc.	4
Workshops		6.2 USTED early 98	2
		6.3 Prepare SAAD3	p.m.
		Time total	12
		Time left for further interactively elaborating and running of USTED; comparison of methodologies A-B-C-D; SAAD3 preparation	7

Beside this input of the Costa Rica field team, input to REPOSA will also be given by staff members of associated departments of WAU, e.g. see Figure 1 for contributions by the departments Agronomy, Soil Science and Geology, and Theoretical Production Ecology. The Department of Development Economics will provide input on the topics moddeling and market research (R. Schipper) and sustainability (E. Bulte), and possibly on sustainability and technology in LP (M. Kuipers). The Department Marketing will continue its work on marketing issues (A. van Tilburg).

6. WORKSHOPS AND COURSES

The following set-up for a series of workshops is proposed:

1. September 1997: Tools Workshop at CIP. Relevant for REPOSA: USTED, CLUE, DSS bananas. Goal: overall impression of a number of tools; first hands-on experiencing of participants. Spin-off: dedicated workshops per method/model later on.
2. Early 1998: dedicated international USTED workshop as follow-up on September workshop (was previously planned for June).
3. Final Workshop to present REPOSA and related activities.

6.1 Tools workshop CIP September 1997

See Annex 1 for an outline of the proposed workshop.

6.2 USTED workshop early 1998

As a follow-up on the national USTED workshop of June 1996 in Guápiles, Cost Rica, it is proposed that an international USTED workshop be held at the beginning of 1998, most probably in Costa Rica as well. This should be a workshop for a total of some 30 participants, 20 from NARSs from within Latin America, and 10 from CGIAR Centers. Again the workshop should be of a hands-on character, *i.e.*, teaching modules are to be followed by practical computer-based exercises which cover the entire spectrum of an USTED application, from data collection/entry until scenario development and analysis. In the context of this workshop it is proposed to explore the possibilities for financial support of the Ecoregional Fund, specifically geared towards the (co-)financing of case studies which are to be jointly executed by a CGIAR Center and NARS(s). The explicit intention would be to seek funding from the Ecoregional Fund as well for a follow-up workshop in which the individual case studies are to be presented and discussed.

6.3 Final workshop spring 1999

A final workshop will be organized by Spring 1999 to present the results of the Costa Rica project. The following is proposed:

- To focus on presentation of methodologies developed in REPOSA (no mix with SAHEL-VF as earlier envisaged)
- To co-present related work along the A-B-C-D elements in the Central/South American area (a.o. DLV, S-American Trustfund projects, ...)
- To have the workshop in Costa Rica
- Target audience: CG, NARS, NGO s,...
- To organize it as SAAD3

6.4 Teaching modules WAU

A decade of multi- and interdisciplinary research activities in Costa Rica has yielded, besides a substantial amount of information, many concepts, methodologies and tools in relation to land use and options to change land use. A strong and unique point is that case studies of many methodologies and tools are available for the same region. An explicit aim of the two last years of the REPOSA program will be to realize a strong feedback to teaching courses in Wageningen (Chapter 1). The following items deserve particular attention:

- Land evaluating approaches and techniques
- Integration of various computer-aided tools for land use analysis
- Quantification of a wide range of actual and alternative agricultural activities
- Methodologies for the exploration of future land use options for various levels of scale and using different time horizons
- Identification of effective policy instruments to realize land use changes

Though there may be several options, developments in relation to the course "Quantitative analysis of agro-ecosystems at higher integration levels" (QUASI) seem to offer a suitable framework for integration of at least a number of the above-mentioned issues in teaching modules. QUASI started as a 3 credit points course given by the departments of Agronomy and Theoretical Production Ecology. Within one or two years QUASI will grow to a 12-15 credit points course in which some eight departments participate, including the departments of Soil Science and Geology and Development Economics. Main teaching aim of the course is: application of basic knowledge on soils, climate, crops, animals and socio-economics for the exploration, design and evaluation of options for sustainable land use at farm, regional and higher integration levels. In the first months of 1997 options for inclusion of REPOSA methodologies and cases in the QUASI course should be further explored by the departments of Agronomy and Theoretical Production Ecology, in close cooperation with other involved departments.

7. STUDENT RESEARCH

Given the tight time schedule outlined in Chapter 5, it was agreed upon that student involvement in REPOSA should directly benefit the research priorities as set in Chapters 4 and 5. REPOSA will be reluctant to accept students whose work does not fit in these research priorities. Student research topics which receive priority include the following:

- Completion of LUST/APST data for Guanacaste and AZ for both "current" and "ecological" crops
- Labor market research in both AZ and Guanacaste
- Transport cost research in Guanacaste
- Risk research in Guanacaste
- Nutrient balance research
- (Possibly) re-estimation of demand models for a limited number of individual products
- Farm typology verification by economic sub region (in the field) for the AZ
- Farm typology and economic subregion verification (in the field) for Guanacaste
- Soil physical measurements in Guanacaste to assess water availability (only in period May-November 1997!)
- Subject to availability of satellite data: land use inventory in Guanacaste
- In general: students on the topics of ecology (see Paragraph 4.5) and sustainability (see Paragraph 4.2)

Information technology as a tool to assess land use options in space and time.

Location
CIP-Lima

Dates
September 28- October 4, 1997

Organizing Institutions

- C.T. de Wit Graduate School of Production Ecology (PE). Wageningen
- CIP Lima Peru
- Under the umbrella of ICASA

Rationale:

An increasing number of tools for the analysis of land use is being developed by different research organizations. Although general methodological aspects and applications are being published in scientific publications, the ins and outs of the tools remain hidden while little attention is paid to the underlying assumptions and rationale and on operational aspects such as data availability and - reliability. Different international research organizations are now cooperating in the Latin America context. The workshop provides the possibility for the different organizations to present their tools in detail in a hands-on setting while considerable time will be dedicated to the underlying assumptions and to the applicability of results obtained.

Objectives:

1. Discuss the underlying assumptions and rationale of applying different methods to assess land use at different scales ranging from fields and farms to regions.
2. Demonstrate six case studies at field and regional level using operational procedures in a hands-on setting.
3. Provide facilities for participants to use their own data sets at last day of the workshop.
4. Evaluate results by discussing possible interactions between the various procedures and most promising future lines of research.

Note:

- Tools to be presented are operational and have been applied in a practical context.
- Cases will be well documented
- The workshop is seen as representing a certain phase of development. Subsequent workshops will develop in time to represent new developments. Cases and tools will therefore change from this workshop to the next.
- Participants will be experienced agronomic scientists working within the CGIAR System and in universities and NARS in South America, who are interested in applying system's analysis in their research. PE has reserved funding to facilitate participation, which will be invitation-only.

Programme:

Monday- September 29

AM General introduction

9:00-12:00 Emphasis on importance of analysing problems to be studied in interaction with stakeholders; selection of proper techniques ("tools") considering the type of problem to be studied, its dimensions in space and time and data availability and - needs. Techniques range between being qualitative and quantitative and between empirical and mechanistic. Brief introduction of the tools to be discussed in the various cases.

PM Decision Support System at farm level.

Banana Farm Costa Rica (Includes pesticide modeling, aspects of spatial variability and GIS).

J.Stoorvogel

13:00-13:30 Introduction and application
13:30-14:00 Introduction to the exercises
14:00-16:00 Hands-on exercises
16:00-17:00 Concluding remarks and discussion

Tuesday-September 30

Decision Support System at farm level.

DSSAT 3.1 (An application for Brazil) W.Bowen

8:00-8:45 Introduction and application
8:45-9:30 Introduction to the exercises
9:30-12:00 Hands-on exercises simulation models
13:00-16:00 Hands-on exercises decision support (incl. Spatial module)
16:00-17:00 Concluding remarks and discussion

Wednesday- October 1

PM Potato simulation models for agro-ecological zonation,, ideotyping and risk assessment.

LINTUL R. van Haren & A.Haverkort

8:00-8:30 Introduction and application
8:30-9:00 Introduction to the exercises
9:00-11:00 Hands-on exercises
11:00-12:00 Concluding remarks and discussion

PM Modeling land use dynamics.

CLUE - Ecuador F de Koning

13:00-13:30 Introduction and application
13:30-14:00 Introduction to the exercises
14:00-16:00 Hands-on exercises
16:00-17:00 Concluding remarks and discussion

Thursday- October 2

Agricultural Production and environmental quality at field level.

(Includes upscaling to the regional level)

Trade-off model J. Antle and J.Stoorvogel

8:00-8:45 Introduction and application
8:45-9:30 Introduction to the exercises
9:30-12:00 Hands-on exercises modules
13:00-16:00 Hands-on exercises trade-offs
16:00-17:00 Concluding remarks and discussion

Friday-October 3

Exploratory modeling of land use scenario's for the Guacimo region in Costa Rica

(Includes linear programming modeling, GIS and livestock systems)

USTED H. Jansen (Costa Rica) and J. Stoorvogel

8:00-8:45 Introduction and application
8:45-9:30 Introduction to the exercises
9:30-12:00 Hands-on exercises modules
13:00-16:00 Hands-on exercises scenarios
16:00-17:00 Concluding remarks and discussion

Saturday-October 4

AM Evaluation of results by course participants: relations between the various procedures and discussion of future research needs.

PM Opportunity to present cases by participants and test procedures with own datasets

APPENDIX II: example of LUSTs in USTED

SFWLZM10	summer maize 'en espeque', typical in Neguev
SFWLZM40	maize potential
SFWLZM41	maize potential, only manual weeding
SFWLZM42	maize, doblar installation of birdchasing, 15% yield reduction
SFWLZM43	maize doblar installation of birdchasing, 15% yield reduction, manual weeding only
SFWLZM44	maize, 50% of potential fertilizer, doblar, 15% additional yield reduction
SFWLZM45	maize, 50% of potential fertilizer, doblar, 15% additional yield reduction, manual weeding
SFWLZM46	maize, no fertilizer, doblar, 15% additional yield reduction, no checking in field
SFWLZM47	maize, no fertilizer, doblar, 15% additional yield reduction, no checking in field, manual weeding
SFWLZM48	maize, no fertilizer, no checking, no insecticide/fungicide, doblar, 20 + 15 % yield reduction
SFWLZM49	maize, no fertilizer, no checking, no insecticide/fungicide, doblar, 20 + 15 % yield reduction, manual weeding only

APPENDIX III: Summary of visit to the Embassy of the Kingdom of The Netherlands

Present were Mr. Frans van Haren, Ambassador; Mr. Jan Bauer, First Secretary; Mr. Kees Konstapel, Sector Specialist Rural Development; Prof. Johan Bouma, Prof. Arie Kuyvenhoven, Mr. Bert Boerrigter, and Dr. Hans Jansen, all of WAU.

The discussion centered around three topics, *i.e.*, (1) ways of involving stakeholders more directly in USTED scenario development; (2) increased development of aspects of ecological agriculture in REPOSA, and relations with the Dutch-Costa Rican Sustainable Development Treaty; and (3) the IFPRI hillside proposal involving WAU expertise.

Ad (1): the Embassy emphasized difficulties of actively involving government planning agencies in scenario development and analysis with USTED. Instead, suggestions were made to involve private sector organizations (*e.g.*, Camaras of producers, farmers' organizations) and donor-supported (regional) activities (*e.g.*, Tropical Science Center, UN organizations, new IFAD initiative in Guanacaste, DRIP, EEC Tortuguero project). Rather than focusing on organizations as such, it may be more effective to contact knowledgeable/influential individuals.

Ad (2): in the context of the Treaty, project proposals are to be submitted to Fundcooperación by Costa Rican organizations in cooperation with a Dutch partner institution.

Ad (3): the proposed IFPRI budget for DGIS financing was discussed. The Embassy indicated that adjustments are required (particularly regarding the proposed budget) and pointed towards opportunities for more substantial WAU involvement through DLV and REPOSA.