

Atlantic Zone Programme

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ANNUAL REPORT FOR THE YEAR 1990

**TROPICAL AGRICULTURAL RESEARCH
AND TRAINING CENTER - CATIE**

**AGRICULTURAL UNIVERSITY
WAGENINGEN - AUW**

**MINISTRY OF AGRICULTURE
LIVESTOCK - MAG**

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1 GENERAL

1.1 Background

In March 1984, the Centro Agronómico Tropical de Investigación y Enseñanza (CATIE) in Costa Rica and the Agricultural University Wageningen (AUW) in the Netherlands signed a letter of intent as a first step towards long-term cooperation in the field of joint multidisciplinary research and training. The first joint activity to be undertaken was identified as research into structural transformation problems in the Atlantic Zone of Costa Rica, with the aim of agricultural planning. Within this context, the problems of sustained land use, small farm development and rapid deforestation were to be highlighted,

In April 1985, an AUW mission visited CATIE to formulate more specific research proposals that would fit within the general objective of studying structural transformations in agricultural systems prevalent in the Atlantic Zone. The region was visited and several institutions dealing with rural research and development in Costa Rica were consulted. The mission concluded that insufficient information was available for selection of specific research activities or specific geographical areas of study. Hence, for 1986 an exploratory survey was proposed, to be followed by a baseline study in 1987 before specific research projects would be formulated, to be initiated in 1988 or later.

In March 1986 the official cooperation agreement between CATIE and AUW was signed, followed by an agreement between CATIE, AUW and the Ministerio de Agricultura y Ganadería (MAG) of Costa Rica in May 1986. Subsequently, additional agreements have been signed since with the Instituto Geográfico Nacional (IGN) and the Asociación Bananera Nacional (ASBANA).

The field work for the exploratory survey was carried out in May and June 1986. The survey resulted in the selection of study areas and in a more specific formulation of themes to be studied during the baseline study. For a summary of the results of the exploratory survey (SLUYS van et al., 1987). A programme document was prepared, outlining the research as envisaged (ANON.1987).

Baseline studies were carried out in four zones - Cocori, Rio Jimenez, Talamanca and Neguev. Major disciplines concerned were soil science, agronomy, rural sociology, forestry, animal husbandry, and agricultural economics. For each of these, a monograph was prepared (and published in 1990). The outcomes were already discussed in a seminar in August 1988. On the basis of the results obtained, follow-up research lines have been developed. To avoid these becoming monodisciplinary regular programme discussions are being held. In the course of 1990 the second phase of the programme was approved, be it the scientific part only. An evaluation of the programme in totality, combined with similar programmes in Ivory Coast and the Sahelian region, was held in August. The results were positive and the consequent approval by the university council is to be expected early 1991.

1.2 Objectives

The long-term objective of the programme (henceforth called the Atlantic Zone Programme, PZA) is to contribute to ecologically sound, socially acceptable and economically viable ways of sustainable land use in the Atlantic Zone of Costa Rica. This is being worked out in three different ways: research, training and development planning, in the following manner:

- The research concentrates on major transformations in the agricultural production systems prevalent in the Atlantic Zone of Central America and Panama.
- The research is to be executed by researchers of AUW, CATIE and possibly other institutions with the aid of AUW, CATIE and other M.Sc. and Ph.D. students. The training of such students is the second objective of the Programme.
- The research is development-oriented and may be used by third parties to design applicable development policies for both government institutions and private organizations such as farmers' cooperatives and associations.

Although the general area under consideration is the Atlantic Zone of Central America and Panama, the research started focusing on the Atlantic Zone of Costa Rica, for this purpose defined as the entire Province of Limón.

1.3 Major events

- In October a workshop was held to present the results of four years of land evaluation. A computerized system of soil maps was shown and decisions concerning follow-up actions were taken, in close consultation with CATIE and MAG.
- In December a big farewell party was organized to say goodbye to Wielemaker, Waaijenberg (both present right from the start), Huising, Castro, de Bruin and Bronkhorst. With their departure the first phase of the programme came to an end. Successors were identified and present at the party.

2 PERMANENT PERSONNEL

2.1 Staff from the Agricultural University Wageningen

The permanent staff of the Programme during the year under review comprised the following persons.

- Willemien Brooijmans M.Sc. PhD. student in agricultural Law. Research theme: law in the struggle for control on the natural resources land and timber in colonization-areas;
- Jeroen Huising M.Sc. PhD. student in geodetics and soil science. Research theme: the use of remote sensing techniques for land use inventory;
- André Nieuwenhuyse M.Sc. PhD student in soil science and Geology. Research theme: genesis of soils and landscapes of the Atlantic Zone;
- Ed Veldkamp M.Sc. PhD. student in soil science and organic material. Research theme: Changes in organic matter content of tropical soils after reclamation from tropical lowland forest;
- Henk Waaijenberg M.Sc. Agronomist. Responsible for the analysis of the production systems;
- Dr. Wim G. Wielemaker Soil Scientist. Responsible for the soil research, soil mapping and land evaluation;
- Hans Bronkhorst M.Sc. Coordinator.

2.2 Local personnel

At 31 December 1990, 15 local personnel assisted the PZA, ten of whom were working in the Guápiles field office. Their functions are: administrative assistant, office assistant, technical assistants (3), cleaning woman and watchmen (3). At the coordinator's office at CATIE, Turrialba, a secretary and a driver and at the laboratory for soil analysis of the Ministry of Agriculture in San José two laboratory assistants and a part-time analyst. Their functioning has been satisfactorily and where possible delegation of more responsibilities is taking place. The services of part time editors, for spanish and english, are regularly being used.

Local academic staff did, since september 1990, participate on a permanent basis. This was a new fact in the cooperation with CATIE and MAG.

3 TEMPORARY PERSONNEL

3.1 Staff from the Agricultural University Wageningen

During the year under review the following persons spent some time in Costa Rica and contributed to the Programme in their specific fields.

- B. Boerrigter M.Sc. Office for International Relations
- Dr.J. Bouma Department of Soil Science and Geology
- Dr.N. van Breemen Department of Soil Science and Geology
- Dr.L. Fresco Department of Tropical Crop Science
- Dr.R. de Graaf Department of Forestry
- Th. Guiking M.Sc. Department of Soil Science and Plant Nutrition
- A. C. Jongmans Ing. Department of Soil Science and Geology
- Dr.S.B. Kroonenberg Department of Soil Science and Geology
- Dr.N.E. Long Department of Rural Sociology of the Tropics and the Subtropics
- Dr.L. 't Mannetje Department of Field Crops and Grassland Science
- Dr.A.P. Oosterom Department of Soil Science and Geology
- R.A. Schipper M.Sc. Department of Development Economics
- M.G.A.C. Smits M.Sc. Department of Silviculture

These visits serve several purposes:

- backstopping the staff and students in Guápiles;
- discussing with colleagues of CATIE and MAG about developments in Costa Rica and developing multi disciplinary programmes;
- giving classes in the M.Sc. courses of CATIE;
- doing research personally.

Some of these visits have been too brief, certainly to do some research, however for backstopping purposes they were sufficient.

3.2 Local scientific participation

R. Alfaro M.Sc., former director - general of the Ministry of Agriculture and Livestock, started in September 1990 his preparations for a Ph.D. study with Wageningen in the field of

J. Arze M.Sc. (CATIE) entered a Ph.D. study with Wageningen in the field of

S. de Bruin M.Sc. functioned as scientific assistant during the whole of 1990. This proved to be very valuable considering his vast knowlegde of the region and the research executed by the programme.

R. Rivera wrote an extensive study on the farmers' participation in the banana region in 1989 and obtained his M.Sc. of the University of Costa Rica in 1990. The study is being edited to become a programme publication and will be published in 1991.

M. Smits M.Sc. prepared a research proposal on " Potential and constraints of commercial wood production in farm forestry systems in the Atlantic Zone ". No financing has so far been found to execute it.

G. Verschoor M.Sc. came for a six month study in the area of Talamanca on social aspects of plantain cultivation of small farmers.

4 THE RESEARCH

4.1 The research approach

As a follow-up to the baseline study, the research approach for the programme was redefined, in order to take into account both monodisciplinary and interdisciplinary work. The objective of the research programme falls into two components, both essential contributions to sustainable land use:

- the development of a system for land use planning using a combination of geographical information systems and simulation models;
- a group of thematic studies in the fields of soils, production systems and socioeconomics.

The land use planning system requires the input of basic data generated during the thematic studies. However, implementing the land use planning system generates new questions which must be solved by thematic research. Thus, there is a complementary relationship between both components. Furthermore, fundamental research which is relevant to sustainable land use is necessary to solve problems which are not directly related to the land use planning system, but are related to soils, production systems and/or socioeconomics.

4.2 Land resource studies

4.2.1 Introduction

Research in this field is organized in two lines. Line 1 deals with effects of land use on the land itself. The results of this investigation are necessary to select land uses which are ecologically sustainable under the prevailing climate and soil conditions.

Line 2 deals with geographic aspects of land and its actual and potential uses. The evaluation of land for its actual and potential land uses requires the results of thematic studies executed under additional lines of research. Thus, in a future plan, the present lines of research will be reorganized. Land evaluation will then form part of a land use planning, which integrates economic, social, technical and ecological aspects of land use for prediction and presentation of land use scenarios.

4.2.2 Line 1: Short and long term changes - an evaluation of natural and anthropogenic effects

Background

After deforestation, most soils undergo rapid and sometimes irreversible changes. To study and quantify those changes, three subprojects were proposed of which the first two have funding and the third has been forwarded for funding to the European Economic Community.

These subprojects have the general objective of the appraisal and

quantification of the effects of land use changes on soil properties in the Atlantic Zone of Costa Rica.

Subproject 1 started in November 1988 and subproject 2 starts at the beginning of 1990. Some introductory research was carried out in subproject 3 which helped to formulate the EEC proposal.

Subproject 1: Landform and soil development in the Atlantic Zone of Costa Rica.

Objective

The objective of subproject 1 is to study long-term (20 - 1000000 years) soil and landscape development, as a reference for short-term changes under different forms of land use.

Responsibilities

The following staff have implemented this project:

- Personnel full time: Ir. A. Nieuwenhuys;
- Scientific guidance: Prof.Dr. S.B. Kroonenberg, Prof.Dr. N. van Breemen, Dr. W.G. Wielemaker.

Studies during 1989 and 1990.

In March 1989, fieldwork for the research assistant ad honorem (AIO) research started. In that year, three chronosequences were selected and partly sampled and analyzed: A sequence on volcanoclastic beach deposits was selected and analyzed. Selection and analysis of chronosequences on volcanoclastic alluvial deposits and lava flows was initiated.

In 1990, micromorphological and mineralogical analyses of the beach ridge chronosequence was further elaborated. During a three months stay at AUW, point counting of the thin sections was carried out in order to quantify weathering rates. Also, mineralogical analyses were refined, using different pre-treatments of the samples, chemical dissolution methods and TEM techniques.

Sampling and analyzing of some profiles of the two other sequences was limited to three profiles; other profiles were selected, but still have to be sampled and analyzed.

Dating of the sequences has been carried out partially. The beach ridge sequence has been dated to a great extent, and also 5 profiles of the other sequences were dated, using C-14 and K-Ar techniques.

Volcanic ash enrichment of the sequences was investigated by investigating soil properties of soils on the slopes of the Turrialba and Irazú volcanoes and by analyzing a thick peat deposit in the alluvial plain by studying of thin sections. It was found that due to influence of ash, selection of profiles on the slopes should be limited to the lower parts. In the alluvial

plain, no evidence for ash fall was found.

Two AUW students, Desiree Jansen and Gwendolyn Zuring carried out a detailed soil survey in a part of the Neguev settlement which was a great help in selecting one of the profiles of the alluvial sequence. A planned geomorphological study of the same area was initiated, but not finished. Their study, together with a sociological part, is currently being printed as a field report.

Margriet Hartman, a student of the University of Utrecht, carried out a study of mass movements in the Toro Amarillo-Chirripó watershed, in order to obtain more information about the actual mass movements on the slopes of the volcanoes and their relation which sheet-flood deposits which are found in the lowlands. Jorge Barquero of the "Observatorio Vulcanológica" of the National University (UNA) did part of the supervising. At the moment of writing, two drafts for short paper in the "Boletín de Vulcanología" are being revised. Also the draft for a field report is ready.

Some time was spend analyzing climatological aspects, which to a great extent determine typical features for the humid tropics like rapid weathering and the occurrence of "temporales", periods of heavy rainfall during which inundations occur.

During 1990, posters of the work on the beach ridge chronosequence was presented on "El XI Congreso Latinoamericano de la Ciencia del Suelo" in La Havana, Cuba, on the "2nd International Symposium Geochemistry of the earth's surface and of mineral formation, Aix-en-Provence, France, and on the "Taller de Suelos" organized by the PZA in Guápiles, and later also presented on CATIE and UNA. The abstract for the symposium in France, titled: "Formation of Andisols in a chronosequence of andesitic beach ridges in Costa Rica", has been published in Chemical Geology, Vol. 84 (1990) 108-110. At this moment, a first draft for a paper to be published in an international magazine is being finished and will be discussed with supervisors in January 1991.

Subproject 2. Changes in organic matter content of tropical soils after reclamation from tropical lowland forest, in particular in volcanic soils in Costa Rica.

Objective

The objective is to set up a process-oriented simulation model describing the changes in soil organic carbon following conversion of forest to agricultural land, as a function of soil properties, climate and land management practices. The model should be useful in further research towards designing optimal management strategies for sustained landuse in wet tropical lowlands, and to quantify the effect of landuse changes in the wet tropics to the emission of CO₂ to the atmosphere.

Responsibilities

The following staff have implemented this period:

- Personnel full time: Ir. E. Veldkamp
- Scientific guidance: Prof Dr N. van Breemen (UAW), Ir W. Bouten (UVA), Dr J.A. van Veen (ITAL)

Studies during 1989-1990

(1) Site selection

Deforestation sequences were selected using old aerial photograph series. In the area of interest, photographs were made in the years: 1952, 1960, 1973, 1981, and 1984. The interesting plots for deforestation sequences, were selected by interpreting the photographs. The photo interpretations were processed with help of ILWIS and MONOPLOT software.

(2) Field experiments

A begin was made with a pulse label experiment to estimate the input of carbon in the soil by two types of pasture. Once a week the length of leaves was measured and once a month the pasture was harvested to measure the growing curve.

On four sites soil physical measurements were made to estimate the effects of deforestation on the water balance. Conductivity measurements were made with help of the adapted crustmethod. The work was carried out by G.J. Weerts.

(3) Modelling

The Carbon module of the CENTURY model was programmed in the PC version of the CSMP programming language. A sensitivity analysis of the model was made by calculating the effect of a change in one factor, on the steady state level of organic matter. The model appears to be very sensitive for the amount and quality of litter, applied to the soil as well as to the place where the plant residue is applied (placements effect). Soil microbial biomass appears to be a rapid and accurate indicator for the final steady state level of the organic carbon in soil. The effect of soil moisture on the decomposition rate is poorly defined. In CENTURY, the proportion of precipitation and potential evapotranspiration is used in stead of moisture availability or pF values. Charge characteristics of clay and soil organic matter are not integrated into the model yet.

Plans for 1990

The deforestation map will be made available by means of a publication. The pulse label experiment will be continued. Soil physical studies will be continued by Weerts. Samples for ¹³C analyses will be sent to the isotope laboratory in the Netherlands. An experiment to estimate the influence of allophane on the decomposition of organic matter will be set up. The data collected will be used to validate and improve CENTURY for the wet tropics.

4.2.3 Line 2. Soil inventory and land evaluation for sustainable land use planning

Background

The Atlantic Zone of Costa Rica is characterized by rapid change. Most of the area has been deforested and colonized during the last 50 years. Land suitable for agriculture is already in use so that now specially areas not suitable for agriculture are threatened with deforestation. At the same time large tracts of land are under-utilized.

There is a lack of knowledge regarding sustainable forms of production (ecologically, socially and economically) and of sufficiently detailed and reliable soil and land suitability maps on which to base development. To help fulfill such needs three subprojects were started. Their objectives are:

- Methodology development for land evaluation, applicable for perhumid climatic zones
- A land evaluation for planning sustainable land use in the Atlantic Zone of Costa Rica

Subproject 1. A soil and landscape information system for the atlantic zone of costa rica.

Objectives

The objectives are twofold:

1. Study of soil and landscape characteristics; mapping of soils and an appraisal of their suitability for a reconnaissance soil and landscape map of the Province of Limon. Several detailed and semi-detailed studies in pilot areas form the basis for these maps.
2. Development of a soil and landscape infosystem, also called SIESTA which stands for: Sistema de Información de Suelos y Tierras del Atlantico. It should serve as a basis for a larger land use planning system. Data should be structured in such a way that data extraction and presentation in geographic form becomes very flexible.

Responsibilities

- Scientific guidance rests with Dr. W.G. Wielemaker, Dr. A.P. Oosterom, Prof. Dr. J. Bouma and Prof. Dr. S.B. Kroonenberg.
- The project is carried out by Dr. A.P. Oosterom, Dr. W.G. Wielemaker, Ing. H.J. Stuiver with the assistance of L.G. Valverde, R. Hootsmans and students of AUW.

Studies during 1990

This year the fieldwork for SIESTA was finalized. Several transects were made on the slopes of the Central Cordillera and in the Coastal Plain area. Field data were digitized, processed and structured in Wageningen. Digitizing was done directly from IR photographs for which a block adjustment had to be executed

according to principles worked out by Ing. H.J. Stuiver (Department of Land Surveying and Remote Sensing of AUW). Application of this technique has the advantage that all topographic detail is correct and adaptable to other geographic material such as satellite images and aerial photographs at different scales. The soil and landscape information is structured in a relational data base with ARC/INFO. The following paper presented at the First European Conference on Geographic Information Systems, gives more details about the methodology:

Oosterom, A.P., H.J. Stuiver and W.G. Wielemaker, 1990. Application of GIS in reconnaissance Soil Survey.

Products of the system were demonstrated during a workshop held from 2-4 October on the premises of MAG's experimental station in Guapiles. Some seventy people participated to both discussions and field demonstrations. Theme of the workshop was "Generation and application of soil information of the Atlantic Zone of Costa Rica". A report called: "Informe de Presentaciones; Taller información de suelos" by W.G. Wielemaker (ed), gives the information and products presented during this workshop.

The information covers the part North of the city of Limon of the Province of Limon including the Canton Sarapiquí. A copy of the preliminar computer produced soil and landscape maps, each at scale 1:150.000, were presented to the provincial representative of MAG. The same document is reedited and published as a working document of the Programme titled:

Wielemaker, W.G. and S.B. Kroonenberg (eds), 1990. Generación y Aplicación de la Información de Suelos de la Zona Atlántica de Costa Rica. Actas del Taller 'Información de suelos'. Guapiles 2-4 oct., 1990. Exposiciones y Guía de excursión. Working Document no. . Atlantic Zone Programme, CATIE-UAW-MAG. CATIE, Turrialba, Costa Rica.

The following four papers dealing with soil information are in these Proceedings:

1. Oosterom, A.P., H.J. Stuiver, R.M. Hootsman and W.K. Krabbe, 1990. Land survey and geographic information techniques used in soil and landscape studies of the Atlantic Zone of Costa Rica.
2. Wielemaker, W.G., and A.P. Oosterom, 1990. Un sistema de información para paisajes suelos.
3. Bruin, S. de, 1990. La aptitud de los suelos en el asentamiento Neguev.
4. Valverde, L.G., and M. Ugalde, 1990. Estudio detallado de los suelos de la finca experimental "Los Diamantes".

The last two papers present results of detailed soil studies using aerial photographs at a scale of 1:10.000. Results of the first study were presented in a form accessible for farmers of the Neguev settlement, who had requested such information. The second detailed study shows how land use of the experimental station can be adapted when information about the potential of the soils is available.

Both studies are in a more elaborate form including maps, edited as working documents of the programme.

Other studies:

1. Wicher Krabbe, student of AUW, started with the development of a user friendly key for the soils of the Atlantic Zone.

The idea is to make it a tool for the potential user of soil information working in the Zone.

2. Oscar Janssen, student of AUW, did an enquiry among farmers in the Neguev regarding the economics of farming. He stratified his sample according to soil type and land use. Presently he processes his data.

Plans for 1991.

The soil and landscape information system (SIESTA) is not yet ready: codes and numbers must be checked, a manual for use of the system must be written and a report explaining the information, must be produced. This work has to be done by Oosterom and Wielemaker in the Netherlands before the system and its information can be made available in Costa Rica. Plans will be worked out by a users group to make the system operational in Costa Rica and provide the necessary training.

The following plans for research and publications are envisaged:

1. Publication about the integrated approach to soil and landscape analysis for land inventarization. Oosterom and Wielemaker.
2. An integrated legend for terrain units. Oosterom and Wielemaker.

Until recently soil information was always presented in a certain form emphasizing those aspects considered important by the producer of the map. Usually two schools of thought are represented: (1) the physiographic school, which puts emphasis on the position of a soil in the landscape and (2), the taxonomic school which emphasizes soil characteristics. This study tries to avoid emphasis on either school of thought but tries to order terrain units in the legend according to the impact of environmental factors on their characteristics. The proper elaboration of this legend may require additional fieldwork to test relation of soils to environmental factors such as climate and age.

3. Application and transfer of knowledge from soil maps.

In this context several studies are envisaged: (1) A user friendly key to the terrain units of SIESTA by W.K. Krabbe, supervised by Oosterom and Wielemaker.

After a first attempt further subjects will be considered and worked out such as (2) Test on applicability and user friendliness of the key to the soils; (3) Accessibility of information from soil maps for extension officers and farmers, (4) Improving SIESTA for application at local level.

Subproject 3. Application of remote sensing and GIS methodology for natural resources inventory and regional development studies in the Atlantic Zone of Costa Rica

Background

For regional studies concerning land use and land cover up to date information is needed. Through remote sensing this information might be obtained. The possibilities for application of remote sensing in per humid tropical regions needs however to be

investigated and is one of the major objectives of the research, together with designing a methodology for inventory of land cover and land use, based on remotely sensed data and on the application of GIS methodologies.

An other important aspect in this research is to define which statements which can be made on regional level and the reliability with which the statements are made, concerning both land use and soil suitability. Soil variability is investigated in a number sites to determine the reliability of statements on soil suitability.

Objectives

- To investigate the usefulness of remote sensing for land cover and land use inventory.
- Design a methodology for the inventory of land cover and land use based on the application of remote sensing and GIS methodologies.
- Investigate the use of satellite imagery for soil inventory at detailed levels.
- Determine the consequences of soil variability for the statements concerning soil suitability.

Responsibilities

- Personnel: Ir. E.J. Huising
- Scientific guidance: Prof.Dr. J. Bouma and Prof.Dr. M. Molenaar.

Studies during 1990

In 1990 the concept of the 'land use zones' (representing areas with a characteristic land use pattern) was further elaborated and tested. Data gathered in the forgoing years was used and no further field work was done except for checking of the final results. A 'land use zone' map for the northern part of the Atlantic Zone in total as well as a more detailed 'land use zone' map for a smaller specific area were prepared.

For a selection out of the total land use zones, the land use has been evaluated in relation to soil suitability, as derived from the 1:100 000 soil map of the Atlantic Zone of Costa Rica.

Results were presented on the workshop held in Guapiles in October 1990.

The application of the land use zone approach for the northern part of the Atlantic Zone and some data on deforestation are presented in the field report.

'A land use classification of the northern Atlantic Zone of Costa Rica and some quantitative data on deforestation'

by Maurice Jacobs, who fulfills a three months subject as part of his graduation programme.

In 1989 Rob Hootsmans en Paul Römken gathered data on soil variability on two sites in the zone. In this study also the application of remotely sensed data for the inventory of soil variability was investigated. Elaboration of the data was done in Wageningen, the first months of this year. Results are presented in a report entitled:

'The impact of soil variability on a low and high level land evaluation model; A methodology with GIS application'.

A third site was selected where a detailed soil mapping and sampling was carried out on bases of satellite image interpretation. The work was carried out from April to September by Rob Tan as part of his practical period. A report is in preparation.

Plans for 1991

In the coming year all attention will be devoted to elaboration of data and presentation of the results. This will be done in the form of a dissertation, which completion is planned for the beginning of 1992.

Subproject 3. Simulation of potential and water limited photosynthesis of banana, applied to Costa Rican circumstances

Results

The study, as described on page 18 of the Annual report for the year 1989 (Atlantic Zone Programme, 1990), resulted in:

- The article "Simulation of potential photosynthesis", accepted for publication in "Revista Turrialba";
- The research proposal "Diseño y validación de un modelo de simulación del rendimiento del cultivo del banano en la Zona Atlántica de Costa Rica".

Additional thorough studies on the soil water balance and plant-soil relations are required in order to simulate the water limited photosynthesis of banana accurately.

ASBANA (CORBANA) agreed to fund 77 % of the research costs of the study towards the design and validation of a banana growth simulation model. The missing 23 % mainly consists of costs related with transportation and the use of a (personal) computer. So far, funds for the salary of the responsible researcher have not been found.

Responsibilities

Personal: Ir. S. de Bruin, Ing. W. Herrera (ASBANA).

Scientific guidance: Prof.dr. J. Bouma, Dr. W.G. Wielemaker.

Detailed soil survey of the Neguev settlement

Background

From the side of the farmers and with respect to future research in the settlement, the need for a detailed soil survey of the Neguev settlement was felt.

Objective

A detailed study of the soils of the Neguev settlement and of the suitability of the land for agricultural use.

Studies during 1986-1990

During 1986-1990, students of the Atlantic Zone Programme performed several soil surveys in the Neguev settlement. In the second half of 1990 these studies were compiled into a detailed soil survey with the help of interpretation of recent 1:10.000 areal photographs and additional fieldwork. A 1:20.000 soil map and a draft of the corresponding report were prepared. The soil map and interpretive tables were offered for permanent exhibition in each sector of the Neguev settlement. In December 1990, an explanation of this information was given in a meeting with farmers.

Responsibilities

Personnel: Ir. S. de Bruin

Scientific guidance: Dr. W.G. Wielemaker.

4.3 Studies of production systems

Several major land uses of the Atlantic Zone were studied: perennial crops (cocoa, plantain), annual crops (eddoe) and pasture (grasses and legumes). They are widely different with regard to their interaction with ecological conditions, their agronomic bottlenecks and socio-economic problems. Their study involves a range of objectives, approaches and methods. The aims include the diagnosis of bottlenecks and the testing of alternatives. The methods consist of informal and structured interviews, (participative) qualitative and quantitative observations and experiments, both in "Los Diamantes" and in farmers' fields.

The binding elements of the land use studies is their emphasis on sustainability, their systems approach and their orientation on small scale farming. The research is aimed at improving the sustainability of the land uses studied - their ecological stability, economic feasibility and social attractiveness. Land uses are seen as systems in which ecology and society interact; even where only a part is studied this should be done in the context of the larger whole, a production system, farming system or regional system. The land uses under study are highly relevant for small farmers, directed at bottlenecks in their production systems, and intended to help them work out alternatives for having to become labourers in large scale (banana) plantations. These, due to their unbalanced socio-economic structure and excessive use of chemical inputs, do not offer a sustainable solution for the agrarian problems of the Atlantic Zone.

All production systems studies are within the research priorities of MAG and CATIE and complement their activities. Information on and understanding of the ecology, agronomy and socio-economy of the studied systems is also an essential element for the land evaluation described elsewhere.

4.3.1. Inventory and analysis of cocoa cropping systems

Background

The appearance of the monilia disease a decade ago has caused a strong drop in cocoa yields, areas and production in Costa Rica. The introduction of hybrids developed by CATIE contributed to the reversal of this trend. However, many farmers complain that the hybrids yield much less than expected.

Objectives

Inventory and analysis of bottlenecks in cocoa production systems in the Atlantic Zone of Costa Rica with the aim of improving the research orientation and extension packages.

Responsibility

The research forms part of the "Improvement of Tropical Crops" programme of CATIE and is supervised by Dr. J.J. Galindo (CATIE) and Prof. Dr. M. Wessel (AUW). The selection of fields is done in cooperation with the Centro Agrícola Regional of MAG in Siquirres. Daily responsibility rests with Henk Waaijbergen (CATIE/AUW/MAG).

Studies during 1990

During the second half of 1989 sample trees in the fields of twenty farmers in the cantons of Guácimo and Talamanca were selected. Wim van Kouwen, Frank du Buy, Kees Tazelaar and David Cruz recorded their phenology and yields every three months, until November 1990, in order to identify and quantify yield limiting factors. The results will be used to suggest improvements at a farm level (sample fields only), in extension messages and in research orientation. Meanwhile many farmers, disappointed by low yields and price have cut down their cocoa plantations.

In 1990 the cooperation with CATIE started to take shape. David Cruz, a Bolivian M.Sc. student, joined our team to make a study of farmers' management practices and of the influence of incompatibility on yields in farmers' fields. Kees Tazelaar (LUW) contributed to José Galindo's research on the epidemiology of monilia, by studying the spread of the disease in a field of "La Lolla", the experimental station of CATIE in the Atlantic Zone.

Shade trees are an important aspect of cocoa management. Frank du Buy determined the numbers, positions, species and sizes of shade trees in the fields of the twenty farmers in Guácimo and Talamanca. Kees Tazelaar used a computer programme developed by CATIE to determine shade patterns in relation with latitude, slope, plant arrangement, height and shape of shade trees.

Plans for 1991

Between January and March David Cruz will complete the field work on (in) compatibility of hybrid cocoa trees. In August/September he will present his thesis to a board consisting of Jorge Morera, Pedro Oñoro, José Arze and Henk Waaijbergen.

Methodology and results of the work on cocoa will be discussed with researchers and extensionists and be published in Spanish

(reports) and English (article).

4.3.2 Phenology, agronomy and sociology of plantain cropping systems

Background

Plantain is one of the major small farmers' cash crops of the Talamanca canton of Costa Rica, being grown for the national and the export market. Yields are low due to continuous ratoon cropping which favours pests and diseases and exhausts the soil.

Objectives

During field work in the Sixaola valley in 1988 a farmer was met who was experimentally evolving alternative ways of growing plantain, based on rotation and relay-cropping instead of ratooning. Study of the variation in farmers' methods may point the way to continuously high plantain yields with low use agrochemicals.

Responsibility

The research is related with genetic improvement of plantain by the "Improvement of Tropical Crops" programme of CATIE. It complements CATIE projects on agroforestry and nature conservation in the same area and efforts by MAG to improve the production and marketing of plantain in the Sixaola Valley. It is coordinated by Henk Waaijbergen (CATIE/UAW/MAG).

Studies during 1990

From August 1989 to November 1990 a study was carried out to compare two of the experimenting farmers' plantain plots with two much better than average plots of nearby farmers:

- determination of the history of the plots and crops by interviews and observations;
- characterization in terms of plant arrangement and density, leaf area, soil fertility, nematodes;
- twoweekly observations of flowering and harvesting and interviews about crop husbandry and marketing;
- informal talks with farmers to find out what determines their choice of activities and the way they carry them out.

Between May and November 1990 Gerard Verschoor made a case study of the village Margarita in the Sixaola Valley. He focused on the formation of a marketing cooperative by small farmers and on the (sociological) factors which influence farmers' choice of technology.

During the last months of 1990 studies were made of eleven very different farmers' fields (soil, crop, pests and diseases, management) by means of quantitative field observations and interviews.

The sudden departure of Prof. Dr. D. Gibbon eroded the AUW support for the longterm programme of adaptive research mentioned in the previous annual report. Due to the interest of the Fundación Quilombé and of Rodrigo Alfaro there is hope that at least part

of the programme may be realized.

Plans for 1991

In November 1990 Annemarie Bouma started a study of harvest losses of plantain, consisting of an evaluation of actual losses and their causes and an experiment with alternative methods of transport.

The data collected so far will be analyzed and presented in workshops with farmers, extensionists and researchers. Results will be published in Spanish (reports) and English (articles).

4.3.3 Root and tuber crops based sustainable cropping SYSTEMS

Background

For many decades maize and cocoa have been the principal cash crops for small farmers in the Atlantic Zone. The monilia disease of cocoa and marketing problems in maize have stimulated interest in alternative crops like root and tuber crops. These are among the few annual crops (rapid return) that can be grown successfully in the Zone.

Objectives

One of the best adapted to the hot and humid climate, Eddoe (*Colocasia esculenta* var. *antiquorum*) has low yields. The ecophysiology of this Araceae is studied as a basis for the design of both profitable and sustainable (multiple-) cropping systems.

Responsibility

The research forms part of the "Improvement of Tropical Crops" programme of CATIE and is supervised by Dr. V. Villalobos (CATIE) and Dr. M. Wessel (AUW). It is carried out in cooperation with Ing. E. Aguilar (MAG), Ing. C. Calderon (MAG) and Ir. F.C.T. Guiking (UAW). Daily responsibility rests with Henk Waaijenberg (CATIE/UAW/MAG).

Studies during 1990

In February Fons Blijleven started an experiment with maize-eddoe in order to evaluate the agronomic feasibility of relay-cropping and the ways in which maize may reduce eddoe yields: directly by competition for light and nutrients, indirectly via effect on weeds. At the end of May the maize was harvested and in October the eddoe.

The Ph.D. project "the ecophysiology of eddoe (*Colocasia esculenta* var. *antiquorum*)" did not receive WOTRO funding.

An experiment with tiquisque (*Xanthosoma* sp.) carried out for Victor Villalobos was harvested.

Plans for 1990

The results of the 1989 (production and distribution of dry

matter by eddoe) and 1990 (relay-cropping maize-eddoe) experiments will be analyzed and published in Spanish (reports) and English (articles).

PRESENTATIONS

H. WAAIJENBERG, 1990. Mijikenda agriculture, Kenya, 1850-1985: tradition and change. Paper presented at the International Symposium on "Origins and development of agriculture in East Africa: the ethnosystems approach to the study of early food production in Kenya". Leiden University and National Museums of Kenya. 7-10th May 1990. Leiden, The Netherlands.

H. WAAIJENBERG & C.J. TAZELAAR, 1990. La problemática del cacao en la Zona Atlántica de Costa Rica. Presentación en el "Taller información de suelos". Programa Zona Atlántica. 2-4 octubre 1990. Los Diamantes, Guápiles, Costa Rica.

H. WAAIJENBERG, 1990. El enfoque de sistemas: conceptos y aplicaciones en la Zona Atlántica de Costa Rica. Presentación en el "Taller Area Piloto de Costa Rica". CATIE/MAG/EARTH. 10-11 de diciembre 1990. Pocora, Costa Rica.

At the request of EARTH two lectures were given on "The agricultural development of the Atlantic Zone of Costa Rica".

OTHER ACTIVITIES

In February and March in cooperation with Danilo Gomez (ENABAS, Nicaragua) and Huub Smits (SNV, The Netherlands) an evaluation was made of the agriculture in the Nueva Guinea area, Atlantic Zone of Nicaragua. The results are summarized in Working Documents No. 8.

The information of the "encuesta general" of 3 x 50 farmers was made available on diskette (ASCII) and in writing (Working Documents No. 7). A start was made with a series of technical reports on major production systems of the Atlantic Zone. The report on plantain production in the Sixaola Valley was published (Informe Técnico No. 159, CATIE; Programme Paper No. 8, Atlantic Zone Programme). The report on pejobaye was submitted to the editorial committee of CATIE. Other reports will follow in 1991.

4.3.5 Social Aspects of Plantain Cultivation by Small Farmers in the Sixaola Valley of Talamanca, Costa Rica.

BACKGROUND

So far, a number of studies have been carried out in the Sixaola district of the Talamanca region in Costa Rica (Bok, 1988; Bok et al, 1988; Bourgois, 1989; Roseboom, 1989; Waaijenberg, 1986). A number of micro-regions have been identified within the Sixaola

district (for a discussion see Bok et al, 1988). These micro-regions were identified on the basis of their social, economic, political and wider ecological characteristics.

The micro-region in which the present research was carried out roughly encompasses the area that stretches from Bribri to Paraíso. Here, we can find the best soils of the Sixaola valley (recent, fertile alluvial soils). The landscape of the micro-region is dominated by large tracts of plantain cultivation, although some diversification does take place (yams, cassava, fruit trees, cacao). Among the most important constraints to agriculture are the periodic floodings of the Sixaola river which are detrimental for plantain cultivation. Commercialization possibilities for crops other than plantain and yams are low, but local initiatives (e.g. farmers' associations) try to open new marketing channels to already existing national and international markets. Institutional agricultural commitment in this area is relatively high if compared with the other micro-regions of the Sixaola district. Furthermore, the micro-region is characterized by its past and present conflicts concerning landownership, which go back to land invasions by "precaristas" on formerly PAIS (Proyecto Agro-Industrial de Sixaola, S.A.) owned properties. Some of the conflicts have recently been settled by IDA (Instituto de Desarrollo Agrario). However, IDA is presently not carrying out its titling program and, from the perspective of smallholders, the situation is inhibiting their production potential since access to credit is generally tied to the possession of land titles. The majority of the population living in this area has arrived in a time-span ranging from 20 to 5 years, and is composed of earlier "precaristas" and farmers that have bought land from the former. These migrants originally come from both outside Costa Rica (especially Nicaragua) and from Guanacaste, the "Meseta Central", Limón and San Carlos.

OBJECTIVES

The research aimed to contribute to an understanding of the social dimensions related to farmers' decisions concerning the management of farming systems heavily relying upon the production of plantain. This was achieved through the use of qualitative fieldwork methods, and complemented the agro-economic research presently carried out in the Baja Talamanca zone by the Ministry of Agriculture (MAG), the "Centro Agronómico Tropical de Investigación y Enseñanza" (CATIE) and the Wageningen Agricultural University (WAU), The Netherlands.

RESPONSIBILITIES:

- Personnel: Ir. G.M. Verschoor
- Scientific Guidance: Prof. Dr. N. Long and Ir. H. Waaijenberg.

STUDIES DURING 1990: The research was carried out from May to November, 1991, in the community of Margarita, Sixaola, Costa Rica. Due to causes outside of the researcher's reach, a finished report was not delivered directly upon completion of the contract period. This will follow at a later date.

PLANS FOR 1991

The product of the study will include the following (forthcoming)

reports and/or publications:

1. "Intervenors Intervened: Organizational Predicaments and Institutional Contradictions in the Production of Export Plantains. A case study from the Atlantic Zone of Costa Rica".

This report will be finished by the end of February, 1991, and will form the basis for an article to be submitted to an internationally acknowledged journal.

2. In preparation: article on the diverse types of farmer knowledge and practice in relation to plantain cultivation in the Sixaola Valley. This paper will be finished before June 1991.

3. In preparation: article on the internal dynamics of a farmer association and its relation to differences in crop (plantain) management. This paper will be finished by October, 1991.

4. In preparation: analysis of quantitative data on differences in plantain cultivation in the Sixaola Valley. This will form part of a wider project on plantain cultivation together with Henk Waaijenberg. The work will be concluded by October, 1991.

The last two articles (3 and 4) can be finished before October, 1991. The initial idea was to use them as a contribution to a workshop on farming systems to be celebrated later in 1991.

4.4 Law in the struggle for control on the natural resources land and timber in colonisation-areas in the Atlantic Zone of Costa Rica

Background

The colonization of the Atlantic Zone is a complex and dynamic process in which different actors with often contradictive interests try to gain control on the natural resources land and timber; a growing sector of capital-intensive enterprises cultivating export-crops as bananas and ornamentals, extensive cattle enterprises occupying large tracks of land but making little use of labour and capital, speculators (small and big ones), industrial timber companies, a labour proletariat, a very varied sector of small farmers (self-settled, and settled through the Agrarian Development Agency IDA), and lately also (inter)national pressuregroups for protecting nature. A special category is the government who is confronted with the opposing interests and practices. She operates through various institutes which badly tuned goals. Some are more concentrated on guarding that property has a social function, while others concentrate more on the protection of nature or on sustainable resource-use. As the resources land and timber form a natural unit, it can be said that these institutes are competing with different strategies in the same areas. This struggle for control- and exploitationpossibilities forms an activity-field which is subject of complex normative and cognitive structures. P.e. Government policy related to ownership and natural resource use is written down and regulated through legislation. Government also prescribes procedures how actors can make use their rights (be

it institutes or private persons) and how they can be forced to observe their obligations. Finally government provides procedures to solve disputes about rights and duties. ; verdicts of the civil and very recently also the agrarian court. Despite the proliferation of government-regulation in the area of natural resources use, the situation in the atlantic zone seems to turn against nature and the small farmers; unwanted deforestation continues and landdistribution is becoming more askewed.

Objectives

Through a description and analysis of this complex situation and her changes, as well as through an analysis of the processes in which the different actors use legal and non-legal means to strengthen their control, the research will contribute to a better understanding of the colonization-process and of law as an intervention instrument in directing and affecting natural resource use. Besides this rather general goal, the research will contribute to the more specific discussion about legal pluralism.

Responsibilities

- Personnel time: Ir. W.J.A.M. Brooijmans
- scientific guidance: Prof. Dr. F. von Benda Beckmann and Mr. S Huber

Studies during 1990

The study was initiated Costa Rica in july 1990 after the proposal was approved by WOTRO. Work mainly consisted of making contacts with the relevant institutes (Registro Público, Dirección General Forestal, Instituto de Desarrollo Agrario, Servicio de Vida Silvestre, International Union for Nature Conservation) and of fieldwork in the refugio de Barra de Colorado.

Plans for 1991

Fieldwork in Costa Rica is planned till july 1991. The research in the refugio will be continued. The final cases in this area will be selected. It is tried to select them in such a way that they give insight into:

- the different forms of appropriation of the natural resources (legal/illegal; buying/ inheritance/ lease/ squatting/ robbing/ etc.//; with and without conflicts
- the different forms of conflictregulation (negotiation, violence, courts, internal legal structures, etc.)

Fieldwork in the settlement-scheme La Pavona will be initiated.

July 1991 - january 1992: developing the fieldmaterial, deliberation with the supervisor, participating in seminars and workshops.

Publications

Till now just one publication is planned; a contribution to the jubilee-publication of the department of agrarian law at the UAW. It comprises an elaboration of the research-proposal "law in the struggle for natural resources".

5 CONTACTS WITH CATIE, MAG AND OTHERS

5.1 CATIE

The proposal for a course on Nematology, to be financed by the Dutch Government was at first rejected. After the visit of the ambassador in 1989 the AUW started new negotiations with the Dutch Ministry of Development Cooperation and the case was reopened. At the end of the year the Ministry informed that the course had been approved, subject to some budgetary changes.

Oswaldo Torres left in December 1989 for a M.Sc. course in crop production (with emphasis on crop protection) at the AUW in Wageningen. Upon his return he will be strengthening the staff of the Nematology course.

During the visit by Boerrigter in December 1989, it was agreed that four visits in 1990 would transpire from CATIE to AUW, two regarding education and two in research. In March Drs. Vergilio Cozzi and Ramon Lastra from the Dirección de Posgrado came to Wageningen. Several promising initiatives followed, one also with the International Agrarian Center (IAC). In June followed the visit of Dr. Victor Villalobos (director of programme 1), who principally visited the departments of Biological Control and Biotechnology. The visit of Dr. Fernando Mujica did not materialize, Dr. Rafael Celis only came in 1991 and so the fourth visit was not effectuated.

The participation of Jose Arse M.Sc. in the research programme was considered a strengthening of the intellectual exchange. It looks very promising that Dr. Prem Sharma of the Programme Cuencas is also interested in a closer collaboration. As a joint course by Cuencas and the programme is contemplated such a tie is very important for a good understanding.

In the Area Piloto de la Zona Atlantica committee the programme was represented by the coordinator. After the change in government the former regional director started serving as secretary of the committee. This was a very helpful development.

5.2 Ministerio de Agricultura y Ganaderia

The excellent relationship which exists with the landlord, the experimental station "Los Diamantes" at Guápiles, continued in 1990. In October it was possible to use the premises and the facilities of the station to run a well received workshop, in which the presentation of the soil information had the central focus.

A close working relation has been established with the Soil Conservation Service and Cuencas/CATIE; this might result in a smooth transfer of the SIESTA programme developed by WAU.

The programme continues using the services of the soil laboratory in Guadalupe. This gives the personnel there also an advantage, namely of both in-service training and possibilities of working with material the Ministry cannot afford.

ELECTIONS

On 8 May the transition of the presidency took place. With the coming into power of the oppositional party the changes in the government were still more radical than when only a new president of the same party arrives. Only the head of the laboratory (of all the officials the programme deals with) was not changed. This led to a temporary stand still in the decision making process and required a renewed presentation of the objectives of the programme to various government officials.

5.3 Others

The PZA has reviewed cooperative projects with the UNA/RUU/ECA project on Desarrollo Rural. Joint research through student activities seems promising. A possible objective might be joint research in the area piloto.

6 TRAINING

6.1 Costarican students

One of the objectives of the PZA is training. The participation of students from regional and Costarican institutes of higher education has been sought through the postgraduate courses of CATIE and in 1990 result were expected. It worked out that a Bolivian and an Ecuadorian student seemed interested in realizing their thesis work in the framework of the programme. Due to some constraints in the training possibilities of the computer center of CATIE, the Ecuadorian looked for other chances. The Bolivian, David Cruz, has been working hard since the beginning of July.

One student from the Universidad de Costa Rica had done his thesis work within the PZA and obtained his M.Sc. in 1990. Two students from the Universidad Nacional Autonoma de Heredia came to do soil fauna studies, for a half year each, starting in August 1989 and wrote their thesis based on the results.

6.2 Dutch students

Blijlevens, A.H.	Agronomía
Bouma, A.T.M.	Fitotécnia Tropical
Epker, C.B.	Suelos
Finnema, J.	Agronomía y Economía
Jansen, O.E.	Agronomía
Stuurman, H. A.	Pastos
Tan Robert	Suelos
Tazelaar, C.J.	Agronomía
Weerts, G.J.	Suelos

The numbers of students per discipline were as follows:

Agronomy	?*	Grassland Science	?
Biology	?	Nematology	?
Development Economics	?	Marketing	?
Forestry	?	Rural Sociology	?*
Geodetics	?	Soil Science	?

* : one student did a combined study both in agronomy and rural sociology.

6.3 Local personnel

Emphasis continued to be placed on training local personnel during 1990. All administrative and technical assistants have taken computer courses (Lotus 123 and WordPerfect 5.0). Other opportunities will be considered in 1990, taken into account their usefulness for the programme.

6.4 Other

Two members of the Soil Conservation Service of MAG participated during three to four weeks each in soil mapping, which is considered a type of in service training for them.

Some trials of eddoes and maize were jointly executed with people from MAG.

On two occasions, a group of CATIE students took a field trip in the Atlantic Zone to review the soil projects of the PZA.

7 INFRASTRUCTURE

7.1 Buildings

The Centro Agronómico Tropical de Investigación y Enseñanza (CATIE) in Turrialba served as the official headquarters of the PZA.

The Ministry of Agriculture (MAG) of Costa Rica provided the PZA with field office space and lodging facilities at the premises of " Los Diamantes ", its experimental station in Guápiles in the Atlantic Zone. Further modifications and improvements were introduced to these accommodations, which resulted in increased office space and a field lab.

7.2 Equipment

Two modems were purchased to realize a quick connection between Guapiles and Turrialba. However both hardware problems and the insufficiency of the telephone lines resulted in a meager connection, although by the end of the year a more positive balance could be drawn. Various pieces of office equipment were bought or made to serve in first instance during the workshop.

7.3 Transportation

The PZA has seven four-wheel drive vehicles and a stationwagon. The two remaining motor cycles functioned well and were relatively often used.

7.4 Other facilities

Most of the soil analytical work was done by the laboratory for soil analysis of the Ministry of Agriculture; only samples for special analyses were sent to Wageningen. Chemicals, spare parts and some minor pieces of laboratory equipment were bought to enable MAG to carry out this work, particularly when specific analyses were required. The PZA paid salaries for two laboratory assistants and a part-time (50%) analyst.

7.5 Expenditures

The expenditures for 1990 are shown below:

Personnel	f 246.000
Housing	9.000
Office	18.900
Travelling	68.000
Research	123.200
General	9.500
Capital equipment	57.600
Total	<u>f 532.000</u>

The funds budgeted for the PZA for 1990 were adequate.

8 PRESENTATIONS AND PUBLICATIONS

8.1 Presentations

WORKSHOP.....

8.2 Publications

The PZA distinguishes three series of reports: Programme Papers, Working Documents and Field Reports.

The Programme Papers form a series of official publications while the Working Documents comprise papers with limited distribution. Opinions expressed and conclusions presented in the Working Documents are not necessarily those of the PZA.

The Field Reports form a series of unpublished reports prepared by students or staff of the PZA and similarly to the Working Documents opinions expressed are the author's own.

See Annex 1 for a complete list of these documents and their respective dates of publication.

By the end of the year drafts were ready of the monographs on each of the three subareas. The draft monograph on Río Jiménez was complete by september and sent to the editorial committee of CATIE. Observations and comments received so far have been partially incorporated. Professional correction and editing is only for the Neguev study still under way.

ANNEX I

PUBLICATIONS

ANNEX I PUBLICATIONS

PROGRAMME PAPERS

SLUYS, F. van et al. 1987. Agriculture in the Atlantic zone of Costa Rica. Summarizing report of an exploratory survey. Serie Técnica. Informe técnico No. 123. CATIE-UAW-MAG. Programme Paper No.1. Turrialba, Costa Rica.

ANONIMO. 1987. Agricultural research programme in the Atlantic Zone of Costa Rica. CATIE-UAW-MAG. Programme Paper No. 2. Turrialba, Costa Rica.

ANONIMO. 1987. Programa de investigación agropecuaria en la Zona Atlántica de Costa Rica. Atlantic Zone Programme CATIE-UAW-MAG. Programme Document No. 3. Turrialba, Costa Rica.

SLUYS, F. van; H. Waaijenberg; W.G. Wielemaker & J.F. Wienk. 1989. Agricultura en la Zona Atlántica de Costa Rica. Informe de estudio exploratorio. Serie técnica. Informe Técnico No. 141. Turrialba, Costa Rica. Programme Papers

WAAIJENBERG, H. 1990. Río Jiménez, ejemplo de la problemática agraria de la Zona Atlántica de Costa Rica: Un análisis con enfoque histórico. Serie Técnica. Informe Técnico No.160. Programme Papers. Turrialba, Costa Rica.

WIELEMAKER, W.G. (Ed.) 1990. Colonización de las Lomas de Cocorí: Deforestación y utilización de los recursos de tierra en la Zona Atlántica de Costa Rica. Serie Técnica. Informe Técnico No.157. Programme Papers. Turrialba, Costa Rica.

Oñoro, T. (Ed.) 1990. El Asentamiento Neguev: Interacción de campesinos y estado en el aprovechamiento de los recursos naturales. Serie Técnica. Informe Técnico No. 162. Programme Papers. Turrialba, Costa Rica.

Roseboom, P., M.T. de Oñoro & H. Waaijenberg . 1990. El cultivo de plátano en el Valle de Sixaola, Costa Rica, 1988. Serie Técnico. Informe Técnico No.159. Programme Papers. Turrialba, Costa Rica.

WORKING DOCUMENTS

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WIENK, J.F. et al. 1987. Workplan first half 1987. Atlantic Zone Programme CATIE-UAW-MAG. Working Document No. 1. Turrialba,

Costa Rica.

WIENK, J.F. et al. 1987. Workplan second half 1987. Atlantic Zone Programme CATIE-UAW-MAG. Working Documents No. 2. Turrialba, Costa Rica.

BOK, A.M. et al. 1988. Análisis regional de la problemática agraria de los distritos Cahuita y Sixaola del Cantón de Talamanca, Costa Rica. Atlantic Zone Programme CATIE-UAW-MAG. Working Documents No. 3. Turrialba, Costa Rica.

BOLAÑOS, C. & C.E. Ulate. 1987. Los problemas jurídicos agrarios de la provincia de Limón. Atlantic Zone Programme CATIE-UAW-MAG. Working Documents No. 4. Turrialba, Costa Rica.

WAAIJENBERG, H. 1988. Ejemplos de la similitud y de la diversidad del agro en la provincia de Limón, Costa Rica. Contribución al sondeo del Programa de Incremento de la Productividad (PIPA) del Ministerio de Agricultura y Ganadería (MAG). Atlantic Zone Programme CATIE-UAW-MAG. Working Documents No. 5. Turrialba, Costa Rica.

ANONIMO. 1989. Taller investigación y desarrollo en la Zona Atlántica de Costa Rica. Organizaciones resúmenes y resultados de los grupos de trabajo. Atlantic Zone Programme CATIE-UAW-MAG. Working Documents No. 6. Turrialba Costa Rica.

BRINK, M. & H. WAAIJENBERG. 1990. Base de datos de encuesta de caracterización de fincas realizada en el norte de la Zona Atlántica de Costa Rica, 1987. Atlantic Zone Programme CATIE-UAW-MAG. Working Documents No.7. Turrialba, Costa Rica.

GOMEZ, D., H. SMITS & H. WAAIJENBERG. 1990. La agricultura de Nueva Guinea, Zona Atlántica de Nicaragua: Evaluación y recomendaciones. Atlantic Zone Programme CATIE-UAW-MAG. Working Documents No.8. Turrialba, Costa Rica.

ANONIMO. 1989. Annual report for the year 1989. Atlantic Zone Programme CATIE-UAW-MAG. Working Documents No.9. Turrialba, Costa Rica.

WIELEMAKER, W.G. (Ed.) 1990. Informe de presentaciones: Taller información de suelos 2-4 oct.1990. Atlantic Zone Programme CATIE-UAW-MAG. Working Documents No.10. Turrialba, Costa Rica.

Buy, F. du & W. van Kouwen. 1990. El cultivo del cacao en la Zona Atlántica de Costa Rica: un análisis preliminar del crecimiento de cacao híbrido. Atlantic Zone Programme CATIE-UAW-MAG. Working Documents No.11. Turrialba, Costa Rica.

FIELD REPORTS

No. 1 KLOOSTERMAN, H., J.S.A. Slijkhuis & W.G. Wielemaker.

Exploratory survey in the Atlantic Zone of Costa Rica. Contribution of the land group.

No. 2 VRIES, P. de. Exploratory survey in the Atlantic Zone of Costa Rica. Sociological report.

No. 3 WEIDE, A.P.A. VAN DER. Exploratory survey in the Atlantic Zone of Costa Rica. Animal production.

No. 4 SCHIPPER, R.A., Exploratory survey in the Atlantic Zone of Costa Rica. Development economics.

No. 5 WAAIJENBERG, H., Exploratory survey in the Atlantic Zone of Costa Rica. Cropping systems.

No. 6 ROMEIJN, P., J. Slijkhuis & F. Staudt. Exploratory survey in the Atlantic Zone of Costa Rica. Contribution of the forestry disciplines.

No. 7 EE, S. VAN, M.P. Grundeman, T.M. van der Hel, J.J. Ottens. The Atlantic Zone of Costa Rica. Agriculture in the Talamanca and Pococi/Guacimo study areas.

No. 8 JANSSEN, J.W.H., H.J.M. Meuffels. Detailed soil survey of Hacienda Breemen.

No. 9 BEKS, J.P., P.E. van Olst. Un levantamiento detallado de los suelos de parte del Asentamiento Neguev.

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